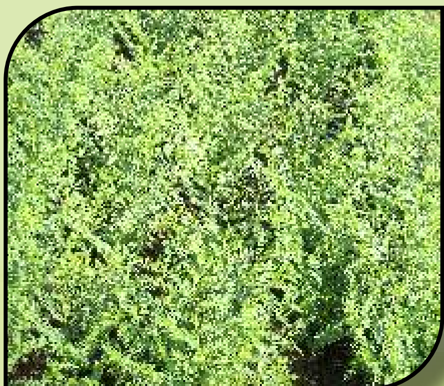
अखिल भारतीय समन्वित खरपतवार प्रबंधन अनुसंधान परियोजना

All India Coordinated Research Project on Weed Management

वार्षिक प्रतिवेदन

ANNUAL REPORT

2017-2018





भा.कृ.अनु.प.- खरपतवार अनुसंधान निदेशालय, जबलपुर

ICAR - Directorate of Weed Research, Jabalpur

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AICRP-WM in the News

परदेशातून येणाऱ्या तणावर प्रति...

अमरवेलसह बोंडअळीला रोखण्यासाठी विद्यापीठ सज्ज

खरपतवार नियंत्रण में कृषि विश्वविद्यालय देश में टॉपर

- जयदीप रिहान, पालमपुर

25 केंद्रों को पछाड़ते हुए पालमपुर के वैज्ञानिकों ने पाया मुकाम

फसलों के लिए हानिकारक खरपतवार के नियंत्रण को लेकर पालमपुर स्थित प्रदेश कृषि विश्वविद्यालय में किए जा रहे प्रयासों को राष्ट्रीय स्तर पर सर्वश्रेष्ठ आंका गया है। खरपतवार नियंत्रण पर काम कर रहे वैज्ञानिकों की मेहनत के चलते देश भर के 25 केंद्रों में से कृषि विवि के केंद्र को पहला स्थान प्राप्त हुआ है। जबलपुर स्थित केंद्र द्वारा साल 2016 के लिए इस संदर्भ में विशेषज्ञों द्वारा करवाए

खरपतवार नियंत्रण में : पृष्ठ दो पर

గడ్డి నివారణపై అవగాహన సదస్సు

బేల: వ్యవసాయ శాఖ, జిల్లా ఏరువాక కేంద్రం ఆధ్వర్యంలో శనివారం కాప్సి, మసాల(బి) గ్రామ రైతులకు వయ్యారి భామ గడ్డి నివారణపై ఏరువాక కేంద్రము వ్యవసాయ శాస్త్రవేత్త డాక్టర్ సుదాన్షుకన్నే, సహాయ వ్యవసాయ సంచాలకులు డి.పుల్లయ్య అవగాహన కల్పించారు. గ్రామీణ విత్తనోత్పత్తి పథకం ద్వారా సోయా, కంది పంటలను పరిశీలించారు. వివిధ దశల్లో తెగుళ్ల పురుగులు, గులాబీ పురుగు, కాండం తొలుచు పురుగు నివారణ, సస్యరక్షణ చర్యల గురించి రైతులకు వివరించారు. నాణ్యమైన విత్తనాలు భద్రపరిచి తదుపరి సీజన్‌లో విత్తనాలు వాడాల్సిందిగా రైతులకు సూచించారు.ఇందులో వ్యవసాయ అధికారి భగత్ రమేష్, కాప్సి సర్పంచ్ గెడాం భాగ్యరేఖ కిషోర్, దేప్పాల పీఏసీ ఎస్ చైర్మన్ జితేందర్ రైతులు పాల్గొన్నారు.

అవగాహన కల్పిస్తు...

बीएयू में गाजर घास जागरूकता सप्ताह

रांची. बिरसा कृषि विवि में बुधवार को गाजर घास (पार्थेनियम) जागरूकता सप्ताह शुरू हुआ, जो 22 अगस्त तक चलेगा. रांची कृषि महाविद्यालय के विद्यार्थियों ने मानव, पशु-पक्षी, फसलों और पर्यावरण के स्वास्थ्य पर गाजर घास ... संबंधित पोस्टर ... उन्मूलन के प्रति ... विवि परिसर ... गाजर घास ...

ಪಾರ್ಥೇನಿಯಂ ಜಾಗೃತಿ ಸಪ್ತಾಹ

ಬೆಂಗಳೂರು: 'ಆಹಾರ ಬೆಳೆಗಳಲ್ಲಿ ಶೇ 40ರಷ್ಟು ಹಾಗೂ ಮೇವಿನ ಬೆಳೆಗಳಲ್ಲಿ ಶೇ 90ರಷ್ಟು ಪಾರ್ಥೇನಿಯಂ ಕಳೆ ಬೆಳೆಯುವುದರಿಂದ ಇಳುವರಿ ಕುಂಠಿತವಾಗುತ್ತದೆ' ಎಂದು ಕೃಷಿ ವಿಶ್ವವಿದ್ಯಾಲಯದ ಕಳೆ ನಿರ್ವಹಣಾ ಪ್ರಾಯೋಜನೆಯ ಮುಖ್ಯಸ್ಥ ಟಿ.ಎಸ್.ಧನಪಾಲ್ ಹೇಳಿದರು.

ಬೆಂಗಳೂರು ಕೃಷಿ ವಿಶ್ವವಿದ್ಯಾಲಯದ ಕಳೆ ನಿರ್ವಹಣಾ ಪ್ರಾಯೋಜನೆ (ಹೆ ಬ್ಬಾಳ) ಹಾಗೂ ಜಬಲ್‌ಪುರದ ಕಳೆ ಸಂಶೋಧನಾ ನಿರ್ದೇಶನಾಲಯ ಜಂಟಿಯಾಗಿ ಆಯೋಜಿಸಿರುವ 'ಜಾಗೃತಿ ಸಪ್ತಾಹ' ಕಾರ್ಯಕ್ರಮದಲ್ಲಿ ಮಾತನಾಡಿದರು.

'ಪಾರ್ಥೇನಿಯಂ ಕಳೆಯಿಂದ ಹಾಸಿಯಾಗದೆ, ಜಾನುವಾರುಗಳ ಮೇಲೆ ದುಷ್ಪರಿಣಾಮ ... ಇದರಿಂದ ಹಾಲಿನ ಇಳುವರಿ ... ಕಡಿಮೆಯಾಗುತ್ತದೆ' ಎಂದು ತಿ...

खरपतवार नियंत्रण में...

गए आकलन में कृषि विश्वविद्यालय हर क्षेत्र में टॉप पर रहा है, जिसके चलते संस्थान के संबंधित विभाग को सम्मानित किए जाने के साथ एक लाख रुपए का पुरस्कार भी प्रदान किया गया है। खेतों में फसलें लगाए जाने के समय हानिकारक माने जाने वाला खरपतवार भी उगने लगता है, जोकि फसलों की पैदावार व उत्पादन को प्रभावित करता है। फसलों के साथ खेतों में उगने वाले खरपतवार को वैज्ञानिक भाषा में क्रॉप-वीड कंपीटीशन के नाम से जाना जाता है। यह खरपतवार किसानों के लिए काफी नुकसानदायक साबित होता है और लंबे समय से विभिन्न किस्म के खरपतवारों पर नियंत्रण को लेकर शोध व प्रयास किए जा रहे हैं, ताकि किसानों का कम से कम नुकसान हो। एक सर्वे के अनुसार विभिन्न प्रकार के खरपतवार फसलोत्पादन को 35 फीसदी तक प्रभावित करने की क्षमता रखते हैं। प्रधानमंत्री नरेंद्र मोदी ने किसानों की आय दोगुनी करने के प्रयास किए जाने का आह्वान किया है और उस संदर्भ में खरपतवार नियंत्रण अहम रोल अदा कर सकता है। देश भर में 25 केंद्र खरपतवार नियंत्रण पर काम कर रहे हैं और इन केंद्रों में किए जा रहे कार्य को विभिन्न स्तरों पर परखा जाता है। हिमाचल प्रदेश में भी नीला फुलणू जैसे खरपतवार किसानों व वैज्ञानिकों के लिए परेशानी का सबब बन चुके हैं और यह खरपतवार काफी हानिकारक माना जाता है। जानकारी के अनुसार संबंधित विभाग के वैज्ञानिक शोध व प्रकाशन के साथ किसानों के लिए प्रशिक्षण कार्यक्रमों का आयोजन करते हैं। इन प्रयासों को डायरेक्टरेट ऑफ वीड रिसर्च द्वारा निर्धारित पैमाने पर आंका जाता है और इसमें प्रदेश कृषि विवि के वैज्ञानिकों डा. दिनेश बड़ियाला, डा. नीलम शर्मा, डा. सुरेंद्र सिंह राणा और राजेंद्र की टीम के काम की सबसे अधिक सराहना गया है। विश्वविद्यालय के जनसंपर्क विभाग के संयुक्त निदेशक डा. हृदयपाल सिंह ने बताया कि खरपतवार नियंत्रण पर अखिल भारतीय समन्वित शोध परियोजना के तहत

వయ్యారిభామను నిర్లక్ష్యం చేయొద్దు

ఏరువాక శాస్త్రవేత్త ప్రవీణ్‌కుమార్

...రాంపూర్ గ్రామంలో పత్తి పంటను పరిశీలిస్తున్న ఏరువాక శాస్త్రవేత్త ప్రవీణ్‌కుమార్

दैनिक जागरण
18.8.2017

राजपुर स्कूल में बच्चों ने जाने सफेद फुलणू के दुष्प्रभाव

पालमपुर : सीनियर सेकेंडरी स्कूल राजपुर में जागरूकता कैंप के दौरान कृषि विषय से जुड़े बच्चों को विशेषज्ञों ने अहम जानकारियां दीं। स्कूल की कृषि अध्यापिका दिव्या ने बताया कि चौधरी सरवण कुमार कृषि विश्वविद्यालय के एग्रोनॉमी विभाग के विशेषज्ञों ने स्कूल के विद्यार्थियों को सफेद फुलणू के बारे में अहम जानकारी दी। कार्यक्रम की अध्यक्षता स्कूल के प्रधानाचार्य नमनदीप बिंद्रा ने की। कार्यक्रम में कृषि विवि से डॉ. नीलम शर्मा, डॉ.जीडी शर्मा, डॉ. एसएस राणा और डॉ.राजेंद्र कुमार समेत कई गणमान्य मौजूद रहे। कृषि विशेषज्ञों ने बच्चों से सफेद फुलणू समेत अन्य कृषि संबंधी जानकारियां साझा करते हुए कहा कि वर्तमान समय में कई तरह के खरपतवारों की वजह से खेती कम हो रही है।

जापानी बुकई कीड़ा हमारी झीलों से साफ करेगा जलकुंभी, जबलपुर से मंगवाया

All India Coordinated Research Project on Weed Management

Annual Report

2017-18

भाकृअनुप
ICAR

भा.कृ.अनु.प.– खरपतवार अनुसंधान निदेशालय, जबलपुर
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Cover page photographs (Left to Right)

- Pendimethalin 1.0 kg/ha + 1 HW 20 DAS in chickpea
- Effect of oxyfluorfen + 1 HW at 25 – 30 DAS in mustard
- Demonstration of multi-boom sprayer in wheat at farmers field
- *Orobanche* infestation in tobacco
- *Striga* spp. in sorghum

Preface

All India Coordinated Research Project on Weed Management (AICRP-WM) was launched in 1978 to undertake the systematic research on weed management in the country. Initially, there were 6 centres in different parts of the country, which grew to 23 centres in 2014, almost in all the Agricultural Universities of the country. Over the last 40 years, information relating to weeds in different cropped and non-cropped situations, management practices, herbicide residues and utilization aspects of weeds has been generated. Location-specific improved technologies on weed management have been developed and adopted in large areas throughout the country. With the continuous efforts of ICAR-Directorate of Weed Research, Jabalpur through AICRP-WM, weed management technologies are now available for almost all crops and cropping systems as well as for non-cropped situations which have the potential to increase productivity, profitability, and ensure environmental sustainability and biodiversity.

Several initiatives were taken to improve and strengthen the research work on weed management under this project. Research work for 2017-18 has made in tune with the research programmes of the Directorate based on the emerging challenges in weed management. Network experiments related to weed management in conservation agriculture, organic farming, input-use efficiency and herbicide use in cropping systems, weed dynamics and management of problematic weeds, monitoring, degradation, and mitigation of herbicides, were made. On-Farm Research was given greater emphasis and impact assessment of weed management technologies was undertaken. The recommendations made by the Quinquennial Review Team (2006-12) were also effectively implemented. Norms of the ICAR for posting of staff and release of funds were followed. Collaborations were initiated with other AICRPs at the same University.

The proposals for the SFC Memo 2017-18 to 2019-20 in terms of infrastructure development, contingencies, staff restructuring and new research programmes were approved and six centres viz., NDUAT, Faizabad; RAU, Pusa; BAU, Ranchi; DBSKKV, Dapoli; CAU, Pasighat and UAS, Raichur were closed from April, 2018. I express my sincere gratitude to Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR; and Dr. K. Alagusundaram, Deputy Director General (Agri. Engg. and NRM), for providing constant encouragement and guidance. I am also thankful to Dr. S. Bhaskar, Assistant Director General (Agronomy, Agroforestry and Climate Change) for his keen interest and support in running the project. I thank Dr. Shobha Sondhia, Incharge, AICRP-WM for help in smoothly running the project activities. Thanks are also due to the Nodal Officers namely Dr. Sushil Kumar, Dr. R.P. Dubey, Dr. Bhumesh Kumar and Senior Technical Officers, Mr. O.N. Tiwari, Mr. Pankaj Shukla and Assistant Chief Technical Officer, Mr. Sandeep Dhagat for their help and cooperation.

I have great pleasure in presenting the annual report of AICRP-Weed Management for the year 2017-18 which contains consolidated information on the research achievements and other related activities undertaken at all the centres of the project during the reported period. I hope this document will be useful to all our stakeholders.

Comments and suggestions are welcome for further improvement

Date: 30.05.2018
Place: Jabalpur

(P.K. Singh)

Contents

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- ikyeij e] eDdk xg Qly pØ dh nkuk Qlyk e 'kU; trkb o ,dhdr [kjirokj ic/ku e vFki.k vf/kd xg d lerY; mit ikjifjd trkb rnkijkr vulf'kr 'kkduk'kh d i;kx l nt dh xbA yfdu nkuk Qlyk e 'kU; trkb o jklk;fud [kjirokj ic/ku }kjk nkuk Qlyk e 'kU; trkb o jklk;fud ;k ,dhdr ;k ;kf=d [kjirokj ic/ku vkj eDdk e 'kU; trkb o ;kf=d [kjirokj ic/ku ,o xg e ikjifjd trkb o ;kf=d [kjirokj ic/ku bld lerY; ik; x;A
- xg dh vf/kd mit ,o ykHk%ykxr vuikr ¼2-7½ xg dh ikjEifjd ifj"dj.k d ckn /kku dh lh/kh cokb ,o fllcfu;k d leko'k l ikb xbA tcfd /kku dh vf/kdre vFki.k mit ikjifjd jkfir /kku rFkk gjh [kkn fllcfu;k d leko'k l 'k) YkkHk d lkFk ykHk% ykxr vuikr ¼1-9½ nt dh xbA fofHkUu [kjiorkj ic/ku fof/k;k e l /kku dh vf/kdre mit ¼4-4 V-@g-½ lefUor [kjirokj ic/ku d lkFk 'k) ykHk ,o ykHk% ykxr vuikr ¼1-8½ iruxj e nt fd;k x;kA
- mn;ij e] xg&eDdk Qly pØ e fofHkUu [kjirokj& uk'kh }kjk [kjirokj ic/ku dju l eDdk d cht vkj pkj dh mit e mPpre mit ,Vkftu 500 xk-@g- vdj.k d io rnkijkr gkFk }kjk fujkb 30&35 fnu lk'pkr dju l nt dh xbA blh idkj xg e vf/kdre nkuk vkj ivky dh mit lYQklY¶;jku $ eV& lY¶;jku 30$2 xk-@g- cokb d 30 fnu lk'pkr i;kx rnkijkr cokb d 50&55 fnu e gkFk }kjk fujkb dju ij ikb xbA
- vdkyk e dNkjh Hkfe e lk;kchu puk Qly pd e nk ckj gjkbx ,d ckj Vkbu gjk vkj ,d ckj CyM gjk ¼ikjifjd trkb½ d cny e jkVkfVy ¼U;ure trkb½ vkj 'kU; trkb d lkFk 'kkduk'kh d i;kx d lkFk ,dhdr [kjirokj ic/ku }kjk u doy enk d Hkkfrd x.k rFkk Qly mRikndrk e c<kRrjh ,o vkfFkd lj{kk ikb xbA
- dk;cVj e] ljte[kh dh Qly e] 'kU; trkb e tM-Vh-& tM-Vh-$vo'k"k i.kkyh e i.MhfeFkfyu 1-0 fd-xk-@g- vdj.k d io $ cokb d 45 fnu ckn gkFk }kjk funkb dju ij vf/kd mit ,o vkfFkd ykHk nt fd;k x;kA tcfd eDdk e lh-Vh-&lh-Vh- i)fr l vdj.k d io ,Vkftu 0-5 fd-xk-@g- $ cokb d 45 fnuk ckn gkFk }kjk fujkb dju ij eDdk dh vf/kd mit d lkFk&lkFk vf/kd ykHk nt fd;k x;kA eDdk& ljte[kh Qly pØ e] jch ,o [kjhQ e 'kU; trkb e tM-Vh-&tM-Vh- $ vo'k"k i.kkyh ,o vdj.k d io i.MhfeFkfyu 1-0 fd-xk-@g-$cokb d 60 fnu ckn fujkb dju ij l{ethoh vfHkfØ;k vkj enk ,tkbe vfHkfØ;k mPpre ik; x;A

McY;w ih1-2 dkcfud df"k e [kjirokj ic/ku

- tkjgV e] dkcfud :Ik l mitkb xb fep e rkth fep d Qyk dh lkFkd mit vkD lk&ck;kfMxMcy lykfLVd dh fQYe vkj /kku d ivky dh efYpx rnkijkr gkFk }kjk ,d ckj fujkb dju ij vU; mipkjk dh ryuk e nt dh xbA dkcfud [krh d rgr pk; e ck;k&fMxMcy fQYe d }kjk pk; d gj iRrk dh mit vU; mipkjk dh ryuk lkFkd :Ik l mPp ikb xbA
- jkph e] fHk.Mh e [kjirokjk dk eYp vkj ivky dk eYp [kjirokjk d fu;=.k d lkFk&lkFk mPp ykHkdkjh ik;k x;kA l;kt dh Qly gr lykfLVd eYp dk mi;kx vf/kdre ykHk gr mruk gh iHkkoh ik;k x;k ftruk vdj.k d io i.MhehFkfy;u 1-0 fd-xk-@g- ;k vkD lh¶ykjQu 0-25 fd-xk-@g- dk mi;kxA
- ikyEkij e] yglu dh 65 ifr'kr vf/kd mit LVy lhM cM$eYp jklk;fud pd dh ryuk e ikIr dh xbA eDdk&yglu Qly pØ e eDdk e vr% Qlyhdj.k d dkj.k ?kkl] ekFkk vkj pkMh iRrh d [kjirokjk d fu;=.k d fy, vR;r iHkkoo'kkyh ik;k x;kA
- jk;ij e] /kku e 50 ifr'kr N ¼xkcj [kkn½ $ 50 ifr'kr N ¼ikYVh [kkn½ $,tkLikbfjye $ ih-,l-ch-

dk mi;kx 50 N ¼xkcj [kkn½ $ 50 ifr'kr N ¼dpvk [kkn½ $, tkLikbfjye $ ih-,l-ch- dh ryuk e vf/kd 'k) ykHk] YkkHk% ykxr vuikr ,o mPprj mit ik;h x;hA [kjirokj ic/ku fof/k;k e dkyh ikyhFkhu eYp dk mi;kx vulf'kr 'kkduk'kh dh vi{kk mPprj 'k) vk; ,o ykHk% ykxr vuikr iklr gvkA

- mn;ij e] ehBh eDdk&lkQ Qly i.kkyh ij tfod [kjirokj ic/ku ijh{k.k e ldjh vkj pkMh iRrh oky [kjirokjk dk ?kuRo lykfLVd eYp e de nt fd;k x;k tk fd xh"edkyhu trkb] LVy lhM cM ;k enk l;hdj.k l [kjirokj fu;=.k e iHkkoh ik;k x;kA
- gnjkckn e fHk.Mh e] ikyh'khV eYp $ vr% ifDr gkFk }kjk cokb d 30 fnu lk'pkr fujkb ;k dYpjy ifDVl ;kf=d fof/k }kjk ikoj ohMj l 20 vkj 40 fnu cokb d lk'pkr ;k LVy lhM cM rnkijkr gkFk }kjk cokb d 20 vkj 40 fnu ckn fujkb dju dh [kjirokjk d iHkko'kkyh fu;=.k dh vulI'kk dh xb gA
- tEe e ljlk d cht dh [kyh 2-5 V-@g- vky] Qpchu vkj jkfir /kku [kjirokjk dh l[;k dk ohMh pd dh ryuk e de dju e iHkko'kkyh ik;k x;kA lcl T;knk vky d dn] Ýpchu dh gjh Qyh vkj /kku d nkuk dh mit ljlk d cht dh [kyh 2-5 V-@g- $,d ckj gkFk l fujkb dju ij yfdu mPpre ykHk% ykxr vuikr ljlk d ik/kk d vd $,d ckj gkFk }kjk fujkb dju d ckn nt dh xbA
- Hkou'oj e 1@3 vulf'kr u=tu ek=k xkcj dh [kkn] <pk vkj uhe dd , tkLihfjy;e $ ih-,l-ch- rnkijkr tfod [kkn dk ,d gh vuikr xkcj dh [kkn] oeh dEikLV vkj uhe dd $, tkVk cDVj $ ih-,l-ch- dk mi;kx VekVj vkj fHk.Mh e /kku&VekVj&fHk.Mh Qly pØ e /kku dh VekVj d Qyk dh vkj fHk.Mh dh vf/kdre mit ik;h x;hA

McY;i ih 1-3 Qly vkj Qly pØka e 'kkdukf'k;ka }kjk fu;=.k

- vkun e eDdk e ub ih<h d 'kkdukf'k;k }kjk [kjirokj ic/ku ij v/;;u dj xg e bud vo'k"kk dk iHkko n[kk x;kA eDdk vk/kkfjr Qly pØ e ,Vkftu $ i.MehfFkfyu ¼500$250 xk-@g-½ vdj.k d io ¼Vd feDl½ rnkijkr 2]4&Mh 1000 xk-@g- vdj.k d lk'pkr dk i;kx [kjirokjk d ic/ku d fy, iHkkodkjh ik;k x;kA xg dh Qly e bldk dkb ifrdy iHkko ugh ik;k x;kA
- tkjgV e] vnjd e lHkh pj.kk e U;ure [kjirokj ?kuRo 30 vkj 60 fnuk e cokb d ckn XykbQkslV 0-80 fd-xk-@g- $ vkDlh¶ykjQu 0-2 fd-xk-@g- vnjd d vdj.k d io nt fd;k x;kA mijko /kku e ik"kd rRo vkj [kjirokj ic/ku i;kx e 75 ifr'kr vulf'kr mojd $ oehdEikLV ¼2 V-@g-½ d feJ.k d mipkj rhu ckj foHkktu ¼cokb d io] cokb d 30 vkj 60 fnu lk'pkr½ $ ifVykDykj 750 xk-@g- dk feJ.k ,d ckj rnkijkr gkFk }kjk cokb d 30 fnu ckn dju ij mPpre mit nt dh x;hA
- ikyeij e] /kku&xg Qly pd e nkuk Qlyk e 25 ifr'kr N dk mi;kx ckjh&ckjh l yUVkuk }kjk LFkkukiUu d mipkj l mPpre LFkk;h mit lpdkd ¼0-775½ d lkFk /kku o xg dh mPpre dy mit iklr dh xbA
- mn;ij e vtokbu e] vdj.k d lk'pkr 25 vkj 50 fnu ij nk ckj gkFk }kjk fujkb dju ij vf/kdre [kjirokj fu;=.k {kerk d lkFk&lkFk mPpre mit ¼694 fd-xk-@g-½ n[kh xb tk fd vdj.k lk'pkr 50 fnu ij ,d ckj gkFk }kjk fujkb rnkijkr D;tkykQki&bFkkby 40 xk-@g- dk Qly mxu d ckn 3&4 ckn iRrh voLFkk ij fNMdko dju d lerY; ik;k x;kA
- tEe e] o"kk vk/kkfjr eDdk e [kjirokj ic/ku d fy, VEckVk;u 100 xk-@g-$,Vkftu 500 xk-@g- vdj.k lk'pkr ;k ,Vkftu 1000 xk-@g- vdj.k VEckVk;u 100 xk-@g- vdj.k lk'pkr mi;kx mPp [kjirokj fu;=.k n{krk d lkFk vkfFkd :lk l mi;Dr gkuk ik;k x;kA eDdk e bu 'kkdukf'k;k dk mi;kx dju ij ljlk dh Qly ij vof'k"V gkfudkjd iHkko ugh ik;k x;kA
- ikl h?kkV e] eDdk e lHkh [kjirokj fu;=.k d mipkj dh ryuk e vdj.k d lk'pkr 25 vkj 50 fnu ij gkFk }kjk fujkb dju ij eDdk $ lk;kchu ¼1%1½ vkj eDdk $ mMn ¼1%1½ vrorh Qly [kjirokjk dk fu;f=r dju e mi;Dr ik; x; ft ld ifj.kkeLo:lk ifr ik/kk gjh dkCl dh mPp l[;k ifr gDV;j vkj ykHk% ykxr vuikr nt fd;k x;kA

MCY;i ih- 2 tyok;q ifjorlu d nkj e [kjirokjka e ifjorlu] ic/ku ,o [kjirokjuk'kh ifrjk/kd {kerk

- vkuUn e *vtheku eDlhdkuk* ub [kjirokj d :i e fofHkUu Qlyk e ik;h xbA
- tkjgV e *dldVk dkeiDVfjt* dk idki tV dh Qly e n[kk x;kA *yMfo;k i:fi;kuk* dk idki xokgkVh vkj ekjhxko d tyh; r= e rho nj l c<k gvk ik;k x;kA
- fglkj d Qrgckn fty e xg vkj cjlhe dh Qly e *ykfy;e* [kjirokj ik;h x;hA eokM d ug] iUukguk {k= e VekVj vkj HkVk e ijthoh [kjirokj *vkjkcdh , tifVdk* dk xHkhj idki ik;k x;kA
- jktlen fty d jyexk] ukFkMokjk rglhyk e eDdk&xg Qly pØ e *ekyok ijhQkjk* of) 'khr ,o o"kk _r e n[kh xbA jyexk rglhy e *jkVokbYyk*

, *tkVkVk* eDdk e ,d xHkhj [kjirokj d :Ik e ik;h x;hA

- *fljfle vjoufl l* vkj *:EkD l* dk idki xg dh Qly e tEe e vkj-, l- ijkCykd e n[kk x;kA
- cxy : e fHk.Mh dh Qly e *vkD tkue fyuvkfVe* ,d ub [kjirokj ik;h x;hA
- Hkou'oj d dkutj fty e mijkr /kku ,o jch nyguk e *lhykfl;k vjtufV;k* ,d xHkhj leL;k d :i e ik;h x;hA
- vkuUn e 2]4&Mh ;k eV l Y¶;jku d yxkrkj i;kx l xg dh Qly e [kjirokj e LFkkukrj.k ik;k x;kA xg dh Qly e 'kkduk'kh dk feDlpj iHkkodkjh ik;k tkrk gA
- fglkj e *Qyfjl ekbuj* ij Økl ifrjk/kdrk d ifj{k.k e vdj.k l io iMheFkyhu $ efVC;thu dk 1500 $ 175 xk@g- ;k iMheFkyhu $ ik;jkDlDyku dk 1500$ 102 xk@g- d ckn fiukDlkMu 60 xk-@g- $ vkbMklY¶;jku dk 14-4 xk@g- cokb d 35 fnuk ckn dec) i;kx l *Qyfjl ekbuj* rFkk pkMh iRrh oky [kjirokjk dk 80&87% fu;=.k n[kk x;kA
- yf/k;kuk e] vdj.k l io doy iMheFkyhu 750 xk $ ikbjkDlk lYQku 102 xk-@g- ;k Øec) DykfMukQki 60 xk- $ eV l Y¶;jku 4 xk-@g- ;k eV l Y¶;jku 12 xk $ vkbMk lY¶;jku 2]4&Mh xk@g- ;k vdj.k i'pkr *Qyfjl ekbuj* dk iHkkodkjh fu;=.k ik;k x;k rFkk xg dh Qly e mYy[kuh; of) ik;h x;hA

MCY;- ih- 3 Qlyh; vkj xj&Qlyh; {k=k e leL;kdkjd [kjirokjk dk tio foKku ,o ickl/ku

- vle e dkQh d cxhp e *fedkfu;k fedjUFkk* dk ftcfyd vEy dk enk e i;kx l 20 fnuk ckn *fedkfu;k* cht dk mPp vdj.k n[kk x;kA vkDlh¶ykjQu dk 80 fnuk ckn i;kx dju ij *fedkfu;k* d dkb ik/k ugh ik; x;A ftcfyd vEy] XykbQkslV vkj 2]4&Mh dk i;kx dju ij dkQh dh mit ij dkb iHkko ugh Ikk;k x;kA vkDlh¶ykjQu u ;ok] lhMh oVM vkj ik/kk dk ydj vlj d lkFk dkQh ckxkuk d lkFk&lkFk mPp cht] mit Hkh] th, vkonu vkj XykbQkslV dk dkb iHkko ugh Fkk vkj dkQh dh mit ij 2] 4&Mh dk vlj ugh FkkA
- fglkj e VekVj e lYQklY¶;jku vkj bFkkDlh& lY¶;jku dk ckn e i;kx dju ij *bVhfIV;u cuji* e 85&90 ifr'kr rd fu;=.k ik;k x;kA lYQklY¶;jku d vo'k"k dk 50 xk-@g- jkiu d 60 vkj 90 fnuk ckn i;kx dju ij vuxkeh Qly lkj?ke ij ifrdy iHkko ik;k x;kA cxu dh Qly e lYQklY¶;jku vkj bFkkDlhlY¶;jku dk i;kx vkjkcdh d fu;=.k e fcuk mipkfjr d fu;=.k e fcuk mipkfjr lykVk dh ryuk e vfr mRd"V iHkko ik;k x;k yfdu cxu dh Qly ,o mit e mldk fo"kkDr iHkko ik;k x;kA
- dk;cVj e ylu e vdj.k Ik'pkr ijkDokV 0-80 fd-xk-@g- Fkk lh/kk fNMdko dju ij dldVk d fu;=.k d lkFk nlj [kjirokj ,o mudk 'k"d Hkkj Hkh de ik;k x;kA i.MhfeFkfyu 1-0 fd-xk-@g- vdj.k io $ vdj.k d 25 fnuk ckn gkFk }kjk funkb rnkijkr vkDlh¶ykjQu d 25 fnuk ckn gkFk }kjk funkb dju ij gj pkj dh mit d lkFk vPNk vFki.k ykHk ik;k x;kA
- Hkou'oj e cxu dh Qly e i.MhehFkfyu 1-0 fd-xk-@g- jki.k d 3 fnuk ckn i;kx dju ij vkjkcdh cxu d ifr ik/k] U;ure [kjirokj ?kuRo jki.k d 60 vkj 90 fnuk ckn nt fd; x;A
- mn;ij e] tydHkh l xflr ekb;k dh ipkyh xko] mn; lkxj d ihN ty fudk; {k= e 20 ifr'kr rd tydHkh e fu;=.k ugh ik;k x;kA
- gnjkckn e =ekfld vrjky e lo{k.k d nkjku ekbykM noiYyh rkykc e dhVk dk idki ik;k x;kA
- Xokfy;j ,o rfeyukM e tydHkh e flQ 30&40 ifr'kr rd fu;kdfVuk itkfr dk lØe.k n[kk x;kA ftle flQ 5&10 ifr'kr ¼1 Ldy½ tydHkh ij fu;=.k n[kk x;kA

MCy;- ih- 4 Ik;koj.k e iin"kdk ,o 'kkduk'kh vo'k"kk dk vi?kVu] fuxjkuh o 'keu

- vle e] lh/kh cokb dh /kku vkj de trkb d ifj{k.k l iVhykDykj d vo'k"k lcl de ik; x;A iUMheFkyhu d 45 fnuk d mipkj d vo'k"k vif{kr Lrj l de ik; x;A ivky] nkuk] enk vkj 'khrdkyhu /kku e C;VkDykj vkj iVhykDykj d vo'k"k vif{kr Lrj l de ik; x;A
- fglkj e] gYnh e iUMheFkyhu d vo'k"k 150 fnuk e mipkj d i'pkr vif{kr Lrj l de ik; x;A l;kt e iUMheFkyhu d vo'k"k 0-011 l 0-354 mg/g] tcfd l;kt cYl e iUMheFkyhu d vo'k"k ,e vkj ,y 0.05 mg/g ik; x;A xg dh Qly e enk e eVhC;thu d vo'k"k 0-005 l 0-013 mg/g tcfd xg dh ivky e eVhC;thu d vo'k"k 0-01 l 0-029 mg/g tk fd ,e vkj ,y dh 0-05 mg/g l de ik;k x;kA /kku dh Qly e ifVykDykj d vo'k"k enk e 0-005 l 0-062 mg/g ik; x;A
- ikyeij e dkcfud et&yglu] Qly pØ e [kjhQ 2017 e ,Vkftu ,o iUMheFkyhu d vo'k"k yglu ,o et e vif{kr Lrj l de ik; x;A DykMhukQki

ikix;y d vo'k"k xg d nku e vif{kr Lrj l de ik; x;A

- gnjkckn e ,jkfcd ,o jkfir /kku d ifj{k.kk e Qly dh dVkb ckn enk] /kku e nkuk ,o /kku d ivky d ueuk e fcl ik;jhcd lkfM;e d vo'k"k vif{kr Lrj l de ik; x;A iMheFkyhu d vo'k"k fHkMh] eyh vkj /kfu;k ueuk e vif{kr Lrj l de ik; x;A
- dk;EIkVj e ,Vkftu vkj iMheFkyhu d vo'k"k enk ,o eDdk d nku e 0-01 mg/g ik; x;A eDdk mi tku okyh enk e ,Vkftu d vo'k"k dk de dju gr ,Q ck; ,e 10 Vu@g- ;k dpvk [kkn 5@g- ;k ck;kpkj 5 Vu@g- iHkkodkjh ik;k x;kA ,Vkftu vkj iUMheFkyhu d vo'k"k ty] enk vkj eDdk d nku e vif{kr Lrj l de ik; x;A

MCY;-ih- 5 [kjirokj rduhd dk d"kd i{k= ij 'kk/k ijh{k.k ,o in'ku rFkk mudk iHkkok dk eY;kdu

- vkuUn e] d"kd i{k= ij bVj dYVho'ku rnkijkr gkFk }kjk cokb d 20 vkj 40 fnuk ij funkb dju ij D; tykQki bFkkby vdj.k lk'pkr i;kx dju ij dh ryuk e lk;kchu e [kjirokj ic/ku gr T;knk iHkkoh ik;k x;kA DykMhukQki ikikjfty ¼15 ifr'kr½ eVlY¶;jku $ eVlY¶;jku feFkkby 32 xk-@g- vdj.k lk'pkr fIQ eVlY¶;jku d i;kx l vPNk ik;k x;kA
- tkjgV e] [kjirokj ic/ku ,o cht mRiknu gr i.MhehFkfyu 750 xk-@g- dk mi;kx fdlkuk dh ijkuh i)fr gkFk }kjk nk ckj funkb l cgrj ik;k x;kA
- mRjk[kM d rjkb {k= e] ifVykDykj ¼1000 xk-@g-½ l mipkfjr jkfir /kku e mUur ,o d"kdk dh i)fr ¼cVkDykj 1000 xk-@g-½ l yxHkx ,d leku nkuk dh mit nt dh xb] tcfd fcl ik;jhcd&lkfM;e ¼20 xk-@g-½ d i;kx l d"kd i)fr dh vi{kk 1-38 ifr'kr vf/kd mit nt dh xbA [kjhQ 2017 d nkjku Hkkoj {k= e lk;kchu dh Qly e] betFkkik;j ¼100 xk-@g-½ vkj vykDykj ¼2500 xk-@g-½ d i;kx l nkuk dh mit e 4-5 ifr'kr vf/kd mit nt dh xbA tcfd d"kd i)fr l nkuk dh mit e 4-5 ifr'kr deh nt dh xbA
- jk;ij ftyk d fulnk ¼vjx½ xko e vkDlkMk;fty 80 xk-@g- vdj.k d io vkj fcl ik;jhcd&lkfM;e 25 xk-@g- cokb d 20 fnu lk'pkr d"kd i)fr dh ryuk e jkfir /kku dh mit e 49-3 ifr'kr c<kRrjh nt dh xbA
- gnjkckn e vkjkcdh d lØe.k d fu;=.k gr uhe dd 200 fd-xk-@g- rnkijkr XykbQkIV 50 xk-@g- dk i;kx iHkkodkjh ik;k x;kA ikyh'khV l efYpx dju ij vkjkcdh d idki dk de fd;k tkuk ik;k x;kA
- fglkj e eDdk e ikp iFke ifDr in'ku e VEckVku d mi;kx l etcr [kjirokj tk fd d"kdk }kjk vVkftu d i;kx l fu;f=r ugh gk ik jgk Fkk] 90&95 ifr'kr fu;=.k d lkFk ykHk% ykxr vuikr VEckVku d mi;kx l 2-40&3-12 d"kd i)fr l 2-26&2-89 ik;k x;kA
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EXECUTIVE SUMMARY

WP1 Development of sustainable weed management practices in diversified cropping systems

- At Hisar and Ludhiana, emergence of *Phalaris minor* was low under ZT wheat with residues under un-weeded situation as compared to ZT/CT wheat without residues. Under IWM, grain yield of wheat after ZT/CT-DSR (5.4 to 5.5 t/ha) were higher than after conventional PTR. During *Kharif* 2017, grain yield of rice under DSR was lower than CT- transplanted due to incidence of brown spot disease in DSR. However, system yields of DSR based rice-wheat were similar to PTR based rice-wheat system.
- At Palampur, zero tillage along with integrated weed management in both maize and wheat resulted in significantly higher wheat grain equivalent yield with an increase of about 13% over conventional tillage followed by recommended herbicide in both the crops. However, zero tillage + herbicide in both crops, zero tillage in maize followed by zero tillage with residue retention in wheat both with herbicide, integrated weed management or hand weding for weed control and CT+HW were comparable to it in influencing the wheat grain equivalent yield.
- Wheat grain yield and B: C ratio (2.7) was highest under conventional wheat after direct seeding of rice with *Sesbania* incorporation. Whereas, significantly highest rice grain yield was achieved under conventional transplanting along with green manuring of *Sesbania* by achieving highest net return as well as B: C ratio (1.9).
- At Udaipur, amongst different weed management practices, highest grain yield and stover yield were recorded by application of atrazine 500 g/ha pre-emergence followed by hand weeding at 30-35 DAS. Likewise in wheat in maize - wheat cropping system, maximum grain and straw yield were observed through IWM i.e., application of sulosulfuron + metsulfuron-(30 + 2 g/ha) at 30 DAS followed by hand weeding at 50-55 DAS.
- At Akola in soybean-chickpea cropping system, use of two harrowing by tyne harrows and a blade harrow (CT) instead of roto-till (MT) and zero-till (ZT) in combination with herbicide application (IWM) improved the physical properties of soil, added productivity and economic security in vertisols.
- At Coimbatore, significantly higher grain yield and economics were recorded in zero tillage in ZT-ZT+R system and in PE pendimethalin at 1.0 kg/ha + HW on 45 DAS in sunflower crop. Whereas, in maize, CT-CT system and in PE atrazine at 0.5 kg./ha + HW on 45 DAS recorded higher productivity as well as high income in maize crop. Microbial acivity and soil enzyme acivity were higher in zero tillage in ZT-ZT+R system and in PE pendimethalin at 1.0 kg/ha + HW at 60 DAS in *Rabi* and *Kharif* in maize – sunflower cropping system.

WP1.2 Weed management in organic farming systems

- At Jorhat fresh fruits was significantly higher due to oxo-biodegradable plastic film mulching and rice straw mulching followed by one hand weeding than other treatments in organically grown chilli. In tea under organic cultivation, total green leaf yield under bio-degradable film was significantly higher as compared to rest of the treatments.
- At Ranchi, application of weed mulch and straw mulch in okra were effective for controlling weeds as well as for fetching higher profitability. In onion, plastic mulch was as much good as application of herbicides pendimethalin 1.0 kg/ha PE or oxyfluorfen 0.25 kg/ha PE for getting maximum benefit.
- At Palampur, raised stale seed bed + mulch resulted in 65% higher garlic equivalent yield over the chemical check. In maize, intercropping was an effective mean of suppressing grasses, sedges and broad-leaved weeds under organically managed maize - garlic cropping system.
- At Udaipur, in sweet corn – fennel system, weed density of grassy and broad leaf weeds were recorded significantly lower in plastic mulch either with summer ploughing, sowing after stale seed bed preparation or soil solarization.
- At Hyderabad, mulching with polysheet + inter row hand weeding at 30 days after sowing or cultural practice involving mechanical weeding with power

weeder at 20 and 40 days after sowing or stale seed bed *fb* hand weeding at 20 and 40 days after sowing found efficient weed control in okra.

- At Jammu, mustard seed meal 2.5 t/ha was found effective in reducing weed population in potato, frenchbean and transplanted rice as compared to weedy check. The highest potato tuber yield, frenchbean green pod yield and rice grain yields were recorded in mustard seed meal 2.5 t/ha + one hand weeding, but highest B: C ratio was recorded with recommended herbicide followed by mustard plant extract + one hand weeding.
- At Bhubaneswar, application of 1/3 recommended dose of N each through FYM, dhaincha and neemcake alongwith *Azospirillum* + PSB to rice followed by same proportion of organics through FYM, vermicompost and neem cake + *Azotobacter* + PSB (T3) to tomato and lady's finger in rice-tomato-okra system resulted in the maximum grain yield of rice, fruit yield of tomato and okra.

WP 1.3 Herbicidal control of weeds in crops and cropping systems

- At Anand, weed management in maize based cropping system by application of atrazine + pendimethalin (500 + 250 g/ha) PE (tank mix) *fb* 2, 4-D 1000 g/ha) PoE found effective. No adverse effect of herbicides on succeeding wheat crop was observed.
- At Jorhat, lowest weed density at all stages and weed dry weight at 30 and 60 DAP were achieved under glyphosate 0.80 kg/ha + oxyfluorfen 0.2 kg/ha just before emergence of sprouts of ginger. In weed and nutrient management under upland direct-seeded rice, treatment of 75 % RD fertilizer + vermicompost (2t/ha) mixture 3 splits (before sowing, 30 and 60 DAS) + pretilachlor 750 g/ha mixed with the first split followed by HW at 30 DAS gave highest grain yield.
- At Palampur, rotational use of herbicides in both the crops along with 25% N substitution through *Lantana* in rice had highest sustainable yield index (0.77) with highest total grain productivity of rice and wheat in rice-wheat cropping system.
- At Udaipur, maximum weed control efficiency and highest yield (694 kg/ha) was observed with two hand weedings at 25 and 50 DAS and it was at par with pre-emergence application of oxadiargyl 100 g/ha followed by one hand weeding at 50 DAS followed by post emergence application quizalafop-ethyl 40 g/ha at 3-4 leaf stage in this respect in Ajwain (*Trachyspermum ammi*).
- At Jammu for weed management in rainfed maize, tembotrione 100 g/ha + atrazine 500 g/ha as post-emergence (PoE) or atrazine 1000 g/ha as pre-emergence (PE) *fb* tembotrione 100 g/ha (PoE) found to be economicaly suitable with higher weed control efficiency without any residual phytotoxicity on succeeding mustard.
- At Pasighat, hand weeding at 25 and 50 days after sowing and maize + soybean (1:1) and maize + black gram (1:1) intercropping was better in controlling weeds resulted in higher number of green cob per hectare and B: C ratio.

WP 2 Weed dynamics and management under the regime of climate change and herbicide resistance

- At Anand, *Argemone mexicana* found as new emerging weed in different field crops in many districts of Gujarat.
- At Jorhat, *Cuscuta campestris* severely infested capsularis jute crop in the Lower Brahmaputra Valley zone of Assam. Infestation of *Ludwigia peruviana* was increased in the water bodies of Guwahati city and Morigaon town in a faster rate.
- At Hisar, intensity of *Lolium* spp., in wheat and berseem crops was on the increase in Fatehbad district. Tomato and Brinjal crops were severely infested with parasitic weed *Orobanche aegyptiaca* in Nuh, Punnahana, Meoli areas of Mewat.
- Infestation of *Malwa parviflora* was increasing in maize-wheat cropping zone in Railmagra, Nathdawara tehsils of Rajsamand district during the winter and rainy season of 2016-17. *Rottboellia exaltata* has become a serious weed of maize in Railmagra tehsil of Rajsamand. No new weed flora was observed in these areas at Udaipur.
- At Jammu, heavy infestation of *Cirsium arvensis* and *Rumex* spp. were observed in wheat crop at R. S. Pura block of Jammu district.

- *Oxygonum sinuatum* (Wavy Leaf Oxygonum) found as a new weed in finger millet crop in Bengaluru Rural District.
- At Bhubaneswar, *Celosia argentea* is observed to be a severe problem in upland rice and *Rabi* pulses in the districts of Keonjhar.
- At Anand , weed flora shifted towards monocot weeds in wheat crop fields due to continuous use of 2, 4-D or metsulfuron-methyl. Herbicide mixtures were found more effective to manage complex weed flora in wheat crop.
- At Hisar, pre-emergence application of pendimethalin + metribuzin (TM) at 1500 + 175 g/ha or pendimethalin + pyroxasulfone (RM) at 1500 + 102 g/ha *fb* sequential use of pinoxaden 60 g/ha mesosulfuron + iodosulfuron (RM) at 14.4 g/ha at 35 DAS provided 80-87% control of resistant population of *P. minor* and BLW's.
- At Ludhiana, pre - emergnece pendimethalin 750 g/ha + pyroxasulfone 102 g/ha alone or in sequence with either clodinafop 60 g + metsulfuron 4 g/ha or mesosulfuron 12 g + iodosulfuron 2.4 g/ha as post-emergence gave effective control of multiple herbicide resistant *P. minor* and significantly increased wheat grain yield than unsprayed check.

WP3 Biology and management of problem weeds in cropped and non cropped areas

- At Jorhat, management of *Mikania micrantha* in coffee plantation showed highest germination of *Mikania* seeds 20 days after application of 500 ppm GA to soil, no *Mikania* plant was observed 80 days after oxyfluorfen application, there was no effect of GA application and glyphosate and 2,4-D application on coffee yield.
- At Hisar, 85-95 % control of *Egyptian broomrape* was obtained with post treatments of sulfosulfuron and ethoxysulfuron in tomato. Residues of sulfosulfuron at 50 g/ha at 60 and 90 DAP caused adverse effect on succeeding sorghum crop. In brinjal crop, although excellent control of *Orobanche* was obtained with post treatments of sulfosulfuron and ethoxysulfuron when compared with non treated controls but proved phytotoxic to brinjal crop with yield penalty.
- At Coimbatore, post-emergence directed application of paraquat at 0.80 kg/ha resulted in lower weed coverage of *Cuscuta* and other weeds; and weed dry weight among the herbicidal management. Higher green fodder yield and better economic returns could be obtained with PE pendimethalin 1.0 kg/ha + hand weeding on 25 DAS *fb* PE oxyflourfen 250 g/ha + hand weeding on 25 DAS.
- At Bhubaneswar, application of pendimethalin 1.0 kg/ha as pre-em at 3 DAP recorded the lowest number of *Orobanche* plant in brinjal, lowest total weed density at 60 and 90 DAP.
- At Udaipur only about 20% defoliation was observed on water hyacinth plants in heavily infested area of Bhoion ki pancholi, back water bodies of Udai Sagar, Udaipur. Complete mortality of water hyacinth plants was not observed.
- At Hyderabad, severe weevil infestation was observed at quarterly interval survey in Mylardevpalli tank.
- At Gwalior and Coimbatore, infestation of *Neochetina* spp. on water hyacinth was observed up to 30 to 40 % only. Only 5-10% (1 scale) die back symptoms were observed on water hyacinth.

WP4 Monitoring, degradation and mitigation of herbicide residues and other pollutants in the environment

- At Jorhat, butachlor and pretilachlor residues were found below detection limit in straw, grain and soil at harvest in summer and winter rice of farmers field.
- At Hisar, residues of pendimethalin were below detectable level after 150 days of application in soil samples of turmeric. In onion crop, soil samples from 18 locations were having pendimethalin residues between 0.011 to 0.354 μg/g, whereas in the onion bulbs and leaf samples pendimethalin residues were below MRL of 0.05 μg/g. In wheat crop, metribuzin residues in soil ranged between 0.005 to 0.013 μg/g, whereas in wheat straw, residues of metribuzin were observed in 7 samples between 0.01 to 0.029 μg/g which were below MRL value of 0.05 μg/g. In rice crop, 11 out of 20 locations were having pretilachlor residues in soil between 0.005 to 0.062 μg/g.
- At Palampur, in organic maize – garlic production system, atrazine and pendimethalin in garlic and maize were found below detection limit (< 0.05 and < 0.01 μg/g) in *Kharif* 2017. Residues were below detectable

limits in (< 0.03µg/g) soil and wheat grain samples collected from the clodinafop-propargyl treated fields of farmers of Kangra district.

- At Ludhiana, adsorption-desorption of penoxsulam varied with concentration of penoxsulam, temperature and organic matter and clay content of the soil and order of adsorption was: clay loam > silt loam > loam > sandy loam > loamy sand.
- At Hyderabad, residues of pendimethalin in okra fruit, radish tuber and coriander plant samples collected from the farmers' field were below the detection limit of 0.05 mg/kg in all the eight samples.
- At Coimbatore, residues of atrazine and pendimethalin in soil and maize grain from different plots were below 0.01 mg/kg irrespective of the tillage management practices followed for weed control. FYM 10 t/ha or vermicompost 5 t/ha or biochar 5 t/ha was efficient in reducing the residual concentration of atrazine in maize grown soil. Residues of atrazine and pendimethalin were below detectable limits in water, soil and maize grain samples collected from farmers' field.

WP5 On-farm research and demonstration of weed management technologies, their adoption and impact assessment

- At Anand, interculture (IC) *fb* HW carried out at 20 and 40 DAS was more effective for weed management as compared to post-emergence application of quizalofop-ethyl in soybean crop. Application of clodinafop-propargyl (15%) + metsulfuron-methyl 64 g/ha PoE (RM) or sulfosulfuron + metsulfuron-methyl 32 g/ha PoE found better than metsulfuron-methyl alone.
- At Jorhat, application of pendimethalin 750 g/ha pre-em showed superiority over farmers' practice (2 hand weedings) in terms of weed control and seed yield of the crop.
- In tarai area of Uttarakhand, transplanted rice treated with pretilachlor (1000 g/ha) as improved practices as well farmers' practices (Butachlor at 1000 g/ha) recorded almost similar grain yield, whereas, bispyribac-Na (20 g/ha) recorded only 1.38% increase over the farmer's practise. During *Kharif* 2017, in Bhabar area in soybean crop, alone application of imazethapyr (100 g/ha) and alachlor (2500 g/ha) were recorded 4.5% increase in grain yield, whereas, recorded 4.5% decrease in grain yield over farmers' practice.
- At Raipur, there was 49.3% increase in grain yield due to application of oxadiargyl 80 g/ha PE and bispyribac- Na 25 g/ha at 20 DAS over farmers practice in village Nisda (Arang), District Raipur.
- At Hyderabad, neem cake 200 kg/ha *fb* glyphosate 50 g/ha was efficient in controlling *Orobanche* infestation. Mulching with polysheet delayed emergence and lowered the incidence of *Orobanche*.
- At Hisar, tembotrione provided 90-95% control of hardy weeds *Eleusine indica* in five front line demonstrations on maize, which were not being controlled by use of atrazine being used by farmers. B: C ratio with use of tembotrione ranged from 2.40-3.12 against 2.26- 2.89 in farmer's practice.
- Approximately 425 demonstrations were conducted on use of glyphosate for the control of *Orobanche* in mustard in Bhiwani, Hisar and Mahender Garh districts. Post-emergence application of glyphosate 25 g/ha at 30 DAS followed by its use at 50 g/ha at 50-60 DAS provided 75-84% control of *Orobanche* in mustard. Application of ethoxysulfuron provided 85-90% control of *Orobanche* with 3.5-3.7 panicles at harvest with tomato yield of 2.70-2.76 t/ha as against 1.68-1.95 t/ha in untreated check. Percent control with use of sulfosulfuron was higher as compared to ethoxysulfuron which ranged from 90-100% with 2.38-2.65 t/ha.
- At Gwalior, application of atrazine 500 g/ha PoE gave 54.4% increase of pearlmillet (2.23 t/ha) followed by 2,4-D (2.15 t/ha). The B:C ratio of 2.01 and 1.95 were obtained in the treatments over 1.41 in farmers practices. The increase was found due to application of atrazine.
- At Bhubaneswar, 10 frontline demonstrations were conducted on transplanted rice during *Kharif* 2017 in Bhubansuni patna, Baghamari of Khorda district revealed the yield increase of 21-42% with the application bispyribac-sodium at 25 DAT over farmers' methods.

1. ORGANIZATION AND FUNCTIONING

1.1 Introduction

Systematic research work on weed management in the country started with the launching of 'All India Coordinated Research Project on Weed Control' by the ICAR in collaboration with the United States Department of Agriculture (USDA) at six locations, viz. Punjab Agricultural University, Ludhiana (Punjab); University of Agricultural Sciences, Bengaluru (Karnataka); Indian Institute of Technology, Kharagpur (West Bengal); Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.); Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (U.K.); and Himachal Pradesh Krishi Vishwa Vidyalaya, Palampur (H.P.). The project came into operation in April, 1978 with the financial outlay of ` 42.97 lakhs for five years. The tenure of the project was, however, extended for one more year till March, 1984 with the savings. Further work was continued at these centres with the AP Cess fund of ICAR till the implementation of VII Plan in April, 1986.

Research and extension activities of the project were extended covering 7 more cooperating centres, viz. Assam Agricultural University, Jorhat (Assam); Marathwada Agricultural University, Parbhani (Maharashtra); Gujarat Agricultural University, Anand (Gujarat); Narendra Dev University of Agriculture and Technology, Faizabad (U.P.); Indian Institute of Horticultural Research, Bengaluru (Karnataka); Indian Grassland and Fodder Research Institute, Jhansi (U.P.) and Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu) through a fresh negotiation between ICAR and FERRO, USDA with a sanctioned outlay of ` 58.10 lakhs for five years. The work at these centres was effectively implemented from 1982-83 to 1986-87.

In the third phase, 9 more centres, *viz*. Birsa Agricultural University, Ranchi (Bihar); Haryana Agricultural University, Hisar (Haryana); Vishwa Bharati, Sriniketan (W.B.); Rajendra Agricultural University, Pusa (Bihar); Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.); Kerala Agricultural University, Thrissur (Kerala); Orissa University of Agriculture and Technology, Bhubaneshwar (Orissa); Acharya N.G. Ranga Agricultural University, Hyderabad (Andhra Pradesh) and ICAR Research Complex, Barapani (Meghalaya) were initiated at total outlay of ` 63.85 lakhs for four years (1985-86 to 1989-90) with the assistance of USDA under USIF funds.

In the VIII Plan, 4 new centres, *viz*. Rajasthan Agricultural University, Bikaner; Indira Gandhi Krishi Vishva Vidyalaya, Raipur; Konkan Krishi Vidhya Peeth, Dapoli and University of Agricultural Sciences, Dharwad were initiated with total outlay of ` 16.41 lakhs. Seventy five percent of the total budget required by each centre was provided by the ICAR and the remaining 25% was met from the state department of agriculture as a state share. There was however 100% funding by the ICAR to Visva Bharati, Sriniketan. During IX Plan (1997-2002), X Plan (2002-2007) and XI plan (2007-2012) and XII plan (2012-17) the total expenditure incurred under AICRP-WM was ` 823.79, 1696.57, 3548.78 lakhs and 4007.26 lakhs, respectively.

During XII Plan (2012-17), four AICRP on Weed Management centres, *viz*. University of Agricultural Sciences, Dharwad; Chandra Shekhar Azad University of Agriculture & Technology, Kanpur; Swami Keshwanand Rajasthan Agricultural University, Bikaner, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani and Visva-Bharati, Sriniketan were closed and new centers at Maharana Pratap University of Agriculture and Technology, Udaipur; University of Agricultural Sciencies, Raichur; Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola; Bidhan Chandra Krishi Viswavidyalaya, Kalyani; Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu and Central Agricultural University, Pasighat by redeployment of existing manpower were opened. During 2017-20, six centres, NDUAT, Faizabad; UAS, Raichur; RAU, Pusa; CAU, Pasighat; BAU, Ranchi and DBSKKV, Dapoli were closed. The coordinating unit of the project was located initially at Central Rice Research Institute, Cuttack, and shifted to National Research

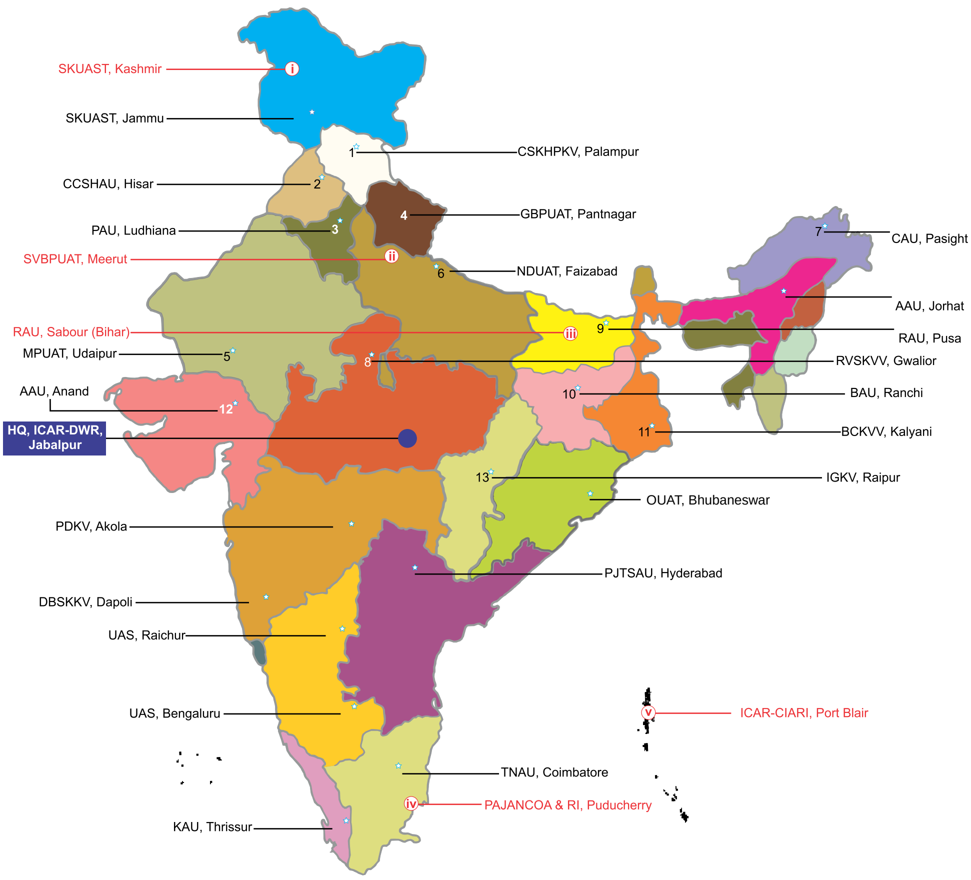
Centre for Weed Science in 1989. Later in 2009, NRC for Weed Science was upgraded to Directorate of Weed Science Research. During XII Plan (2012-17), it has renamed as “Directorate of Weed Research” and “AICRP on Weed Control” was renamed as “AICRP on Weed Management”.

1.2 Mandate

- To conduct location-specific research for developing appropriate weeds management technologies.
- To demonstrate the weed management technologies through on-farm adaptive trials.

1.3 Objectives

- To survey and surveillance of weed flora, mapping their distribution, ecology and habitat
- To evaluate new herbicides and working out the residual effect on non-targeted organisms
- To work out effective and economic weed management modules for field and horticultural crops and in different aquatic situations
- To study biology and control of problem weeds including aquatic and parasitic weeds
- To study long-term residual and cumulative effects, if any, of herbicides
- To standardize techniques for herbicide residues in soil, water and food chain
- To carry out basic research at different centres having adequate laboratory facilities for rendering support to adaptive research
- To test available tools/ implements for weed management under various agro-ecosystems
- To transfer weed management technologies on farmers' fields through OFT and FLDs their impact assessment and training.



AICRP-Weed Management

Regular Centre

1. CSKHPKV, Palampur
2. CCSHAU, Hisar
3. GBPUAT, Pantnagar
4. PAU, Ludhiana
5. NDUAT, Faizabad*
6. MPUAT, Udaipur
7. CAU, Pasighat*
8. RVSKVV, Gwalior
9. RAU, Pusa*
10. BAU, Ranchi*
11. BCKV, Kalyani
12. AAU, Anand
13. IGKVV, Raipur
14. OUAT, Bhubaneswar
15. AAU, Jorhat
16. PDKV, Akola
17. DBSKKV, Dapoli*
18. PJTSAU, Hyderabad
19. UAS, Raichur*
20. TNAU, Coimbatore
21. KAU, Thrissur
22. UAS, Bengaluru
23. SKUAST, Jammu

Volunteer Centres

i SKUAST, Kashmir
ii SVBPAUT, Meerut
iii RAU, Sabour (Bihar)
iv Pajncoa & RI Punducherry
v ICAR-CARI, Port Blair

* These centres are closed w.e.f. - 01-04-2018

2. STAFF POSITION AND EXPENDITURE

AICRP on Weed Management is presently under operation in 17 State Agricultural Universities in 17 different states of the country. These centres represent 17 agro-ecological regions. Altogether, 63 scientists of different disciplines (Agronomy, Plant Physiology, Taxonomy, Residue Chemistry and Microbiology) are working in inter-disciplinary mode. Besides 23 main centres, 5 volunteer centres are also in operation. The details of staff position and funds allocated in the financial year 2017-18 are given below:

Staff position at different coordinating centres during 2017-18

Centre	Scientific		Technical (Including Driver)		Administrative		Supporting	
	Sanctioned	Filled	Sanctioned	Filled	Sanctioned	Filled	Sanctioned	Filled
PAU, Ludhiana	4	4	3	3	1	-	2	1
UAS, Bengaluru	4	2	3	3	1	1	2	1
RVSKVV, Gwalior	3	2	2	2	1	-	2	2
GBPUAT, Pantnagar	4	4	1	1	1	1	2	1
CSKHPKV, Palampur	4	4	3	3	1	1	2	2
AAU, Jorhat	4	4	3	3	1	1	1	1
AAU, Anand	4	4	3	2	-	-	2	-
TNAU, Coimbatore	4	4	3	3	1	1	2	2
NDUAT, Faizabad*	4	2	2	2	1	-	2	1
BAU, Ranchi*	3	2	2	2	1	1	1	1
KAU, Thrissur	4	4	2	2	1	1	1	1
OUAT, Bhubaneshwar	3	3	3	3	1	-	1	1
PJTSAU, Hyderabad	3	3	1	1	1	-	1	1
CCSHAU, Hisar	4	3	2	2	1	-	2	1
RAU, Pusa*	3	2	1	1	1	1	1	1
DBSKKV, Dapoli*	2	2	1	1	1	1	1	1
IGKVV, Raipur*	3	3	1	1	1	1	1	1
PDKV, Akola	2	2	1	1	1	-	1	1
CAU, Pasighat*	2	1	1	-	1	-	1	-
UAS, Raichur*	2	2	1	1	1	1	1	1
MPUAT, Udaipur	2	2	1	-	1	-	1	-
SKUAST, Jammu	2	2	1	-	1	1	1	1
BCKV, Kalyani	2	2	1	-	1	1	1	1
Total	**72**	**63**	**42**	**37**	**22**	**12**	**32**	**23**

* These centres are closed w.e.f. - 01-04-2018 along with post.

Funds released to different coordinating centres during the financial year 2017-18

(` in lakhs)

Sl. No.	Centre name	Capital	Salary	TA	Research and Operations	Infrastructure	Repair & Maintenance	Miscellaneous expense other item	Total ICAR Share
1	PAU, Ludhiana	0.00	52.58	0.95	2.65	0.31	0.17	1.00	57.66
2	UAS, Bengaluru	0.00	41.26	1.05	2.75	0.46	0.17	1.00	46.69
3	RVSKVV, Gwalior	0.00	39.74	0.78	2.40	0.27	0.17	1.00	44.36
4	GBPUAT, Pantnagar	0.00	47.46	0.97	3.00	0.33	0.17	1.25	53.18
5	CSKHPKV, Palampur	0.00	42.68	0.88	3.00	0.27	0.17	2.00	49.00
6	AAU, Jorhat	0.00	53.08	1.02	3.25	0.44	0.17	1.00	58.96
7	AAU, Anand	0.00	48.49	0.88	3.00	0.27	0.17	1.00	53.81
8	TNAU, Coimbatore	0.00	65.60	0.97	3.20	0.37	0.17	2.00	72.31
9	NDUAT, Faizabad*	0.00	34.91	0.65	2.68	0.12	0.12	0.00	38.48
10	BAU, Ranchi*	0.00	26.70	0.51	2.10	0.17	0.17	0.00	29.65
11	KAU, Thrissur	0.00	55.48	0.97	3.00	0.27	0.17	1.00	60.89
12	OUAT, Bhubaneshwar	0.00	30.24	0.75	2.31	0.37	0.17	1.00	34.84
13	PJTSAU, Hyderabad	0.00	50.79	0.75	2.45	0.37	0.17	1.25	55.78
14	CCSHAU, Hisar	0.45	31.27	0.88	3.00	0.37	0.17	1.50	37.64
15	RAU, Pusa*	0.00	32.70	0.51	2.25	0.17	0.17	0.00	35.80
16	DrBSKKV, Dapoli*	0.00	18.69	0.34	1.42	0.17	0.17	0.00	20.79
17	IGKV, Raipur	0.00	41.86	0.66	2.25	0.27	0.17	1.00	46.21
18	PDKV, Akola	0.90	23.31	0.44	1.54	0.27	0.17	1.00	27.63
19	BCKV, Kalyani	0.60	9.28	0.44	2.00	0.22	0.12	1.00	13.66
20	CAU, Pasighat*	0.20	0.00	0.20	0.37	0.08	0.08	0.00	0.93
21	UAS, Raichur*	0.90	15.49	0.34	1.50	0.17	0.17	0.00	18.57
22	MPUAT, Udaipur	0.90	26.66	0.53	2.35	0.27	0.17	1.00	31.88
23	SKUAST, Jammu	0.90	21.73	0.53	1.52	0.27	0.17	1.00	26.12
24	PC UNIT, Jabalpur	1.88	00.00	0.00	0.00	0.00	0.00	0.00	01.88
	Total	**6.73**	**810.00**	**16.00**	**53.99**	**6.28**	**3.72**	**20.00**	**916.72**

* These centres are closed w.e.f. - 01-04-2018.

3. RESEARCH ACHIEVEMENTS

WM 1 Development of sustainable weed management practices in diversified cropping systems

WM 1.1 Weed management in conservation agriculture systems

WM 1.1.1.1 Weed management in rice-green gram-rice cropping system under conservation agriculture

Cooperating centers:

Bengaluru, Dapoli, Faizabad, Hisar, Hyderabad, Jammu, Jorhat, Ludhiana, Pantnagar, Bhubneswar, Raipur and Pantnagar

A. Tillage and residue management (main plot)

Treatment	*Kharif* (Rice)	*Rabi* (Green gram)	Summer
T_1	CT (Transplanted)	CT	-
T_2	CT (Transplanted)	ZT	ZT
T_3	CT (Direct -seeded)	CT	ZT
T_4	ZT (Direct -seeded)	ZT	ZT
T_5	ZT(Direct -seeded) + R	ZT + R	ZT

CT- Conventional tillage (3-4 harrowings / cultivations followed by planking)
ZT-No tillage, opening a slice for placing seed / fertilizer leaving inter-row areas undisturbed:
R - Crop residues - all residues produced to be retained in situ on soil surface

UAS, Bengaluru

Experimental plots was mainly infested with *Cyperus difformis*, *Scirpus* sp. (sedges), *Echinochloa colona, Paspalum distichum*, *Panicum repens* (grasses); *Ludwigia parviflora, Alternanthera sessilis*, *Monochoria vaginalis*, *Marselia quadrifolia, Spilanthes acmella* (Broad leaf weeds, BLW). Pre-emergence application of pyrazosulfuron-ethyl at 25 g / ha at 3 DAS / P alone or followed by passing cono weeder (45 DAS / P) reduced the weed density over weedy check. Weed density and weed dry weight did not differ much between conventional tillage and zero tillage, similarly transplanted rice and conventional tilled rice had similar weeds at 60 DAP / S (Table 1.1.1.1). Plots treated with pyrazosulfuron ethyl alone (3.48 t / ha) or followed by (*fb*) passing cono weeder (45 DAS / P) yeilded 3.8 t / ha of grain yield. Among tillage practices rice grain yield ranged from 2.31 t / ha to 3.1 t / ha.

Table 1.1.1.1 Effect of CRP practices in weed density and weed dry weight in rice-green gram-rice cropping system

Treatments	**Weeds density (No./m^2)**				**Weeds dry weight (g/m^2)**			
.	**Sedge#**	**Grasses+**	**BLW#**	**Total#**	**Sedge#**	**Grasses+**	**BLW#**	**Total#**
T_1	1.3(20.3)	3.4(10.8)	1.5(29.6)	1.8(60.8)	0.9(7.5)	2.2(4.3)	1.1(13.0)	1.3(24.9)
T_2	1.3(23.2)	3.4(11.3)	1.5(29.6)	1.8(64.2)	0.9(8.9)	2.2(4.6)	1.1(13.3)	1.4(26.9)
T_3	1.3(23.6)	3.6(12.6)	1.5(28.7)	1.8(65.1)	1.0(9.4)	2.4(5.6)	1.1(12.5)	1.4(27.6)
T_4	1.4(22.7)	3.7(13.8)	1.5(31.5)	1.8(68.2)	1.0(8.7)	2.5(6.0)	1.2(14.5)	1.4(29.2)
T_5	1.4(25.2)	3.8(14.6)	1.5(31.6)	1.8(71.5)	1.0(10.2)	2.6(6.7)	1.2(14.9)	1.4(31.9)
SEm ±	0.043	0.200	0.021	0.024	0.031	0.109	0.017	0.021
LSD (P=0.05)	0.150	0.693	0.071	0.082	0.106	0.376	0.060	0.072
W_1	1.3(17.1)	3.3(10.4)	1.5(31.4)	1.8(59.0)	0.9(5.6)	2.1(3.5)	1.1(12.2)	1.4(21.4)
W_2	1.1(12.2)	2.7(6.6)	1.4(21.4)	1.6(40.2)	0.7(2.5)	1.5(1.3)	0.8(4.7)	1.0(8.7)

W_3	1.6(39.8)	4.7(21.0)	1.6(37.9)	2.0(98.7)	1.3(18.7)	3.5(11.5)	1.4(23.9)	1.7(54.2)
SEm ±	0.035	0.123	0.027	0.020	0.025	0.074	0.024	0.018
LSD (P=0.05)	0.104	0.368	0.082	0.060	0.076	0.223	0.072	0.055
T_1W_1	1.2(16.0)	3.2(9.0)	1.5(28.6)	1.7(53.6)	0.8(4.9)	1.9(2.7)	1.1(10.3)	1.3(18.0)
T_1W_2	1.0(10.3)	2.6(6.0)	1.3(20.0)	1.6(36.3)	0.6(2.0)	1.4(1.0)	0.8(3.8)	0.9(6.9)
T_1W_3	1.5(34.6)	4.3(17.6)	1.6(40.3)	2.0(92.6)	1.2(15.6)	3.2(9.1)	1.4(25.0)	1.7(49.7)
T_2W_1	1.3(17.0)	3.1(8.6)	1.5(29.6)	1.8(55.3)	0.9(5.4)	1.9(2.7)	1.1(11.2)	1.3(19.4)
T_2W_2	1.1(11.0)	2.7(6.6)	1.4(20.6)	1.6(38.3)	0.6(2.3)	1.5(1.2)	0.8(4.3)	1.0(7.9)
T_2W_3	1.6(41.6)	4.4(18.6)	1.6(38.6)	2.0(99.0)	1.3(19.1)	3.3(9.8)	1.4(24.3)	1.7(53.4)
T_3W_1	1.2(16.0)	3.2(9.3)	1.5(31.0)	1.8(56.3)	0.9(5.2)	2.0(3.0)	1.1(12.0)	1.3(20.4)
T_3W_2	1.2(12.6)	2.7(6.3)	1.4(22.0)	1.6(41.0)	0.7(2.7)	1.5(1.2)	0.8(4.8)	1.0(8.8)
T_3W_3	1.6(42.3)	4.8(22.3)	1.5(33.3)	2.0(98.0)	1.3(20.3)	3.7(12.5)	1.3(20.6)	1.7(53.4)
T_4W_1	1.3(17.0)	3.6(12.6)	1.5(32.3)	1.8(62.0)	0.9(5.7)	2.3(4.4)	1.2(12.9)	1.4(23.1)
T_4W_2	1.2(13.6)	2.8(7.0)	1.4(22.3)	1.7(43.0)	0.7(2.8)	1.6(1.4)	0.9(5.3)	1.1(9.7)
T_4W_3	1.6(37.6)	4.8(22.0)	1.6(40.0)	2.0(99.6)	1.3(17.7)	3.6(12.1)	1.4(25.2)	1.8(55.0)
T_5W_1	1.3(19.6)	3.6(12.3)	1.6(35.6)	1.8(67.6)	0.9(6.8)	2.4(4.5)	1.2(14.6)	1.4(26.0)
T_5W_2	1.2(13.3)	2.9(7.3)	1.4(22.0)	1.6(42.6)	0.7(2.9)	1.6(1.6)	0.9(5.5)	1.1(10.0)
T_5W_3	1.6(42.6)	5.0(24.3)	1.6(37.3)	2.0(104.3)	1.3(20.9)	3.9(14.1)	1.4(24.6)	1.8(59.6)
SEm ±	0.070	0.245	0.054	0.040	0.050	0.149	0.048	0.037
LSD (P=0.05)	0.209	0.736	0.163	0.121	0.151	0.446	0.144	0.111

Data analyzed using transformation, + = square root of (X + 1), # = Log (X+2) values within the parentheses are original values; BLW = Broad leaf weeds

DBSKKV, Dapoli

Effect of tillage and residue management did not influence weed density of dicots and monocots at 30 DAS and at harvest. Among weed management practices, application of oxadiargyl 0.1 kg/ha *fb* 1 HW at 40 DAS/DAT recorded significantly lower weed density of monocots and BLWs over oxadiargyl alone and weedy check during all the stages of observations. In mustard, application of pendimethalin *fb* 1 HW at 40 DAS exhibited highest WCE % and harvested highest seed and straw yield. Similarly, in cowpea, tillage had no significant effect on weed density and dry biomass. Amongst the weed management practices pendimethalin *fb* 1 HW at 40 DAS significantly suppressed the weeds and resulted in higher weed control efficiency and seed yield over weedy check.

NDUAT, Faizabad

Major weed species in rice was *E. colona*, *E. crus-galli*, *E. indica*, *D. aegyptium*, *C. axillaris*, *A. sessilis*, *E. alba*, *Cyperus* sp. and *F. miliacea*. Among the tillage practices, there was no significant deviation was observed in with respect of weed density and dry biomass, whereas, transplanted rice obtained highest grain yield (4.9 t/ha) and straw yield (6.5 t/ha). Amongst weed management, integration of weed management practices (herbicide + one hand weeding) significantly increase in panicle (252.4 number/m^2), grain yield (5.8 t/ha) and straw yield (7.1 t/ha) of rice over others. Highest improvement in physico-chemical and microbial properties of soil was observed under wheat ZT + R- *Sesbania* ZT + DSR + ZT + ZT treatment in both the crop components in presence of residues of preceding crop during wheat followed by *Sesbania* and rice crops caused more accumulation of organic matter on the soil surface and as consequence increased the abundance of microbial population (bacteria, fungi, actinomycetes and fertility status (available N, P and K).

CCSHAU, Hisar

In rice–wheat system, *Phalaris minor* was the dominant weed in wheat. Among tillage and residue management, the lowest emergence of *P. minor* was recorded with ZT with previous crop residues (7.6-9.7/m^2) over ZT/CT wheat without crop residues (15.2-30.6/m^2). Wheat grain yield was higher with ZT/CT-DSR (5.4-5.5 t/ha) followed by conventional PTR (5.1 t/ha). During *Kharif* 2017, grain yield of rice under DSR was lower (2.6-2.8 t/ha) than CT-PTR (3.0-3.1 t/ha) due to incidence of brown spot disease in DSR. However, system yields of DSR based rice-wheat were similar to PTR based rice-wheat system.

PJTSAU, Hyderabad

Tillage and residue management has significant influence on weed density and dry biomass at 30 DAT/60 DAS. Transplanted rice has lowest weed dry biomass as compared to CT (directed seeded), ZT and ZT+R tillage practices. More productive tillers, grains/panicle, test weight and lower weed index were noticed with CT transplanted rice owing to this higher grain (5.3 t/ha) and straw yield which was significantly superior over CT, ZT and ZT+R sown under aerobic system (directed). Integrated weed management practice (PE of pendimethalin 1000 g/ha *fb* bispyribac sodium 25 g/ha at 20 -25 DAS and 2,4-D sodium salt at 60 DAS) significantly reduced the weed density and weed dry biomass followed by chemical weed management and resulted in more grain and straw yield. At 30 DAS, significantly low weed biomass (4.42 g/m^2) was noticed in *Rabi* maize with conventional tillage compared to ZT. Integrated weed management recorded significantly lowest weed biomass compared to weedy check. However there was no significant interaction effect due to tillage practices and methods of weed control.

SKUAST, Jammu

In wheat, major weed flora was *Phalaris minor, Cynodon dactylon, Rumex dentatus, Ranunculus arvensis, Anagallis arvesnsis, Melilotus indica* and *Vicia* spp. Among the tillage and residue management treatments, significantly lower grassy, broad-leaved, total weed density and weed biomass were recorded in ZT-wheat+R as compared to CT-wheat and ZT-wheat. Among weed management, integrated weed management (sulfosulfuron + metsulfuron 32 g/ha at 30 DAS *fb* HW at 45 DAS) recorded significantly higher panicles/m^2, grain and straw yields and B: C of wheat then weedy check and alone chemical (sulfosulfuron + metsulfuron 32 g/ha at 30 DAS). The non-significant interaction was found between tillage and weed management treatments with respect to growth, yield attributes and yield of wheat.

In rice, *Echinochloa* sp., *Cynodon dactylon* and *Digitaria sanguinalis* (grass); *Alternanthera philoxeroides, Caesulia axillaris, Phyllanthus niruri* and *Physalis minima* (broad-leaf) and *Cyperus* sp. (sedge) were major and *Ammannia baccifera* and *Commelina benghalensis* were other weed recorded. Transplanted rice had significantly lower grassy, broad-leaved, sedges, total weed density and weed biomass as compared to ZT-DSR+residue, ZT-DSR and CT-DSR. Among the weed management treatments, weedy check has highest weed density and weed biomass. Integrated weed management (herbicide + one hand weeding) recorded significantly lower density and biomass of weeds over weedy check and herbicidal treatment.

AAU, Jorhat

Major broad leaved weeds, *viz. Ageratum houstonianum* and *Polygonum glabrum*, grassy weeds like *Cynodon dactylon, Digitaria setigera, Echinochloa crus-galli, Eleusine indica* and *Panicum repens* and *Cyperus rotundus* was major sedge present in DSR. Transplanted rice was mainly infested with *Cyperus iria, Fimbristylis littoralis* and *Scirpus juncoides* (sedges), *Monochoria vaginalis, Sagittaria guayanensis* and *Sphenochlea zeylanica* (broadleaf) and *Echinochloa crus-galli, Leersia hexandra* and *Sacciolepis interrupta* (grass). Weed density and weed dry biomass was lower with transplanted rice followed by DSR (Table 1.1.1.2.). At 30 DAS, the lowest weed density was observed in pretilachlor 0.75 kg/ha *fb* hand weeding. With advancement of crop at 40 DAS, significant difference in weed density among these two treatments was observed.

Table 1.1.1.2 Effect of tillage practices and weed management on weed dry matter and weed density at 20 and 40 DAS of winter rice in *Sesbania* - winter rice - Indian mustard (IM) sequence

Treatment	Weed dry matter (kg/ha)		Weed density (no./m^{-2})	
	20 DAS	40 DAS	20 DAS	40 DAS
Tillage practices				
CT(S)-CT(TR)-CT(IM)	5.13(26.7)	4.71(24.1)	5.23(27.8)	7.87(70.3)
MT(S)-CT(TR)-MT(IM)	5.25(27.4)	4.70(23.8)	5.25(27.5)	7.80(70.1)
MT(S)-CT(DSR)-CT(IM)	5.59(31.2)	5.26(30.3)	5.87(34.2)	9.12(94.5)
MT(S)-MT(DSR)-MT+R(IM)	5.34(28.7)	4.96(27.2)	5.70(33.4)	8.17(75.0)
MT(S)-MT(DSR)-MT(IM)	5.30(27.9)	4.99(27.1)	5.67(32.9)	8.26(75.5)
SEm±	0.07	0.08	0.14	0.25
LSD (P=0.05)	0.24	0.26	0.46	0.82
Weed management				
Pretilachlor 0.75 kg / ha PE	4.62(20.9)	5.59(30.9)	4.70(21.9)	9.39(88.5)
Pretilachlor 0.75 kg / ha PE + hand weeding at 30 DAS	4.65(21.1)	2.93(8.1)	4.69(21.7)	4.04(16.0)
Hand weeding at 20 and 40 DAS	6.01(35.6)	3.93(15.0)	6.33(39.7)	7.36(53.8)
Weedy check	6.03(35.8)	7.24(52.0)	6.45(41.4)	12.20(150.1)
SEm±	0.06	0.06	0.11	0.21
LSD (P=0.05)	0.19	0.18	0.32	0.62
Interaction (T X W)				
SEm±	0.14	0.14	0.25	0.48
LSD (P=0.05)	0.41	0.40	NS	NS

PAU, Ludhiana

In wheat, major weeds were *Phalaris minor* (grass) and *Rumex dentatus, Coronopus didymus, Anagallis arvensis, Chenopodium album* and *Medicago denticulata* (broad leaf). Among tillage and residue management, CT-wheat, following CT-DSR recorded significantly higher density and biomass of *P. minor* than all other tillage and residue management treatments at 30 and 60 DAS. ZT wheat with residue retention, following ZT-DSR, recorded the lowest density of all the weeds. *Phalaris minor*, *R. dentatus*, *A. arvensis* and *C. album* were the major weeds found in seed bank during *Rabi* 2016-17. Unlike last year, *P. annua* was not observed while *C. album* was added to the soil seed bank. Interaction effects of tillage, residues and weed management were significant for weed seed bank of *P. minor* and *R. dentatus.* Like previous year, the lowest numbers of both *P. minor* and *R. dentatus* seeds were recorded in ZT-ZT+R-ZT. Recommended herbicides and IWM recorded significantly lower seed numbers of weed species as compared to unweeded control. All the tillage and residue management treatments gave statistically similar wheat grain yield and yield attributes; ZT+R, following DSR+R gave the highest net returns and B:C ratio. Among weed control, IWM and herbicides recorded significantly higher wheat grain yield and economic returns compared to unweeded control.

In rice, major weed was *Echinochloa colona* in PTR, whereas in DSR, weed flora included *E. colona, Dactyloctenium aegyptium, Digitaria sanguinalis, Digera arvensis, Phyllanthus niruri* and *C. rotundus.* Among tillage and residue management, PTR recorded significantly lower population and biomass of grass, broadleaf and sedges compared to DSR at 60 DAS and at harvest. At harvest, weed biomass in PTR was significantly lowest than CT-DSR. Among DSR, weed density and biomass in CT-DSR was the lowest and seconded by ZT-DSR+R; however, ZT-DSR recorded significantly higher density and biomass of weeds. Among weed control, IWM recorded significantly lower population and dry matter of grass, broadleaved and sedges weeds as compared to recommended herbicides and unweeded control.

During *Kharif* 2017, *E. crus-galli, E. colona, D. aegyptium* and *Trianthema portulacastrum* were major weeds in seed bank. Weed seed bank of *E. colona* recorded significant interaction effects of tillage, residue and weed management treatments. The highest numbers of *E. colona* seeds were reported in conventional DSR followed by ZT rice with residues retained only of wheat. In unweeded treatments, higher number of *E. crus-galli, E. colona* and *D. aegyptium* seeds were observed in DSR than in TPR. Unlike last year, seeds of *Trianthema portulacastrum* were observed in all the treatments.

TPR recorded significantly higher grain yield, yield attributes and economic returns than DSR. In DSR crop, severe iron deficiency and hopper attack resulted in low yield levels; CT-DSR and ZT-DSR+R recorded significantly higher grain yield and returns than ZT-DSR. Rice grain yield, yield attributes and B:C under both weed control treatments were significantly higher than unsprayed control. IWM recorded higher gross returns than recommended herbicide treatment, but due to more cost involved in hand pulling; net returns and B:C were low compared to recommended herbicide (Table 1.1.1.3). Under recommended herbicide and IWM treatments, residues of pendimethalin and fenoxaprop-p-ethyl in soil and rice grain at harvest were below detectable limit under all the tillage and residue combination.

Among tillage and residue management systems, CT-CT and ZT-DSR + R *fb* ZT wheat + R *fb* ZT green manure system turned out to be the most energy efficient production system in wheat; in rice, CT (TPR) - CT (wheat) were more productive than DSR based systems. Among weed control, IWM was the most efficient energy production system.

Table 1.1.1.3 Effect of tillage, residue and weed management on growth, yield and yield attributes of wheat and economics of different treatments (*Rabi* 2016-17).

Treatment	Effective tillers (No./m²)	Spike length (cm)	Wheat grain yield (t/ha)	Biological yield (t/ha)	Nutrient depletion at harvest (kg/ha)			Variable cost (`/ha)	Gross returns (`/ha)	Net returns (`/ha)	B:C
					N	P	K				
Tillage and residue management											
TRM1	439.3	12.6	3.2	7.2	4.1	0.5	6.2	39361	48490	9129	1.2
TRM2	458.3	12.7	3.4	8.3	7.8	1.0	11.8	34548	51951	17403	1.5
TRM3	458.8	12.6	3.8	9.4	3.7	0.5	5.6	39361	59328	19968	1.5
TRM4	478.0	12.6	3.9	8.4	5.6	0.7	8.5	34548	57752	23205	1.7
TRM5	491.5	12.6	4.0	12.7	3.4	0.4	5.1	34548	61035	26487	1.8
Sem ±	16.9	0.1	0.1	0.2	-	-	-	-	-	-	-
LSD (P=0.05)	NS	NS	NS	0.757	-	-	-	-	-	-	-
Weed management											
W1	472.4	12.6	4.8	11.7	1.2	0.2	1.8	32915	80486	47571	2.4
W2	481.3	12.7	5.1	11.5	0.6	0.1	0.8	44653	82533	37881	1.8
W3	441.8	12.6	1.0	4.5	16.5	2.2	24.8	31853	16948	-14904	0.5
SEm ±	12.4	0.1	0.03	0.2	-	-	-	-	-	-	-
LSD (P=0.05)	NS	NS	0.09	0.78	-	-	-	-	-	-	-
Interaction LSD (P=0.05)	NS	NS	NS	2.282	-	-	-	-	-	-	-

MSP of wheat: ` 16250 / t

GBPUAT, Pantnagar

Major weed flora in the study area under weedy check were *P. minor* (37.4%), *M. denticulata* (3.5%),*P. plebeium* (1.0%), *C. didymus* (3.4%), *M. alba* (9.7%), *C. album* (7.5%), *V. sativa* (0.8%), *R. acetosella* (31.9%) and *C. rotundus* (4.6%) at 60 DAS. Higher *P. minor* density was observed in CT while *M. denticulata* and *C. didymus* density was lower in CT, *P. plebeium* and *C. album* was found minimum with zero tillage along with residue retention which was significantly superior to rest of the establishment system. Residue retention with ZT-DSR as well as CT—TPR along with zero tillage wheat and *Sesbania* achieved lowest density of *M. alba* which was significantly superior to rest of the treatments. CT with or without *Sesbania* as well as CT- TPR and ZT wheat along with *Sesbania* recorded lowest density of *V. sativa*. CT as well as CT-TPR and ZT wheat along with *Sesbania* recorded lowest density of *C. rotundus* which was significantly superior to rest of the treatments. Among establishment systems, CT-TPR recorded maximum number of panicles/m^2, grains/panicle and test weight which was comparable to conventional till system (TPR) with inclusion of *Sesbania*. Grain and straw yield of rice was achieved maximum with CT-TPR with inclusion of *Sesbania* which was found at par with CT-TPR. Among weed management practices, IWM found superior towards recording maximum yield attributing characters and yield of rice which was significantly superior to recommended herbicide practice.

Interaction between the establishment method and weed control treatments significantly affected the yield of rice (Table 1.1.1.4). TPR (CT)-wheat (ZT)-*Sesbania* (ZT) recorded maximum grain yield of rice with integration of IWM practices which was superior to rest of the establishment system in combination with other weed management practices except TPR (CT)- wheat (CT) and TPR (CT)-wheat (ZT)-*Sesbania* (ZT) along with weed management practices, IWM and recommended herbicide, respectively. Among different establishment methods, the highest net return and benefit cost ratio of ` 73,638.3 and 1.9 respectively was recorded in the plots where wheat was sown in the TPR (CT)-wheat (ZT)-*Sesbania* (ZT) incorporated as green manure system while within weed management practices, IWM clodinafop + MSM at 64 g/ha + HW recorded the highest net return (` 110673.3) and benefit cost ratio (1.8).

Table 1.1.1.4 Interaction effect of establishment methods and weed management on grain yield of rice in rice-wheat cropping system

Treatment	TPR (CT) - Wheat (CT)	TPR (CT) - Wheat (ZT) - *Sesbania* (ZT)	DSR (CT) - Wheat (CT) - *Sesbania* (ZT)	DSR (ZT) - Wheat (ZT) - *Sesbania* (ZT)	DSR (ZT) + R-Wheat (ZT) + R- *Sesbania* (ZT)	Mean
Bispyribac-Na 20 g/ha	4.6	4.9	3.5	2.3	3.4	3.7
IWM (Recomended herbicide *fb* HW)	5.2	5.4	4.5	3.0	3.8	4.4
Weedy check	4.1	4.3	0.1	0.1	0.1	1.7
Mean	4.6	4.9	2.7	1.8	2.4	
LSD (P=0.05)	0.6					

HW: hand weeding

OUAT, Bhubaneswar

Major weed flora was *E. crus-galli, E. colona, P. scorbiculatum, C. dactylon* among grasses, *M. quadrifolia, A. sessilis, L. parviflora* among broadleaved weed, *C. difformis, C. iria, C. rotundus* and *F. miliacea* among sedges. At 60 DAP, the lowest weed density and weed dry biomass was recorded CT over CT-DSR. Application of butachlor 1.5 kg/ha significantly reduced weed density to the tune of 57% over unweeded check, subsequent use of mechanical weeding along with butachlore 1.5 kg/ha further improved the weed control efficiency by 64%. The rice grain yield was not much influenced by tillage, whereas, integrated weed management (butachlore *fb* mechanical weeding) harvested with 3.43 t/ha which was at par to butachlore 1.5 kg/ha (3.3 t/ha).

IGKV, Raipur

Major weed flora was *E. colona* and *Ischaemum rugosum* (grass), *Cyperus iria* (sedge), *Alternanthera triandra, Spilanthes acmella, Cynotis axillaris, Commelina benghalensis, Ludwigia parviflora* (BLW) *etc*. Broad leaf weeds and sedges were the dominated weed flora at all the growth stages as compared to grasses. Other weeds were also found in irregular and less number. Weed density and weed biomass recorded at 30, 60 DAS/T and at harvest revealed that tillage practices caused remarkably variation in weed density at all the stages of crop growth. The lowest weed density was found under CT (Transplanted) over CT, ZT (DSR) and ZT (DSR) with residue at all the stages. However, in case of DSR, weed density was lower in ZT (DSR) with residue. As regards to weed management the lower density of total weeds was less under integrated weed management followed by recommended herbicide over control (Table 1.1.1.5).

Table 1.1.15 Weed density at harvest as influenced by weed management practices in conservation agriculture in rice, (*Kharif* 2017)

Treatments		Weed density, m^{-2}				
Main plot	Sub plot	*A. triandra*	*C. axillaris*	*S. acmella*	Others	Total
CT (Transplanted)	Recommended (pyrazosulfuron 20 g/ha *fb* pinoxsulam 22.5 g/ha POE)	2.12 (4.0)	3.39 (11.0)	2.12 (4.0)	1.58 (2.0)	4.64 (21.0)
	Integrated weed management (oxadiargyl 80 g PE *fb* hand weeding at 25 DAT/S	1.58 (2.0)	3.24 (10.0)	1.58 (2.0)	1.58 (2.0)	4.06 (16.0)
	Control	3.67 (13.0)	3.39 (11.0)	1.87 (3.0)	3.24 (10.0)	6.12 (37.0)
CT (Transplanted)	Recommended (pyrazosulfuron 20 g/ha *fb* pinoxsulam 22.5 g/ha POE)	2.12 (4.0)	3.08 (9.0)	2.35 (5.0)	2.35 (5.0)	4.85 (23.0)
	Integrated weed management (oxadiargyl 80 g PE *fb* hand weeding at 25 DAT/S	2.35 (5.0)	2.55 (6.0)	1.87 (3.0)	3.39 (11.0)	5.05 (25.0)
	Control	2.74 (7.0)	3.39 (11.0)	2.35 (5.00)	3.54 (12.0)	5.96 (35.0)
CT (Direct seeded)	Recommended (pyrazosulfuron 20 g/ha *fb* pinoxsulam 22.5 g/ha PoE)	1.87 (3.0)	3.39 (11.0)	2.55 (6.0)	3.81 (14.0)	5.87 (34.0)
	Integrated weed management (oxadiargyl 80 g PE *fb* hand weeding at 25 DAT/S	2.92 (8.0)	3.08 (9.0)	2.55 (6.0)	2.55 (6.0)	5.43 (29.0)
	Control	3.54 (12.0)	5.05 (25.0)	3.39 (11.0)	2.12 (4.0)	7.25 (52.0)
ZT (Direct seeded)	Recommended (pyrazosulfuron 20 g/ha *fb* pinoxsulam 22.5 g/ha PoE)	1.22 (1.0)	4.18 (17.0)	1.87 (3.0)	2.74 (7.0)	5.34 (28.0)
	Integrated weed management (oxadiargyl 80 g PE *fb* hand weeding at 25 DAT/S	2.35 (5.0)	2.35 (5.0)	2.74 (7.0)	2.92 (8.0)	5.05 (25.0)
	Control	3.54 (12.0)	3.94 (15.00)	1.58 (2.0)	3.39 (11.0)	6.36 (40.0)
ZT (Direct seeded) + R	Recommended (pyrazosulfuron 20 g/ha *fb* pinoxsulam 22.5 g/ha PoE)	2.12 (4.0)	3.24 (10.0)	1.87 (3.0)	3.24 (10.0)	5.24 (27.0)
	Integrated weed management (oxadiargyl 80 g PRE *fb* hand weeding at 25 DAT/S	2.92 (8.0)	3.67 (13.0)	2.35 (5.0)	1.58 (2.0)	5.34 (28.0)
	Control	3.81 (14.0)	3.81 (14.0)	2.74 (7.0)	2.35 (5.0)	6.36 (40.0)

Significantly higher number of effective tillers was observed under CT (transplanted) – CT followed by CT (transplanted) – ZT. However, lower number of effective tillers was obtained under ZT (DSR) + R which were comparable with all the ZT (DSR) – ZT tillage practices. Among weed management practices, integrated weed management through oxadiargyl 80 g PRE *fb* hand weeding at 25 DAT/S produced the significantly higher number of effective tillers over recommended practice and unweeded check.

The grain yield of transplanted rice under CT was significantly superior over DSR with CT, ZT and ZT+ R. Among the DSR the highest yield was obtained under CT (DSR) whereas the lowest grain yield of rice was recorded under ZT (DSR) which was statistically at par with ZT (DSR) + R. Among weed management practices, significantly higher grain yield was recorded under oxadiargyl 80 g PRE *fb* HW at 25 DAT/S. Pyrazosulfuron 20 g/ha *fb* pinoxsulam 22.5 g/ha POE was next in order. Both the weed management practices were significantly superior over untreated control. Net income and B:C ratio (1.54) was higher under CT (transplanted) followed by CT (DSR). However, the lowest net return (` 9250) and B:C ratio were obtained under ZT (DSR). Among the weed management practices higher net return (` 31,600) and B : C ratio (2.6) were found in IWM followed by chemical weed management (3.4t / ha).

Physico-chemical properties of soil was evaluated with respect of different tillage and weed management practices. Study was started by taking wheat as a first crop and continued up to the harvest of paddy which was the third crop in the cycle (end of *Kharif 2017*). Significantly lower electrical conductivity (EC) of soil was observed in plots where weed management treatments applied under transplanted conditions. It might be due to washout of soil salt under water logging transplanted conditions. The OC was found significantly higher under zero tillage conditions (ZT-ZT-ZT) over CT (transplanted) and CT (DSR) tillage systems (Table 1.1.1.6).

Table 1.1.1.6 Changes in Physico-chemical properties of soil as influenced by different tillage and weed management practices

Treatment	Physico-chemical property					
	At sowing of wheat (2016-17)			After harvest of paddy (2017)		
	pH	EC	OC	pH	EC	OC
Main plot (Tillage methods)						
CT (Transplanted) -CT – CT Tillage	6.71	0.16	0.47	6.94	0.14	0.48
CT (Transplanted) -CT – ZT Tillage	6.62	0.17	0.50	6.89	0.16	0.52
CT (DSR) –CT-ZT Tillage	6.61	0.17	0.51	6.87	0.15	0.54
Zero Tillage (DSR)- ZT+ R-ZT	6.63	0.20	0.53	6.85	0.20	0.56
Zero Tillage (DSR) + R-ZT + R-ZT	6.68	0.20	0.56	6.83	0.21	0.59
LSD (P= 0.05)	N.S.	0.02	0.05	N.S.	0.02	0.06
Sub-plot (Weed management methods)						
Recommended Herbicide	6.68	0.17	0.50	6.91	0.17	0.52
Integrated Weed Management	6.62	0.17	0.47	6.85	0.16	0.50
Unweeded	6.65	0.18	0.56	6.88	0.18	0.60
LSD (P= 0.05)	N.S.	N.S.	0.04	N.S	N.S.	0.05

pH: Soil reaction; EC: Electrical conductivity in dSm^{-1}; OC : Organic Carbon (%)

RAU, Pusa

Major weed flora in rice was *Echinocloa crus-galli, E. colona, Dactyloctenium aegyptium, Digitaria sanguinalis, Cynodon dactylon* (grass), *Caesulia axillaris, Lippia nodiflora, Ammannia baccifera, Eclipta alba, Phyllanthus niruri, Ipomoea aquatica* (BLW), *Cyperus rotundus, Cyperus difformis, Fimbristylis miliacea* (Sedges). Weed density at 30, 60 DAS and at harvest were the lowest in CT (Transplanted)-ZT-ZT (8.8, 10.5 and 7.5 no./m^2 respectively) and weed dry weight (14.9, 20.2 and 11.8 g/m^2, respectively) which were statistically at par with CT (Transplanted)- CT but was significantly superior over rest of the treatments under tillage and residue management. However, the highest grain yield of rice (4.75 t/ha) was recorded under CT (Transplanted) – CT- which was statistically at par with CT (Transplanted)-ZT-ZT (4.66 t/ha).

Weed flora in wheat were *Avena fatua, Cynodon dactylon, Phalaris minor, Cyperus rotundus, Anagallis arvensis, Chenopodium album, Cirsium arvense, Convolvulus arvensis, Eclipta alba, Fumaria purviflora, Lathyrus aphaca, Launia pinnatifida, Melilotus alba, Physalis minima, Rumex dentatus* and *Vicia hirsuta.* At 30 and 60 DAS, CT (Transplanted) - CT recorded lowest weed density (6.48 and 23.7 no./m^2) and weed dry weight (10.7 and 12.9 g/m^2) however, in CT (Transplanted)-ZT-ZT lower weed density (6.07 no./m^2) and weed biomass (10.1 g/m^2) were found at harvest. The highest wheat grain yield (4.75 t/ha) was recorded under CT (Transplanted) – CT, which was significantly superior to rest of the treatments. Whereas, the lowest wheat grain yield (4.18 t/ha) was recorded under treatment ZT (Direct-seeded) – ZT- ZT.

In greengram, major weed flora was *Cynodon dactylon, Cyperus rotundus, Dactylectanium aegyptium, Physalis minima, Caesulia axillaris* and *Eclipta alba.* At 30 and 60 DAS and at harvest, the lowest weed density (6.48, 33.49 and 7.75 no./m^2) and weed biomass weight (9.74, 19.0 and 10.8 g/m^2) was recorded in CT (Transplanted) - ZT - ZT. However, the highest grain yield of greengram (1.33 t/ha) was recorded under CT (Direct seeded) – CT-ZT which was significantly superior over rest of the treatments. The lowest grain yield of greengram (0.95 t/ha) was recorded under treatment ZT. The highest gross return (` 2,26,373/ha), net return (` 1,58,160/ha) and B:C ratio (3.32) were recorded under CT (Transplanted)-ZT-ZT which was significantly superior than rest of the treatments. Among weed management practices the highest gross return (` 2,40,538/ha) was recorded in integrated weed management (herbicide + hand weeding). However, the highest net return (` 1,65,718/ha) and B:C ratio (3.73) were recorded in treatment recommended herbicides.

The treatment ZT+R resulted in higher *Azotobacter* population (3.96 x 10^4 cfu/g), *Pseudomonas* population (8.71 x 10^5 cfu/g) and *Bacillus* population (6.25 x 10^5 cfu/g). Similarly ZT+R also resulted in significantly higher total PSB population (9.57 x 10^5 cfu/g) and CO_2 evolution (99.8 mg/1000 g soil). Zero tillage with crop residue enhanced the microbial activity expressed as CO_2 evolved mg/1000 g of soil. P solublizationg efficiency of *Pseudomonas* and *Bacillus* was also significantly more in ZT+R. Among weed management pH was recorded with following trend highest to lowest IWM>herbicide>weedy check, other parameters were comparable with each others.

WM 1.2 Weed management in maize based cropping system

Field experiments were carried out at Coimbatore, Ranchi and Udaipur centres to develop information on weed population dynamics in maize based cropping system.

TNAU, Coimbatore

In maize-sunflower cropping system under conservation agriculture, predominant broad leaved weeds were *Trianthema portulacastrum*, *Digera arvensis* and *Parthenium hysterophorus* and in grassey weeds *Cynodon dactylon*, *Dactyloctenium aegyptium* and *Chloris barbata* were found whereas *Cyperus rotundus* was the only sedge present. There was no distinct difference in relative weed density in maize-sunflower cropping system. Amongst weed management methods, pre emergence application of atrazine 0.5 kg/ha with hand weeding on 45 DAS and PE pendimethalin 1.0 kg /ha + HW on 45 DAS resulted in lower percentage of grasses and broad leaved weeds.

In sunflower, at 45 days significantly lower total weed density and dry weight (30.82/m^2 and 14.87 g/m^2) were recorded in ZT-ZT+R system and resulted in higher weed control efficiency (76.10%) at 60 DAS. Among different tillage methods, zero tillage method in ZT-ZT+R system recorded significantly higher seed yield (2.26 t / ha), net return (` 23035 / ha) and B: C ratio (2.14) over others. Among weed management practices, PE pendimethalin at 1.0 kg / ha + HW on 45 DAS recorded lower weed density and dry weight (26.16 no. / m^2 and 13.62 g / m^2) and it was followed by PE pendimethalin at 1.0 kg / ha. This leads to obtain higher weed control efficiency (81.3%) at 60 DAS. PE pendimethalin at 1.0 kg / ha + HW on 45 DAS recorded higher seed yield (2000 kg / ha), net return (` 17223 / ha) and B: C ratio (1.76) in sunflower.

Total bacteria, fungi, actinomycetes and soil enzymes, *viz*. alkaline phosphatase and dehydrogenase were significantly higher in ZT-ZT+R system and in PE pendimethalin at 1.0 kg / ha + HW on 45 DAS. Among the tillage method, conventional tillage in ZT-ZT+R system recorded maximum number of total bacteria, fungi, actinomycetes, alkaline phosphatase and dehydrogenase. Among the weed management practices, PE atrazine at 0.5 kg / ha + HW on 45 DAS recorded maximum number of microbial population and soil enzymes in sunflower at 60 DAS.

In maize, among tillage methods, significantly lower total weed density and dry weight (31.46 / m^2 and 19.97 g / m^2) was recorded in conventional tillage in CT-CT system resulted in 80.2% WCE. Among weed management practices, PE atrazine at 0.5 kg / ha + HW on 45 DAS recorded lower weed density and dry weight (13.1 / m^2 and 10.1 g / m^2) leads to higher WCE (86.4%) and it was followed by PE atrazine at 0.5 kg / ha + PoE 2,4-D application. Among different tillage methods, conventional tillage method in CT-CT system recorded significantly higher grain yield (5.23 t / ha), higher net return (` 35569 / ha) and B: C ratio (2.47). Atrazine at 0.5 kg / ha + HW on 45 DAS recorded seed yield of 5.34 t / ha, higher net return of ` 36360 / ha and B:C ratio (2.46) over others.

Total bacteria, fungi, actinomycetes and alkaline phosphatase and dehydrogenase were significantly higher in zero tillage in ZT-ZT+R system on par with conventional tillage in CT-CT system. Among the weed management practices, PE atrazine at 0.5 kg / ha + HW on 45 DAS recorded the higher population of total bacteria, fungi, actinomycetes and phospho-bacteria, alkaline phosphatase and dehydrogenase 60 DAS.

CSKHPKV, Palampur

During 2013-14, *Avena ludoviciana*, *Coronopus didymus*, *Phalaris minor*, *Lolium temulentum* and *Vicia sativa* were major weed flora in wheat. Whereas, *Phalaris*, *Avena* and *Lolium* were not recorded during 2016-17. *Erodium cicutarium*, *Euphorbia helioscopia* and *Oxalis corniculata* were the new weeds. In *Kharif* maize, *Echinochloa* sp. and *Panicum dichotomiflorum* those observed in *Kharif* 2014 were not recorded in the survey of *Kharif* 2017. *Ageratum conyzoides*, *Echinochloa* sp., *Commelina benghalensis*, *Digitaria sanguinalis*, *Panicum* sp. and *Cyperus* sp. were recorded in maize during 2014. During 2017, the density of *Ageratum conyzoides* and *Commelina benghalensis* significantly increased and *Cynodon dactylon* was emerged.

Among weed management, herbicide applied plots recorded significantly higher yield of maize and wheat. In inter cropped wheat, yield was significantly reduced due to replacement of wheat rows with intercrop. But in maize, soybean was additional crop without changing the plant density of maize, hence higher yield obtained. IWM was comparable to herbicide and hand weeding in influencing maize fodder yield. Interaction between tillage and weed management practices was significant for wheat grain as well as maize fodder. ZT+IWM – ZT+IWM resulted in significantly higher wheat grain yield, whereas, rest of the treatments were comparable. Overall system's net returns were not significantly influenced under tillage treatments but weed management practice in system found significant variation in overall system's net returns. As herbicidal treatment is cheap, H-H gave significantly higher net returns over INM-INM or HW-HW treatments (Table 1.1.2.2).

Table 1.1.2.2 Effect of tillage and weed management on yield and economics during 2016-17

Weed management	Tillage					
	CT-CT	CT-ZT	ZT-ZT	ZT-ZTR	ZTR-ZTR	Mean
Wheat grain (t/ha)						
H-H	3·3	3·8	3·3	3·8	3·7	3·6
IWM-IWM	2·0	1·9	2·8	2·4	2·1	2·2
HW-HW	3·0	3·2	3·0	3·4	3·1	3·2
Mean	2·8	3·033	3·0	3·2	3·0	
LSD (P=0.05)		M	S	M*S		
		NS	401	459		
Maize fodder (t/ha)						
H-H	20.5	17.5	24.1	20.0	18.7	20.1
IWM-IWM	23.2	22.3	21.7	21.9	18.9	21.6
HW_HW	20.7	22.8	19.6	23.7	21.7	21.7
Mean	21.5	20.9	21.8	21.9	19.8	
LSD (P=0.05)		M	S	M*S		
		NS	NS	3.1		
Wheat grain equivalent (kg/ha)						
H-H	7.3	7.2	8.0	7.7	7.4	7.5
IWM-IWM	7.9	7.3	8.2	8.0	7.4	7.8
HW-HW	7.1	7.7	6.8	8.1	7.3	7.4
Mean	7.4	7.4	7.7	7.9	7.4	
LSD (P=0.05)		M	S	M*S		
		NS	NS	716		
Net return (000' INR/ha/annum)						
H-H	74.2	82.8	99.5	87.4	75.8	84.0
IWM-IWM	48.0	46.6	75.3	64.7	44.7	55.9
HW-HW	27.4	46.3	33.3	54.1	31.3	38.5
Mean	49.8	58.6	69.3	68.8	50.6	
LSD (P=0.05)		M	S	M*S		
		NS	27.3	NS		

BAU, Ranchi

Conventional tillage in *Kharif* and *Rabi* reduced the weed density and dry matter but it was not sufficient enough to reduce the wheat yield as produced under zero tillage with or without crop residue left in field. Application of 2,4-D 0.5 kg/ha similar to integrated weed management comprised of 2,4-D 0.5 kg/ha *fb* one hand weeding at 50 DAS recorded higher grain yield and net return. Conventional tillage sequences performed in *Kharif* and *Rabi* produced higher yield attributes resulting higher grain yield of wheat. Among weed control methods, IWM – IWM recorded better yield attributes resulted in higher wheat grain and straw yield followed by recommended herbicide. Conventional tillage recorded maximum gross return (` 84472) and net return (` 60549 / ha) of wheat as compared to rest of the tillage sequences. However B:C ratio was similar to CT-ZT and ZT+R-ZT+R tillage.

In maize, ZT-ZT tillage sequence recorded significantly lower density and dry biomass of narrow, broadleaved weeds and sedges. The total weeds at 30 and 60 DAS (Table 1.1.2.3) and by produced higher net return and B:C ratio, whereas the highest maize grain yield was found in CT-CT. However, ZT-ZT tillage sequence was similar to ZT-ZT+R and ZT+R-ZT+R recorded higher B:C ratio compared to CT-CT and CT-ZT. Among weed management, IWM-IWM recorded reduced weed dry weight at 30 and 60 DAS thus recorded higher net return compared to recomended herbicide.

Table 1.1.2.3. Effect of tillage and weed control methods on weed dry weight at different crop stages of maize

Treatments	Weed dry weight (g/m^2)						Total weed dry weight (g/m^2)	
		30 DAS		60DAS			30 DAS	60 DAS
	Grassy	Broad leaved	Sedges	Grassy	Broad leaved	Sedges		
Tillage methods								
CT-CT	10.26 (106)	4.61 (21.4)	4.80 (23)	9.44 (91)	5.83 (39)	6.84 (47)	12.21 (150)	12.94 (172)
CT-ZT	8.49 (73)	4.03 (15.8)	3.63 (13)	7.79 (62)	3.78 (14)	5.12 (28)	9.92 (99)	9.76 (96)
ZT-ZT	7.49 (59)	3.91 (15.6)	3.62 (14)	6.73 (49)	3.31 (13)	4.10 (19)	9.18 (89)	8.32 (76)
ZT-ZT+R	7.96 (68)	4.00 (16.5)	3.78 (15)	7.22 (56)	3.49 (15)	5.26 (28)	9.68 (101)	9.48 (96)
ZT+R-ZT+R	8.12 (67)	4.09 (16.5)	3.59 (13)	7.57 (58)	3.53 (14)	5.18 (27)	9.8 (98)	9.66 (96)
SEm ±	0.12	0.07	0.23	0.33	0.63	0.32	0.13	0.46
LSD (P=0.05)	0.39	0.21	0.75	1.08	2.04	1.05	0.44	1.50
Weed control								
R H - RH Recomended herbicide	8.10 (67)	4.14 (17.31)	3.58 (13)	7.18 (54)	3.81 (16)	5.04 (28)	9.73 (97)	9.40 (94)
IWM – IWM	6.99 (50)	3.58 (12.6)	3.16 (10)	6.71 (47)	3.08 (12)	4.55 (21)	8.36 (72)	8.50 (76)
WC - WC	10.30 (106)	4.67 (21.6)	4.92 (24)	9.36 (89)	5.06 (29)	6.31 (40)	12.39 (154)	12.20 (152)
SEm ±	0.08	0.03	0.14	0.24	0.28	0.30	0.08	0.24
LSD (P=0.05)	0.31	0.13	0.54	0.95	1.09	1.17	0.32	0.93
Interaction								
SEm ±	0.24	0.20	0.31	0.64	0.82	0.45	0.28	0.62
LSD (P=0.05)	0.72	0.61	NS	NS	NS	1.33	0.83	1.86
CV%	4.91	8.59	13.97	14.33	35.72	14.54	4.71	10.73

MPUAT, Udaipur

In maize, major weed species in the experimental plot were *Echinochloa colona* (30.4%), *Dinebra retroflexa* (17.4%), *Commelina benghalensis* (16.7%), *Digera arvenris* (15.7%), *Trianthema portulacastrum* (12.9%) and *Corchorus olitorious* (6.9%). *Echinochloa colona* was dominant among grassy and *Digera arvensis* was dominant among broadleaf weeds. Among tillage and residue management treatments, total weed density at 60 DAS and at harvest attained highest in the treatment maize (ZT)-wheat (ZT)- greengram (ZT) and lowest in maize (CT)-wheat (CT)- greengram (ZT). Grain and stover yield of maize did not recorded significant response with tillage and residue management practices. Among weed management, minimum number of grassy and broadleaf weeds was observed at 60 DAS and at harvest in atrazine 500 g / ha as pre-emergence *fb* hand weeding at 30-35 DAS. Similar trends were observed by weed dry matter at both 60 and harvest over weedy check. Marked increase in grain and stover yield of maize was recorded with weed management treatments. Amongst different weed management practices, highest grain yield (2.83 t / ha) and stover yield (4.29 t / ha) were obtained by controlling weeds through IWM that recorded increase in yields of 55.2 and 101.5% respectively, over weedy check.

WM 1.1.3 Pearlmillet based cropping system

RVSKVV, Gwalior

In mustard, integrated weed management (oxyfluorfen + one HW at 25-30 DAS) gave maximum seed yield (1.81 t / ha) as well as reduced the weed density and dry weight of weeds followed by pendimethalin 1.0 kg / ha PE. Conventional tillage practices CT-CT gave maximum seed yield (1.96 t / ha) as compared to other tillage practices. Similarly, highest B:C ratio was recorded in CT-CT tillage practices (3.91%). In case of weed management practices the highest B:C ratio was obtained in pendimethalin (3.65) followed by IWM practices (3.56).

In cowpea, main weeds in the experimental field were *Cyperus rotundus, Dactyloctenium aegyptium, Cynodon dactylon* and *Echinochloa colonam* (grass), *Commelina benghalensis, Convolvulus arvensis, Digera arvensis* and *Trianthema monogyna* (BLW). The NLWs were found much higher although appearance of BLWs was meagre. In sedges the *Cyprrus rotundus* was dominant from beginning to till the end of the experiment. Maximum grain yield (757.1 kg / ha) was obtained in ZT+R-ZT+R-ZT followed by CT–ZT–CT (613.6 kg / ha). Among weed management, IWM (pendimethalin + imazethapyr + one HW) gave maximum seed yield (630.7 kg / ha) as well as reduced the weed density and dry weight of weeds followed by imazethapyr + imazamox 80 g / ha PoE.

In pearlmillet, main weeds in the study area were *Echinochloa crus-galli, Celosia argentia, Acrachne racemosa, Leptochloa panicea, Cynodon dactylon, Phyllanthus niruri, Setaria glauca, Eragrostis* spp., *Brachiaria reptans, Digera arvensis, Commelina*

Table 1.1.3.1 Effect of different weed management & conservation tillage practices on grain yield, stover yield and weed biomass (kg / ha) in pearlmillet

S. N.	Treatments		Grain yield (t/ha)			Stover yield (t/ha)			Weed biomass at harvest (t/ha)		
			2015	2016	2017	2015	2016	2017	2015	2016	2017
T1	Conventional tillage (CT-CT)	Atrazine + 2,4-D	2.56	2.46	3.12	5.13	4.54	5.32	1.01	0.94	0.15
		Atrazine + 1 HW	2.08	2.51	3.90	4.38	5.52	7.32	0.54	0.57	0.03
		Weedy check	1.41	1.58	2.03	2.67	3.94	4.33	2.24	2.03	0.30
		Mean	2.02	2.18	3.02	4.06	4.66	5.66	1.26	1.18	0.16
T2	Conventional tillage (CT-ZT-ZT)	Atrazine + 2,4-D	2.06	2.45	3.09	6.20	4.55	4.87	0.85	1.06	0.21
		Atrazine + 1 HW	2.72	2.88	3.12	5.24	5.63	6.82	0.55	0.63	0.06
		Weedy check	1.66	1.76	1.88	2.56	4.05	3.57	1.87	1.65	0.30
		Mean	2.15	2.36	2.70	4.67	4.74	5.08	1.09	1.12	0.19
T3	Zero tillage (ZT-ZT-ZT)	Atrazine + 2,4-D	1.71	1.91	2.29	3.74	4.40	2.63	1.14	1.17	0.39
		Atrazine + 1 HW	2.19	2.59	2.65	4.70	4.42	3.39	0.47	0.69	0.07
		Weedy check	0.87	1.45	1.59	1.34	3.30	2.69	1.87	2.31	0.43
		Mean	1.59	1.98	2.17	3.26	4.04	2.90	1.16	1.39	0.30
T4	Zero tillage (ZT-ZT+R-ZT)	Atrazine + 2,4-D	2.20	2.34	2.25	6.09	4.35	4.80	1.25	1.19	0.28
		Atrazine + 1 HW	2.65	2.48	2.64	5.24	5.34	6.87	0.56	0.63	0.10
		Weedy check	1.14	1.29	1.81	2.08	3.04	3.06	2.08	2.22	0.36
		Mean	2.00	2.04	2.23	4.47	4.24	4.91	1.30	1.35	0.25
T5	Zero tillage + Crop residue (ZT+R-ZT+R-ZT)	Atrazine + 2,4-D	2.11	2.14	2.14	5.34	4.08	5.34	1.33	1.13	0.25
		Atrazine + 1 HW	3.28	2.61	3.00	5.98	5.07	5.44	0.55	0.61	0.08
		Weedy check	1.15	1.60	1.76	2.03	3.79	4.06	2.51	2.22	0.45
		Mean	2.18	2.12	2.30	4.45	4.31	4.95	1.46	1.32	0.26

benghalensis, Oldenlandia corymbosa, Euphorbia geniculata and *Cyperus rotundus*. Out of above weeds *Oldenlandia corymbosa* and *Euphorbia geniculata* as broad leaved weeds and *Brachiaria reptans* as narrow leaved weeds were observed as new weeds in this year.

Narrow, broad and total weed population at 30 DAS and 60 DAS were significantly influenced by tillage and weed management practices and the lowest weed density and weed biomass was recorded with conventional tillage CT-CT and CT-ZT-ZT followed by ZT+R-ZT+R-ZT. During the season, population of broad leaved weeds was observed very less in comparison to last three years. Under conservation tillage practices highest grain yield was obtained in conventional tillage (CT-CT) followed by (CT-ZT) while B:C ratio was highest (2.69) in (CT-CT) followed by (2.41). Among weed management, IWM practices (atrazine 500 g/ha PE + one HW) significantly reduced weed population and weed biomass which resulted in significant higher yield (3.06 t/ha) followed by atrazine + 2,4-D (2.58 t/ha) (Table 1.1.3.1). The highest B:C ratio was obtained in treatment atrazine + one HW (2.36).

WM 1.1.4 Soybean based cropping system

PDKV, Akola

Major weed flora during *Kharif* and *Rabi* in soybean–chickpea crop sequence in the study area comprised with *Xanthium strumarium, Celosia argentea, Tridax procumbens, Phyllanthus niruri, Portulaca olerocea, Lagascea mollis, Euphorbia geniculata Euphorbia hirta, Phyllanthus niruri, Abutilon indicum, Abelmoschus moschatus, Boerhavia diffusa, etc.* At 40 DAS, CTR registered significantly lowest weed biomass (34.7 g/m^2), whereas ZT and ZTR recorded significantly higher weed biomass (43.5 g/m^2). Lower weed biomass in CTR achieves WCE of 57% and seed yield of 2.31 t/ha followed by MTR and CT. Among weed management, diclosulam 30 g/ha PE *fb* imazethypyr + imazamox 100 g/ha POE + one hoeing/one HW 20 DAS (HHW) registered the lowest weed biomass (19.3 g/m^2) with 76% WCE, which was followed by diclosulam 30 g/ha PE *fb* imazethypyr + imazamox 100 g/ha POE (RH). However, weedy check recorded significantly highest weed biomass (79.1 g/m^2). The HHW recorded highest seed yield (2.4 t/ha) followed by RH (2.27 t/ha) and the lowest seed yield in UW (1.89 t/ha).

In chickpea at 40 DAS, CTR recorded lowest weed density and weed biomass which was closely followed by CT, whereas, the highest weed density and dry biomass was recorded in ZT followed by ZTR. Lower weed biomass help to achieved higher WCE in CTR. The lowest WCE was recorded in ZT and ZTR. The highest seed yield of 1.37 t/ha recorded with CTR, while CT (1.35 t/ha) being at par with treatment CTR. At 40 DAS, pendimethalin 1.0 kg/ha PE + one hoeing/one HW 20DAS (HHW) recorded significantly lower weed density and weed biomass followed by pendimethalin 1 kg/ha PE *fb* quizalofop-ethyl 75 g/ha POE. The highest weed control efficiency in HW may be due to better control of weeds at early stage of crop itself. At later stage, better control of weeds was due to combination of herbicides with cultural practices. The lowest WCE was found in weedy check. Lower weeds in HR resulted the higher seed yield (1.44 t/ha) followed by RH (1.32 t/ha) over (0.94 t/ha).

WM 1.1.5 Cotton based cropping system

AAU, Anand

At 30 DAS , tillage and residue management significantly influenced the weed density and weed biomass in cotton. The significantly higher weed density and weed biomass of monocot was recorded under ZT+R and ZT, respectively. Similarly, the highest weed density and weed biomass of dicot and sedges were recorded under ZT, respectively. The significantly highest total weeds density and dry biomass was observed under ZT+R, respectively. Among the weed management treatments, IC + HW at 15, 30 and 45 DAS recorded highest weed density and weed biomass in monocot weed category. Whereas, dicot weeds were highest under quizalofop-ethyl 50 g/ha PoE *fb* IC+HW at 30 DAS, whereas, both observation in sedges category were highest under pendimethalin 900 g/ha PE *fb* IC+HW at 30 and 60 DAS. Total weed density and weed biomass were highest in IC + HW at 15, 30 and 45 DAS and quizalofop-ethyl 50 g/ha PoE *fb* IC+HW at 30 DAS treatment, respectively.

Impact of different tillage and weed management practices gave significant differences among the treatments with respect to seed cotton yield. The highest seed cotton yield was obtained under conventional tillage treatment and pendimethalin 900 g/ha PE *fb* IC+HW at 30 and 60 DAS. The lowest yield was obtained under zero tillage and quizalofop-ethyl 50 g/ha PoE *fb* IC+ HW at 30 DAS (Table 1.1.4.1).

Total bacterial, fungal, actinobacteria, diazotrophs and PSM count and soil dehydrogenase activity from cotton were influenced by tillage and weed management. Tillage practices have non-significant effect on all microbial properties, although the number and microbial activities were increased in ZT+R. Regarding different weed management practices, total bacterial population and soil dehydrogenase activity were significantly influenced, while total fungal, actinobacterial, diazotrophic and PSM population were not significantly influenced at harvest.

Table 1.1.4.1 Growth attributes as influenced by tillage and weed management practices in cotton

Sr. No.	Treatments	Plant stand at 15 DAS (no./m^2)	Plant height (cm)				Seed cotton yield (t/ha)	Stalk yield (t/ha)
			30 DAS	60 DAS	90 DAS	At harvest		
Tillage and *crop residue management practices in cotton (T)*								
T1	CT - CT	35.7	37.0	98.3	133	142	2.52	5.14
T2	CT - ZT	35.7	35.7	101	128	136	2.48	5.13
T3	ZT - ZT	35.3	37.0	96.1	132	140	1.88	4.90
T4	ZT - ZR+R	35.3	37.1	97.9	122	136	1.95	4.36
T5	ZT+R - ZT+R	35.3	37.0	102	143	150	2.19	4.98
	S. Em. ±	3.84	0.44	1.7	3.6	1.24	0.05	0.16
	LSD (P=0.05)	NS	NS	NS	11.87	4.03	0.17	NS
	CV %	0.60	3.6	5.4	8.3	2.6	6.9	10.0
Weed management practices in cotton (W)								
W1	Pendimethalin 900 g/ha PE *fb* IC+HW at 30 & 60 DAS	35.6	36.6	102	130	137	2.33	5.08
W2	Quizalofop ethyl 50 g/ha PoE *fb* IC+HW at 30 DAS	34.8	36.6	90.3	125	136	2.12	4.47
W3	IC + HW at 15, 30 and 45 DAS	36.0	37.0	105	139	149	2.17	5.16
	S. Em. ±	6.94	0.34	1.98	1.98	1.37	0.05	0.07
	LSD (P=0.05)	NS	NS	7.78	7.80	5.39	NS	0.27
	CV %	0.70	3.6	7.8	5.8	3.7	8.2	5.4
	Interaction M x W	NS	NS	NS	15.4	9.49	NS	NS
	CV %	0.04	5.2	6.4	6.7	3.9	9.6	5.4

In greengram, the highest weed density was obtained under ZT + R (11.3 no./m^2) and weed biomass (11.7 g/m^2) in monocot weed category. Similarly, dicot weed density was highest observed under ZT (3.27 no./m^2) and dry biomass under CT (3.49 g/m^2). Weed density and weed biomass of sedges was observed to be highest under ZT + R (3.12 no./m^2 and 3.91 g/m^2, respectively). ZT+R and ZT had highest total weed density and weed biomass. Among weed management practices, the highest monocot (12.8 and 7.46 no/m^2), sedges (2.64 and 2.52 no./m^2) and total (13.4 and 8.82 no./m^2) weed density was observed under imazethapyr 75 g/ha POE *fb* IC + HW at 30 DAS followed by pendimethalin 500 g/ha PE *fb* IC+HW at 30 and 60 DAS. The weed dry biomass of monocot and total weeds was obtained highest under IC + HW at 20 and 40 DAS (8.80 and 9.83 g/m^2) treatment, respectively. Though, weed biomass of monocot, sedges and total weed biomass was non significant , whereas significantly highest dicot weeds biomass was obtained under pendimethalin 500 g/ha PE *fb* IC+HW at 30 DAS treatment (2.77 g/m^2).

In greengram, the highest seed yield was obtained under ZT+R – ZT+R (677 kg/ha) and pendimethalin 500 g/ha PE *fb* IC+HW at 30 DAS (720 kg/ha) followed by CT (587 kg/ha) and IC + HW at 20 and 40 DAS (620 kg/ha). The lowest seed yield was observed under ZT (547 kg/ha) and imazethapyr 75 g/ha PoE *fb* IC + HW at 30 DAS (413 kg/ha).

WP 1.2 Weed Management in organic farming systems

WP 1.2.1 Weed management under organic farming system in fennel and its residual effect on succeeding summer greengram

AAU, Anand

Fennel

Major weeds observed during the experimentation were *Eleusine indica* (36.1%), *Dactyloctenium aegyptium* (17.3%), *Commelina benghalensis* (15.8%), *Eragrostis major* (13.5%) under monocots, whereas *Oldenlandia umbellata* (58.4%), *Phyllanthus niruri* (24.7%), *Digera arvensis* (6.80%) and *Boerhavia duffusa* (4.20%) were the major dicots.

At 60 DAP, the lowest weed density and dry biomass of dicot and total weeds in organic applied plots was achieved under FYM 20 t/ha treatment (8.38 no./m^2 and 5.66 g/m^2 ; 13.5 no./m^2 and 8.12 g/m^2, respectively) and monocot weeds under vermicompost 8.0 t/ha treatment (6.69 no./m^2 and 5.62 g/m^2), respectively. Similarly, in weed management practices, pendimethalin 0.75 kg/ha pre-transplant *fb* IC + HW at 40 DATP recorded lowest weed density and dry biomass of monocot, dicot and total weed (1.0 no./m^2 and 1.0 g/m^2 in all category), respectively. At harvest, weed density under organic manures was found non-significant in monocot, dicot and total weeds (Table 1.2.1.1).

Seed yield of fennel was non-significant between different organic sources. The highest seed yield was achieved under paddy straw mulch 10 t/ha *fb* HW at 30, 60 DATP (2.84 t/ha). The lowest seed yield was observed under weedy check (0.61 t/ha).

At 45 DATP, all soil microbial parameters were found significantly influenced by application of organic manures in fennel. The highest bacterial count (61.5X10^5 CFU/g), total diazotrophs (86.8X10^3 CFU/g) and soil dehydrogenase activity (18.9 TPF/g soil/24 h) were recorded in treatment receiving application of vermicompost 8.0 t/ha. Total fungi (51.3X10^3 CFU/g), actinobacteria (78.1X10^3 CFU/g) and PSM (71.8X10^3 CFU/g) were recorded high in treatment receiving application of FYM 20 t/ha. At 90 DATP and harvest, all the parameters except fungi and dehydrogenase activity were found influenced non-significantly by application of organic manures.

For weed management practices, at 45 DATP highest microbial activity was recorded in treatment receiving application of paddy straw mulch 10 t/ha *fb* HW at 30, 60 DATP while lowest was recorded for pendimethalin 0.75 kg/ha pre-transplant *fb* IC + HW at 40 DATP. At 90 DATP and harvest influence of all weed management practices were found non-significant on microbial activity.

Table 1.2.1.1 Effect of organic manure and weed management practices on weed density, weed dry biomass at 60 DATP and seed yield in fennel

S. No.	Treatment	Weed density (no./m²)			Weed dry biomass (g/m²)			Seed yield (t/ha)
		Monocot	Dicot	Total	Monocot	Dicot	Total	
Organic manure (M)								
M_1	Farm yard manure 20 t/ha	7.63 (89.1)	8.38 (92.7)	13.5 (182)	5.68 (60.2)	5.66 (40.0)	8.12 (100)	2.03
M_2	Vermicompost 8.0 t/ha	6.69 (73.3)	9.05 (126)	14.1 (199)	5.62 (55.4)	6.05 (48.3)	8.30 (105)	2.29
	S.Em.±	0.25	0.13	0.26	0.04	0.22	0.14	0.04
	LSD (P=0.05)	NS	NS	NS	NS	NS	NS	NS
	CV%	13.7	5.8	8.9	2.9	14.8	6.9	7.9
Weed management practices (W)								
W_1	Paddy straw mulch 5 t/ha *fb* HW at 30, 60 DATP	5.17 (27.3)	13.0 (169)	14.0 (196)	4.75 (22.3)	7.08 (50.1)	8.55 (72.4)	2.29
W_2	Paddy straw mulch 10 t/ha *fb* HW at 30, 60 DATP	4.91 (24.0)	7.14 (53.7)	8.67 (77.7)	3.40 (11.4)	5.49 (29.7)	6.44 (41.1)	2.84
W_3	IC + HW at 30 and 60 DATP *fb* earthing-up at 75 DATP	7.97 (74.0)	5.47 (29.3)	9.89 (103)	3.49 (12.2)	4.90 (23.8)	6.06 (36.0)	2.80
W_4	Pendimethalin 0.75 kg/ha pre-transplant *fb* IC + HW at 40 DATP	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	2.25
W_5	Weedy check	16.8 (281)	17.0 (295)	23.9 (575)	15.6 (243)	10.8 (117)	18.9 (360)	0.614
	S.Em.±	0.34	0.29	0.31	0.19	0.30	0.27	0.05
	LSD (P=0.05)	1.01	0.87	0.92	0.57	0.91	0.81	0.15
	CV%	11.6	8.1	6.6	8.3	12.8	NS	5.6

Greengram

The lowest density of all weed categories (3.54, 2.56 and 4.27 no./m², monocots, dicots and total, respectively) was recorded under vermicompost 8.0 t/ha in organic treated plots and monocot weed (3.47 no./m²) under paddy straw mulch 5 t/ha *fb* HW at 30, 60 DAS and dicot (2.36 no./m²) and total weed (4.48 no./m²) under IC + HW at 30 and 60 DAP *fb* earthing-up at 75 DAP in weed management plots. The least dry biomass of monocot (3.52 g/m²), dicot (2.63 g/m²) and total weed (4.32 g/m²) was recorded under vermicompost 8.0 t/ha treatment. Least dry biomass of monocot (3.19 g/m²) and total weed (4.08 g/m²) under different weed management practices were recorded in pendimethalin 0.75 kg/ha pre-transplant *fb* IC + HW at 40 DAS and dicot weed (2.44 g/m²) in IC + HW at 30 and 60 DAP *fb* earthing-up at 75 DAP, respectively.

The seed yield of greengram recorded non-significant results between different organic sources, whereas weed management practices observed significant differences. The highest seed yield was recorded under vermicompost 8.0 t/ha (588 kg/ha) and paddy straw mulch 5 t/ha *fb* HW at 30, 60 DAS (613 kg/ha). The lowest seed yield under weed management practices recorded under weedy check (492 kg/ha) followed by pendimethalin 0.75 kg/ha pre-transplant *fb* IC + HW at 40 DAS (556 kg/ha). Influence of various organic manures applied in fennel-green gram cropping system achieved highest benefit : cost ratio under FYM 20 t/ha (3.56) followed by vermicompst 8.0 t/ha (3.10). Henceforth, overall combination of FYM 20 t/ha (3.56) and IC + HW at 30 and 60 DAP *fb* earthing-up at 75 DAP (3.94) proved to be superior combination of organic applied and weed management practices for fennel - green gram cropping system.

OUAT, Bhubaneswar

WP.1.2.1.2 Weed management in rice-tomato-okra system under organic farming

Treatment details:

Treatment	*Kharif*	*Rabi*	Summer
T1	50% RDF + 50%N as FYM (8 t/ha)	50% RDF + 50%N as FYM (8 t/ha)	50% RDF + 50%N as FYM (8 t/ha)
T2	Different organic sources equivalent to 1/3 of recommended N (1/3 N as FYM 5.5 t/ha, 1/3N as *Dhaincha* , 1/3 N as NEO)	Different organic sources equivalent to 1/3 of recommended N (1/3 N as FYM 5.5 t/ha, 1/3N as vermicompost, 1/3 N as NEO)	Different organic sources equivalent to 1/3 of recommended N (1/3 N as FYM 5.5 t/ha, 1/3N as vermicompost, 1/3 N as NEO)
T3	T2+*Azospirillum* + PSB	T2+*Azotobacter* + PSB	T2 + *Azotobacter* + PSB
T4	T2 + agronomic practice for weed and pest control (No chemical pesticides)	T2 + manual weed control + biopesticide	T2 + manual weed control + biopesticide
T5	T2+ residue recycling	T2+ residue recycling	T2+ residue recycling
T6 (Observation strip)	Recommended herbicide (pretilachlor 1.0 kg/ha pre-emergence)	Recommended herbicide (pendimethalin 1.0 kg/ha pre-emergence)	Recommended herbicide (pendimethalin 1.0 kg/ha pre-emergence)

RDF (kg NPK/ha): Rice/ Okra - 80 : 40 : 40, Tomato – 100 : 75 : 80 NEO – Non edible oil cake

Application of 1/3 recommended dose of N each through FYM, *Dhaincha* and neemcake alongwith *Azospirillum* + PSB to rice followed by same proportion of organics through FYM, vermicompost and neem cake + *Azotobacter* + PSB (T3) to tomato and Okra in rice-tomato-lady's finger system resulted in the maximum grain yield of rice (4.5 t/ha), fruit yield of tomato (17.7 t/ha) and Okra (7.2 t/ha) with REY of 23.6 t/ha/yr followed by T1 and T4 with REY of 21.5 and 21.4 t/ha/yr, respectively. The higher yield of T3 over other organic combinations was supported by favorable yield attributing characters of the crops in the treatment. But the same treatment (T3) with the highest gross returns of ` 2,89,217/ha/yr fetched NMR of only ` 1,24,340/ha/yr with B:C ratio of 0.75 as compared to corresponding values of ` 2,56,301/ha/yr and 0.77 in inorganic treatment (T6). Uptake of nutrients by rice (77.8 kg N, 23.7 kg P and 89.7 kg K/ha), tomato (56.3 kg N, 7.0 kg P and 94.3 kg K/ha), Okra (156.6kg N, 34.9 kg P and 210.8 kg K/ha) and the system as a whole (292.8 kg N, 65.7 kg P and 394.9 kg K/ha) were the highest in T3. Nutrient status of the soil improved with respect to organic carbon, N, P and K values in all the treatments except T6 at the end of the cropping cycle.

TNAU, Coimbatore

WP 1.2.3 (i) Non-chemical weed management in organically grown okra + leaf coriander - maize + cowpea cropping system

Weed flora of the experimental field predominantly consisted of thirteen species of broadleaved, eight species of grasses and a sedge weed. The broadleaved predominant weeds were *Trianthema portulacastrum, Digera muricata, Amaranthus viridis, Amaranthus polygamus, Portulaca oleracea, Desmodium triflorum, Parthenium hysterophorus* and *Boerhavia erecta*. Among the grasses, *Cynodon dactylon, Chloris barbata, Dactyloctenium aegyptium, Echnicholoa colona, Setaria verticillata* and *Dinebra retroflexa* were the dominant ones. *Cyperus* *rotundus* was the only sedge present in the experimental field of okra-maize cropping system.

Okra

Among different non-chemical methods, significantly lower total weed density and dry weight (3.1 no./m^2 and 1.1 g/m^2) was recorded in crop residue mulching 5 t/ha. Crop residue treatments recorded comparatively less weed density and dry weight than recommended herbicide treatment (PE pendimethalin 1.0 kg/ha) at 45 DAS. Among different non-chemical weed management methods, crop residue mulching 5 t/ha recorded significantly higher fruit yield of 30.2 t/ha. Higher net return (` 5.40 lakh/ha) and B:C ratio of 5.87 was recorded in crop residue mulching. Among non-chemical weed management practices, comparatively higher net return were recorded with crop residue treatments. The recommended herbicide treatment recorded lower net return and B:C ratio when compared to non-chemical weed management treatment in maize and okra crops.

Maize

Among different non-chemical methods in maize, significantly lower total weed density and dry weight (2.9 no./m^2 and 1.1 g/m^2) were recorded in twin wheel hoe weeding on 20 DAS + crop residue mulching 5 t/ha and this treatment recorded significantly higher weed density and dry weight than recommended herbicide treatment (PE atrazine 0.5 kg/ha) at 45 DAS. Grain yield was significantly higher (5.71 t/ha) in twin wheel hoe weeding on 20 DAS + crop residue mulching 5 t/ha and other mechanical weeding treatments had significant influence on the grain yield of maize. In this treatment higher net return (` 39546/ha) and B:C ratio of 2.61 was also recorded.

WP 1.2.3 (ii) Non-chemical weed management in organically grown beetroot - maize

The predominant among broadleaved weeds were *Trianthema portulacastrum, Digera muricata, Amaranthus viridis* and *Boerhavia erecta*. Among the grass weeds, *Cynodon dactylon, Dinebra retroflexa* and *Brachiaria reptans* were the dominant ones. *Cyperus rotundus* was the only sedge present in the experimental field of beetroot-maize cropping system. In beetroot, among different non-chemical methods in beet root, significantly lower total weed density and dry weight (3.3 no./m^2 and 1.2 g/m^2) was recorded in crop residue mulching 5 t/ha. At 45 DAS, higher weed control efficiency of 94.5% was recorded in crop residue mulching in beetroot. All other crop residue mulched plots recorded higher weed control efficiency than recommended herbicide plot at 45 DAS.Among different non-chemical weed management methods, crop residue mulching recorded significantly higher tuber yield of 71.9 t/ha. Higher net return (` 202440/ha) and B: C ratio of 7.5 was recorded in crop residue mulching. The recommended herbicide treatment recorded lower net return and B:C ratio when compared to non-chemical weed management treatments.

In maize, among different non-chemical methods in maize, significantly lower total weed density and dry weight (2.7 no./m^2 and 1.1 g/m^2) were recorded in twin wheel hoe weeder weeding on 20 DAS + crop residue mulching 5 t/ha and this treatment recorded significantly higher weed density and dry weight than recommended herbicide treatment (PE atrazine 0.5 kg/ha) at 45 DAS. Grain yield was significantly higher in twin wheel hoe weeding on 20 DAS + crop residue mulching recorded significantly higher grain yield (5.74 t/ha) and other mechanical weeding treatments had significant influenced grain yield of maize. Higher net return (` 39704/ha) and B:C ratio of 2.62 was recorded in twin wheel hoe weeding on 20 DAS + crop residue mulching.

DBSKKV, Dapoli

WM 3.2 Long-term trial on management of complex weed flora in organically cultivated rice - groundnut cropping system

The dominant weed species observed in *Kharif* rice were *Cyperus rotundus, Isachne globosa, Echinochloa colona*, among sedges and grasses whereas, among broadleaved weeds, *Celosia argentea, Alternanthera sessilis, Eriocaulon hexangularis* and *Ludwigia octovalvis* were present. Green manuring with *Sesbania rostrata* and without green manuring did not influence significantly in reducing weed density of monocots and broadleaved at all stages of observations. Application of oxadiargyl PE 0.1 kg/ha *fb* 2,4-D POE 1.0 kg/ha 25 DAT recorded significantly least weed density of monocots as well as broadleaved as compared to weedy check, while it was at par with treatment mulching with *G. maculata* (5 t/ha) 20 DAT in monocots and treatment mulching with *G. maculata* (5 t/ha) 20 DAT *fb* one HW 40 DAT in respect to broadleaved at 60 DAT. Green manuring and without green manuring were non-significant in maximum number of tillers, height, grain and straw yield. Significantly maximum number of tillers and grain yield was recorded in mulching with *G. maculata* (5 t/ha) 20 DAT *fb* one HW 40 DAT and mulching with *G. maculata* (5 t/ha) 20 DAT *fb* one hoeing with cono weeder 40 DAT in respect to grain yield.

In groundnut, dominant weed species observed in R*abi* groundnut were *Cyperus rotundus, Oryza sativa,* among sedges and grasses, whereas among broadleaved weeds *Ludwigia octovalvis, Cardiospermum helicacabum, Mimosa pudica, Cleome viscosa, Physalis minima* and *Blumea lacera* were present. Mulching with black polythene (7 micron) recorded significantly least weed density of monocots as well as broadleaved as compared to rest of the treatments except application of pendimethalin PE 1.0 kg/ha *fb* imazethapyr POE 100 g/ha 25 DAT during 30 and 60 DAS. While at harvest mulching with black polythene (7 micron) recorded significantly least weed density of monocots as well as broadleaved as compared to rest of the treatments.

NDUAT, Faizabad

WP1.2.5 Weed management in turmeric based organic cropping system

The weed flora of the experimental field was *Echinochloa* spp., *Dactyloctenium aegyptium* and *Elesine indica* among grasses, *Ludwigia* sp., *Commelina benghalensis, Ammania baccifera, Ageratum conyzoides,* and *Solanum nigrum* among broadleaved weeds; and *Cyperus rotundus* and *Fimbristyllis* among sedges. *Commelina benghalensis, Ludwigia* sp., sedges and *Echnochloa* spp. were observed up to 120 days stage of crop growth. However, *Ageratum conyzoides* and *Solanum nigrum* did not appear in early stages but recorded beyond 120th day stage and remained up to harvest of the crop. Total weed density increased up to 120th day stage and declined later, but later on broadleaved weeds were dominant. Beyond 120 days stage of crop, appearance of *Rabi* weeds eg. *Phalaris minor, Melilotus alba, Chenopodium album* was also observed.

At 60 and 120 days after planting, minimum density of weeds was recorded where rice straw mulch 10 t/ha + 50% N (pressmud) +50% N vermicompost was applied followed by rice straw mulch (10 t/ha) + farm yard manure 20 t/ha treatment. Straw mulch provided effective control of weeds. This treatment also recorded highest yield and yield attributing characters and gross returns. Rice straw mulch, farm yard manure and vermicompost also slightly improved the soil physio-chemical and biological property during 2016-17.

WP 1.2.6 Weed management in greengram-potato cropping system under organic farming

RVSKVV, Gwalior

Potato

Major weed flora of experimental site during *Rabi* was *Cyperus rotundus, Phalaris minor, Cynodon dactylon, Spergula arvensis, Polypogon monspeliense* and *Hordeum spontaneum* as grasses and *Medicago hispida, Chenopodium album, Convolvulus arvensis, Rumex dentatus* and *Anagallis arvensis* were the major broad-leaved weeds. *Cyperus rotundus* and *Chenopodium album* were the most dominating among all the weeds.

P. monspeliense, H. spontaneum, C. album, C. arvensis, M. hispida and *A. arvensis* were reduced significantly by weed control treatments. The highest reduction of broadleaved weeds was recorded in recommended herbicide + one hand weeding followed by recommended herbicide alone. At 60 DAS, minimum narrow leaved weeds were recorded in one hand weeding + straw mulching followed by two hand weedings, while broad leaved weeds were recorded in recommended herbicide + one hand weeding treatment followed by recommended herbicide, two hand weedings and one hand weeding + straw mulching. At 60 DAS one hand weeding followed by straw mulch showed good result to control the weeds.

Dry weight of weeds was affected significantly by different treatments. The minimum dry weight production of weeds was found under the treatment two hand weedings followed by one hand weeding with straw mulching. The maximum weed control efficiency (80.1%) was recorded in two hand weedings. Among four mulching treatments the maximum WCE was recorded in treatment one hand weeding + straw mulch (74.6%) followed by straw mulch alone. Yield of potato tuber was recorded highest (14.5 t/ha) under two hand weedings treatment followed by recommended herbicide with one hand weeding (14.2 t/ha). The lowest tuber yield (6.7 t/ha) was obtained in unweeded control plot. Among all four mulching treatments the one hand weeding at 20 days + straw mulching gave highest yield (13.9 t/ha) followed by straw mulching 5 t/ha (9.2 t/ha) alone.

Greengram

The major weed flora observed at experimental site during *Kharif* 2017 was *Setaria glauca, Echinochloa crus-galli, Celosia argentea, Acrachne racemosa, Cynodon dactylon, Leptochloa panicea, Eragrostis pilosa* and *Phyllanthus niruri* as narrow leaved weeds and *Digera arvensis* and *Commelina benghalensis* were observed as major broadleaved weeds. *Cyperus rotundus* was the most problematic weed in the experimental site during the year of study.

The significantly lowest weed population and dry weight was recorded in one hand weeding at 20 DAS conjointly with straw mulching at 25 DAS followed by two hand weedings at 20 and 40 DAS as compared to weedy check. The highest weed control efficiency (94.1%) was recorded with one hand weeding at 20 DAS + straw mulching at 25 DAS followed by two hand weedings at 20 and 40 DAS (92.1%) and recommended herbicide (imazethapyr 80g/ha) + HW at 40 DAS (87.5%). The maximum grain yield (824 kg/ha) and B:C ratio (2.50) was recorded under one hand weeding at 20 DAS + straw mulching at 25 DAS followed by two hand weedings at 20 and 40 DAS and recommended herbicide (imazethapyr 80g/ha) + one hand weeding and recommended herbicide. Among all organic weed management practices application of white and black plastic mulch resulted in higher productivity of greengram crop, but was not economically feasible and viable.

WP 1.2.7 Non-chemical weed management in turmeric and it residual carry over effect on succeeding greengram

CCSHAU, Hisar

The weed flora of the experimental field consisted of *Echinochloa colona, Dactyloctenium aegyptium, Brachiaria reptans, Digitaria sangualis, Eragrostis tenella* among grasses and *Euphorbhia hirta, Trianthema portulacastrum* among broadleaved weeds. Pendimethalin followed by straw mulch were found most effective against all type of weeds particularly against broadleaved weeds and sedges followed by three hoeings at 25, 50 and 75 DAS. Paddy straw alone used as mulch irrespective of dose was found effective to minimize weed emergence but its integration with one hand weeding at 50 DAS helped to increase control grassy and broadleaved weeds virtually creating weed free conditions as is evident from density and dry weight of weeds at 60 and 90 DAS.

In all pre-emergence use of pendimethalin at 1000 g/ha followed 10 t/ha of mulching, mulching 6-12 t/ha integrated with one hoeing, three hoeings at 25, 50 and 75 DAS were found to be best treatments as evident from density and dry weight of weeds at 60 and 90 DAS which were significantly less than all mulching treatments alone and weedy check. Number of tillers/plant were maximum (6) in pendimethalin treated plots which were at par with all mulching treatments integrated with one hoeing, two or three hand hoeings and weed free treatment. Plant population of turmeric did not vary significantly among treatments. Maximum turmeric yield (14.5 t/ha) was recorded with three hoeings which was at par with mulching 12 t/ha + one hand weeding, weed free and pendimethalin (PRE) integrated with mulching at 10 t/ha.

WP 1.2.8 Organic weed management practices in okra-carrot organic cropping system

PJTSAU, Hyderabad

Okra

Weed flora infesting the experimental field consisted of *Cyperus rotundus* among sedges; *Rottboellia* spp, *Cynodon dactylon* and *Dactyloctenium aegyptium* among grasses; and *Commelina benghalensis*, *Parthenium hysterophorus, Trianthema portulacastrum, Digera arvensis* and *Celosia argentea* among the broadleaved weeds. At 60 DAS, mulching with polysheet (25 microns) + HW in the inter row at 30 DAS (15.3 no./m^2) recorded lowest weed density followed by cultural practice (MW at 20 & 40 DAS *fb* HW) and SSB preparation *fb* HW at 20 & 40 (5.9 no./m^2) which in turn was on par with pendimethalin 1000 g/ha *fb* HW at 30 DAS (49.6 /m^2). Highest weed density was recorded with unweeded control (147.3/m^2).

Organic weed management practices significantly influenced fruit yield of okra. Among all the treatments, significantly higher fruit yield was recorded with mulching with polysheet (25 microns) + HW in the inter row at 30 DAS, proved effective (3.63 t/ha) followed by cultural practice involving manual weeding at 20 & 40 DAS (and SSB preparation *fb* HW at 20 & 40. Lowest fruit yield (0.82 t/ha) was recorded with unweeded control.

Carrot

The weed flora observed during crop growing season consisted of *Cyperus rotundus*, *Parthenium hysterophorus, Alternanthera paranychioides, Melilotus alba, Digera arvensis, Blumea* sp, *Sonchus* sp, at 30 DAS. However, in addition to these weeds, *Amaranthus viridis, Amaranthus polygamus, Aacalypha indica* at 60 DAS, *Dactyloctenium aegyptium, Portulaca oleracea* at 90 DAS, *Euphorbia geniculata* and *Cyanotis axillaris* at harvest were recorded.

At 30 DAS, lowest weed density was recorded with hand weeding *fb* cultural practice (hand weeding at 15 and 45 DAS or hoeing (twice) at 15 DAS & 30 DAS or hand weeding at 15 DAS *fb* straw mulch 3 t/ha or hand weeding at 15 DAS *fb* straw mulch 3 t/ha or pendimethalin 1000 g/ha *fb* HW at 30 DAS. Highest weed density was recorded with unweeded control. The same trend was followed at 60 DAS.

Organic weed management practices significantly influenced root length and root girth of carrot. Highest root length and girth (17.4 and 4.8 cm) were recorded by cultural practice (hand weeding at 15 and 45 DAS) followed by or hoeing (twice) at 15 DAS & 30 DAS. Pendimethalin 1000 g/ha *fb* HW at 30 DAS also recorded higher root length and root girth. Lowest root length and root girth of carrot were recorded by unweeded control (7.7 and 2.1 cm). Organic weed management practices significantly influenced root yield of carrot. Highest root yield was recorded with cultural practice (hand weeding at 15 and 45 DAS) followed by or hoeing (twice) at 15 DAS & 30 DAS. Pendimethalin 1000 g/ha *fb* HW at 30 DAS also recorded higher root yield. Lowest root yield of carrot were recorded by unweeded control.

WP 1.2.9 Weed management options in high value basmati rice-potato-french bean cropping system under organic farming

SKUAST, Jammu

Potato

The experimental field was dominated by *P. minor* amongst grassy: *Anagallis arvensis, Rumex dentatus, Melilotus alba* amongst broad-leaved weeds beside these, *R. arvensis*and *Vicia* spp.were recorded as other weeds.

Different weed management treatments had significant effect on weed density and weed biomass 60 days after planting of potato and at harvest of potato. At 30 days after planting, mustard seed meal 2.5 t/ha and atazine 500 g/ha were statistically at par on total weed density, which were significantly lower than weedy check and other organic weed management treatments. At 60 and at harvest, rice bran 2.5 t/ha + one hand weeding, mustard seed meal 2.5 t/ha + one hand weeding, rice husk extract + one hand weeding and mustard plant extract +one hand weeding recorded significantly lower total weed density and biomass as compared to weedy check and other weed management treatments.

Weed management treatment had a significant influence on plant dry matter (g/plant), number tuber/plant, average weight of tuber (g/tuber) and potato yield. The highest number tuber/plant, average weight of tuber (g/tuber), potato yield were recorded with mustard seed meal 2.5 t/ha + one hand weeding at 30 DAT which was statistically at par with rice bran 2.5 t/ha + one hand weeding and significantly higher than all other treatments. Highest B.C ratio was recorded with atrazine 500 g/ha followed by mustard plant extract + one hand weeding.

Comparison between mustard seed meal and weedy check in potato

French bean

French bean field was dominated by *Digitaria sanguinalis* and *Cynodon dactylon* amongst grassy weeds; *Amaranthus viridis*, *Physalis minima* and *S. nigrum* amongst broad-leaved weeds and *Cyperus* spp. in sedges. At 30 days after sowing, mustard seed meal 2.5 t/ha and pendimethalin 1.0 kg/ha were statistically at par on weed density, which were significantly lower than weedy check and other organic weed management treatments. The significantly lowest density of *Cyperus* spp. was recorded in mustard seed meal 2.5 t/ha treatment than all other treatments at 30 DAS. At 60 DAS and harvest, mustard seed meal 2.5 t/ha + one hand weeding and rice bran 2.5 t/ha + one hand weeding were recorded significantly lower total weed density and biomass as compared to weedy check and other weed management treatments.

Weed management treatments had a significant influence on plant dry matter (g/plant), number of pods/plant, grains/pod and green pod yield. The highest green pod yield was recorded with mustard seed meal 2.5 t/ha + one hand weeding at 30 DAS which was statistically at par with rice bran 2.5 t/ha + one hand weeding, pendimethalin 1.0 kg/ha and weed free showed significantly higher yield than all other treatments. Highest B.C ratio was recorded with pendimethalin 1.0 kg/ha followed by mustard plant extract + one hand weeding.

Rice

Experimental field was dominated by *Echinochloa* spp. and *Cynodon dactylon* amongst grassy weeds; *Alternanthera philoxeroides* and *Caesulia axillaris* amongst broad-leaved weeds and *Cyperus* spp. beside these major weeds, *Ammannia baccifera* and *Commelina benghalensis* were recorded as other weeds.

At 30 days after transplanting, mustard seed meal 2.5 t/ha and butachlor 1.5 kg/ha were statistically at par on density of *Echinochloa* spp., *Alternanthera philoxeroides, Caesulia axillaris,* total weed density and total weed biomass, which were significantly lower than weedy check and other organic weed management treatments. The significantly lowest density of *Cyperus* spp. was recorded in mustard seed meal 2.5 t/ha treatment than all other treatments. At 60 DAT and harvest, rice bran 2.5 t/ha + one hand weeding, mustard seed meal 2.5 t/ha + one hand weeding, rice husk extract + one hand weeding and mustard plant extract + one hand weeding recorded significantly lower total weed density and biomass as compared to weedy check and other weed management treatments. The highest number of panicles/m^2, grain yield and straw yield were recorded with mustard seed meal 2.5 t/ha + one hand weeding at 30 DAT which was significantly higher than rice bran 2.5 t/ha, rice husk extract, mustard plant extract, weedy check and statistically at par with all other treatments. The highest number of grains/panicles was recorded with mustard seed meal 2.5 t/ha + one hand weeding at 30 days after transplanting which was significantly higher than rice husk extract, mustard plant extract and weedy check and statistically at par with all other treatments. Highest B.C ratio was recorded in butachlor 1.5 kg/ha followed by mustard plant extract + one hand weeding.

WP 1.2.10 (i) Weed management in organic chilli

AAU, Jorhat

Dominant weeds during the experiment were *Cynodon dactylon* and *Eleusine indica* among grasses, *Cyperus halpan* and *Cyperus rotundus* among sedges and *Ageratum houstonianum* and *Polygonum plebeium* among broadleaved weeds. The lowest weed density was observed in oxo-biodegradable plastic film mulching which was followed by rice straw mulching followed by one hand weeding and recommended herbicide (metribuzin 0.50 kg / ha). Weed density at all stages due to oxo-biodegradable plastic film mulching was significantly less than other treatments.

Weed dry weight as affected by the treatments showed that oxo-biodegradable plastic film mulching resulted in significantly lower values at all stages of recording as compared to rest of the treatments. It was closely followed by metribuzin 0.50 kg/ha and rice straw mulching followed by one hand weeding. Yield of fresh fruits was also significantly higher due to oxo-biodegradable plastic film mulching and rice straw mulching *fb* one hand weeding. Yield loss due to uncontrolled weeds was 83% as compared to these two treatments. Higher soil moisture content under oxo-biodegradable plastic film mulching at all the dates of recording which was closely followed by rice straw mulching *fb* one hand weeding. Thus, a higher soil moisture content and better weed control under these two treatments resulted in better crop growth and yield.

WP 1.2.10 (ii) Weed management in organic tea (in collaboration with Department of Tea Husbandry & Technology, AAU, Jorhat)

Experimental field was dominated by broadleaved species. *Scoparia dulcis* and *Ageratum houstonianum* was rather highly populated from the early part of crop life followed by *Spermacoce hispida, S. ocimoides* and *Mikania micrantha*. Some of the broadleaved species *viz. Gynura bicolor, Cuphea balsamina, Mimosa* sp., *M. diplotricha etc.* appeared in the field with the rise of summer temperature. Sedges were not recorded in the experimental field. However, *Axonopus compressus, Cynodon dactylon, Cyrtococcum patens, Digitaria setigera* and *Oplismenus burmanii* were the common grasses.

Lowest weed density at different stages was recorded under the treatment with bio-degradable film. Similarly, the record on weed dry weight showed lower values under bio-degradable film at different stages which were significantly lower than rest of the treatments. The highest weed density was recorded due to sickling, Guatemala mulching and *Citronella* and Lemon grass mulching at different stages. Total green leaf yield under bio-degradable film was significantly higher as compared to rest of all treatments. Green leaf yield due to bio-degradable film was highest at all the stages of plucking and it was significantly higher than other treatments at 1st to 7th and 9th plucking.

WP 1.2.11 Weed management in organic based basmati rice-durum wheat cropping system

PAU, Ludhiana

Durum wheat

The crop was infested with broadleaved weeds only; *Anagallis arvensis* and *Chenopodium album* were the major weeds. Other weeds present in the field in small densities included *Coronopus didymus, Rumex dentatus, Medicago denticulata.* ZT with or without residue, CT and deep tillage along with paddy straw much, all integrated with 50% higher crop density resulted in significant reduction in density and biomass of weeds at 30 and 60 DAS. Soil weed seed bank consisted of three weed spp. *P. minor, R. dentatus* and *A. arvensis.* Different weed control treatments however did not show any significant influence on wheat crop growth, grain yield and yield attributes as compared to unweeded control.

Basmati rice

The crop was infested with *Echinochloa colona, Eclipta alba* and *Alternanthera philoxeroides*. Soil weed seed bank consisted of two new weeds, *Echinochloa colona* and *Cyperus compressus*, along with *Dactyloctenium aegyptium, Trianthema portulacastrum*. All the weed control treatments recorded higher weed seed bank as compared to previous year. Deep tillage treatments recorded higher weed seed bank of *D. aegyptium* and C. *compressus* as compared to normal tillage. Weed pressure was however low and did not significantly influenced the basmati rice growth, grain yield and yield attributes as compared to unweeded control.

WP1.2.2 Weed management in organic crop production system (maize-garlic)

CSKHPKV, Palampur

Raised stale seed bed + mulch resulted in significantly higher bulb yield of garlic as compared to other weed control treatments. Bulb yield ranged from 1.2 to 3.3 t/ha under different treatments. All treatments were comparable in influencing green fodder yield of maize during *Kharif*. Due to higher bulb yield of garlic, garlic equivalent yield was highest under raised stale seed bed + mulch applied both in maize and garlic.

After garlic crop, organic weed control treatments had higher number of bacteria than herbicide check (10 x 10^6). The population of bacteria significantly highest in intercropping (pea) + hoeing treatment (15.7 x 10^6) followed by mulch (*Lantana*) 5t/ha (14.4 x 10^6) treatment. Fungal population was lowest in herbicide check (30.10 x10^3). The population was higher in mulch (*Lantana*) 5 t/ha (38.6 x 10^3) being statistically at par with stale seed bed + mulch 5 t/ha (38.3 x 10^3) in garlic crop, the population of Actinomycetes was highest in intercropping (pea) + hoeing (45.8 x 10^4) treatment followed by stale seed bed + mulch 5 t/ha (44.6 x 10^4) which was statistically at par with other organic treatments. Herbicide check revealed the lowest count of actinomycetes (39.9 x10^4).

WP 1.2.13 Weed management options in wheat under organic mode of rice-wheat cultivation

GBPUAT, Pantnagar

Wheat

Among different weed species, density of *P. minor* was completely eradicated under soil solarization of TPR as well as DSR *fb* one HW; ZT wheat with rice straw *fb* one HW and DSR (control); ZT wheat (control). Population of *C. didymus* was totally reduced with both the control measures, whereas, *M. indica* under TPR and conventional wheat under control measures. *F. parviflora* was completely controlled under direct-seeded rice (FIRB) on stale bed *fb* one hoeing and one HW; wheat (FIRB) *fb* one HW as well as DSR with incorporation of *Sesbania fb* one MW and one HW; conventional wheat on stale bed technique *fb* one HW. Density of *C. album* was totally reduced with TPR with stale bed *fb* one MW and one HW; conventional wheat with stale bed technique *fb* one HW, DSR (FIRB) on stale bed *fb* one hoeing and one HW; wheat (FIRB) *fb* one HW and both the control measures. Among organic mode, zero density of *V. sativa* was recorded under TPR with stale bed *fb* one MW and one HW; conventional wheat with stale bed technique *fb* one HW and DSR with incorporation of *Sesbania fb* one MW and one HW; conventional wheat on stale bed technique *fb* one HW as well as DSR and ZT wheat under control measures.

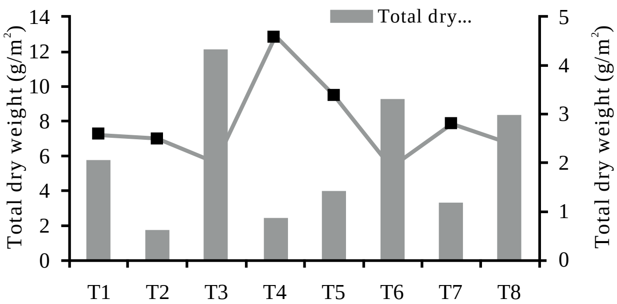


Fig. 1.2.13.1 Relationship between total dry weight (g/m^2) at 60 DAS/DAT and wheat grain yield (t/ha)

Among the different organic modes, highest grain (4.6 t/ha) and straw (6.1 t/ha) yield was achieved in DSR (FIRB) on stale bed *fb* one hoeing and one HW; wheat (FIRB) *fb* one HW and was significantly superior over all other organic modes of treatments as well as control measures (Fig 1.2.13.1).

Rice

Density and dry matter accumulation of weeds at 60 DAS/DAT was significantly influenced due to different treatments. Under organic mode, TPR on stale bed technique with one mechanical *fb* one hand weeding; conventional bed *fb* one HW completely controlled density of *E. indica* and *D. aegyptium*. However, *D. aegyptium* also got eliminated with DSR on soil solarized beds *fb* one hand weeding; ZT wheat with rice straw *fb* one HW and TPR; conventional wheat (control). *Echinochloa colona* and *F. miliacea* were not observed under DSR on soil solarized beds *fb* one hand weeding; ZT wheat with rice straw *fb* one HW. However, *F. miliacea* also got eliminated with TPR on soil solarized bed *fb* one hand weeding; ZT wheat with rice straw *fb* one HW as well as DSR; ZT wheat (control). Complete removal of *A. baccifera* and *C. iria* was also recorded under DSR; ZT wheat (control). Whereas, *M. stricta* was absent in

TPR (control); conventional wheat. Density of *P. maximum* and *C. rotundus* was recorded minimum with DSR incorporated with *Sesbania fb* one mechanical and one hand weeding; ZT wheat with rice straw *fb* one HW and was significantly superior to rest of the treatments including organic mode or control practice (Fig 1.2.13.2).

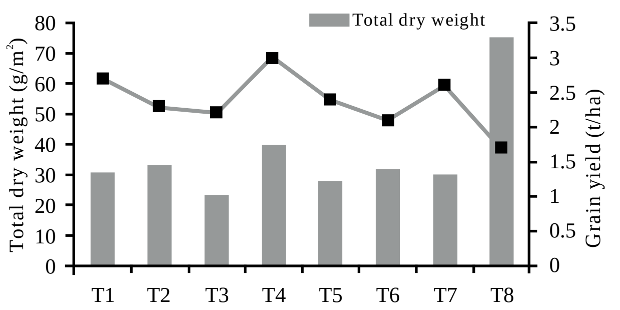


Fig. 1.2.13.2 Relationship between total dry weight (g/m^2) at 60 DAS/DAT and rice grain yield (t/ha)

Transplanted rice with summer ploughing + stale seed bed *fb* one mechanical *fb* one hand weeding; conventional wheat on stale bed technique *fb* one HW as well as control practices of DSR; ZT wheat was found at par with the above organic mode in obtaining grain yield and superior to rest of the treatments, whereas, in respect to straw yield, all the treatments (either organic mode or control practices) were statistically significant with each other.

WP 1.2.15 Weed management in organically grown direct-seeded aromatic rice-sweet corn-cropping system

IGKV, Raipur

Rice

Weed flora of the experiemental site was dominated with *Echinochloa colona* in grasses, *Cyperus iria* in sedges and *Cyanotis axillaris* and *Spilanthes acmella* in broadleaved weeds. Other weed flora in the field was *Ischaemum rugosum*, *Fimbristilis miliacea* and *Alternanthera trianda etc.*

No significant difference in weed dry weight was recorded at all the observational stages due to various organic nutrient management sources. Weed management options showed significant variation in weed dry weight. At 30 DAS, significantly lower dry weight of weeds was observed under oxadiargyl 80 g / ha *fb* bispyribac - Na 25 g / ha, whereas at 60 DAS and at harvest the lowest weed dry weight was recorded under hand weeding twice followed by herbicidal treatment. Significantly higher dry weight of weeds was recorded under untreated control over rest of the weed management options.

Application of 50% N (FYM) + 50% N (poultry manure) + *Azospirilium* + PSB produced significantly higher grain yield over 50% N (FYM) + 50% N (vermicompost) + *Azospirillium* + PSB. However, in weed management practices maximum grain yield was found under application of oxadiargyl 80 g / ha *fb* bispyribac - Na 25 g/ha which was significantly superior to rest of the treatments. In case of other than chemical method of weed management, hand weeding twice and motorized weeder (single row type) twice were equally effective and recorded comparable yields. Highest net return and B:C ratio was found under 50% N (FYM) + 50% (PM) + *Azospirillium* + PSB. Whereas, under weed management practices chemical weed management gave higher net return and B:C ratio however, among other methods motorized weeder single row type twice gave maximum net return and B:C ratio.

Maximum amount of organic carbon content in soil was accumulated in green manuring treatment which was found at par with rest of the treatments. Among different nutrient management treatments significantly higher DHA, MBC and BSR of soil was found due to nutrient management by 50% N through FYM + 50% N by poultry manure and application of PSB and *Azospirillum*, which was found at par with treatment 50% N by FYM + 25% N by vermicompost + 25% N by poultry manure and application of PSB and *Azospirillum* treatments.

Sweet corn

Weed flora of the experimental site was dominated with *Medicago denticulata*, *Chenopodium album* and *Echinochloa colona*. Other weed species observed in less density was *Melilotus alba*. Weed dry weight recorded at 30 and 60 DAS was not influenced significantly due to different sources of organic nutrients. However, it was influenced significantly at harvest. The weed dry weight was significantly lower under 50% N (FYM) + 50% N (PM) over other sources. Significantly lower weed dry weight was recorded in black polythene mulch at all the stages of observation, followed by atrazine 1.0 kg / ha PE.

Organic nutrient sources did not significantly influence the green cob yield of sweet corn, but it was influenced significantly due to various weed management practices. Black polythene mulch produced significantly higher green cob yield over other weed management practices. Herbicide treatment of atrazine 1.0 kg / ha PE was next to it and produced significantly higher green cob yield over straw much and weedy check. Weedy check resulted in lowest green cob yield. Non-significant variation in organic carbon in soil was observed due to different organic and weed management treatments. Different organic manures improved the microbiological and bio-chemical properties of soil. However, variation in MBC and BSR due to different nutrient management practices was found non-significant.

WM 1.3.15 Weed management in organic vegetable production in okra-onion cropping system

BAU, Ranchi

Okra

Experimental field was infested with narrow leaved weeds like *Echinochloa colona*, *Echinochloa crus-galli*, *Digitaria sanguinalis*, *Dactyloctenium aegyptium*, *Cynodon dactylon*, *Eleusine indica*, among broadleaved weeds, *Commelina benghalensis*, *Commelina nudiflora*, *Stellaria media*, *Ageratum conyzoides*, *Celosia argentea*, *Phyllanthus niruri* and among sedges *Cyperus rotundus*.

Treatments having plastic mulch recorded significantly reduced narrow, broadleaved and sedges as well as total weed density and total weed dry matter. However, plastic mulch was similar with hand weeding in controlling all categories of weeds except in total dry matter. Application of plastic mulch recorded maximum yield (19.3 t / ha) and gross return during both the years as well as under pooled data. During 2016, it was similar to available weeds mulching, while available weed mulch as well as straw mulch recorded higher net return and B:C ratio compared to other treatments. However maximum net return during 2017 was recorded with straw mulch. Different weed control methods did not influence microbial population, change in pH, EC, OC g / kg soil, CO_2 µg / g soil / h, bb Dehydrogenase (µgTPF / h / g soil) and Azatobacter cfu (x10^3) population. However, SMBC was found to increase significantly compared to rest of the treatments.

Onion

All weed control methods affected similarly in reducing weed dry matter at 30 DAS except cover crop and weedy check, while at 60 and 90 DAS hand weeding recorded reduced dry matter of weed and at 90 DAS it was similar to plastic mulch. At 30 DAS, weed control efficiency was maximum with application of oxyfluorfen 0.25 kg / ha PE and was similar to all weed control methods except cover crop, while at 60 and 90 DAS, hand weeding recorded maximum weed control efficiency and was equal to hand weeding at 90 DAS it was also similar to plastic mulch. Maximum yield (24.6 t / ha) and net return (` 240679 / ha) was recorded with plastic mulch. Plastic mulch recorded similar net return with application of oxyfluorfen 0.25 kg / ha PE, pendimethalin 1.0 kg / ha PE and hand weeding. While, application of pendimethalin 1.0 kg / ha PE recorded maximum B:C ratio (1.44) and was similar to application of oxyfluorfen 0.25 kg / ha PE and plastic mulch.

KAU, Thrissur

WP 1.2 (i) Organic farming methods to manage weeds in pineapple

At 60 DAA, diuron 3.0 kg / ha application recorded total weed control in this treatment. Hand weeding was on par with diuron application. This was followed by all the organic mulches. Cowpea intercropping was inferior to organic mulches in total weed count but was superior to unweeded control.

Regarding weed dry weight, at 60 DAA, diuron application resulted in best control of weed growth, followed by hand weeding, plastic mulching and paper mulching. Coir pith mulching recorded the next best result.

WP 1.2 (ii) Effect of different mulches on weed management and productivity in brinjal

At 30 DAP, hand weeding, spade weeding and polythene mulching recorded least weed growth, while pendimethalin application 1.0 kg/ha, dried leaves mulching and coir pith mulching recorded significantly higher values. At 45 DAP, all mulching and herbicide treatments recorded lower values of weed dry matter production which were on par and significantly higher than polythene mulching. At 60 DAP, best treatments after polythene mulching were spade weeding and hand weeding. Application of pendimethalin, dried leaves mulching and coir pith mulching were on par, and recorded high values of weed dry matter production. Mulching was seen to significantly increase the yield of brinjal and yields on par with hand weeding were obtained in mulched plots. Yields in the range of 8.2 to 9.2 t/ha were obtained. Spade weeding and application of pendimethalin produced significantly lower yields than these treatments. However, lowest yield (2.8 t/ha) was recorded in the unweeded plot.

MPUAT, Udaipur

WP 1.2.18 Organic weed management in sweet corn – fennel system

In sweet corn, major broadleaved weeds in the experimental fields were *Digera arvensis* (3.26%), *Trianthema portulacastrum* (15.0%) and *Commelina benghalensis* (14.2%). The grassy weeds were *Echinochloa colona* (36.8%) and *Dinebra retroflexa* (5.0%). Weed density of grassy and broad leaf weeds were recorded significantly lower in plastic mulch either with summer ploughing, sowing after stale seed bed preparation or soil solarization. Treatment of soil solarization with plastic mulch proved most effective and recorded 90.6% and 90.7% reduction in total weed dry matter at 60 DAS and at harvest, respectively in comparison to weedy check at 60 DAS (43.9 g/m^2) and at harvest (57.1 g/m^2). Maximum values of seed yield (2.84 t/ha) and stover yield (4.75 t/ha) of sweet corn were recorded with crop sown with treatment of stale seed bed with plastic mulch, which was at par with plastic mulch with soil solarization and summer ploughing. All the organic weed management treatments proved statistically superior over weedy check. The highest net return (` 49090/ha) and B:C of (2.51) was obtained with soil solarization with plastic mulch.

In fennel, major broadleaved weeds in the experimental field were *Chenopodium album* (39.9%), *Chenopodium murale* (29.9%), *Fumaria parviflora* (16.6%), *Convolulus arvensis* (5.6%). The grassy weed and sedges were *Phalaris minor* (4.0%) and *Cyperus rotundus* (3.9%). Weed dry matter recorded at 60 DAS and at harvest was significantly influenced by organic weed management practices. Broad leaf weeds contributed about 90% of total dry matter at both the stages and major weed was C*henopodium* sp. in the field during *Rabi*. Plastic mulch in different combinations proved most effective and recorded 95-100% reduction in total weed dry matter at 60 DAS and at harvest in comparison to weedy check.

Among different organic weed management treatments, maximum values of seed yield (1.2 t/ha) of fennel was recorded treatment of summer ploughing with plastic mulch, which was at par with plastic mulch with soil solarization and stale seed bed and pre-emergence application of pendimethalin 1.0 g/ha with straw mulch. Application of plastic mulch with summer ploughing, stale seed bed and soil solarization recorded 227.4, 216.0 and 204.4%, respectively, increase in yield over weedy check (386 kg/ha). All the organic weed management treatments proved statistically superior over weedy check. Highest net return (` 132609/ha) was recorded with soil solarization with plastic mulch and B:C (4.45) was obtained with soil solarization with one hand weeding.

Sesbania as green manuring 30 DAS + 1 HW at 40 DAS

Soil solarization + plastic mulch at sowing

Stale seed bed + plastic mulch at sowing in Sweet corn

Summer ploughing + plastic mulch at sowing

Effect of different treatments in sweet corn - fennel cropping system

WP 1.2.18 Weed management in rice-tomato-cowpea system under organic farming

BCKV, Kalyani

Significant difference though very narrow has been found among the treatment means in both weed density and weed biomass production at all the stages except weed density at 60 DAP. Treatment RDF (60:30:30) weed density and weed biomas offer significantly at all the growth stages except weed dinsity at 60 DAP + recommended herbicide pretilachlor 0.75 kg/ha has found to be the lowest performer in all the cases for sedges while 50% FYM + 50% as *Dhaincha* + manual weed control (20 & 40 DAT) was the highest producer of weed biomass both at 60 and 90 DAP. However weed biomass production at 30 DAP was maximum 1.94 g/m^2 in 50% RDF + 50 % FYM + manual weed control (20 & 40 DAT).

Total biomass production by the crop transplanted paddy was found maximum of 11.04 t/ha in the RDF (60:30:30) + recommended herbicide (pretilachlor 0.75 kg/ha). Regarding grain production, 50% RDF + 50% FYM + manual weed control (20 & 40 DAT) was at par with 50% FYM+ 50 % *Dhaincha* + 25% higher plant density + one manual weed control (20 DAT). However, all the yield attributes like panicle/m^2, grains/panicle and also the 1000-grain weight were found better in RDF (60:30:30) + recommended herbicide, (pretilachlor 0.75 kg/ha) than the other treatments. The treatment 50% FYM+ 50% as *Dhaincha* + manual weed control (20 & 40 DAT) + *Azospirillum* + PSB has been found to be the poor performer for grain production as well as total biomass production as compared to other treatments.

WM 1.3 Herbicidal control of weeds in crops and cropping system

WM 1.3.1 Weed Management in rice and rice based cropping systems

UAS, Bengaluru

WM 1.3.1 (i) Herbicides combinations for control of complex weed flora in transplanted rice

In transplanted rice at Mandya, major weed flora in the experimental plots was *Cyperus difformis, Cyperus iria* (among sedges), *Panicum* sp., *Paspalum distichum* and *Echinochloa colona* (among grasses), *Alternethera sessilis, Monochoria vaginallis, Marselia quadrifolia* and *Ludwigia parviflora* (among broad leaf weeds). At 60 DAP application of bensulfuron-methyl + pretilachlor (60 + 600 g/ha) as PE *fb* triafamone+ ethoxysulfuron (60 g/ha) at 30 DAT and oxadiargyl (100 g/ha) as PE *fb* triafamone + ethoxysulfuron (60 g/ha) at 30 DAT significantly reduced the weed density (Table 1.3.1). Bensulfuron methyl + pretilachlor *fb* triafamone + ethoxysulfuron at 30 DAT recorded significantly higher paddy grain yield and B: C ratio followed by bensulfuron-methyl 60 g/ha + pretilachlor *fb* bispyribac-Na at 25 DAT and bensulfuron-methyl 60g/ha+ pretilachlor bensulfuron-methyl + pretilachlor (60+600 g/ha) *fb* passing of conoweeder at 25 DAT and these were on par with the two hand weedings (25 and 45 DAP).

Table 1.3.1 Effect of herbicide mixtures on weeds' density and dry weight – category wise (sedge, grasses and broad leaf weeds) at 60 DAP in transplanted rice during *Kharif*, 2016

Treatments	Weeds' density (No /m²)				Weeds' dry weight (g/m²)			
	Sedges #	Grasses +	Broad leaf#	Total #	Sedges+	Grasses +	Broad leaf#	Total #
Bensulfuron methyl + pretilachlor *fb* passing of cono weeder	1.26(16.6)	2.76(7.0)	1.15(12.7)	1.58(36.3)	2.90(7.5)	2.07(3.4)	1.00(8.3)	1.32(19.1)
Oxadiargyl *fb* passing of cono weeder	1.20(17.6)	2.92(8.0)	1.23(15.7)	1.60(41.3)	2.95(8.6)	2.24(4.2)	1.09(10.5)	1.38(23.3)
Bispyribac-Na *fb* passing of cono weeder	1.35(20.3)	3.06(8.6)	1.29(17.7)	1.69(46.6)	3.76(13.2)	2.59(5.8)	1.17(12.9)	1.53(32.01)
Triafamone+ ethoxysulfuron *fb* passing of cono weeder	1.26(18.3)	2.94(8.3)	1.21(16.0)	1.64(42.6)	3.32(10.6)	2.41(5.5)	1.09(11.5)	1.46(27.4)
Bensulfuron methyl + pretilachlor *fb* bispyribac-Na	1.09(11.3)	2.43(5.0)	1.13(11.7)	1.47(28.0)	2.17(3.8)	1.61(1.6)	0.89(5.8)	1.12(11.2)
Oxadiargyl *fb* bispyribac-Na	1.18(13.7)	2.52(5.7)	1.09(11.0)	1.51(30.3)	2.41(4.9)	1.67(1.8)	0.87(5.6)	1.16(12.4)
Bensulfuron methyl + pretilachlor *fb* triafamone+ ethoxysulfuron	1.06(9.7)	2.60(6.3)	1.08(10.0)	1.44(26.0)	2.02(3.0)	1.80(2.4)	0.83(4.8)	1.08(10.3)
Oxadiargyl *fb* triafamone + ethoxysulfuron	1.04(9.3)	2.69(6.7)	1.08(10.6)	1.46(26.6)	2.01(3.0)	1.88(2.6)	0.84(5.1)	1.11(10.8)
Hand weeding at 25 and 45 DAS	0.96(7.7)	2.51(5.7)	1.02(8.67)	1.37(22.00)	1.69(1.9)	1.59(1.59)	0.67(2.7)	0.91(6.2)
Weedy check	1.51(30.6)	4.34(18.3)	1.54(32.67)	1.92(81.67)	5.11(25.1)	4.15(16.8)	1.51(30.7)	1.87(72.5)
SEm ±	0.10	0.47	0.08	0.06	0.31	0.32	0.07	0.05
LSD (P = 0.05)	0.31	1.39	0.23	0.17	0.91	0.95	0.21	0.15

Data within the parentheses are original values; Transformed values: # = log (X+2), + = square root of (X+1);

PAJANCOA & RI, Karaikal

Application of ready mix of triafamone+ ethoxysulfuron significantly reduced weed density (2.7 no./m^2) and resulted in higher rice yield (5.5 t/ha). Excellent control of the grass, sedge and broadleaved weeds were noticed in this treatment during 2016-17. It was followed by pre-emergence application of either pretilachlor or bensulfuron methyl *fb* chlorimuron + metsulfuron in terms of increased of weed control and rice yield. Post-emergence application of bispyribac-sodium *fb* chlorimuron + metsulfuron was found ineffective in controlling broad leaved weeds. Hence higher weed density was recorded. Unweeded control accounted for 36% yield loss in coastal ecosystem of Karaikal.

WM 1.3.1.1 (ii) Herbicides combinations for control of complex weed flora in dry direct seeded rice

UAS, Bengaluru

Major weed flora observed during *Kharif* 2017 was *Cyperus rotundus* (sedge), *Cynodon dactylon, Chloris barbata, Digitaria marginata, Echinolchloa colona* (among grasses). Whereas, among broad leaf weeds, *Commelina benghalensis, Acanthospermum hispida, Euphorbia hirta, Euphorbia geniculata, Borreria hispida, Tridax procumbens* and *Ageratum conyzoides* were found. Among the weed species, densities of *C. rotundus, D. marginata, A. conyzoides, C. benghalensis* and *C. dactylon* were more than other weed species, indicated their dominance and competitiveness with the dry direct seeded rice. Effective control of weeds was noticed at 60 DAS with application of bensulfuron-methyl + pretilachlor (60 + 600 g/ha) as PE *fb* bispyribac-sodium (25 g/ha) at 25 DAS followed by bensulfuron-methyl + pretilachlor (60 + 600 g/ha) as PE *fb* triafamone + ethoxysulfuron (60 g/ha 25 DAS) as evident from the reduced weed density and weed biomass. All these herbicide mixtures were superior to unwedded control in reducing the weeds' density and dry biomass. However, hand weeding at 20, 40 and 60 DAS produced significantly higher grain (5.66 t/ha) and straw yield (7.31 t/ha) followed by the plots treated with application of bensulfuron-methyl + pretilachlor (60 + 600 g/ha) as PE *fb* bispyribac-sodium (25 g/ha) at 25 DAS (5.52 and7.25 t/ha respectively) and bensulfuron-methyl + pretilachlor (60 + 600 g/ha) as PE *fb* triafamone + ethoxysulfuron (60 g/ha) at 25 DAS (5.43 and 7.03 t/ha respectively). Unweeded control gave the lowest paddy grain yield (1.31t/ha) due to severe competition from all types of weeds. None of the herbicides caused phytotoxicity to rice in terms of yellowing, curling, epinasty, hyponasty and wilting symptoms.

PAJANCOA& RI, Karaikal

Dominant weed flora in the study area were *Echinochloa colona, Leptochloa chinensis, Ludwigia purpurea, Eclipta prostrata, Sphaeranthus indicus, Cyperus difformis, Cyperus iria* and *Fimbristylis meliacea.* The highest relative density revealed that *Echinochloa colona* was the major grassy weed infested the experimental field. Pre- emergence application of pendimethalin 1.0 kg/ha *fb* bispyribac (POE) 25 g/ha either alone or with a manual weeding on 45 DAS (15.3 no./m^2 and 7.3 g/m^2) effectively control the wider weed population. It was followed by manual weeding thrice at 20, 40 & 60 DAS. Post-emergence application of bispyribac sodium alone (25 g/ha) was found ineffective in controlling *Leptochloa chinensis*, and resulted in poor weed control efficiency (51.5%). Little improvement in the WCE (80.7%) was noticed with application of pyrazosulfuron *fb* bispyribac application. Lower yield loss caused by weeds was recorded under manual weeding thrice at 20, 40 and 60 DAS (8.3%). However, unweeded control accounted for 70.8% yield loss in coastal ecosystem of Karaikal. Economic analysis revealed that application of pendimethalin 1.0 kg/ha integrated with a manual weeding at 40 DAS was better in terms of B: C ratio (1.72) followed by pre-emergence application of pendimethalin 1.0 kg/ha *fb* bispyribac (POE) 25g/ha integrated with a manual weeding (1.65).

WP 1.3.1.2 Long term herbicide trial in transplanted lowland rice-rice cropping system

TNAU, Coimbatore

Lower total weed density and weed biomass was recorded in PE pyrasosulfuron-ethyl *fb* hand weeding. Among the different herbicide combination, significantly higher grain yield and income was obtained with PE bensulfuron-methyl + pretilachlor *fb* hand weeding during *Rabi 2016-17*. But, PE pyrasosulfuron-ethyl *fb* hand weeding during *Kharif 2017* was better than rest of the weed management practices. Significantly lower grain yield was recorded with weedy check (Table 1.3.1.2.1). In general all the four herbicides *viz.*, PE pyrasosulfuron-ethyl, bensulfuron-methyl, pretilachlor and PoE bispyribac-sodium reduced the soil microflora and soil enzymes upto 5 days after herbicide application. But at 15 days after application, the microflora were increased 10 times as compared with conrol during both the seasons. Residues of all the studied herbicides in soil and rice grain at harvest from both *Rabi* and *Kharif* were found below the detection limit (0.01 mg / kg). Soil nutrients status was also unaffected significantly by the herbicidal weed management practices.

Table 1.3.1.2.1 Total weed density and total weed dry weight at 60 DAT and productive tillers, grain yield and economics as influenced by Long term herbicide trial in transplanted lowland rice-rice cropping system

	Rabi 2016 -17						*Kharif 2017*					
Treatment combination	Total weed density (No./m²)	Total weed dry weight (g/m ²)	Productive tillers (No./m²)	Grain yield (t/ha)	Net return (` / ha)	B:C ratio	Total weed density (No./m²)	Total weed dry weight (g/m²)	Productive tillers (No./m²)	Grain yield (t/ha)	Net return (`/ha)	B:C ratio
PE pyrasosulfuron ethyl *fb* hand weeding (K & R)	3.19 (10.2)	2.98 (8.9)	339	4.9	16155	2.17	2.49 (6.2)	8.67 (75.1)	367	6.3	22531	2.48
PE pyrasosulfuron ethyl *fb* hand weeding (K) + PE bensulfuron methyl + pretilachlor (6.6%) *fb* hand weeding (R)	4.01 (16.1)	3.65 (13.3)	371	5.9	20277	3.10	3.69 (13.3)	7.81 (61.1)	398	6.2	29072	3.00
PE pyrasosulfuron ethyl *fb* PoE bispyribac sodium (K & R)	5.66 (32.0)	5.86 (34.3)	361	5.41	18508	2.48	3.58 (12.8)	9.0 (81.0)	392	6.8	27287	2.69
PE pyrasosulfuron ethyl *fb* POE bispyribac sodium (K) + PE bensulfuron methyl + pretilachlor *fb* POE bispyribac sodium (R)	5.22 (27.3)	4.77 (22.8)	338	5.0	17003	2.37	4.79 (22.9)	9.85 (67.1)	359	6.3	17174	2.28
Hand weeding twice	3.45 (11.9)	4.06 (16.5)	324	5.2	17435	2.06	6.45 (41.6)	9.71 (94.2)	354	6.0	15056	1.97
Unweeded check	8.88 (78.9)	9.33 (87.1)	280	3.1	11399	1.44	11.18 (125.1)	23.82 (567.6)	312	2.3	10395	1.66
SEd	1.22	1.33	12.0	0.24	-	-	1.46	2.52	13	0.22	-	

WP1.3.1.3 Weed management studies in rice –wheat cropping system

NDUAT, Faizabad

The major weed flora was *Echinochloa colona*, *Echinochloa crus-galli*, *Panicum maximum* (grassy), *Caesulia axillaris* and *Eclipta alba* (BLWs) and *Fimbristylis miliacea* and *Cyperus difformis* (sedges). Pendimethalin *fb* bispyribac–Na and oxadyrazil *fb* bispyribac-Na was superior combination of treatments in order to suppress the weeds. Combination of two herbicides or along with hand weeding (HW) recorded significantly lower values of weed biomass with higher WCE (Table 1.3.1.3.1). A combination of pendimethlin *fb* bispyribac being at par with pendimethalin *fb* bispyribac *fb* MW recorded significantly less weed biomass (22.71 g/m^{-2}) with highest WCE (80.6%). Combined application of pendimethalin 1000 g/ha PE *fb* bispyribac-Na 25 g/ha *fb* one hand weeding at 45 DAS recorded the maximum grain and straw yield (4.1 and 4.7 t/ha respectively) which was at par with application of pendimethalin *fb* bispyribac-Na (1000 and 25 g/ha) and oxydiargyl *fb* bispyribac-Na (100 and 25 g/ha). The higher grain yield of direct seed rice in pendimethalin 1000 g/ha PE *fb* bispyribac-Na 25 g/ha *fb* one hand weeding at 45 DAS may be attributed due to better yield contributing characters.

WP.1.3.1.5(i) Integrated weed management in upland direct seeded rice

AAU, Jorhat

Dominant weed flora in the study area was *Ageratum houstonianum, Spermacoce articularis, Melochia corchorifolia, Mimosa pudica, Mollugo pentaphylla* and *Polygonum glabrum* (BLW), *Cyperus flavidus, C. iria, C. rotundus, Fimbristylis bisumbellata, F. littoralis* and *Scleria terrstris* (Sedges), *Cynodon dactylon, Digitaria setigera, Eleusine indica* and *Panicum repens* (grasses).

Weed biomass was significantly affected by treatments with microbial cultures at different stages. The lowest values were recorded with consortium which was significantly lower to rest of the treatments at 30 and 60 DAS but at harvest, the consortium and ABT microbial culture were at par. Among the weed management treatments brought about significant variation in respect of weed density and dry weight at all stages. Application of pretilachlor 0.75 kg/ha *fb* one hand weeding could significantly reduce the density and weed biomass over the mechanical weeding and weedy check at all the stages (Table 1.3.1.5.1).

Table 1.3.1.5.1 Weed density and dry weight at various stages as affected by treatments

Treatment	Weed density* (no./ m²)			Weed dry weight* (g/m²)		
	30DAS	60DAS	Harvest	30DAS	60DAS	Harvest
Microbial cultures						
Trichoderma	10.75 (124.00)	13.51 (185.33)	16.05 (270.22)	9.01 (82.67)	8.17 (69.33)	11.70 (137.33)
ABT microbial culture	11.05 (127.11)	13.34 (180.00)	15.74 (260.00)	9.65 (96.00)	8.09 (68.00)	11.34 (129.33)
Consortium	10.37 (113.78)	13.24 (178.67)	14.98 (232.00)	8.26 (71.11)	7.01 (50.22)	10.71 (116.00)
Hydration	11.40 (137.33)	14.87 (226.22)	16.42 (280.89)	9.45 (92.44)	8.45 (73.78)	11.85 (141.78)
LSD (P=0.05)	0.69	0.49	0.40	0.41	0.65	0.70
Weed management						
Pretilachlor 0.75 kg/ha *fb* one hand weeding	8.27 (68.33)	11.72 (137.33)	12.72 (161.67)	7.28 (53.00)	6.07 (36.67)	10.05 (101.33)
Mechanical weeding twice (15 and 45 DAS)	9.97 (99.67)	13.29 (176.67)	14.26 (203.33)	8.72 (76.33)	8.05 (65.00)	11.75 (138.33)
Weedy	14.44 (208.67)	16.21 (263.67)	20.41 (417.33)	11.28 (127.33)	9.67 (94.33)	12.40 (153.67)
LSD (P=0.05)	0.60	0.43	0.35	0.36	0.57	0.60

WP 1.3.1.5(ii) Long-term herbicidal trial in rice-rice cropping sequence

AAU, Jorhat

In autumn rice at all the stages, all the weed control practices resulted in lower weed density and weed biomass as compared to farmers practice (Pretilachlor 0.75 kg/ha + NPK fertilizer). The lowest weed biomass was recorded with pyrazosulfuron 25g/ha *fb* 2,4-D 0.5 kg/ha rotated with pretilachlor 0.75 kg/ha (75% nutrient through fertilizers + 25% nutrient through organic source). The growth parameters were higher in pyrazosulfuron 25 g/ha *fb* 2, 4-D 0.5 kg/ha (100% nutrient through fertilizers) but the yield attributes, grain and straw yield were highest due to pyrazosulfuron 25 g/ha *fb* 2,4-D 0.5kg/ha rotated with pretilachlor 0.75 kg/ha (75% nutrient through fertilizers + 25% nutrient through organic source).

In winter rice, treatments comprising pyrazosulfuron *fb* 2,4-D with or without rotating with pretilachlor resulted in similar weed biomass at all stages but these treatments showed significantly less weed biomass as compared to farmers' practice. Application of pyrazosulfuron 25g/ha *fb* 2,4-D 0.5 kg/ha rotated with pretilachlor 0.75 kg/ha (75% nutrient through fertilizers + 25% nutrient through organic source) recorded taller plants in rice. Similarly, this treatment also resulted highest panicle number, longest panicle, highest filled grain number, least false grain number, highest grain and straw yields in winter rice. Grain yield obtained under this treatment was significantly higher than other treatments (Table 1.3.1.5.2).

Table 1.3.1.5.2 Growth, yield attributes, grain and straw yield of rice due to treatments

Treatment	Plant height (cm)	Panicle No./ m^2	Panicle length (cm)	Filled grains/ panicle	False grains/ panicle	Grain yield (t/ha)	Straw yield (t/ha)
Farmers practice (Pretilachlor 0.750kg/ha + NPK fertilizer)	89.6	206.1	21.3	76.3	15.6	2.2	2.4
Pyrazosulfuron 25g/ha + 2,4-D 0.5kg/ha (100% nutrient through fertilizers)	93.0	285.4	21.6	87.3	9.0	2.9	3.2
Pyrazosulfuron 25g/ha + 2,4-D 0.5kg/ha (75% nutrient through fertilizers + 25% nutrient through organic source)	91.3	311.8	22.7	89.3	7.6	2.9	3.2
Pyrazosulfuron 25g/ha + 2,4-D 0.5kg/ha rotated with pretilachlor 0.750kg/ha (75% nutrient through fertilizers + 25% nutrient through organic source)	90.0	329.0	24.4	97.6	5.6	3.3	3.6
Pyrazosulfuron 25g/ha + 2,4-D 0.5kg/ha rotated with pretilachlor (100% nutrient through fertilizers)	91.3	318.0	24.1	95.3	7.6	3.1	3.4
LSD (P=0.05)	NS	10.1	2.0	2.2	2.0	78.8	48.1
CV (%)	12.6	10.8	14.7	11.3	12.0	11.4	10.7

WP 1.3.2.1 Herbicides combinations for control of complex weed flora in wheat (Year of commencement: *Rabi*- 2016)

PDKV, Akola

The major weed flora in wheat was composed of *Parthenium hysterophorus, Chenopodiam album, Chenopodiam murale, Melilotus indica, Portulaca oleraca, Euphorbia hirta, Poa annua, etc.* with more dominancy of BLW. Weed density and weed biomass at 60 DAS significantly influenced due to different weed management practices. The lower weed density and weed biomass were recorded in twice hand weeding at 30 and 60 DAS followed by pendimethalin *fb* sulfosulfuron 1.0 + 0.018 kg/ha, pinoxaden + metsulfuron, sulfosulfuron, mesosulfuron + iodosulfuron. The highest weed density and weed biomass was noticed in weedy check.

The lowest weed index was registered in pendimethalin *fb* sulfosulfuron 1.0 + 0.018 kg/ha followed by clodinafop + metsulfuron 0.06 + 0.004 kg/ha at 35 DAS (Table 1.3.2.1.1). This might be due to better control of weeds in these treatments which ultimetely increasesd the yield in this treatment compared to all other treatments. The highest grain yield and gross return was recorded in twice hand weeding (4.59 t/ha and 90718 `/ha, respectively) followed by pendimethalin *fb* sulfosulfuron 1.0 + 0.018 kg/ha (4.48 t/ha and 88321 `/ha). The lowest grain yield was recorded in weedy check (2.58 t/ha).

Table 1.3.2.1.1 Weed control efficiency and weed index as influenced by weed control treatments

Treatments	Weed Control Efficiency (%)		Weed index	Grain yield (t/ha)	GMR (`/ha)
	60 DAS	At Harvest			
Pendimethalin 1 kg/ha	66.84	67.04	25.36	3.42	67404
Sulfosulfuron 0.025 kg/ha PoE at 35 DAS.	77.73	76.75	17.63	3.78	74495
Metribuzin 0.21 kg/ha PoE	65.08	65.44	21.56	3.60	70771
Clodinafop 0.06 kg/ha PoE at 35 DAS	71.46	70.99	18.31	3.75	73736
Pendimethalin + Metribuzin 1.0 + 0.175 kg/ha PoE	66.78	65.81	22.17	3.57	70287
Pendimethalin *fb* sulfosulfuron 1.0 + 0.018 kg/ha PE & PoE	90.96	90.46	2.32	4.48	88321
Sulfosulfuron + metsulfuron) 0.03 + 0.002 kg /ha at 35 DAS	75.07	73.60	10.97	4.09	80693
Pinoxaden + metsulfuron 0.06 + 0.004 kg/ha at 35 DAS	81.48	79.69	5.78	4.32	85041
Mesosulfuron + iodosulfuron 0.012 + 0.0024 kg/ha at 35 DAS	78.79	76.56	6.94	4.27	83997
Clodinafop + metsulfuron 0.06 + 0.004 kg /ha at 35 DAS.	76.02	73.87	3.03	4.45	87453
2 Hand weeding – (30 and 60 DAS)	96.22	94.82	0.00	4.59	90718
Un-weeded control	0.00	0.00	43.81	2.58	50596
				0.22	4325
				0.64	12660

WP 1.3.3.1 Weed management with new generation herbicides in maize and its residual effect on succeeding wheat

AAU, Anand

At the study area, monocot weeds were dominant in (77.3%). Major weeds were *Eleusine indica* (55.8%), *Dactyloctenium aegyptium* (16.6%), *Commelina benghalensis* (14.5%), *Eragrostis major* (6.4%) in monocot weeds category and *Digera arvensis* (66.9%), *Phyllanthus niruri* (11.9%), *Trianthema monogyna* (9.6%) in dicot weed category. At 40 DAS, all the treatment where herbicides followed by hand weeding at 30 DAS were performed has evidenced no monocot, dicot and total weed density, hence no weed biomass. Whereas, at 60 DAS, the significantly lowest weed density and dry biomass of monocot (4.57 no./m^2 and 5.22 g/m^2) and total weeds (6.06 no./m^2 and 5.98 g/m^2) in maize was recorded under atrazine +

pendimethalin (500+250 g/ha) PE *fb* 2,4-D 1000 g/ha PoE treatment, respectively and in dicot it was found under atrazine 1000 g/ha PE *fb* 2,4-D 1000 g/ha PoE (1.0 no./m^2 and 1.0 g/m^2). Weed density and weed biomass of monocot and total weeds in weedy check was reported to be the highest (12.3 no./m^2, 17.1 g/m^2 and 14.0 no./m^2 and 19.7 g/m^2 respectively) followed by tembotrione 120 g/ha EPoE (12.0 no./ m^2, 15.9 g/ m^2 and 13.1 no./ m^2, 16.1 g/ m^2 respectively). However, highest weed density and dry biomass of monocot was recorded in tembotrione 120 g/ha EPoE and atrazine + pendimethalin (500+250 g/ha) PE *fb* 2, 4-D 1000 g/ha LPoE, respectively. In case of dicot weeds it was under topramezone 25.2 g/ha EPoE and total weeds under tembotrione 120 g/ha EPoE and atrazine + pendimethalin (500+250 g/ha) PE *fb* 2,4-D 1000 g/ha LPoE, respectively. Among weed management practices on grain yield and B:C ratio was superior under atrazine + pendimethalin (500+250 g/ha) PE *fb* 2,4-D 1000 g/ha LPoE (5.38 t/ha and 2.98, respectively) followed by topramezone + atrazine 25.2 + 500 g/ha EPoE *fb* IC + HW at 30 DAS (5.11 t/ha and 2.42 respectively), atrazine 1000 g/ha PE *fb* HW at 40 DAS (4.67 t/ha and 2.41, respectively) and lowest under weedy check (2.62 t/ha and 1.66, respectively).

WP 1.3.3.2 Evaluation of different herbicide mixtures for post-emergence weed control in maize and residual effect on succeeding mustard under rainfed conditions

SKUAST, Jammu

The dominated weeds comprised with *Cyperus* spp., *Digitaria sanguinalis, Echinochloa colona, Cynodon dactylon, Acrache racemosa, Eragrostis tenella, Eleusine* spp., *Amaranthus viridis, Solanum nigrum, Commelina benghalensis, Physalis minima* and *Phyllanthus niruri*. Among the herbicidal treatments, the lowest weed density and weed biomass recorded with tembotrione 100 g/ha + halosulfuron 67.5 g/ha which was significantly lower than all other herbicidal treatment at 30 DAS. At 60 DAS, tembotrione 100 g/ha + atrazine 500 g/ha recorded lowest weed density and weed biomass which was significantly lower than other herbicidal treatments. All the herbicidal weed management treatment recorded significantly higher yield attributes. Highest net returns and B.C ratio were recorded in with tembotrione 100 g/ha + atrazine 500 g/ha followed by atrazine 1000 *fb* tembotrione 100 g/ha and atrazine 1000 *fb* metribuzin 250 g/ha. Weed management treatments of maize had no-phytotoxicity or adverse effect on mustard crop (Table 1.3.3.2.1).

Table 1.3.3.2.1 Effect of different herbicides mixture for post emergent weed management on weed biomass (g/m^2) at 60 DAS in maize

Treatment	Grasses	Broadleaf	Sedges	Total	Grain Yield (t/ha)	Stover yield (t/ha)	B:C ratio
Tembotrione 100 g/ha at 15-20 DAS	4.13 (16.1)	3.83 (13.6)	2.34 (4.4)	5.93 (34.2)	3.03	6.21	2.65
Halosulfuron 67.5 g/ha at 15-20	5.26 (26.6)	4.08 (15.6)	1.83 (2.3)	6.75 (44.6)	2.83	5.05	2.13
Atrazine 1000 g/ha at 0-3 DAS	4.22 (16.8)	3.95 (14.6)	3.90 (14.2)	6.83 (45.7)	2.93	5.95	2.69
Atrazine 500 g/ha at 15-20 DAS	5.18 (25.8)	4.93 (23.3)	4.80 (22.0)	8.50 (71.2)	2.26	4.36	2.08
Tembotrione 100 g/ha+atrazine 500 g/ha at 15-20 DAS	2.06 (3.2)	1.72 (23.3)	1.59 (1.5)	2.78 (6.7)	3.62	7.39	3.13
Tembotrione 100 g/ha+ halosulfuron 67.5 g/ha at 15-20 DAS	2.86 (7.1)	2.42 (4.8)	1.47 (1.1)	3.77 (13.2)	3.51	7.26	2.56
Halosulfuron 67.5 g/ha+ atrazine 500 g/ha at 15-20 DAS	5.08 (24.8)	2.74 (6.5)	1.34 (0.8)	5.76 (32.2)	2·91	6.15	2.24
Atrazine1000 g/ha 0-3 DAS *fb* 2,4-D 500 g/ha at 15-20 DAS	4.41 (18.4)	2.13 (3.5)	3.11 (8.6)	5.63 (30.7)	3.01	6.13	2.69

Atrazine 1000 g/ha *fb* metribuzin 250 g/ha	3.00 (8.0)	2.53 (5.4)	2.67 (6.1)	4.53 (19.5)	3.49	6.92	3.06
Atrazine 1000 g/ha *fb* tembotrione 100 g/ha	2.87 (7.2)	2.99 (7.9)	2.08 (3.3)	4.42 (18.5)	3.62	7.39	3.05
Weed free	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	3.74	7.90	2.34
Weedy check	6.13 (36.5)	6.08 (36.0)	5.43 (28.4)	10.10 (101.0)	2.06	3.67	1.92
SEm±	0.08	0.08	0.08	0.08	148	366	-
L.S.D (P=0.05)	0.24	0.22	0.22	0.25	433	1073	-

Data was subjected to square root transformation ($\sqrt{X+0.5}$) Original values are in parenthesis

WP1.3 Herbicidal control of weeds in crops and cropping systems

WP 1.3.3.3 Weed management in maize (sweet/corn) French bean cropping system

CAU, Pasighat

Weed management in sweet corn

The major weed flora in the study area was comprised with *Cynodon dactylon, Echinochloa colona, Spilanthes acmella, Eclipta alba, Cyperus iria, Amaranthus viridis, Amaranthus spinosus, Solanum nigrum, Ageratum conyzoides, Physalis minima, Commelina benghalensis*, etc. Two hand weedings at 25 and 50 DAS significantly reduced the weed density. Intercropping of soybean (1:1) and black gram (1:1) in sweet corn also found effective in suppressing weeds. At 60 DAS, lowest weed biomass recorded with two hand weeding with higher WCE. Cultivation of sweet corn with intercrop of soybean and blackgram showed a reduction in weed biomass and increased WCE. The highest weed biomass (5.8 g/m^2) was recorded under weedy check. Hand weeding twice at 25 and 50 DAS resulted in significantly higher number of cobs/plant, cob length and number of rows/cob which was at par with remaining all weed control treatments. Intercropping of soybean with maize (1:1) recorded significantly higher number of cobs (0.78 lakh/ha) than weedy check followed by hand weeding twice at 25 and 50 DAS.

Rabi 2016-17 (French bean)

At 60 DAS, weed biomass was lowest with twice hand weeding with maximum WCE. Cultivation of French bean with black plastic mulch showed a reduction in weed biomass and increased WCE. The highest weed biomass (11.8 g/m^2) was recorded under weedy check. All weed control treatments exert significant effect on weed biomass and weed control efficiency **(Table 1.3.3.3)**. Among weed control treatments application of plastic mulch resulted in significantly higher number of pods/plant (11.9), pod yield/plant (60.3 g) and green pod yield (5.8 t/ha) which was at par with remaining all weed control treatments.

Table 1.3.3.3 Effects of weed management practices on growth and yield of French bean

Treatments	Plant height (cm)	No. of leaves/ plant	No. of pods/plant	Pod yield (g/plant)	Pod yield (t/ha)
T1	42.3	63.0	11.9	60.3	5.8
T2	41.2	49.7	11.1	57.3	5.5
T3	40.5	48.0	10.2	51.0	5.0
T4	41.9	52.7	11.6	63.3	6.2
T5	41.6	50.7	11.1	56.7	5.6
T6	40.0	44.3	9.7	46.3	4.6
T7	35.7	30.7	4.2	21.3	1.9
S.Em.±	2.21	2.40	0.9	5.0	0.5
LSD(P=0.05)	5.57	6.05	2.2	12.69	1.25

WP 1.3.3.4 Integrated weed management in zero tillage *Rabi* maize

RAU, Pusa

Study area comprised with *Echinocloa crus-galli, E. colona, Dactyloctenium aegyptium, Digitaria sanguinalis*, *Cynodon dactylon* (grasses), *Cyperus rotundus, C. difformis, Fimbristylis miliacea* (sedges), *Caesulia axillaris*, *Lippia nodiflora, Ammannia baccifera, Eclipta alba, Phyllanthus niruri* and *Ipomoea aquatica* (BLWs). The lowest weed density (1.19 no./m^2) and weed biomass (2.05 g/ m^2) were recorded under weed free which were significantly superior over rest of the treatments. Among different herbicides the lowest weed density (1.89 no./m^2) and weed biomass (3.45 g/m^2) were recorded under atrazine 1.5 kg/ha as PE *fb* power weeder at 25 DAS which were significantly superior to rest of the treatments. The highest WCE was recorded under weed free (90.4%) which was closely followed by atrazine 1.5 kg/ha as PE *fb* power weeder at 25 DAS (83.8%) and halosulfuron 67.5 g/ha as PE *fb* power weeder at 25 DAS (74.9%). The highest grain yield of maize (7.86 t/ha) was recorded under weed free which was statistically at par with glyphosate 1.6 kg/ha (3 days before sowing) *fb* power weeder at 25 DAS (7.59 t/ha), halosulfuron 67.5 g/ha as PE *fb* power weeder at 25 DAS (7.36 t/ha), atrazine 1.5 kg/ha as PE *fb* power weeder at 25 DAS (7.63 t/ha).

WP 1.3.4 Weed management in other cropping systems

WP 1.3.4.1 Weed management in Japanese mint (*Mentha arvensis*) mustard

NDUAT, Faizabad

Application of 10 t/ha rice straw mulch recorded maximum growth and yield attributes like plant height, siliqua/plant, seeds/siliqua, seed yield and stover yield due to reduced weeds competition at lowest possible limit and provided weed free environment, resulted in higher seed yield (50%) and stover yield (71%) over weedy check plot. Among the different weed control measures the maximum seed and stover yield was recorded (1.93 and 6.37 t/ha) with 10 t/ha rice straw mulch followed by two hand weeding (1.77 and 5.32 t/ha) and pendimethalin 1000 g/ha + 5 t rice straw mulch/ha (1.67 and 4.71 t/ha) treatments respectively. Maximum net returns (` 51656) was recorded under 10 t/ha straw mulch treated plot. However, B: C ratio was maximum (2.05) with two hand weeding treatment.

WP 1.3.4.2 Weed management in okra-vegetable pea cropping system

CAU, Pasighat

In okra at 60 DAS, weed free plots significantly reduced the weed density followed by plastic mulch and pendimethalin 1.5 kg/ha + hand weeding at 30 DAS. Maximum fruit weight/plant and more number of fruit/plant were recorded in plots under plastic mulch followed by application of pendimethalin *fb* HW. Plastic mulched plots recorded significantly higher fresh fruit yield (7.2 t/ha) than weedy check followed by application of pendimethalin *fb* HW. Higher net return of ` 28400 and ` 25600 were recorded with black plastic mulched plot and pendimethalin *fb* HW. Higher B: C of 1.5 was recorded with plastic mulched plot and pendimethalin *fb* HW.

Pea

The maximum weed density recorded in the weedy check plots, whereas weed free up to 60 DAS significantly reduced the weed density. Placement of black plastic mulch and quizalofop-ethyl 0.25 kg/ha *fb* HW at 30 DAS significantly reduced the weed biomass. Maximum pod weight/ plant was recorded in plastic mulch followed by pendimethalin *fb* HW at 30 DAS. Application of quizalofop-ethyl *fb* HW significantly influenced number of pods/plant. Plastic mulched plots recorded significantly higher pod yield (6.28 t/ha) and higher net return than weedy check followed by application of two hand weedings treatment (6.07 t/ha).

WP 1.3.5 Weed management in greengram

WP 1.3.5.1 Weed management of problematic weeds in green gram

RVSKVV, Gwalior

Growth and yield attributes of greengram were highest with hand weeding twice followed by imazethapyr + imazamox 80 g/ha and pendimethalin + imazathapyr 750 g/ha over weedy check. The maximum seed yield (1.06 t/ha) was recorded under two hand weedings at 20 and 40 DAS followed by imazethapyr + imazamox 80 g/ha (1013 kg/ha) and pendimethalin + imazathapyr 750 g/ha (864 kg/ha).

WP 1.3.5.2 Herbicidal weed management in green gram

CCSHAU, Hisar

Experimental field was infested with *Trianthema portulacastrum* and *Cyperus rotundus*. Pre-emergence herbicide provided effective control of *T. portulacastrum* but not against *C. rotundus*. Post emergence application of aciflourfen + clodinafop (RM) at all the rates proved very effective against *T. portulacastrum* but poor against *C. rotundus*. Pyroxasulfone alone at 127.5 and 150 g/ha and its combination with pendimethalin proved effective against all weeds. Imazethapyr and its combination with quizalofop and imazamox were poor against *T. portulacastrum*. Pyroxasulfuron alone at 127.5 g/ha and its combination with pendimethalin provided good control of *C. rotundus*. Post emergence of application of imazethapyr and imazethapyr + imazamox (RM) at 70 g/ha proved less effective in minimizing density and dry weight of weeds. Presence of weeds throughout the season caused 76% reduction in seed yield of greengram. Seed yield was maximum (1.29 t/ha) with use of aciflourfen + clodinafop at 370 g/ha which was at par with its lower dose, pyroxasulfone 150 g/ha, pyroxasulfone + pendimethalin (TM), imazethapyr + pendimethalin (RM) at 1000 g/ha and weed free.

WP 1.3.5.3 Management of complex weed flora in summer green gram

PAU, Ludhiana

The major weed flora was *Trianthema portulacastrum*, *Dactyloctenium aegyptium*, *Digitaria sanguinalis* and *Cleome viscosa*. Application of pre-mix of sodium acifluorfen + clodinafop propargyl at 245 and 306 g/ha gave effective control of all the weeds species which was significantly better than use of sodium acifluorfen, clodinafop-propargyl and pendimethalin alone. All the weed control treatments gave significantly higher seed yield of green gram than unsprayed check (Table 1.3.5.1). Application of pre-mix of sodium acifluorfen plus clodinafop-propargyl at 245 and 306 g/ha gave the highest seed yield of green gram which was at par to weedfree treatment.

Table 1.3.5.3.1 Growth, yield attributes and yield of green gram and economics of different weed control treatments (Summer 2016).

Treatment	Dose (g/ha)	Weed density (No./m^2) at 40 DAS				Wed biomass (g/m^2) at 40 DAS		Pods (No./ Plant)	Seed Yield (kg/ha)
		T. portulacastrum	*D. aegyptium*	*D. sanguinalis*	*C. viscosa*	Grasses	Broadleaves		
Sodium acifluorfen + clodinafop propargyl	184	1.4 (1)	1.3 (1)	1.3 (1)	1.4 (1)	2.3 (4)	3.2 (9)	23.3	1.39
Sdium acifluorfen+ clodinafop propargyl	245	1.1 (0)	1.1 (0)	1.0 (0)	1.0 (0)	1.3 (1)	1.7 (2)	26.7	1.63
Sodium acifluorfen + clodinafop propargyl	306	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	27.1	1.63
Sodium acifluorfen	165	1.1 (0)	1.9 (3)	2.0 (3)	1.3 (1)	3.6 (12)	2.8 (7)	22.7	1.28
Clodinafop-propargyl	80	2.2 (4)	1.1 (0)	1.1 (0)	2.4 (5)	1.6 (2)	6.3 (39)	23.9	1.28
Pendimethalin	750	1.1 (0)	1.3 (1)	1.1 (0)	1.1 (0)	1.6 (2)	1.8 (2)	23.7	1.29
Weed free	Hand weedings	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	27.2	1.61
Weedy check	-	2.2 (4)	2.1 (3)	2.3 (4)	2.4 (5)	4.4 (18)	6.4 (40)	13.5	0.81
SEm ±	-	0.1	0.1	0.1	0.1	0.1	0.2	0.7	0.06
LSD (P=0.05)		0.3	0.3	0.3	0.3	0.3	0.5	2.2	0.20

Data is subjected to square root transformation. Figures in parenthesis are means of original values.

WP 1.3.5.5 Evaluation of pre and post-emergence herbicides against complex weed flora in green gram (*Kharif*)

MPUAT, Udaipur

The major weeds in experimental plot were infested with grassy, broad leaf weeds and sedges. The prominent weed species were *Echinochloa colona* (31.7%), *Commelina benghalensis* (20.0%), *Trianthema portulacastrum* (17.2%), *Digera arvensis* (6.7%), *Parthanium hysterophorus* (10.5%) and *Cyperus rotundus* (13.9%). Post-emergence application of ready mix combination of aciflourfen + clodinafop applied at 370 g/ha recorded the maximum seed yield (653 kg/ha) followed by pyroxasulfone alone, tank mix applications of pyroxasulfone + pendimethalin and imazethapyr + quizalofop, ready mix of imazethapyr + pendimethalin (RM) and two hand weedings. The lowest yield was recorded in weedy check. Among the herbicidal weed control treatments PE of pendimethalin *fb* quizalofop 1000+60 g/ha recorded lowest seed yield (529 kg/ha), which was superior than weedy check.

WP 1.3.7 Weed management in soybean

WP 1.3.7.1 Integrated weed management in soybean

RAU, Pusa

Hand weeding twice at 20 and 40 DAS had lowest weed density (5.65 no./m^2) and dry weight of weeds (5.43 g/m^2) with higher WCE (65.2%) follwed by pendimethalin 1.0 kg/ha *fb* quizalofop-ethyl 50 g/ha at 20-25 DAS (7.15 no./m^2 and 6.97g/m^2) and imazethapyr 100 g/ha as PE *fb* fenoxaprop 100 g/ha at 20-25 DAS (8.04 no./m^2 and 7.12 g/m^2). The highest seed yield obtained under twice hand weeding (1.88 t/ha) followed by pendimethalin 1.0 kg/ha *fb* quizalofop-p-ethyl 50 g/ha at 20-25 DAS (1.67 t/ha) and imazethapyr 100 g/ha as PE *fb* fenoxaprop 100 g/ha at 20-25 DAS (1.58 t/ha). This helped in realizing significantly higher gross return in twice hand weeding (` 82,020/ha) followed by pendimethalin 1.0 kg/ha *fb* quizalofop- ethyl 50 g/ha at 20-25 DAS (` 73,220/ha) and imazethapyr 100 g/ha *fb* fenoxaprop 100 g/ha at 20-25 DAS (` 69,420/ha). However, pendimethalin 1.0 kg/ha *fb* quizalofop-ethyl 50 g/ha at 20-25 DAS produced significantly highest net return and B: C (` 42040/ha and 2.35) over all other treatments but was comparable to twice hand weeding and imazethapyr 100 g/ha *fb* fenoxaprop 100 g/ha at 20-25 DAS.

WP 1.3.8 Weed management in mustard

WP 1.3.8.1 Management of complex weed flora in rapeseed and mustard crops

PAU, Ludhiana

Study area was dominated with *Cyperus rotundus* followed by other weeds *Eleusine indica, Digitaria sanguinalis, Eragrostis tenella, Anagallis arvensis, Trianthema portulacastrum, Phyllanthus niruri*. Pre-emergence application of napropamide at 1125 and 1406 g/ha significantly reduced density of all the weeds as compared to weedy check. Napropamide at all doses significantly reduced the biomass of grasses, broadleaves and sedges as compared to weedy check; there was significant decrease in weed biomass with every increment of napropamide. Application of napropamide at all the levels significantly increased seed yield of toria as compared to weedy check. Seed yield with napropamide at 1125 and 1406 g/ha were at par to weed free treatment (Table 1.3.8.1.). The herbicide was safe to the crop at the doses tested.

Table 1.3.8.1 Effect of weed control treatments on growth and yield attributes and yield of toria (Autumn 2016-17).

Treatment	Dose (kg/ha)	Branches (No./plant)	Pods (No./plant)	Seed yield (t/ha)	Biological yield (t/ha)
Napropamide	0.84	280.1	40.5	1.23	4.97
Napropamide	1.12	281.1	41.0	1.40	5.14
Napropamide	1.4	289.8	42.5	1.44	5.13
Weed free	Hand weeding	290.3	44.8	1.43	5.19
Weedy check	-	272.3	29.3	0.92	3.56
SEm ±		15.7	2.8	0.04	0.14
LSD (P=0.05)		NS	9.1	0.13	0.44

WP 1.3.9.1 Integrated weed management in turmeric

PDKV, Akola

At 60 DAS, treatment hand weeding (25, 45 & 75 DAP) recorded significantly lower weed density and weed biomass followed by glyphosate *fb 2* HW (45 & 75 DAP), pendimethalin 1.0 kg / ha (0-5 DAP) *fb* straw mulch 10 t / ha (10 DAP) *fb* one HW (75 DAP) and metribuzin 0.7 kg / ha (0-5 DAP) *fb* straw mulch (10 DAP) *fb* HW (75 DAP). Similar trend of result was noticed in weed count and dry matter accumulation at 90 DAS. Highest weed count and weed biomass was recorded in weedy check. The highest weed control efficiency was recorded under metribuzin 0.7 kg / ha (0-5 DAP) *fb* straw mulch (10 DAP) *fb* HW (75 DAP) followed by post emergence application of glyphosate *fb 2* HW (45 & 75 DAP) followed by pendimethalin 1.0 kg / ha (0-5 DAP) *fb* straw mulch 10 t / ha (10 DAP) *fb* one HW (75 DAP). This may be due to better control of weeds in response to sequential application of pre and post emergence herbicides.

Lowest weed index was recorded in treatment pendimethalin 1.0 kg / ha (0-5 DAP) *fb* straw mulch 10 t / ha (10 DAP) *fb* one HW (75 DAP)T6 followed by metribuzin 0.7 kg / ha (0-5 DAP) *fb* straw mulch (10 DAP) *fb* HW (75 DAP) T3 integrated weed management practices of turmeric were significantly influenced the rhizome yield, where all the IWM treatments resulted in increase of rhizome yield over the weedy check. Maximum rhizome yield was observed in weed free treatment (22.78 t / ha). Among the IWM treatments application of pendimethalin 1.0 kg / ha (0-5 DAP) *fb* straw mulch 10 t / ha (10 DAP) *fb* one HW (75 DAP) recorded higher rhizome yield (21.6 t / ha) which was closely followed by metribuzin 0.7 kg / ha (0-5 DAP) *fb* straw mulch (10 DAP) *fb* HW (75 DAP).

WM 1.3.10 Weed management in ginger

WM 1.3.10.1 Integrated weed management with pre- and post-emergence herbicides in Ginger

UAS, Bengaluru

Major weed flora in the experimental plots were *Cyperus rotundus* (sedge), *Cyanodon dactylon, Eleusine indica, Dactyloctenium aegyptium* (grass), *Acanthospermum hispidum, Borreria hispida, Commelina benghalensis, Alternentera sessilis, Mimosa pudica, Tridax procumbens, Spillanthes acmella, Ageratum conyzoides, Euphorbia hirta, Euphorbia geniculata, Emilia sonchifolia* and *Amaranthus viridis* (BLW). *C. rotundus*, *C. dactylon, C. benghalensis, E. indica, D. aegyptium, B. hispida* and, *S. acmella* were dominant weed species.

At 60 DAP, herbicide treatments were significantly superior to weedy check with regards to weed density and weed biomass. Weedy check plots were dominated with broad leaved weeds followed by sedges and grasses. Metribuzin at 0.7 kg / ha *fb* hand weeding at 45 DAP were effective in controlling weeds followed by pendimethalin at 1.0 kg / ha *fb* hand weeding at 45 DAP. Application of pre-emergence herbicides followed by hand weeding showed better results compared to combination of pre- and post-emergence herbicides. However, all the herbicide treatments reduced the weed density and weed biomass as compared to weedy check.

AAU, Jorhat

Experimental area was dominated with *Panicum repens* along with *Cynodon dactylon*, *Digitaria setigera* and *Eleusine indica.* However, broadleaved weed *Mimosa diplotricha* appeared nearly two months after planting of the crop and became dominant within a couple of weeks after appearance and smothered the crop. *Scoparia dulcis, Ageratum houstonianum, Spermacoce* spp. amongst other broadleaved species, and *Fimbristylis* spp. and *Scleria terrestris* among the sedges. The lowest weed density at all stages and weed biomass at 30 and 60 DAP were achieved under glyphosate 0.80 kg / ha + oxyfluorfen 0.2 kg / ha just before emergence of sprouts of ginger.

WP 1.3.11.1 Bioefficacy evaluation of different herbicides in fenugreek and their residual effect on succeeding crop

MPUAT, Udaipur

Experimental field was infested with grassy, broad leaf weeds and sedges. Prominent weed species were *Chenopodium album* (48.4%), *Chenopodium murale* (28.2%), *Fumaria parviflora* (15.6%), *Melilotus indica* (0.67%), *Convolvulus arvensis* (0.67%) and *Phalaris minor* (7.8%). Weed density of grassy and broad leaf weeds recorded at 60 DAS and at harvest were found significant affected due to weed management practices. Weed density of broad leaf weeds were higher than grassy weeds. The lowest weed density among the herbicidal treatments at both stages were found in oxadiargyl 100 g / ha *fb* one hoeing at 40 DAS followed by oxyfluorfen 129 g / h as PE + one hoeing at 40 DAS and imazethapyr 70 g / ha as PE + One hoeing at 40 DAS. Maximum weed control efficiency at 60 DAS (90.1%) at harvest (72.7%) was recorded with oxadiargyl 100 g / ha *fb* one hoeing at 40 DAS.

WP 1.3.12 Weeds management in Onion

OUAT, Bhubaneswar

Thrice hand weeding at 20, 40 and 60 DAS recorded significantly highest onion yield of 27.2 t / ha, whereas weedy check treatment recorded the lowest yield (6.7 t / ha). Among different herbicide combinations, significantly higher onion yield of 23.4 t / ha was obtained with application of pendimethalin *fb* quizalofop–p-ethyl over all other sole and herbicide combination. Application of pendimethalin *fb* quizalofop –p-ethyl recorded lowest weed density at all the growth stages. Thrice hand weeding obtained with highest net return and B:C ratio of ` 85,426 / ha and 2.62 respectively followed by application of pendimethalin *fb* quizalofop–p-ethyl (` 71,523 / ha and 2.59 respectively).

WP 1.3.13.1 Integrated management of complex weed flora in vegetable peas and residual effect on succeeding crops

CCSHAU, Hisar

Experimental field was infested with *Anagallis arvensis, Euphorbia, Fumaria parviflora, Coronopus didymus, Vicia sativa, Chenopodium album, Lathyrus* sp., *Rumex dentatus* along with some other broadleaf weeds. Imazethapyr + imazamox at 60 – 80 g / ha at 2-4 leaf stage provided excellent control of weeds to the tune of 93.7 to 95% without any phytotoxicity on pea. Maximum pea grain yield (4.54 to 4.80 t / ha) was obtained in imazethapyr + imazamox at 60 - 80 g / ha. No phytotoxicity was observed on succeeding crop of sorghum. Clodinafop at 60 g / ha, pinoxaden 50 g / ha, pendimethalin alone at 1000 g / ha alone or its pre mix combination with imazethapyr at 800-1000 g / ha(PRE) did not cause any residual toxicity on any of the succeeding crop planted after harvest of peas. Imazethapyr and its pre mix combination with imazamox caused severe toxicity on sorghum and bottle gourd.

SKUAST, Jammu

Among the herbicidal treatments lower grassy, broad-leaved, sedges, total weed density and weed biomass were recorded in pendimethalin + imazethapyr at 1250 g / ha PRE followed by pendimethalin + imazethapyr at 1000 g / ha PRE. All the weed management treatments recorded significantly higher plant height, plant dry matter, number of nodules, number of pods and green pod yield as compared to weedy check. Among the herbicidal treatments, highest green pod yield was recorded with pendimethalin + imazethapyr at 1250 g / ha pre followed by pendimethalin + imazethapyr at 1000 g / ha pre. The highest net returns and B:C ratio was recorded in pendimethalin + imazethapyr at 1250 g / ha pre followed by pendimethalin + imazethapyr at 1000 g / ha pre. There was no residual phytotoxicity on succeeding cucurbit crops (Cucumber and Round gourd).

WP 1.4 Improving input-use efficiency through weed management

WP 1.4.1 Impact of methods of irrigation and weed control measures on management of complex weed flora in *Rabi* sweet corn

DBSKKV, Dapoli

The major weed flora recorded was *Oryza sativa, Eleusine indica, Cyperus rotundus* among grasses and sedges, whereas the broadleaved weeds were *Cardiospermum helicacabum, Physalis minima, Alternanthera sessilis, Celosia argentea* and *Amaranthus viridis.* Application of irrigation through drip (75% PE) significantly reduced the weed density of monocots and broadleaved at all stages of observations. Mulching with black polythene (25 micron) recorded significantly least weed density of monocots as compared to rest of the treatments except treatment mulching with paddy straw (5 t / ha) at 60 DAS and treatment of herbicide (Tembotrione) 100 g / ha (POE) 20 DAS. The interaction effect between irrigation methods and weed control measures was found to be non-significant. Effect of different irrigation methods recorded significantly higher growth attributes, yield attributes and yield of sweet corn. Application of irrigation through drip (75% PE) recorded significantly higher growth attributes, yield attributes and yield of sweet corn over surface irrigation method. The different weed control measures influenced significantly the plant height, length of cob, girth of cob, cob and straw yield. Among different weed control measures mulching with black polythene (25 micron) recorded significantly maximum height, length of cob, girth of cob, cob and straw yield as compared to rest of the treatments.

Treatments	Weed dry matter at 60 DAS (no./m^2)		Height at harvest (cm)	Cob yield (t/ha)	Straw yield (t/ha)
A) Main plot treatments: Irrigation methods	G & S	BLWs	197.5	10.9	17.2
I1: Drip irrigation (75% PE)	2.3 (1.62)	4.2 (2.05)	191.0	9.8	16.2
I2: Surface irrigation (100% PE)	3.8 (2.06)	6.0 (2.51)	0.24	0.1	0.1
SEm ±	0.1 (0.02)	0.1 (0.02)	4.24	1.10	0.9
LSD (P=0.05)	1.0 (0.43)	1.0 (0.40)	199.0	11.1	17.4
B) Sub plot treatments: Weed control measures					
T1: Mulching with black polythene (25 micron)	2.1 (1.56)	3.7 (2.05)			
T2: Mulching with paddy straw (5 t/ha)	3.7 (2.05)	4.6 (2.22)	191.8	9.7	16.3
T3: Tembotrione 100 g/ha (POE) 20 DAS	3.3 (1.93)	4.6 (2.22)	193.8	10.4	16.6
T4: Weed free check (3 HW at 20, 40 and 60 DAS)	1.5 (1.35)	2.3 (1.61)	196.8	11.7	18.6
T5: Weedy check (1 hoeing 20 DAS)	4.8 (2.30)	10.2 (3.27)			
SEm ±	0.3 (0.12)	0.5 (0.13)	189.8	9.0	14.8
LSD (P=0.05)	2.1 (1.56)	3.7 (2.05)	1.19	0.2	0.1
Interaction effects	3.7 (2.05)	4.6 (2.22)	3.58	0.6	0.5
SEm ±	3.3 (1.93)	4.6 (2.22)	0.45	1.8	3.2
LSD (P=0.05)	1.5 (1.35)	2.3 (1.61)	NS	NS	NS

SKUAST, Jammu

WP 1.4.2 Effect of irrigation methods and weed management on weed flora dynamics in direct-seeded rice and wheat

Wheat (*Rabi* 2016-17)

The experimental field was dominated by *P. minor* and *Avena* spp. amongst grassy weeds; *Rumex dentatus, Anagallis arvensis, M. indica* and *R. arvensis* amongst broadleaved weeds. Beside these major weeds, *Chenopodium album* and *Vicia* spp. were recorded as other weeds.

Different irrigation treatments had non-significant effect on weed density and weed biomass at 60 days after sowing and at harvest. However, lower weed density and weed biomass were recorded in flooding irrigation as compared to sprinkler and sprinkler with variable speed drive (VSD). Among the weed management treatments, significantly lowest total weed density and biomass were recorded in sulfosulfuron + carfentrazone (25 + 20 g/ha) than other herbicidal treatments. Different irrigation treatments had non-significant effect on growth, yield attributes and grain and straw yield of wheat. However, higher growth, yield attributes and grain and straw yield of wheat were recorded in flooding irrigation as compared to sprinkler and sprinkler with VSD. The higher grain and straw yield were recorded in sulfosulfuron + carfentrazone (25 + 20 g/ha) which was statistically at par with clodinafop-propargyl + metribuzin (60 + 210 g/ha) and clodinafop-propargyl + metsulfuron (60 + 4 g/ha). The higher B:C ratio was recorded with flood irrigation as compared to sprinkle irrigation and sprinkler with VSD. However, highest water use efficiency was recorded with sprinkler with VSD as compared to sprinkler and flood irrigation. Amongst the weed management treatments highest B:C ratio and water use efficiency were recorded sulfosulfuron + carfentrazone (25 + 20 g/ha) in wheat.

Rice (*Kharif* 2017)

The experimental field was dominated by *Echinochloa* spp., *Cynodon dactylon*, *Digitaria* *sanguinalis* and *Setaria glauca* amongst grassy weeds; *Caesulia axillaris, Phyllanthus niruri, Physalis minima* and *Euphorbia* spp. amongst broadleaved weeds, and *Cyperus* spp.*Commelina benghalensis, Cucumis* spp. and *Dactyloctenium aegyptium* were recorded as other weeds. Different irrigation treatments had non-significant effect on weed density and weed biomass at 60 days after sowing and at harvest of rice. However, lower weed density and weed biomass were recorded in flood irrigation as compared to sprinkler and sprinkler with VSD. Density *Caesulia axillaris* was higher in flooding irrigation as compared to sprinkler and sprinkler with VSD. However, density of *Echinochloa* spp., *Cynodon dactylon*, *Digitaria sanguinalis, Setaria glauca, Phyllanthus niruri, Physalis minima, Euphorbia* spp. and *Cyperus* spp. were higher in sprinkler irrigation method as compared to flood irrigation in rice.

Among the weed management treatments, significantly lowest total weed density and total biomass of weeds were recorded in pendimethalin 1000 g/ha (PE) *fb* bispyribac-sodium 25g/ha + ethoxysulfuron-ethyl 18 g/ha (POE) than all other herbicidal treatments at 60 days after sowing and harvest. Higher growth, yield attributes and grain and straw yield of rice were recorded in flooding irrigation as compared to sprinkler and sprinkler with VSD. Among the weed management treatments, the higher grain and straw yield were recorded in pendimethalin 1000 g/ha (PE) *fb* bispyribac-sodium 25g/ha + ethoxysulfuron-ethyl 18 g/ha (POE) which was statistically at par with pendimethalin 1000 g/ha (PE) *fb* penoxsulam + cyhalofop-butyl 135 g/ha (POE) and significantly higher than all other herbicidal treatments. Highest B:C ratio was recorded with flood irrigation as compared to sprinkle irrigation and sprinkler with VSD. Amongst the weed management treatments highest B: C ratio and water use efficiency were recorded in pendimethalin 1000 g/ha (PE) *fb* bispyribac-sodium 25g/ha + ethoxysulfuron-ethyl 18 g/ha(POE) in direct-seeded rice.

AAU, Jorhat

WP 1.4.3 Weed and nutrient management under upland direct-seeded rice

Grasses were the most dominant weed flora, followed by sedges, in comparison to broadleaved species. *Cynodon dactylon, Digitaria setigera, Eleusine indica* and *Panicum repens* amongst the grasses, and amongst the sedges the dominant species were *Cyperus flavidus, C. iria, C. rotundus, Fimbristylis bisumbellata, F. littoralis* and *Scleria terrestris. Ageratum houstonianum, Melochia corchorifolia, Mimosa pudica, Mollugo pentaphylla, Spermacoce ocimoides, etc.*, were the most common broadleaved weed species in the field.

The weed dry weight was significantly affected by the treatments at 30 and 60 DAS and the lowest value at 30 and 60 DAS was recorded due to two hand weedings (15 and 30 DAS) and 75% RD fertilizer, as vermicompost (2.0 t/ha) mixture in 3 splits (before sowing, 30 DAS and 60 DAS) pretilachlor 750 g/ha mixed with the first split followed by HW 30 DAS, respectively. Highest values of plant growth in terms of number of tillers and plant height, yield attributes in terms of number of panicle, panicle length and number of filled grains were recorded in the treatment of 75% RD fertilizer + vermicompost (2 t/ha) mixture in 3 splits (before sowing, 30 DAS and 60 DAS) + pretilachlor 750 g/ha mixed with the first split followed by HW 30 DAS. This treatment finally resulted in highest grain and straw yield which was significantly superior to rest of the treatments.

RAU, Pusa

WP 1.4.3(i) Effect of weed management and water regimes on direct-seeded rice

Weed flora found in the experimental field comprised of grasses: *Echinochloa crus-galli, E. colona, Digitaria sanguinalis, Dactyloctenium aegyptium, Cynodon dactylon*, sedges: *Cyperus rotundus, C. difformis, C. iria* and *Fimbristylis milliacea,* broadleaved weeds: *Caesulia axillaris, Lippia nodiflora, Amaranthus spinosus, A. viridis, Eclipta alba, Phyllanthus niruri* and *Monochoria vaginalis.*

The lowest weed population (13.5 / m^2) and weed dry weight (20.4 g / m^2) were recorded in 3 days after disappearance (DAD) of water regime which was significantly superior over rest of the water regime treatments and the lowest weed population (8.7 / m^2) and weed dry weight (14.2 g / m^2) were recorded in weed-free treatment (3 hand weedings at 20, 40, 60 DAS) which was significantly superior over rest of the treatments. Among the different herbicide treatments, the lowest weed population (11.1 / m^2) and weed dry weight (19.3 g / m^2) were recorded in pendimethalin 1.0 kg / ha (PE) *fb* bispyribac-sodium 25 g / ha at 20 DAS which were significantly superior over rest of the treatments in sub plots.

The highest grain yield of rice (3.75 t / ha) was recorded by the treatment 3 DAD water regime which was significantly superior over rest of the treatments in main plots and the highest grain yield of rice (3.68 t / ha) was recorded by weed-free treatment (3 hand weedings at 20, 40,60 DAS) which was statistically at par with pendimethalin 1.0 kg / ha (PE) *fb* bispyribac-sodium 25 g / ha at 20 DAS treatment (3.49 t / ha) and significantly superior over rest of the treatments in sub plots. Water use efficiency was not influenced by moisture regimes. The highest B:C ratio (2.0) was also recorded by 3 DAD water regime treatment which was significantly superior over rest of the treatments in main plots. In sub plots, the highest B:C ratio (1.96) was recorded by pendimethalin 1.0 kg / ha (PE) *fb* chlorimuron + metsulfuron 4.0 g / ha at 20 DAS which was statistically at par with pendimethalin 1.0 kg / ha (PE) *fb* bispyribac-sodium 25 g / ha at 20 DAS (1.9) and chlorimuron + metsulfuron 4.0 g / ha at 20 DAS (1.9) in sub plot treatments.

WP 1.4.3(ii) Effect of weed management and nitrogen on weed dynamics and yield of rice under aerobic condition

Weed flora found in the experimental field comprised of grasses: *Echinochloa crus-galli, E. colona, Digitaria sanguinalis, Dactyloctenium aegyptium, Cynodon dactylon,* sedges: *Cyperus rotundus, C. difformis, C. iria* and *Fimbristylis milliacea,* broadleaved weeds: *Caesulia axillaris, Lippia nodiflora, Amaranthus spinosus, Amaranthus viridis, Eclipta alba, Phyllanthus niruri* and *Monochoria vaginalis.* The lowest weed population (12.5 / m^2) and weed dry weight (25.6 g / m^2) were recorded in 160 kg N / ha which were significantly superior over rest of the treatments in main plots and the lowest weed population (8.2 / m^2) and weed dry weight (19.3 g / m^2) were recorded in weed-free treatment (3 hand weedings at 20, 40,60 DAS) which were significantly superior over rest of the treatments in sub plots. Among the different herbicide treatments, the lowest weed population (9.2 / m^2) and weed dry weight (21.9 g / m^2) were recorded in pendimethalin 1000 g / ha (PE) + pyrazosulfuron 25 g + bispyribac-sodium 25 g (tank mix) (20 DAS) which were significantly superior over rest of the treatments in sub plots. The highest grain yield of rice (3.61 t / ha) was recorded by the treatment 160 kg N / ha which was statistically at par with 140 kg N / ha (3.48 t / ha) in main plots and the highest grain yield of rice (4.09 t / ha) was recorded by weed-free treatment (3 hand weedings at 20, 40, 60 DAS) which was significantly superior over rest of the treatments except pendimethalin 1000 g / ha (PE) + pyrazosulfuron 25 g + bispyribac-sodium 25 g (tank mix) (20 DAS) treatment (3.86 t / ha) which was statistically at par with weed-free treatment.

The highest B:C ratio (2.13) was also recorded by 160 kg N / ha treatment which was statistically at par with 140 kg N / ha (2.08) in main plots. In sub plots, the highest B:C ratio (2.32) was recorded by pendimethalin 1000 g / ha (PE) + pyrazosulfuron 25 g + bispyribac-sodium 25 g (tank mix) (20 DAS) which was statistically at par with pyrazosulfuron 25 g + bispyribac-sodium 25g (tank mix) (20 DAS) (2.31) and bispyribac-sodium 25 g / ha (20 DAS) (2.31).

WP 1.4.3(iii) Integrated nutrient and weed management on growth, yield and quality of aromatic rice

Weed flora found in the experimental field comprised of grasses: *Echinochloa crus-galli, E. colona, Digitaria sanguinalis, Dactyloctenium aegyptium, Cynodon dactylon,* sedges: *Cyperus rotundus, C. difformis, C. iria* and *Fimbristylis milliacea,* broadleaved weeds: *Caesulia axillaris, Lippia nodiflora, Amaranthus spinosus, A. viridis, Eclipta alba, Phyllanthus niruri* and *Monochoria vaginalis.*

The lowest weed population (14.1/m^2) and weed dry weight (29.4 g/m^2) were recorded in 50% RDN through inorganic source + 50% RDN through vermicompost which were significantly superior over rest of the treatments in main plots and the lowest weed population (9.5/m^2) and weed dry weight (17.6 g/m^2) were recorded in weed-free treatment (2 HW at 20 and 40 DAT)which were significantly superior over rest of the treatments in sub plots. Among the different herbicide treatments, the lowest weed population (13.6/m^2) and weed dry weight (25.4 g/m^2) were recorded in pretilachlor 1.5 kg/ha (P.E.) + 1 HW at 20 DAT which were significantly superior over rest of the treatments in sub plots. The highest grain yield of rice (5.08 t/ha) was recorded by the treatment 50% RDN through inorganic source + 50% RDN through vermicompost which was statistically at par with 75% RDN through inorganic source + 25% RDN through vermicompost (4.83 t/ha) in main plots and the highest grain yield of rice (4.65 t/ha) was recorded by weed-free treatment (2 HW at 20 and 40 DAT) which was significantly superior over rest of the treatments except pretilachlor 1.5 kg/ha (P.E.) + 1 HW at 20 DAT treatment (4.58 t/ha) which was statistically at par with weed-free treatment. The highest B: C ratio (2.71) was also recorded by the treatment 100% RDN (120 kg N-60 kg P_20_5- 40 kg K_2O/ha) through inorganic source which was significantly superior over rest of the treatments in main plots. In sub plots, the highest B:C ratio (3.04) was recorded by pretilachlor 1.5 kg/ha (P.E.) + bispyribac-sodium 20 g/ha at 20 DAT which was statistically at par with pretilachlor 1.5 kg/ha (P.E.) + 1 HW at 20 DAT (2.80) and significantly superior over rest of the treatments in sub plot treatments.

WP 1.4.4 Studies on weed dynamics in long-term fertilizer experiment in maize–wheat cropping sequence

BAU, Ranchi

In maize, application of 120 kg N, 80 P_2O_5/ha and 40 kg K_2O/ha recorded significantly reduced total weed dry matter (7.5 g/ha) indicating selective stimulation to maize crop through balanced nutrient supply made the plant more competitive against weed flora. Application of 120 kg N/ ha similar to 80 kg N/ha recorded 11.4% significantly higher grain yield compared to that recorded under 40 kg N/ha (2.36 t/ha). Application of 80 Kg P_2O_5 recorded 18.4 and 276.8% higher grain yield compared to 40 and P_2O_5 respectively. Application of 40 kg K_2O recorded 12.8% higher wheat yield (2.71 t/ha).

In wheat, application of 120 kg N/ha recorded significantly reduced weed dry weight compared to its lower levels *i.e.* 40 and 80 kg N/ha to the tune of 33.1% (73.1 g/m^2) and 31.9% (71.5 g/m^2), respectively. Application of phosphorus enhanced weed dry matter to the tune of 27.7 and 64.5% compared to no phosphorus application (49.3 g/m^2). While increase in K_2O from 0 to 40 kg/ha increased weed dry matter to the extent of 9.5%. (67.4 g/m^2). Application of 120 kg N/ha being similar to 80 kg N/ha recorded 12.4% higher grain yield compared to 40 kg N/ha. While, application of 80 kg P_2O_5 recorded 19.6% and 182.3% higher wheat yield compare to 40 and 80 kg P_2O_5 respectively. Application of 40 kg K_2O recorded 13.6% higher wheat yield (5.06 t/ha).

WP 1.5 Station trials on weed management

WP-1.5.1 (v) Efficacy of post emergence herbicides in groundnut (*Arachisahypogaea*)

PDKV, Akola

Major weed flora during *Kharif* in groundnut was *Cynodon dactylon, Cyperus rotundus, Commelina benghalensis, Ischaemum pilosum, Digitaria sanguinalis, Dinebra retroflexa, Poa annua, Cyanotis axillaris* among monocot weeds and *Digera arvensis, Lagascea mollis, Euphorbia geniculata, Tridax procumbense, Parthenium hysterophorus, Celosia argentea, Alysicarpus monolifer, Alternanathera triandra, Portulaca oleracea, Amaranthus viridis, Acalypha indica, Cardiospermum halicacabum, Ipomoea reniformis, Corchorus acutangulus, Phyllanthus niruri, Abutilon indicum, Abelmoschus moschatus,* *Boerhavia diffusa etc.* among dicot weeds. Weed count and weed dry matter were recorded significantly lowest in pendimethalin 1.0 kg/ha PE at 20 DAS this might be due to effect of pre-emergence application of herbicide. At 40 DAS, propaquizafop 0.10 kg/ha PoE 20 DAS recorded lowest weed count and weed dry matter but found at par with imazethapyr + imazomox 0.1 kg/ha PoE 20 DAS. Highest weed control efficiency was noticed in pendimethalin 1.0 kg/ha PE at 20 DAS. However, it was recorded maximum in propaquizafop 0.1 kg/ha PoE 20 DAS followed by byimazethapyr + imazomox 0.1 kg/ha PoE 20 DAS at late stages *i.e.* 40 DAS and at harvest. At the same time, phytotoxicity symptoms on the leaves of groundnut were observed in oxyflurofen 0.2 kg/ha PoE 20 DAS. Results showed that weed free treatment gave highest pod yield (2.51 t/ha) followed by post-emergence application of propaquizofop 0.1 kg/ha PoE 20 DAS (2.35 t/ha) and imazethapyr + imazomox 0.1 kg/ha PoE 20 DAS (2.28 t/ha). Propaquizafop 0.1 kg/ha PoE 20 DAS treatment also registered highest B:C ratio (3.52) followed by application of imazethapyr + imazomox 0.1 kg /ha PoE 20 DAS (3.36) than rest of treatments.

WP 1.5.2 Management of complex weed flora in garlic (*Allium sativum* L.)

AAU, Anand

Major weeds observed in the experimental field were *Chenopodium murale* (90.8%), *Chenopodium album* (4.3%) and *Melilotus indica* (3.4%) among dicot weed and *Eleusine indica* (34.8%), *Asphodelus tenuifolius* (17.4%), *Setaria gluaca* (13%) and *Digitaria sanguinalis* (8.7%) among monocot weeds. Phytotoxicity symptoms were observed in pendimethalin 500 g/ha + oxyfluorfen 120 g/ha EPoE (tank-mix) which recoverd after 20 days. Whereas, application of oxyfluorfen 240 g/ha PoE found slightly phytotoxic and burning of tips of leaves was observed. Weed density and dry biomass of weeds were recorded significantly lowest under paddy straw mulch 5.0 t/ha treatment. Among various weed management practices, significantly the lowest weed density and weed dry biomass of monocot (2.65 and 1.55) and total weeds (4.44 and 2.59) were observed under pendimethalin 500 g/ha EPoE + oxyfluorfen 120 g/ha EPoE (tank-mix) treatement whereas, both observations of dicot weeds recorded lowest under hand weeding at 30 and 60 DAP. Bulb yield of garlic was significantly influenced by mulching treatment and significantly the highest bulb (6.24 t/ha) yield of garlic was recorded in paddy straw mulch 5.0 t/ha. While among weed management practices, highest bulb yield (7.71 t/ha) was obtained in PE application of oxyfluorfen 240 g/ha *fb* HW at 60 DAP. Economic analysis of different treatment revealed that application of oxyfluorfen 240 g/ha PE *fb* HW at 60 DAP with paddy straw mulch 5.0 t/ha gave highest net return and B: C ratio (3.79).

WP 1.5.3 (ii) Weed management in kinnow basins

The most dominent weed species found in experimental field during *Rabi* were *Vicia sativa.*, *Anagallis arvensis*, *Melilotus indica*, *Medicago denticulata*, *Rumax* spp. and *Cynodon dactylon*. However in summer *Solanum nigrum*, *Physalis minima*, *Amaranthus viridis*, *Imperata cylindrica* and *Cynodon dactylon* were found. *Amaranthus viridis*, *Alternanthera philoxeroides*, *Cirsium arvense*, *Erigeron* spp. *Phyllanthus niruri*, *Solanum nigrum*, *Digitaria sanguinalis*, *Paspalum* spp and *Cynodon dactylon* were recorded in *Kharif*.

Among the treatments, significantly lower grassy, broad-leaved, sedges, total weed density and weed biomass were recorded in polythene mulch followed by atrazine 2 kg/ha + paddy straw muching *fb* non-selective herbicide and pendimethalin 1.0 kg/ha + paddy straw muching *fb* non-selective herbicide. Polythene mulch also recorded significantly highest fruit yield and yield attributes followed by atrazine 2.0 kg/ha + paddy straw muching *fb* non-selective herbicide and pendimethalin 1.0 kg/ha + paddy straw muching *fb* non-selective herbicide (Table 1.5.3.1).

Table 1.5.3.1 Effect of different weed management practices on growth, yield and yield attributes in kinnow orchard

Treatments	Number of fruit/plant	Fruit size (mm)	Fruit weight (g)	Fruit yield/ plant (kg)
Pendimethalin 1.0 kg/ha	110.3	64.9	118.3	14.5
Atrazine 2.0 kg/ha	111.3	64.4	122.3	13.6
Paddy straw muching	116.6	65.3	124.6	13.0
Pendimethalin 1.0 kg/ha + paddy straw muching	117.0	65.8	128.0	15.0
Atrazine 2.0 kg/ha + paddy straw muching	120.6	66.4	130.6	15.8
Pendimethalin 1.0 kg/ha + paddy straw muching *fb* non-selective herbicide	125.6	66.8	135.6	17.0
Atrazine 2 kg/ha + paddy straw muching *fb* non-selective herbicide	127.3	67.3	137.3	17.6
Directed application of glyphosate1% (each season)	114.6	65.5	123.6	14.2
Directed application of paraquat 0.5% (each season)	113.6	65.0	122.6	13.9
Black polythene mulching	129.3	69.7	138.3	17.5
Weed free	132.0	70.6	143.3	18.9
Weedy check	108.3	63.8	116.6	12.6
SEm ±	3.5	1.3	2.9	0.7
LSD (P=0.05)	10.3	4.0	8.6	2.1

AAU, Jorhat

WP 1.5.4(iii) Seed priming and weed management in upland direct-seeded rice

Most common broadleaved weeds found in the experiment were *Ageratum houstonianum, Melochia corchorifolia, Mimosa pudica, Mollugo pentaphylla, Polygonum glabrum* and *Spermacoce ocimoides.* Among the sedges *Cyperus flavidus, C. iria, C. rotundus, Fimbristylis bisumbellata, F. littoralis* and *Scleria terrestris*; and among the grasses *Cynodon dactylon, Digitaria setigra, Eleusine indica* and *Panicum repens.*

Results indicated that seed priming with GA_3 at both the concentrations, *viz.* 50 and 100 ppm caused significant decrease of weed density at all the stages and weed dry weight at 30 DAS and harvest as compared to no seed priming. However, between the two concentrations of GA_3 , seed priming with 100 ppm GA_3 resulted significantly lower weed density and dry weight at 60 DAS and harvest than seed priming with 50 ppm GA_3.

Among the weed management treatments, application of pretilachlor 0.75 kg/ha *fb* hand weeding 40 DAS and hand weeding at 20 and 40 DAS resulted similar effects at different stages but better effects were observed with these treatments than application of pretilachlor 0.75 kg/ha only at 60 DAS and harvest (Table 1.5.4.1) The highest values of number of tillers, plant height, number of panicles, panicle length and number of filled grains were observed due to seed priming with GA_3 100 ppm but it was superior to GA_3 50 ppm other than plant height. Finally, the grain and straw yield obtained from seed priming with GA_3 100 ppm was significantly better than that of seed priming with GA_3 50 ppm and priming with water only.

Treatments with pretilachlor 0.75 kg/ha *fb* HW 40 DAS resulted in significantly higher values of different growth and yield attributes than hand weeding at 20 & 40 DAS and pretilachlor 0.75 kg/ha alone other than plant height. Grain and straw yields were increased significantly due to pretilachlor 0.75 kg/ha *fb* HW 40 DAS as compared to hand weeding at 20 and 40 DAS, pretilachlor 0.75 kg/ha alone and weedy.

Table 1.5.4.2 Weed density, dry weight, yield attributes, grain and straw yield of direct seeded rice due to seed priming and weed management treatments

Treatments	Weed density* (no./m²)			Weed dry weight* (g/m²)			No of Tiller/m	No of Panicle/m	No of filled grain/ panicle	Grain Yield (t/ha)	Straw Yield (t/ha)
	30DAS	60DAS	Harvest	30DAS	60DAS	Harvest					
Seed priming											
Soaking seeds with GA_3 50 ppm for 8 hours	12.91 (168.6)	16.53 (275.6)	15.64 (248.3)	6.04 (37.0)	8.45 (72.0)	10.27 (106.67)	24.50	21.75	76.75	1.87	2.27
Soaking seeds with GA_3 100 ppm for 8 hours	12.68 (162.0)	15.35 (238.0)	14.88 (224.3)	5.65 (32.0)	8.28 (68.6)	9.73 (96.3)	28.58	24.75	82.66	2.11	2.56
No regulator (no seed priming)	13.43 (181.6)	17.66 (314.3)	16.61 (279.0)	6.78 (46.0)	8.61 (74.3)	10.80 (117.6)	20.25	17.41	66.25	1.51	1.83
LSD (P=0.05)	0.36	0.53	0.54	0.43	NS	0.45	1.52	1.31	1.99	0.05	0.06
Weed management											
Pretilachlor 0.750kg/ha	12.57 (157.7)	16.55 (276.0)	15.48 (241.7)	5.98 (36.0)	8.52 (72.8)	9.91 (98.2)	25.55	22.77	81.77	1.81	2.19
Pretilachlor 0.750kg/ha followed by HW 40 DAS	12.25 (149.7)	15.15 (229.7)	13.74 (188.8)	5.90 (34.6)	7.79 (60.4)	9.22 (85.3)	31.00	27.66	94.11	2.30	2.81
Hand weeding at 20 & 40 DAS	12.02 (144.4)	15.36 (236.4)	15.08 (227.5)	5.54 (30.6)	7.91 (62.2)	9.60 (92.0)	29.00	25.88	90.00	2.01	2.42
Weedy	15.21 (231.1)	19.00 (361.7)	18.54 (344.0)	7.21 (52.0)	9.56 (91.1)	12.34 (152.0)	12.22	8.88	35.00	1.21	1.46
LSD (P=0.05)	0.42	0.61	0.63	0.49	0.59	0.52	1.75	1.51	2.30	0.06	0.08

WP 1.5.5 Management of mixed weed flora in potato

PAU, Ludhiana

The major weed flora in the experimental field included one grassy weed *viz. Eleusine indica*, five broad leaf weeds *viz. Anagallis arvensis, Rumex dentatus, Medicago denticulata, Coronopus didymus* and *Spergula arvensis* and sedge *Cyperus rotundus*. Post-emergence application of pre-mix of clodianfop plus metribuzin at 195, 260 and 325 g/ha significantly reduced the density of all the grass and broadleaf weed as compared to unsprayed control. Metribuzin 350 g/ha as pre-emergence controlled weeds as compared to weedy but resulted in suppression of crop growth. Post-emergence application of metribuzin recorded effective control of weeds till 40 days, however it suppressed crop growth. Clodinafop alone controlled grassy weed only. Pre-mix of clodinafop plus metribuzin at all doses recorded significantly lower biomass of grass and broadleaf weeds as compared to unsprayed control. All the herbicides, however did not influence density and biomass of *C. rotundus*. Pre-mix clodinafop plus metribuzin at 325 g/ha recorded the highest potato tuber yield and it was statistically similar to its lower doses 195 and 260 g/ha and the weed free treatment. All the weed control treatments except clodinafop 60 g/ha gave significantly higher potato tuber yield than unsprayed check.

CSKHPKV, Palampur

Studies on bioefficacy of tembotrione in controlling weeds in maize and its residual effects in wheat and sarson

Echinochloa colona and *Commelina benghalensis* were the major weeds constituting 25.7 and 23.2%, respectively of the total weed flora in maize during *Kharif*. This was followed by *Ageratum conyzoides* (13.7%), *Cyperus iria* (15.1%), *Aeschynomene indica* (9.4%) and *Galinsoga parviflora* (8.0%) and other weeds (5%). Among treatments applied in maize, post emergence application of tembotrione 130 g/ha along with surfactant at 21 DAS was as effective as weed free to control the grassy as well as non-grassy weeds. Tembotrione 130 g/ha with surfactant at 21 DAS resulted in lowest weed index (5.05%) and highest weed control efficiency (82.95%) during both the years.. Tembotrione 130 g/ha with surfactant at 14 and 21 DAS was comparable to weed free in increasing yield attributes and grain and stover yield of maize during both the years. Addition of surfactant (1000 ml/ha) significantly increased the grain yield and reduced the density of weeds effectively as compared to the application of tembotrione without surfactant. Dehydrogenase activity in soil decreased for applied herbicide concentrations from 20 to 60 DAS. However, at later stages of the crop growth (60, 80 and 100 DAS), there was a drastic increase in the activity of dehydrogenase enzyme in all the treatments. Weed free being at par with tembotrione 130 g/ha + surfactant at 21 DAS resulted in significantly higher N, P and K uptake by maize crop during both the years.

Anagallis arvensis and *Phalaris minor* were the major weeds constituting 29.6 and 24.7%, respectively of the total weed flora in wheat during *Rabi*. This was followed by *Vicia sativa* (15.2%), *Trifolium repens* (12.8%), *Spergula arvensis* (11.3%) and other weeds (6.6%). In sarson, *Phalaris minor* and *Lathyrus aphaca* were the major weeds constituting 43.9 and 24.3%, respectively of the total weed flora. This was followed by *Vicia sativa* (19.5%) and other weeds (12.4%). In wheat, hand-weeding (30 and 60 DAS) followed by isoproturon 1.25 kg/ha was found to be effective for controlling weeds and increasing yield as compared to weedy check. In sarson, hand-weeding (30 and 60 DAS) followed by pendimethalin 1.5 kg/ha was also found effective for controlling weeds and increasing yield. In maize, net returns over weedy control/check were highest in weed free followed by tembotrione 130 g/ha + surfactant at 21 DAS during both the years. Marginal benefit cost ratio was highest in tembotrione 130 g/ha + surfactant at 21 DAS followed by tembotrione 130 g/ha + surfactant at 14 DAS during both the years. In maize-wheat and maize-sarson cropping system, tembotrione 130 g/ha with surfactant at 21 DAS was comparable to weed free for increasing gross and net returns in maize and highest B:C ratio were obtained with same treatment in maize and isoproturon 1.25 kg/ha in wheat and pendimethalin 1.5 kg/ha in sarson during both the years.

GBPUAT, Pantnagar

WP 1.5.7 (i) Management of *Argemone mexicana, Solanum nigrum* and *Polygonum plebeium* in wheat crop

Highest density of *Argemone maxicana* was found in sulfosulfuron followed by pendimethalin and clodinafop + metsulfuron-methyl. On the other hand it was significantly lower in metribuzin-post, carfentrazone and carfentrazone + sulfosulfuron. In case of *Solanum nigrum*, the highest density was recorded in metsulfuron-methyl treatment while lowest density was recorded in metribuzin-pre and carfentrazone treatments. Similarly in case of *Polygonum plebeium* the higher density was recorded in weedy plot and sulfosulfuron treatments while the density was significantly lower in treatments pendimethalin, metribuzin, clodinafop + met-sulfuron-methyl, sulfosulfuron + metsulfuron-methyl and carfentrazone + sulfosulfuron.

The biomass of *Argemone maxicana* was highest in sulfosulfuron followed by pendimethalin and clodinafop + metsulfuron-methyl treatments. In case of *Solanum nigrum* the highest biomass was recorded in metsulfuron-methyl and weedy plot whereas the treatments metribuzin (pre) and carfentrazone (post) recorded minimum weed biomass. In *Polygonum plebeium* the weed biomass was significantly higher in weedy plot and sulfosulfuron while lower was recorded in pendimethalin, metribuzin, sulfosulfuron + metsulfuron-methyl and carfentrazone + sulfosulfuron treatments.

Minimum biological yield was recorded in weedy check (1.2 kg/m^2). However, there were no significant changes in total biological yield among the herbicide treatments.

Among the treatments, higher grain yield was obtained in pendimethalin, metribuzin (pre & post), clodinafop + metsulfuron-methyl and sulfosulfuron + metsulfuron-methyl as compared to weedy plot.

WP 1.5.8 Weed management in mango orchard
RAU, Pusa

Weed flora found in the experimental field were *Echinochloa crus-galli, E. colona, Digitaria sanguinalis, Dactyloctenium aegyptium, Cynodon dactylon* among grasses; *Cyperus rotundus, C. difformis, C. iria* and *Fimbristylis milliacea* among sedges and *Caesulia auxillaris, Lippia nodiflora, Amaranthus spinosus, A. viridis, Eclipta alba, Phyllanthus niruri* and *Monochoria vaginalis* among broad-leaved weeds.

The lowest weed population (1.87 / m^2) and weed dry weight (4.68 g/m^2) were recorded by hand weeding which were significantly superior over rest of the treatments which was closely followed by glyphosate at 2.0 kg/ha (2.65/m^2 & 5.88 g/m^2), cover cropping (2.95/m^2 & 6.45 g/m^2), atrazine 2.0 kg/ha as pre post-emergence treatment to soil and one spray of paraquat (3.0 kg/ha) as post-emergent spray on weeds (3.05/m^2 & 7.21 g/m^2), mulching (3.25/m^2 & 7.25 g/m^2) and application of paraquat (2.0 kg/ha) (4.16/m^2 & 9.87 g/m^2). The highest weed control efficiency (83.3%) was recorded under hand weeding which closely followed by glyphosate at 2.0 kg/ha (79.0%), cover cropping (77.0%) and atrazine 2.0 kg/ha as pre post-emergence treatment to soil and one spray of paraquat (3.0 kg/ha) as post-emergent spray on weeds (74.3%).

WP 1.5.10 Integrated weed management in tomato

IGKV, Raipur

Dominated weed flora in tomato was *Medicago denticulata*, *Chenopodium album* and *Rumex dentatus*. On the other hand *Melilotus alba* was present in less number. *Medicago denticulata* was found in abundance throughout the crop growth period and reduced at the time of harvest. At 30 DAP, *Medicago denticulata* was found lesser in density in treatments oxyfluorfen 0.25 kg/ha PE + straw mulch 5 t/ha *fb* metribuzin 0.525 kg/ha PE + straw mulch 5 t/ha. In case of *Chenopodium album*, it was controlled by metribuzin 0.525 kg/ha + straw mulch 5 t/ha and metribuzin 0.525 kg/ha PE *fb* metribuzin 0.525 kg/ha PoE as sequential application. At 60 DAP, *E. colona* was observed alongwith above weeds but its density was less under above mentioned herbicides.

Among different weed management practices, significantly lower dry weight of weeds was found under metribuzin 0.525 kg/ha PE + straw mulch 5 t/ha which was comparable with oxyfluorfen 0.25 kg/ha+ straw mulch 5 t/ha at 30 and 60 DAP. At harvest, similar results were obtained. Maximum number of fruits/plantand fruit weight was recorded under metribuzin 0.525 kg/ha + straw mulch 5 t/ha which was at par with oxyfluorfen 0.25 kg/ha + straw mulch 5 t/ha. The highest fruit yield and B: C ratio of tomato was recorded under metribuzin 0.525 kg/ha+ straw mulch 5 t/ha (33.4 t/ha, 3.54) which was at par with oxyfluorfen 0.25 kg/ha+ straw mulch 5 t/ha (30.3 t/ha, 2.72).

WP 2 Weed dynamics and management under the regime of climate change and herbicide resistance

WP 2.1 Monitoring of appearance of new weed species

Surveillance were made for appearance of new weed/weeds at places of high risks (*i.e.* nearby area of public distribution systems, procurement centres, FCI godowns, garbage area or any other hot spot). Such places (fixed spots) were visited frequently and appearance of new weed species were recorded. Centre-wise report is given below.

AAU, Anand

During survey, intense infestation of *Argemone mexicana* was observed in different parts of Gujarat. Due to thorny nature and high seed production potentiality, this weed was spreading very fast in cultivated fields. After harvesting of *Rabi* crops this weed flourish and entered in new cultivated field as new emerging weed in Gujarat. A survey was done at different locations for *Striga* species. *Striga* was found to be present in sorghum fields at eight locations namely Vallabhipur, Barvala, Dhandhuka, Buranpur, Varna-Vataman, Tarapur, Derol and Shivrajpur.

AAU, Jorhat

Presence of two new invasive weeds namely *Cuscuta campestris* and *Ludwigia peruviana* have been observed in Lower Brahmaputra Valley zone. *Cuscuta campestris* is a wiry yellowish leafless partial stem-parasite, commonly found on *Mikania micrantha* and few other species. Morphologically, *C. campestris* differes from another most common parasitic weed *C. reflexa* in having distinctly elongated compact cymose inflorescence, 2 styles in flowers and wiry yellow stems, comparing to spicate inflorescence, one styles in flowers and greenish yellow stems of *C. reflexa.* During last couple of years, infestation of *C. campestris* is becoming severe in capsularies jute in Dhubri and Bongaigaon districts of Assam, caused serious problem to the jute farmers. The most seriously infested area was Naya Alga Char in Dhubri district and in Abhayapuri in Bongaigaon district.

Another newly introduced invasive weed *Ludwigia peruviana* is extending in Morigaon and Kamrup districts besides its core area Dhansiri catchment of Karbi Anglong district of Assam. At Kamrup district, the weed was first recorded in peatland of Ulubari during 2015-16; however, within three years, the weed has spread fast and infested the drains and marshlands of Arya Nagar, Rupnagar, Ulubari, Jonakpur and Lachitnagar areas of Guwahati city, Morigaon town and its neighbouring villages.

CCSHAU, Hisar

Weed surveillance studies conducted in *Kharif* crops revealed that no new weed has appeared in any crop. No weedy / wild rice was not observed in any of the rice growing districts. In north eastern Haryana, despite of heavy use of atrazine and metribuzin, sugarcane crop is heavily infested with *Cyperus rotundus*, *Digitaria sanguinalis*, *Eluesine indica* and *Brachiaria reptans, Conyza canadensis* and *Ipomoea* spp. In Fatehbad, Sirsa and Hisar areas of Haryana, *Ipomoea* spp. (Bael) has started infesting cotton crop and the infestation is increasing every year causing economic losses to the cotton growers. None of recommended herbicide is effective against this weed. *Parthenium hysterophorus* and *Cannabis sativa* have started infesting sugarcane and maize crops in Yamuna Nagar, Panchkula and Ambala areas. In north-eastern Haryana, *Ageratum conyzoides* infestation in sugarcane fields is increasing every year. *Cyperus rotundus*, *Amaranthus viridis*, *Corchorus olitorius, Physalis minima* and *Solanum nigrum* were the major weeds observed in *Kharif* and spring urdbean crop even despite of application of pendimethalin.

In berseem fodder, *Coronopus didymus* and *Cuscuta* sp. were emerged as new major weeds causing losses in Kaithal, Kurukshetra, Ambala and Yamuna Nagar areas of state. Tomato and Brinjal crops were severely infested with parasitic weed *Orobanche aegyptiaca* in Nuh, Punnahana, Meoli areas of Mewat. In mustard, occurrence of *Orobanche aegyptiaca* was increasing in Balsamand, Juglan, Adampur and Barwala areas of Hisar. Pea crop in north-eastern districts of state was severely infested with grassy as well as broadleaf weeds viz. *P. minor*, *Poa annua, Polypogon monspliensis*, *C. didymus, Malwa parviflora, Medicago denticulata.* Wheat crop in Rohtak, Kalanaur, Beri areas have been found to infest severely with *Lathyrus aphaca* (Matri) and with thorny weed *Carthamus oxycantha* in Rewari, Gurgaon, Mewat and Narnaul areas.

CSKHPKV, Palampur

Fumaria infestation is increasing in the cultivated fields especially in berseem. Infestation of *Alternanthera pheloxeroides* increasing in turmeric fields very fast. *Artemisia* sp. invaded cultivated fields which was earlier a plant on the bunds or the non-cropped lands. *Erodium cicutarium* infestation was also found in wheat.

Fumaria parviflora

Buttercup weed

Erodium cicutarium

GBPUAT, Pantnagar

Ten locations were surveyed in Udham Singh Nagar, Nainital, Almora and Bageswar districts to monitor the appearance of new weed species. No new weed species were observed in these locations at the farmers' fields. However, the distribution and infestation levels of *Argemone mexicana, Solanum nigrum* and *Polygonum plebeium* altered in farmers' fields at different locations. One new weed flora was found in sugarcane crop at Pantnagar research centre which is further being analyzed for its nomenclature and other taxonomic aspects.

IGKV, Raipur

No new weed species has been recorded in the area under major crops and cropping systems.

KAU, Thrissur

New types and unidentified species of *Echinochloa* have been seen to occur in the rice fields, which are believed to have been brought to the area through contaminated seeds and through mechanical harvesters which were previously used in other states, or may be due to introgression of the existing *Echinochloa* types. Three types of *Echinochloa* were obtained in the surveys. Panicle samples were identified at Botanical Survey of India, Southern Regional Centre Coimbatore as (1) *Echinochloa crus-galli,* which consisted of two morphotypes, *viz*., *Echinochloa crus-galli* (type A) and *Echinochloa crus-galli* (type B), synonym: *Echinochloa oryzoides* and (2) *Echinochloa colona*. The three types included *E. colona* and two types of *E. crus-galli*, one with short awns designated as *Echinochloa crus-galli* (type A) and the other with longer awns named *E. crus-galli* (type B). Frequency of distribution of *E. crus-galli* types was higher than that of *E. colona* in Palakkad rice tracts (Table 2.2.1).

MPUAT, Udaipur

Surveillance was kept on hot spots (PDS shops, FCI godown, railway yard and krishi upaj mandi) of Udaipur, Fateh Nagar and Pratapgarh during *Rabi 2016-17* and *Kharif* 2017. No new weed flora has been witnessed in these areas.

PAU, Ludhiana

Weed surveillance was carried out in *Rabi* 2016-17 and *Kharif* 2017 in Roopnagar, Hoshiarpur, Jalandhar, Kapurthala, Nawan Shahar, Ludhiana, Moga, Bathinda, Muktsar and Faridkot districts of Punjab. In wheat, *Phalaris minor* continue to be major and problematic weed. *Leptochloa chinensis* was found to be the major weed in rice in Ludhiana, Moga, Ferozepur and Barnala. *Portulaca oleracea* is emerging as a major weed in summer vegetable crops including capsicum and cucurbits.

PDKV, Akola

Heavy infestation of *Anisomeles indica* (Ran Tulas) was observed along the road sides in eastern Vidarbha. In western and central Vidarbha zone weed species *viz; Cassia tora, Celosia argentea* and *Alteranthera trianda* were found more prominently along road side. Heavy infestation of *Cuscuta* was observed in some pocket on farmers field particularly on soybean and pigeonpea crops in western Vidarbha.

PJTSAU, Hyderabad

Public distribution systems, procurement centers, FCI godowns in Kodicherla, Penjerla and Rangapuram were kept under surveillance for appearance of new weed species as compared to the previously recorded (2015-16) weed flora in these areas. No new weed species was found in any of these fixed spots. During survey of the fields at Kodicherla, Penjerla and Rangapuram villages and discussion with farmers, it was found that severity of *Rottboellia* has increased tremendously during the past three years and farmers are unable to control this weed.

RVSKVV, Gwalior

No new weed was observed at the target areas.

SKUAST, Jammu

No new weed species was found in *Kharif* 2017 and *Rabi* 2016-17 at high risks places (i.e nearby area of public distribution system, procurement centres. FCI, godowns, garbage area and other hot spots) as compared to bench mark survey of *Kahrif* 2016 and *Rabi* 2015-16. In the farmers' field, heavy infestation of *Cirsium arvensis* and *Rumex* spp. was observed in wheat crop at R.S. Pura block of Jammu district. Low to moderate infestation of *Lolium* spp. in wheat at R.S. Pura block of Jammu district and Ramgarh block in Sambha district was also observed.

TNAU, Coimbatore

Surveillance were made throughout the year 2017 in Coimbatore, Tirupur and Erode districts. No new weed species was noticed in any of the three districts. *Parthenium hysteroporus* was the predominant broadleaved weed and was followed by *Trianthema portulacastrum*. Among the grasses, *Dactyloctenium aegyptium* and *Cynodon dactylon* showed their existence. The *Cyperus rotundus* was dominant sedge weed in the surveyed areas.

RAU, Pusa

No new weed species were appeared during weed surveillance and monitoring.

UAS, Bengaluru

A new weed in finger millet crop noticed at Bagaluru village, Bengaluru North District, Karnataka. This weed was identified as 'Wavy-leaf oxygonum [*Oxygonum sinuatum* (Hochst. & Steud. ex Meisn.) Dammer] which belong to family Polygonaceae. Wavy-leaf oxygonum is a more or less erect branched annual herb, with ribbed stems up to 1 m tall. Leaves are ovate-elliptic to elliptic-lanceolate in outline, up to 8 x 3 cm, usually with 3 unequally deep lobes on each side. Flowers are borne in 2-5-flowered clusters in the axils of bracts, together appearing as spike-like terminal or axillary inflorescences, 25-40 cm long. Flowers are 4-5-petalled, 6-8 mm in diameter, white or pinkish. Fruit is an erect or spreading, trigonous nut, 5-7 mm long, with 3 prickles in the middle of the angles, pubescent.

WP 2.2 Monitoring of weed shift due to weed management practices, changes in cropping systems and climatic parameters in prevailing ecosystems

Weed shift and appearance of new weeds have been documented in all long-term trials. Centre-wise report has been given below.

AAU, Anand

In many areas of different districts of Gujarat weed flora shifted towards monocot weeds in wheat crop fields due to continuous use of 2,4-D or metsulfuron-methyl which provide opportunities to flourish monocot weeds. Awareness campaign/ training programme/OFT/FLDs conducted to manage complex weed flora in wheat by using premixed herbicides. Escape incidence of monocot weed *Commelina benghalensis* after application of recommended herbicides in different crops were observed at farmers and research farms. Escape of dicot weed *Digera arvensis* was also observed in the research farm as a result of pre-emergence application of pendimethalin.

AAU, Jorhat

The weed vegetation study was conducted at altogether nine main locations at Brahmaputra river banks in Jorhat district belonged to two development blocks (DB), namely Koliapani DB towards east and North-West Jorhat DB towards west. Major part of these beds are used by inhabitants of neighbouring villages for cultivation of winter field-crops like potato, rapeseed and mustard, and mixed cropping of several winter vegetables and banana. The soil of this study area was very light new alluvial silty-loam and most of the beds are exposed annually during winter season as a result of receding river water. Altogether, 40 numbers of most common plant species have been recorded growing as weeds in the study area out of these, density of annual erect grasses, comprising of *Eleusine indica, Eragrostis japonica, Paspalum distichum* and *Paspalum longifolium* was the highest comparing to other lifeforms, and distributed mostly in the territory of Koliapani DB. Perrenial erect grasses, represented by *Imperata cylindrica* and *Saccharum spontaneum*, showed the highest population density in the central region of the studied river beds, namely Bengena Ati and its adjoining areas. Comparing to these, perennial prostrate and creeping grasses like *Cynodon dactylon, Digitaria setigera, Isachne himalica, Setaria glauca, etc.* were well distributed in the entire study area and showed higher density mostly towards the western part of the district.

Kharif rice field of four out of total eight Developmental Blocks of Golaghat district were surveyed during 2017 in between 25 to 45 days after transplanting. Aquatic anchored emerged weed *Monochoria vaginalis* and aquatic free floating weed *Eichhornia crassipes* were the most dominant weeds in Golaghat East DB, Gomariguri DB and Golaghat South DB. However, sedges like *Fimbristylis littoralis* and *Cyperus difformis* were the most dominant weeds in Morongi DB. Sedge dominant rice fields were also recorded in Gomariguri DB and Golaghat South DB; crop fields of which were situated near the hills of Nagaland and Karbi Anglong district of Assam. Species diversity was found to be comparatively higher in these two Developmental Blocks with as many as 17 and 15 number of species, respectively; that was composed of 10 number of species in

Golaghat East DB and 11 number of species in Morongi DB.

CCSHAU, Hisar

Coronopus didymus, *Anagallis arvensis*, *Polypogon monspeliensis* and *Leptochloa phleoidea* were on the rise in wheat. The pot-culture studies with 16 biotypes of *P. minor* from different parts of Haryana indicated decrease in efficacy of all herbicides which includes clodinafop, sulfosulfuron and meso + iodosulfuron (RM). Some of the biotypes showed even resistance 2X dose of these herbicides which indicated a case of cross-resistance. To manage resistance problem against these herbicides at farmers' field, use of tank mixtures of pendimethalin + metribuzin (2000+120 g/ha) *fb* sequential use of mesosulfuron + iodosulfuron (RM) 14.4 g/ha, sulfosulfuron + metsulfuron (RM) at 40 g/ha and pinoxaden at 70 g/ha performed well exhibiting 75-80% control of *P. minor* resulting in good yields. Efficacy of metsulfuron against *Rumex dentatus* and *R. spinosus* in wheat crop has decreased and use of metsulfuron + carfentrazone (TM) have been found effective against these at farmers' fields. New grassy weed *Lophochloa* has started appearing along with *Poa annua* and *P. monspeliensis* in wheat crop under high moisture conditions in heavy textured soils. Berseem crop found to be heavily infested with *Cuscuta chinensis* in Kaithal district. In Amabala district, sugarcane heavily infested with *Ageratum conyzoides.*

CSKHPKV, Palampur

This year increased dominance of *Oenothera* sp. in the residential areas and that of *Bidens pilosa* and *Rumex obtusifolius* in cropped and non-cropped land was noticed. Weed shift studies this year was made in two experiments (conservation agriculture and long-term continuous and rotational use of herbicides in rice – wheat).

IGKV, Raipur

After completion of three cycles of weed management in rice-wheat-cowpea cropping system under conservation agriculture, there was weed shift of annual grassy and broad leaf weeds to perennial weed *Cynodon dectylon* especially under ZT (DSR) –ZT + R-ZT and ZT (DSR) + R – ZT + R –ZT treatments.

KAU, Thrissur

During a survey, different *Echinochloa* species were found to be distributed in the main paddy cultivating blocks of Palakkad district, *viz.*, Chittur, Alathur, Kuzhalmannam, Kollengode, and Nenmara.

All the surveyes fields were under saturated moisture condition during August-September. Another survey was also conducted in Varode, Amayur, Pallippuram, Pattambi, Parali, Mundur, Malambuzha and and no infestation of *Echinochloa* species was noticed in the rice fallows. *Sacciolepis interrupta* was the dominant weed in these areas (Table 2.2.1).

Table2.2.1 Frequency and relative frequency of *Echinochloa* species / morphotypes in surveyed areas of Palakkad

Echinochloa species/ Morphotype	Frequency (%)	Relative frequency (%)
Echinochloa colona	36.36	23.53
Echinochloa crus-galli (type A)	54.54	35.29
Echinochloa crus-galli (type B)	63.64	41.18

MPUAT, Udaipur

Study of status of weed flora from cropped and non cropped area of the district was undertaken for Railmagra, Nathdawara tehsils of Rajsamand district during winter and rainy season of 2016-17. During *Rabi* wheat was the major cereal while rapeseed and mustard was the major oilseed. The foremost broad-leaved weeds were *Chenopodium album*, *Chenopodium murale*, *Melilotus indica,* while the grassy weed *Phalaris minor* is the most important annual grassy weed which infests wheat fields. The major weed of berseem was found to be *Chicorium intybus* while lucern is quite often infested with *Cuscutta reflexa.* Infestation of *Malwa pariflora* is increasing in maize - wheat cropping zone.

The non-cropped areas, wastelands and road sides of the region are heavily infested with *Parthenium hysterophorus*. This weed has also invaded the cropped areas. The presence of *Lantana camara* and *Lantana alba* in the interior pastures, wasteland and forest area is noticable. Major grassy weeds of non-cropped areas *Cynodon dactylon*, *Dactyloctenium aegyptium* were major grassy weeds. Among braod-leaved weed species *Physalis minima, Euphorbia* *geniculata, Cassia tora, Ipomoea* spp., *Tephrosia purpurea* and *Ziziphus rotundifolia* were major species. In non cropped land *Lantana camara* becoming the major weed of Railmagra, Rajsamand and Nathdawara tehsils.

Bench mark survey was completed during *Kharif* and *Rabi* of 2016-17 in Udaipur district which fall under zone IV[th]a of the Southern Rajasthan. Survey was carried out in 10 villages of 3 tehsils of Rajsamand district.

PAU, Ludhiana

A long term field experiment was started in *Rabi* 2012-13 to study the effect of tillage and residue management practices on shifts in weed flora and productivity of rice-wheat system. Changes in weed flora of the wheat and rice crop (Table 2.2.2).

Table 2.2.2 Weed flora shift in wheat and rice under tillage and residue management practices

In wheat		
2012-13	2015-16	2016-17
Phalaris minor	*Phalaris minor*	*Phalaris minor*
Rumex dentatus	*Rumex dentatus*	*Rumex dentatus*
Medicago denticulata	*Anagallis arvensis*	*Anagallis arvensis*
Anagallis arvensis	*Coronopus didymus*	*Coronopus didymus*
Chenopodium album	*Cyperus rotundus*	*Chenopodium album*
Coronopus didymus		*Medicago denticulata*
Malva parviflora		*Avena ludoviciana*
Fumaria parviflora		
In rice		
2013	2016	2017
Echinochloa colona	*Echinochloa colona*	*Echinochloa colona*
Echinochloa crus-galli	*Echinochloa crus-galli*	*Echinochloa crus-galli*
Dactyloctenium aegyptium	*Dactyloctenium aegyptium*	*Dactyloctenium aegyptium*
Cyperus iria	*Digera arvensis*	*Digera arvensis*
Digera arvensis	*Cyperus compressus*	*Digiataria sanguinalis*
Cyperus compressus	*Digiataria sanguinalis*	*Phyllanthus niruri*
Digiataria ciliaris	*Euphorbia microphylla*	*Eragrostis diarrhena*
Eleusine indica	*Phyllanthus niruri*	*Cyperus rotundus*
Euphorbia microphylla	*Eragrostis diarrhena*	*Eleusine indica*
Commelina benghalensis	*Alternanthera philoxeroides*	
Phyllanthus niruri	*Cyperus rotundus*	
Eragrostis spp.		
Acrachne racemosa		

PDKV, Akola

In Western and Central Vidarbha zone predominant crop is soybean and farmers growing soybean year after year and using imazethapyr to control weeds. Now they are facing problem of resistance in monocot weed *Commelina benghalensis* against this herbicide in their fields.

PJTSAU, Hyderabad

To monitor weed shift in organic based pearl millet- groundnut cropping system experiment were started in collaboration with AICRP on IFS. After first year of experiment, in *Kharif* pearl millet crop *Cyperus rotundus* was found to be ecologically more dominant species followed by *D. aegyptium* at 30 DAS. At 60 DAS, *P. hysterophorus* and *C. dactylon* were dominant species while at 90 DAS *E. colona* was the most dominant species.

RVSKVV, Gwalior

The long term field experiment on weed management in pearl millet based cropping system under conservation agriculture was started during *Kharif* 2014 with 5 different tillages and 3 weed management practices. In mustard, major weeds were *Fumaria parviflora* and *Rumex dentatus* in 2014-15, while in 2016-2017, *Medicago hispida* and *C. dactylon* were also observed. In pearlmillet, major weeds *C. rotundus, E. crus-galli, D. arvensis, C. argentea, S. glauca C. benghalensis* were recorded in 2014. In 2015, new weeds *A. racemosa, L. penicia, C. dactylon,* and *P. niruri* were also observed. In 2016, new weed *Eragrotis* spps was observed in the experimental field. In *Kharif* 2017, the *Setaria glauca* was also observed again although it was not present in *Kharif* 2016.

SKUAST, Jammu

Density of *Echinochloa* spp., *Cynodon dactylon, Digitaria sanguinalis, Setaria glauca, Phyllanthus niruri, Physalis minima, Euphorbia* spp. and *Cyperus* spp. were higher in sprinkler irrigation method as compared to flooding irrigation in direct seed rice. In conservation agriculture experiment density of *Phyllanthus niruri* and *Physalis minima* were significantly higher in ZT-direct seeded rice as compared to transplanted rice.

TNAU, Coimbatore

Monitoring of weed flora in the ongoing long term herbicide trial in rice- rice cropping system was done. *Echinochlea crus-galli*, *Ludwigia parviflora* and *Cyperus iria* was dominant species in both *Rabi* 2016 and *Kharif* 2017 after 4th cycle of experiment.

OUAT, Bhubaneswar

In east and south-eastern coastal plain zone, *Mikania micrantha* is spreading alarmingly in the interior areas of Puri, Jagatsinghpur, Kendrapara and Khurda districts. Emergence of this weed was first reported after the devastation of Super Cyclone in 28th October, 1999. A shift from *Alternanthera sessilis* to *Alternanthera philoxeroides* was recorded in several low-lying rice areas. Sporadic incidence of *Orobanche* was observed in brinjal and tomato in vegetable tracts of Cuttack and Khurda district along river Mahanadi

RAU, Pusa

During *Kharif* in transplanted rice crop, initially dominant weed species were *E. colona, D. aegyptium, Cynodon dactylon,* C*yperus rotundus, Eleusine indica,* and *Amaranthus viridis* but with the passage of time *Caesulia axillaris* and *Cleome viscosa* were also emerged as the dominant weeds. During *Rabi*, initially dominant weeds were *Rumex dentatus*, *Chenopodium album, Cyperus rotundus, Cynodon dactylon, Melilotus alba, Melilotus indica, Canabis sativa* and *Avena fatua* but with the passage of time weed shift was observed and there were dominancy of *Physalis minima, Phalaris minor, Solanum nigrum, Launea pinnatifida* and *Cirsium arvense* due to weed management practices.

WP 2.3 Management of cross resistance in *P. minor* against recommended herbicides in wheat

CCSHAU, Hisar

To study the efficacy of different herbicides against *P. minor*, a field experiment was conducted during *Rabi* 2016-17. Treatments included PRE application of pendimethalin 1500 g/ha and mixture with metribuzin 175 g/ha alone and their sequential application with POE mesosulfuron+iodosulfuron (RM) 14.4 g/ha, sulfosulfuron+metsulfuron (RM) 32 g/ha and pinoxaden+metsulfuron (TM) 60 g/ha. Wheat cultivar HD 2967 was sown on at a row spacing of 20 cm using seed rate of 100 kg / ha. Plot size was 7x7 m^2 with 3 replications. Observations on *P. minor* were recorded at 60 days after treatment. Phytotoxicity in terms of chlorosis, stunting, leaf burning and epinasty was recorded at 120 days after sowing.

Pre-emergence application of pendimethalin + metribuzin (TM) at 1500 + 175 g / ha or pendimethalin + pyroxasulfone (RM) at 1500+102 g / ha *fb* sequential use of pinoxaden 60 g / ha or meso+iodosulfuron (RM) 14.4 g/ha at 35 DAS provided 80-87% control of resistant population of *P. minor* and BLWs. Although pre-emergence use of pendimethalin + metribuzin was effective to control *P. minor* but weed control efficacy increased with sequential application of post emergence herbicides. Pre-emergence use of pendimethalin + metribuzin alone was not sufficient to control second flush of *P. minor*. Maximum seed yield (6.28 t/ha) was obtained with use of pendimethalin at 1500 g/ha *fb* sequential use of pinoxaden 60 g/ha with 87% control of *P. minor* and BLWs which was at par with sulfosulfuron (BI) followed by pinoxaden 60 g/ha, pendimethalin + pyroxasulfone (TM) *fb* meso+iodosulfuron, pendimethalin+metribuzin *fb* meso+iodosulfuron.

In another experiment, sixteen such biotypes were collected from different parts of Haryana. These biotypes along with biotype from Barwala, Hisar as susceptible check were sown in pots during *Rabi* 2016-17. Spray of graded doses (1/2X, X and 2X) of herbicides (clodinafop, sulfosulfuron, mesosulfuron+ iodosulfuron (RM) and pinoxaden) was done at 35 DAS (2-4 leaf stage). Observations were taken at 30 days after herbicide application.

Out of 16 biotypes of *P. minor* evaluated; 10 biotypes were resistant to recommended dose of clodinafop, 4 biotypes to sulfosulfuron and 2 biotypes to meso + iodosulfuron (RM) and pinoxaden each. Even 6 biotypes (Nangla-1, Pipaltheh 1, Pipaltheh 2, Kalwan, Ludas, Dhos) were found tolerant to 2X dose of clodinafop. Biotype Ludas (Hisar), Rasidan (Jind) were resistant to 2X dose of sulfosulfuron. P_1 and P_{14} biotypes (Nangla and Samain) were not controlled satisfactorily by recommended dose of pinoxaden. Less than 45% control of biotypes P_9 (Ludas) and P_{15} (Rasidan) was achieved when treated with 2X dose of sulfosulfuron. Two biotypes P_{15} Rasidan (39% control)) and P_{16} Kalwan (31.7% control) gave poor control when treated with recommended dose of meso + iodosulfuron (RM) at 14.4 g/ha. Only 53.3 % control of biotype P_{15} from Rasidan was achieved when treated with 2X dose of meso + iodosulfuron (RM). Results of this experiment clearly indicated the development of cross-resistance against clodinafop in majority of areas. Pinoxaden, sulfosulfuron and mesosulfruon + iodosulfuron (RM) could also play an important role in management of resistant populations.

GBPUAT, Pantnagar

An experiment to manage cross resistance in *P. minor* against recommended herbicides in wheat was conducted. Data on weed density and biomass as well as crop biomass, yield and yield components were recorded. Weed density at 45 DAS was maximum in the treatment mesosulfuron + idosulfuron (58/m^2) followed by the weedy plot (33/m^2) and clodinafop + MSM (29/m^2). Weed was completely absent in all other treatments except penidmethalin. All the herbicide treatments effectively controlled this weed at 90 DAS except the pendimethalin treatment.

45 DAS, biomass was found maximum under weedy plot (3.78 g/m^2) followed by mesosulfuron + iodosulfuron (2.97 g/m^2) and pendimethalin (1.10 g/m^2) treatments. There was no significant difference in the tiller numbers in the treatments at different growth stages. pendimethalin + metribuzin *fb* mesosulfuron + idosulfuron (RM) treatment had highest tiller number whereas plant under weedy plot in treatment carried least number of tillers irrespective of sampling stages. At harvest, number of panicles was lowest in the weedy plots as compared to all other treatments. Among the treatments, there were no significant differences in panicle numbers except for treatment pendimethalin+ metribuzin which had the lowest number of panicles. Biological yield was found maximum in pendimethalin + metribuzin *fb* clodinafop + metsulfuron-methyl (RM) treatment (1300 g/m^2) followed by pendimethalin + metribuzin (1291 g/m^2) treatment whereas biological yield of pendimethalin + clodinafop (T5) was at par with clodinafop+metsulfuron-methyl (T8) treatment. Weedy plot gave lowest biological yield 658.3 g/m^2, Grain yield of wheat was also highest in the (T4) pendimethalin + metribuzin (T4) *fb* clodinafop + metsulfuron methyl (RM) treatment (541 g/m^2) followed by pendimethalin + metribuzin (516 g/m^2) (T2) and pendimethalin (pre) (T6) *fb* clodinafop + metsulfuron methyl (RM) treatment (508 g/m^2) whereas lowest grain yield was found in weedy plot (187 g/m^2).

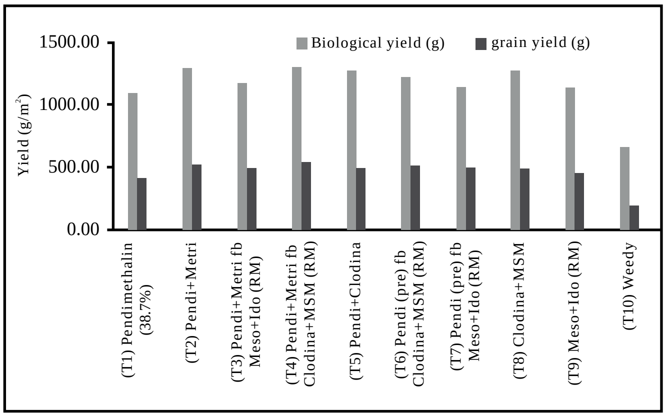


Fig 2.3.1 Biological yield and grain yield of wheat (m^2)

PAU, Ludhiana

To study the bio-efficacy of combination of herbicides against cross resistant *P. minor*, a study was carried out as per details given below:

Crop / Variety		Wheat / HD 2967	
Irrigated / Rain fed		Irrigated	
Treatments			
	Treatment	Dose (g / ha)	Application time
T_1	Pendimethalin	750	PRE
T_2	Pendimethalin + metribuzin	750 + 210	PRE
T_3	Pendimethalin + metribuzin *fb* mesosulfuron + iodosulfuron (RM)	750 + 210 *fb* 12 + 2.4	PRE *fb* POST
T_4	Pendimethalin + metribuzin *fb* clodinafop-propargyl + metsulfuron-methyl (RM)	750+210 *fb* 60+4	PRE *fb* POST
T_5	Pendimethalin + pyroxasulfone (TM)	750+102	PRE
T_6	Pendimethalin + pyroxasulfone (TM) *fb* clodinafop-propargyl + metsulfuron-methyl (RM)	750+102 *fb* 60+4	PRE *fb* POST
T_7	Pendimethalin + pyroxasulfone (TM) *fb* mesosulfuron + iodosulfuron(RM)	750+102 *fb* 12 + 2.4	PRE *fb* POST
T_8	Clodinafop-propargyl + metsulfuron-methyl (RM)	60+4	POST
T_9	Mesosulfuron + iodosulfuron(RM)	12 + 2.4	POST
T_{10}	Weedy	-	-
*Pendimethalin (Stomp Xtra 38.7% CS)			

Pre-emergence application of pendimethalin 750 g / ha and tank-mix of pendimethalin 750 g + metribuzin 210 g / ha significantly (>75%) reduced *P. minor* density as compared to unsprayed control at 20 DAS. At 40 and 90 DAS, all the weed control treatments significantly reduced the *P. minor* density and biomass as compared to unsprayed control. Pendimethalin + pyroxasulfone resulted in good weed control after first irrigation and sequential application of pendimethalin 750 g + pyroxasulfone 102 g / ha as pre-emergence followed by either clodinafop propargyl 60g + metsulfruon-methyl 4 g / ha or mesosulfuron 12g + iodosulfuron 2.4 g / ha as post-emergence gave >90% control of *P. minor*. Among the herbicides tested, no one showed any significant influence on crop plant height, tiller production and biomass indicating the safety of these chemical combinations for wheat. All the weed control treatments gave significantly higher wheat grain yield than unsprayed check and were at par among each other. The weed control with these chemicals increased the net returns form wheat by ` 19000 to ` 24000 / ha as compared to unsprayed check.

WP 2.4 Threshold study of dominant weed species

AAU, Jorhat

In the year 2017, in transplanted *Kharif* rice threshold level of *Echinochloa crus-galli* was studied in the var. Ranjit sub-1. Rice was transplanted in a well puddle field following all the recommended cultivation practices without use of any herbicide. Just after transplantation of rice, seed of *Echinochloa crus-galli* was also sown in the field on the same day. Emergence of *Echinochloa* seedlings was noticed after sixth day of sowing. Except *Echinochloa* seedlings all other weeds were eradicated manually at an interval of seven to ten days and this operation was continued up to the end of the critical period of crop weed competition (60 DAT). Out of 66 plots in the experiment, one plot in each replication was maintained weed free. The average density of *Echicnochloa* maintained in the plots were 0, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 22, 25, 27, 30 and 32 / m^2.

Rice var. Ranjit sub-1 had average stature of around 116.15 cm at their vegetative stage and the

Echinochloa density did not influence it. Reduction in leaf number was noticed at *Echinochloa* density above 20/m^2. *Echinochloa* dry weight (g/m^2) was also varied significantly from plot to plot and density to density. The highest gain yield was recorded under *Echinochloa* dry weight 7.1g/m^2 (5.63 t/ha), which was at par up to the weed dry weight from 0 to 16.5g/m^2 (Table 2.4.1).

Table 2.4.1 Crop height, leaf number and yield of transplanted *Kharif* rice under competition with different densities and dry weight of *E. crus-galli*

Echinochloa density	*Echinochloa* dry weight (g/m^2)	Crop height (cm)	Number of leaves/plant	Grain yield (t/ha)
0	0.0	114.3	235	5.43
3	7.1	124.7	231	5.63
5	11.8	121.7	226	5.21
6	14.2	118.0	226	5.1
7	16.5	131.3	231	4.95
8	18.9	115.0	217	4.89
9	21.2	118.7	211	4.86
10	23.6	119.0	207	4.73
11	26.0	112.3	216	4.30
12	28.3	117.7	208	4.40
13	30.7	124.3	218	4.15
14	33.0	116.7	192	4.04
15	35.4	115.7	209	3.48
16	37.8	115.7	187	3.33
17	40.1	112.7	211	3.16
18	42.5	108.3	213	3.00
20	44.8	95.0	201	3.16
22	49.6	106.3	178	2.93
25	51.9	107.3	179	3.08
27	59.0	132.0	174	2.96
30	68.4	116.3	178	2.93
32	70.8	109.3	180	2.80
LSD (P=0.05)	4.16	ns	35.17	6.87
CV%	7.59	13.35	10.37	4.02

PAU, Ludhiana

Thirty days old seedlings of rice variety PR 121 were transplanted in a puddled field. Water was kept standing in the field for first 2 weeks and then irrigations were applied as per recommendation. Nursery of *Ischaemum rugosum* seeds was sown on the day of crop transplanting and 20 days old seedlings of *I. rugosum* were transplanted in the rice field. Seven densities of this weed (0, 1, 2, 4, 6, 8 and 10 plants per m^2) were maintained. Weeds other than *I. rugosum* were uprooted at weekly intervals. *Ischaemum rugosum* at different densities up to 10 plants/m^2 did not show any adverse effect on rice grain yield and yield attributes.

Similarly, effect of varying densities of *P. minor* (0, 1, 2, 4, 6, 8 and 10 plants / m^2) were studied in wheat (cv. PBW 677) field. Yield and yield attributes of all treatments were at par indicating that *P. minor* at densities upto 10 plants / m^2 were not competitive with wheat (Table 2.4.2).

Table 2.4.2 Effect of *P. minor* density (no. / m^2) on yield and yield attributes of rice

Density of *P. minor* (no./m ^{2})	Plant height (cm)	Effective tillers (no./m ^{2})	Biological yield (t/ha)	Grain yield (t/ha)
0	111	393	15.2	5.37
1	114	412	15.1	5.59
2	113	403	15.3	5.40
4	113	404	15.3	5.37
6	110	410	15.1	5.35
8	115	394	14.9	5.35
10	109	398	14.7	5.43
SEm±	1.8	10.3	0.24	0.12
LSD (P=0.05)	NS	NS	NS	NS

WM 2.5 Management of herbicide resistant *Rumex dentatus* population (Pot culture)

CCSHAU, Hisar

There have been reports of poor efficacy of herbicides particularly metsulfuron against *Rumex dentatus* population from KVK, Panipat. To verify it and to evaluate the resistance development in this biotype of *Rumex* against different herbicides, a pot experiment was conducted at RRS, Karnal. The seeds of uncontrolled *Rumex dentatus* population from KVK, Panipat were collected during *Rabi* 2015-16 and sown in pots (9” diameter) during *Rabi* 2016-17. Spray of graded doses (1 / 4X, 1 / 2X, X, 2X and 4X) of herbicides (metsulfuron-methyl, carfentrazone and 2, 4-D) was done at 2-4 leaf stage. Observations on control of weeds were taken at 30 days after herbicide application.

At recommended doses, metsulfuron 4.0 g / ha provided no control (0%) of *Rumex dentatus* population from KVK, Panipat; however, efficacy of 2,4-D 600 g / ha (92%) and carfentrazone 20 g / ha (87%) was good (Fig.2.5.1). It indicated towards development of herbicide resistance in *Rume*x against metsulfuron-methyl.

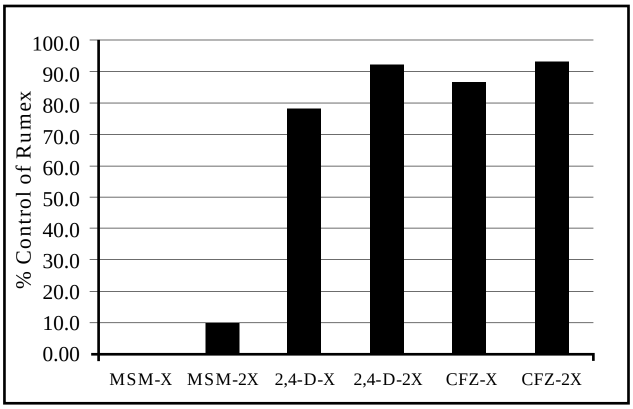


Fig 2.5.1 Efficacy of different herbicides at X and 2X doses against *Rumex dentatus* population from Panipat (*rabi* 2016-17)

WP 3 Biology and management of problem weeds in cropped and non cropped areas

WP 3.1 Biology of important weeds

PAU, Ludhiana

Studies on germination ecology of *Verbesina encelioides*

Effect of various environmental variables viz., light, temperature, moisture stress, salinity and burial depth was studied on seed germination of *V. encelioides.* Seeds of *V. encelioides* germinated equally under both light and dark conditions. Results demonstrated that light is not a prerequisite for germination of *V. encelioides* indicating non-photoblastic nature of seeds. Maximum germination was observed in seeds grown under 12h light/12h dark but was at par with seed germination under either continuous darkness or light conditions. Seedlings grown in dark were etiolated having chlorotic and elongated shoots.

Optimum temperature for the germination of *V. encelioides* seeds was 15°C; however the seeds were able to germinate under wide temperature range from 15-30°C. Time to start germination and mean germination time was minimum with maximum speed of germination at 15°C. Germination was completely inhibited either at 10°C or at 35°C. With the increase in temperature above 15°C, germination of *V. encelioides* was significantly decreased with concomitant reduction in germination speed.

V. encelioides seeds could tolerate moisture stress upto -0.4 MPa but no germination was observed at -0.6, -0.8 and -1.0 MPa. There was sharp decrease in germination with increase in moisture stress from 0 (100% germination) to -0.4 MPa (34.4%). Time to start germination was increased by two days when seeds were germinated under -0.4 MPa. Germination speed was decreased by 36.6, 53.7 and 84.3% when seeds were germinated under -0.1, -0.2 and -0.4 MPa moisture stress respectively as compared to control. The seeds exhibited significant reduction in germination above 10 mM NaCl. Maximum germination was observed in control. Germination was completely inhibited at 180 mM NaCl. NaCl concentration required for 50% inhibition of maximum germination was 91.82 mM. Time to start germination was increased by three days at NaCl concentration of 160 mM as compared to control. Mean germination time was increased with concomitant reduction in speed of germination under salinity stress. Mean germination time was increased by about two fold at 160 mM NaCl as compared to control coupled with 95.1% decrease in speed of germination than control.

Germination of *V. encelioides* decreased with the increased depth of buried seeds. Maximum germination (95%) of seeds was found at the soil surface and it was reduced by 84 per cent at 4 cm soil depth. No germination was observed from soil profile deeper than 4 cm. *V. encelioides* seeds recorded considerable germination of 83-11% from soil depth of 0.5-4 cm.

KAU, Thrissur

Biology of *Alternanthera* spp

Biology of two species of *Alternanthera bettzickiana* and A. *brasiliana* were studied using pot culture.

Fifty seeds were sown in pots half filled with soil. Seeds were then covered with soil upto depths of 15, 10, 5 and 0 cm and the germination percentage of seeds was noted. Eighty eight percent of the seeds of *A. bettzickiana* and 74% of *A. brasiliana* germinated within 5 cm depth of sowing. Maximum seed germination was from the surface of the soil. In both the species, when the depth of sowing was 10 cm or more, none of the seeds germinated.

To study the effect of temperature on germination of *A. bettzickiana* and *A. brasiliana,* 25 seeds each of the two species were kept for germination in petridishes on wetted filter paper. Petridishes were kept in a BOD incubator for germination at temperatures ranging from 15-40^{o}C. In both the species, highest germination of 100% was observed when the seeds were kept at 20 ^{o}C. However germination was also observed at 15 and 40 ^{o}C indicated that the seed can tolerate both high and low temperatures. Speed of germination was highest at 20°C for both the *Alternanthera* species and it was low at 40°C. Based on germination percentage and the speed of germination of the seeds, it may be concluded that for germination, the seeds prefer a temperature between 15 and 20 °C.

A study was conducted to find the effect of different herbicides (Diuron 2 kg/ha, glyphosate 1.64 kg/ha, glufosinate-ammonium 0.5 kg/ha, and 2,4-D 1.0 kg/ha) on the weed species. After 5 days of application in glufosinate-ammonium and glyphosate treatments, while in diuron treatment, only slight yellowing was seen. In 2,4-D treatment, partial drying was seen. On 10th day, complete drying of the plants was observed with 2,4-D, glyphosate and glufosinate-ammonium treatments in both the species while only partial drying was observed in diuron treatment. On 18th day re-growth of *A. bettzickiana was* seen in glufosinate-ammonium treatment and by the 25th day luxuriant re-growth was evident. Results of the study showed that while *A. brasiliana* could be controlled by all of the herbicides, *A. bettzickiana* was not sensitive to diuron and glufosinate-ammonium. Among the herbicides tested, 2, 4 -D and glyphosate were found most effective for control of both the weed species.

Biology of *Trianthema portulacastrum*

PJTSAU, Hyderabad

Seeds of *Trianthema portulacastrum* were sown at three depths (2.5, 5.0 and 7.5 cm) in pots. Seed sown at 2.5 cm emerged 5th day after sowing and the seed sown at 5 cm depth emerged 7th to 10 days after sowing, but the seeds sown at 7.5 cm depth did not germinate. The leaves were fleshy with dilated with membranous petiole. It showed rapid and vigorous growth with 4 to 7 branches with each branch growing up to 27 to 37 cm in length. Peak growth was noticed at 40 to 45 days after emergence. Flowering started at 25 days after emergence with axillary budding. Flowers were pinkish white in colour. The plants matured or dried at 85 to 90 days after emergence.

WP 3.2 Management of problematic weeds

CCSHAU, Hisar

(a) *Orobanche management in tomato*

During survey of weed flora in tomato fields in Haryana, crop of tomato in Nuh, Ferozepur Jhirka, Nagina, Taoru areas of Mewat, Charkhi Dadri of district Bhiwani was found badly infested with *Orobanche aegyptiaca* threatening cultivation of this crop in these regions. Farmers reported 40-75 % loss in fruit yield due to its infestation in tomato crop depending on intensity of infestation. A continuous increase in *Orobanche* infestation in these areas has forced farmers to abandon tomato cultivation and switch over to other crops. Efficacy of various sulfonylurea herbicides against *Orobanche aegyptiaca* in tomato were assessed. Tomato hybrid 2853 was planted on November 18, 2016 at farmer's field in tehsil Nuh Distt. Mewat (Haryana). All PRE herbicides were sprayed by knap sack sprayer fitted with flat fan nozzle using 375 litres of water / ha.

At Bivan location, *Orobanche* panicles did not appear in any of the treatment up to 60 DAS. Excellent control of *Orobanche* was obtained with post treatments of sulfosulfuron and ethoxysulfuron when compared with non treated control. At harvest, *Orobanche* stalks to the tune of 0.67-11.0 panicles / m^2 appeared in various herbicide treatments which was significantly less than untreated control. Weed control efficiency (WCE) in various herbicide treatments calculated on the basis of fresh weight of broomrape spikes varied from 95-98%. Maximum spike length (19.3 cm) was recorded in weedy check which was significantly higher as compared to all other treatments. Pre treatments of ethoxysulfuron 25 g / ha and oxyflurofen (120 g / ha) were more phytotoxic than post treatments of ethoxysulfuron and sulfosulfuron with severe growth reduction. No damage was observed to tomato plant with use of post emergence application of either sulfosulfuron or ethoxysulfuron. Ethoxysulfuron 25 g / ha (pre) and oxyflurofen 120 g (pre), proved very effective against

Orobanche but caused 88-95% suppression in crop growth. Maximum fruit yield (20.5 t/ha) was recorded from use of sulfosulfuron 50 g/ha at 60 and 90 DAT, respectively which was significantly higher than all other treatments and 48.7% higher than untreated check. Maximum B:C ratio (5.88) was obtained with post emergence use of sulfosulfuron 50 g/ha at 60 and 90 DAT and minimum (3.22 & 3.44) with hand pulling and weedy check treatments.

At Rehna village, tehsil Nuh (Haryana), in tomato hybrid 2853, *Orobanche* panicles (1-2 panicle/m^2) appeared in some of the treatments even up to 60 DAS and number of panicles emerged above ground were few even at 90 DAS. Excellent control of *Orobanche* was obtained with POST treatments of sulfosulfuron and ethoxysulfuron when compared with non treated controls. At harvest, *Orobanche* stalks to the tune of 1.67-3.0 panicles/m^2 appeared in various herbicide treatments which was significantly less than in untreated control (15.67/m^2). Toxicity to tomato crop due to post emergence use of ethoxysulfuron 50 g/ha at 60 and 90 DAT varied from 10-11.7 % at 10 and 30 DAT but it mitigated to 3.3% at 120 DAT which did not translate in to any yield reduction. Similarly, sulfosulfuron at 50 g/ha at 60 and 90 DAT caused only 3.3% toxicity at 10 DAT but at 120 DAT it mitigated completely. At harvest, visual *Orobanche* control in various herbicide treatments varied from 78-95%. Pre treatments of ethoxysulfuron 25 g/ha and oxyflurofen (120 g/ha) were phytotoxic and tomato exhibited severe growth reduction in these treatments. Ethoxysulfuron 25 g/ha (pre) and oxyflurofen 120 g (pre) although proved very effective against *Orobanche* but caused 58-85% suppression in crop growth. Plant height and number of fruits per plant varied significantly due to various herbicide treatments. Maximum plant height (47 cm) was recorded in post emergence treatments of sulfosulfuron and ethoxysulfuron which was significantly higher than all other treatments. Number of tomato fruits/plant were maximum (37) which were significantly higher than all other treatments except sulfosulfuron 25 g/ha at 60 DAS and 50 g/ha at 90 DAS. Similar trend was recorded on fruit yield. Maximum fruit yield (26.9 t/ha) was recorded from use of sulfosulfuron 50 g/ha at 60 and 90 DAS, respectively which was at par with sulfosulfuron 25 g/ha at 60 DAS and 50 g/ha at 90 DAS and significantly higher than all other treatments with 46.5 % increase over untreated check. Maximum B:C ratio (8.0) was obtained with post emergence use of sulfosulfuron 50 g/ha at 60 and 90 DAT and minimum (3.7 and 4.9) with hand pulling and weedy check treatments (Fig 3.2.1).

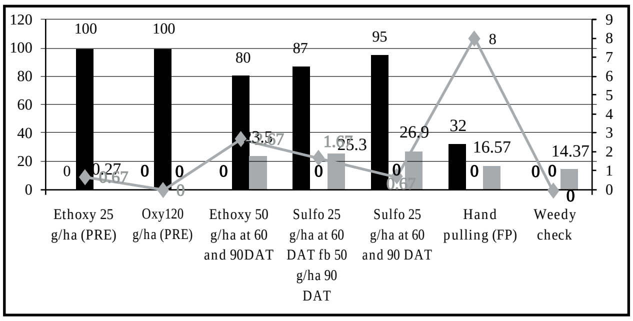


Fig 3.2.1 Effect of different treatments on *Orobanche* control and yield of tomato

b) Chemical control of *Orobanche aegyptiaca* L. in brinjal

Orobanche panicles did not appear in any of the treatment up to 60 DAT. Application of neem cake at sowing in combination with pendimethalin followed by soil drenching of metalaxyl MZ 0.2 % at 20 DAT did not cause any inhibition of *Orobanche* emergence as evident from density of broom rape at 120 DAP. Although excellent control of *Orobanche* was obtained with post or pre plus post treatments of sulfosulfuron and ethoxysulfuron when compared with non treated control but proved phytotoxic to brinjal crop. *Orobanche* stalks to the tune of 1.7-3.0 panicles/m^2 appeared in various herbicide treatments which was significantly less than untreated control. Treatment of ethoxysulfuron 20 g/ha was more phytotoxic than sulfosulfuron and brinjal exhibited 70% growth reduction under this treatment. Only 25% suppression on brinjal plant was recorded with use of post emergence application of sulfosulfuron at 25 g/ha at 25 and 45 DAP resulted in 80% control of *Orobanche*. Crop suppression with use of 25 g/ha sulfosulfuron had reflection on plant height, number of fruits/plant and total fruit yield of brinjal.

KAU, Thrissur

Identification, morphological characterization and management of algal species prevalent in rice ecosystems of Kerala

A survey was conducted to identify and characterize the submerged weeds in wetland rice ecosystem. Samples were collected from 21 locations of central Kerala (Palakkad, Thrissur and Ernakulam districts). The major algal species observed were *Spirogyra, Chara, Nitella, Nostoc* and blue green algae. The major hydrophytes observed were *Utricularia auria, Utricularia exoleta, Elodea canadensis, Hydrilla* sp., *Egeria densa, Cabomba caroliniana* and *Najas* sp. Among these, *Utricularia* was found to be the most dominant hydrophyte in the rice ecosystem of Kerala and its incidence has been observed to increase (Table 3.2.1). Currently, *Utricularia* control is being attempted with 2, 4-D, lime and $CuSO_4$.

Table 3.2.1 Submerged weeds identified in wet land rice ecosystems of central Kerala

Panchayath	Location	Algae	Hydrophytes
Chazhoor	Alappad	*Spirogyra*	*Utricularia Cabomba*
Madakkathara	Pandiparambu	Blue green algae	*Utricularia, Hydrilla*
Madakkathara	Vellanikkara	*Spirogyra*	*Utricularia*
Madakkathara	Chirakkakode	*Spirogyra*	*Elodea canadensis*
Thrissur corporation	Cheeyaram	*Spirogyra*	*Utricularia*
Thrissur corporation	Puzhakkal	*Spirogyra*	-
Panancheri	Peechi	*Chara*	-
Panancheri	Pattikadu	*Spirogyra*	*Utricularia*
Mala	Vadama	*Spirogyra*	*Hydrilla, Egeriadensa, Najas*
Velukkara	Nadavaramba	*Chara*	-
Pattambi	Pattambi	*Spirogyra, Nostoc*	-
Kuzhalmannam	Chithali	*Spirogyra*	*Utricularia*
Kuzhalmannam	Kuzhalmannam	*Spirogyra*	*Utricularia*
Vandazhi	Anjumoorthi	*Spirogyra*	*Utricularia*
Vandazhi	Vandazhi		*Najas*
Koduvayoor	Koduvayoor	*Spirogyra*	*Utricularia*
Kollengod	Kollengod	*Spirogyra*	*Utricularia*
Nenmara	Nenmara	*Spirogyra*	-
Vytilla	Vytilla	-	*Najas*
Kottuvally	Kottuvally south	-	*Utricularia*
Kottuvally	Thuruthissery	-	*Utricularia*

TNAU, Coimbatore

Integrated management of parasitic weed *Cuscuta* sp. in *Lucerne*

Cuscuta species have become a serious problem specially in crops like onion, chillies, pulses and forage crops like Lucerne. The trial was conducted to study the effect of herbicides (Pendimethalin 1 kg / ha PE, Oxyfluorfen 250 g / ha PE, Pendimethalin 1 kg / ha PE + hand weeding on 25 DAS, Oxyfluorfen 250 g / ha PE + Hand weeding on 25 DAS, directed spray of Paraquat 0.75 kg / ha POE, Hand weeding twice on 25 and 50 DAS) on cuscuta in lucern at farmer's field (Udumalpet). Hand removal of *Cuscuta chinensis* and other associated weeds recorded lesser weed coverage and weed dry weight. Post-emergence directed application of paraquat at 0.80 kg / ha resulted in lower weed coverage of cuscuta and other weeds and weed dry weight among the herbicidal management. Higher green fodder yield and better economic returns could be obtained with PE pendimethalin 1.0 kg / ha + hand weeding on 25 DAS followed by PE Oxyfluorfen 250 g / ha + hand weeding on 25 DAS.

SKUAST, Jammu

Management of *Loranthus*

During *Rabi* 2016-17, four treatments *viz*. cotton padding of copper sulphate 4 g + 2, 4-D sodium salt 0.5 g on parasitic weed, directed spray of paraquat 0.5%, directed spray of glyphosate 1% and spray of ethrel 25 mL / L on parasitic weed were applied on infested fruit trees of fig, walnut, peach, timbru, pomegranate and citrus at Narole and Trishi Village of Udhampur. Cotton padding of 4 g copper sulphate + 0.5 g 2, 4-D sodium gave good control the *Dendrophthoe* spp. as compared to other treatments. Slight phytotoxicity on host plant by cotton padding of 4 g copper sulphate + 0.5 g 2, 4-D sodium was also noticed.

AAU, Jorhat

Management of *Mikania micrantha* in coffee plantation

A study was taken up to develop effective management methods for *Mikania micrantha* in *Coffea canephora* plantation in different situation (age). Significantly high germination of *Mikania* seeds were found 20 DAA of 500 ppm GA to soil which was followed by GA 250 ppm and without GA. After 80 days of oxyfluorfen application, no *Mikania* plant was observed. In young coffee, after 80 days of oxyfluorfen application, the seedling height and leaf number was significantly high in all oxyfluorfen treated plots than in weedy plots. In rejuvenated coffee, sucker height and leaf number was statistically at par at 20 days after GA application. In bearing coffee, after 80 days of oxyfluorfen application, number of coffee beans per node was significantly higher in all oxyfluorfen treated plots than in weedy plots. In bearing plot, yield of clean coffee / ha was significantly higher in all herbicide treated plots than control. There was no effect of GA application on coffee yield.

GBPUAT, Pantnagar

Management of *Cirsium arvense*

To test the efficacy of different herbicides [glyphosate (1.0 kg / ha), metribuzin (0.250 kg / ha), metsulfuron-methyl (0.004 kg / ha), 2,4-D (0.5 kg / ha), carfentrazone (0.020 kg / ha)] for control of *Cirsium arvense*, experiment was conducted during winter 2016-17. For establishment of *C. arvense* in the plot, cuttings of *C. arvense* stem were sown in the plots. When the new plants emerged, different post - emergence herbicides were applied. Among the treatments, post-emergence application of glyphosate (1.0 kg / ha), metribuzin (0.25 kg / ha) and metsulfuron-methyl (0.004 kg / ha) completely controlled the weed. However, in the rest of treatments, plants survived. Biomass of plants was highest in the carfentrazone treatment (644 g / plot) while it was lowest (200 g / plot) in the pre-emergence application of metribuzin (0.25 kg / ha).

OUAT, Bhubaneswar

Management of *Orobanche* in brinjal

A field trial as OFT on management of *Orobanche* in brinjal crop was initiated in infested vegetable tract of Cuttack disrict (Talabasta village) during September, 2016 in farmers field. Emergence of *Orobanche* shoot takes around 49 days and it goes up to a height of 14.3 cm and produced 4500 seeds / floret. Application of neem cake 200 kg / ha at sowing *fb* PE pendimethalin 1.0 kg / ha, 3 DAP *fb* soil drenching of metalaxyl MZ 0.2% at 20 DAP recorded the lowest density / brinjal plant at 30 DAP. Among weed management practices, hand weeding twice recorded the highest yield (34.7 t / ha) which was at par with the yield from the plots applied with pendimethalin 1.0 kg / ha.

WS 3.2.1(f) Making of *Parthenium* free campus and awareness on *Parthenium*

Parthenium has become one of the worst, weeds in the country threatening crop yield reduction, health deterioration in men and animals, environment deterioration and diversity depletion. None of the state in the country completely free from the *Parthenium*. Keeping in view the seriousness of the weed, it was decided that each AICRP-WM centers should make concentrated efforts to make their campus *Parthenium* free. After achieving the goal in due course, a display board should be put up in the main gate of the University. Almost all the AICRP-WM centers except a few centers where *Parthenium* was not a problem did many activities like spray of chemicals, uprooting of *Parthenium* and releasing of bioagent *Zygogramma bicolorata* during rainy season. General public and farmers were made aware about the menace and the ways of management of *Parthenium* through various methods during *Parthenium* Awareness Week observed from 16-22 August 2017. In the awareness week, it was emphasized to clean the vicinity around the houses and campuses to reduce the seed bank of *Parthenium*.

Many awareness programs like students' rallies, demonstrations, lectures, training, uprooting *etc.* were organized by AICRP-WM centres at PAU, MPUAT, UAS, BAU, SKUAST, CSKHPKV, GBPUAT, CCHAU, RVSKVV, IGKV, NDUAT, PDKV, BCKV, OUAT, TNAU, PJTSAU, they were able to mobilize different departments of the university and involved people for uprooting of *Parthenium* from the campus. But so far none of the centers has claimed to put the board on the gate of the University. All the AICRP-WM centers motivated university staff to come forward to uproot *Parthenium* from the campus during *Parthenium* Awareness Week observed from 16-22 August, 2017. Many school and colleges premises were also cleaned during the awareness week.

AICRP-WM PAU, Ludhiana center has done commendable job to create awareness among the villagers to make their village *Parthenium* free. This year a village named Jonewal in district Ludhiana has been declared as the second *Parthenium*-free village in the Punjab. This center in 2016 also made Mansuran village as the first *Parthenium* free village of the state.

Activities of PAW in collaboration with NSS unit of Home Science, Udaipur

Uprooting of *Parthenium* by students and teachers at UAS, Bengaluru

Student rally at Kanke, Ranchi

Parthenium eradication programme at NEB CRC, Pantnagar

WP 3.3. Use of botanicals for weed management

Many plants extracts suppress germination of weedy plant and useful plants as well. Experiments were done to find out effect of extracts of crops residue, weedy and tree plants on germination of weed seeds and their subsequent growth.

AICRP-WM PAU, centre studied the effect of 5% water extract of rice straw of six basmati and non basmati rice varieties (*PR 115 (125d), PR 124 (135d), PR* 118 (158d), *Pusa Punjab Basmati - 1509* (120d), Punjab Basmati 3 (139d), Basmati 386 (155d) against *P. minor* under controlled conditions in laboratory. Results revealed that rice straw extracts of different varieties effectively inhibited germination of *P. minor* up to 32-68% as compared to 92% germination in control with concomitant reduction in seedling vigour index I and II. PR 115 exhibited maximum inhibitory effect and reduced the germination to 32% (Table 3.3.1).

Table 3.3.1 Effect of rice straw extracts (5%) of different rice cultivars against *Phalaris minor.*

Rice cultivar	Germination (%)	SVI I	SVI II
Control	92.5	4980	371
PR115	32.5	1761	124
PR124	57.5	2008	263
PR118	68.3	3151	352
Pusa Punjab Basmati -1509	38.3	1826	98
Punjab Basmati -3	47.5	2084	203
Basmati-386	60.8	3152	338
SEm±	2.75	4.66	7.60
LSD (P=0.05)	8.6	124.7	87.8

AICRP-WM BAU, Ranchi centre conducted an experiment to find out the effect of weed control methods on weeds and yield of gram and their effects on succeeding winter crops by applying different concentration of leaf extract of *Hyptis suaveolens* and *Derris indica* (*Pongamia pinnatta*) for weed control. Treatments comprised of weed control methods in maize in main plots i.e. pre emergence application of atrazine 0.75 kg/ha, two hand weeding at 30 and 60 DAS and weedy check.

Leaf extract of *Hyptis suaveolens* 50 g/litre recorded reduced narrow leaved weeds, while leaf extract of *Derris indica* 50 g /liter recorded reduced broad leaved weeds. Leaf extract of *Hyptis suaveolens* 25 g /liter and 50 g /liter affect similarly in reducing sedges. Leaf extract of *Derris indica* 25 g / liter recorded reduced total weeds and was similar to all concentration of leaf extracts of *Derris indica.* Plant population, numbers of pods, seed and straw yields were not affected by weed control methods applied in *Kharif.* Maximum plant height was recorded in hand weeding, while application of atrazine and hand weeding recorded maximum branch (Table 3.3.2 and 3.3.3).

Plant height, number of branches, seed and straw yield were not affected by leaf extract concentrations. Numbers of pods / plant was maximum with extract of *Derris indica* 10 g /liter and was similar to all concentration of leaf extracts of *Derris indica* and leaf extract of *Hyptis suaveolens* 10 g /liter.

Table 3.3.2 Effect of weed control methods and leaf extract on weed density in chickpea

Treatments	**Weed density (no./m2)30 DAS**			Total weed density (no./m^2)
	Grassy	Broad leaved	Sedges	
Weed control				
Atrazine 1.0 kg/ha	3.11 (15)*	22 (489)	1.74 (5.33)	22 (510)
Hand weeding	4.87 (34)	23 (548)	1.90 (6.1)	24 (588)

Weedy check	4.68 (29)	20 (427)	2.14 (7.62)	21 (464)
SEm ±	0.91	0.90	0.85	0.89
LSD (P=0.05)	NS	2.93	NS	2.89
Leaf Extract				
Pongamia 10g/L	4.21 (25)	20 (432)	2.01 (7.11)	21 (464)
Pongamia 25g/L	3.11 (20)	19 (382)	2.38 (8.89)	20 (411)
Pongamia 50g/L	6.00 (52)	19 (377)	2.94 (12.44)	21 (441)
Hyptis 10g/L	4.28 (25)	23 (578)	1.83 (5.33)	24 (608)
Hyptis 25g/L	4.13 (23)	26 (677)	0.71 (0)	26 (700)
Hyptis 50g/L	3.08 (14)	21 (460)	1.45 (3.56)	22 (478)
Control	4.74 (25)	22 (510)	2.20 (7.11)	23 (542)
SEm ±	0.61	0.44	0.27	0.47
LSD (P=0.05)	2.40	1.72	1.08	1.83
Interaction				
SEm ± LSD (P=0.05)	1.00 2.99	1.13 3.40	0.74 2.21	1.05 3.15
CV%	40.87	9.03	66.26	8.09

* Original values as given in paranthesis. Data was subjected to square not transferrable.

Table 3.3.3 Effect of weed control methods and leaf extract on growth, yield attributes and yield of chickpea

Treatments	Plant population/m row length	Height cm	Branch	Pods/plant	Seed yield kg/ha	Straw yield kg/ha
Weed control						
Atrazine 1.0 kg/ha	16	55	4	36	1994	2202
Hand Weeding	17	113	4	39	2123	2345
Weedy check	14	50	3	35	1706	1880
SEm ±	1.96	7.89	0.26	1.65	303	339
LSD (P=0.05)	NS	25.71	0.85	NS	NS	NS
Leaf Extract						
Pongamia 10g /L	14	54	4	42	1713	1890
Pongamia 25g/L	15	54	3	40	2060	2277
Pongamia 50g/L	16	51	3	36	2014	2222
Hyptis 10g/L	17	54	4	40	1968	2172
Hyptis 25g/L	16	51	4	32	2084	2297
Hyptis 50g/L	15	51	4	34	1852	2044
Control	14	194	4	32	1898	2094
SEm ±	0.39	6.99	0.25	1.80	119	131
LSD (P=0.05)	1.52	NS	NS	7.05	NS	NS
Interaction						
SEm ±	1.15	16.13	0.46	7.16	451	498
LSD (P=0.05)	3.45	48.35	1.38	21.46	1351	1492
CV%	12.94	38.43	22.22	33.84	40	40

Effects on weeds in mustard: In mustard, narrow leaved weeds were reduced by application of atrazine in *Kharif*. Broad-leaved weeds as well as total weeds were reduced in hand weeding and was similar to application of atrazine during *Kharif*. Leaf extract of *Derris indica* 50 g/liter recorded reduced narrow leaved weeds, it was similar to all concentration of leaf extracts of *Derris indica* and *Hyptis suaveolens* 25 g/liter, while leaf extract of *Hyptis suaveolens* 25 g/liter recorded reduced broad leaved weeds as well as total weeds and was similar to leaf extracts of *Derris indica* 10 and 50 g /liter, leaf extract of *Hyptis suaveolens* 10 g /liter (Table 3.3.4).

Table 3.3.4 Effect of weed control methods and leaf extract on weed density and yield in mustard

Treatments	Weed density (no./m2)30 DAS				
	Grassy	Broad leaved	Total weed density (no./m2)	Seed yield kg/ha	Straw yield kg/ha
Weed control					
Atrazine 1.0 kg/ha	3.30 (18)	23 (556)	23.17 (574)	1361	2650
Hand Weeding	5.94 (41)	21 (442)	21.77 (483)	1528	2980
Weedy check	6.45 (49)	24 (573)	24.70 (622)	958	1869
SEm ±	0.71	0.74	0.81	146	289
LSD (P=0.05)	2.31	2.41	2.65	475	941
Leaf Extract					
Pongamia 10g/L	4.38 (21)	21 (459)	22.26 (517)	1588	3058
Pongamia 25g/L	4.44 (39)	24 (578)	24.57 (617)	1495	2919
Pongamia 50g/L	3.38 (18)	21 (460)	21.73 (478)	1264	2463
Hyptis 10g/L	5.77 (44)	21 (455)	22.07 (500)	1273	2488
Hyptis 25g/L	4.44 (25)	21 (436)	21.41 (460)	1088	2132
Hyptis 50g/L	6.57 (46)	23 (523)	23.76 (569)	1111	2174
Control	7.65 (59)	26 (756)	26.68 (777)	1158	2264
SEm ±	0.30	0.42	0.36	143	269
LSD (P=0.05)	1.19	1.66	1.42	NS	NS
Interaction					
SEm ±	0.89	1.13	1.07	210	407
LSD (P=0.05)	2.66	3.39	3.22	630	1222
CV%	29.33	8.75	8.02	28.38	28.24

Effects on weed in lentil: In lentil, narrow leaved weeds, sedges and total weeds were reduced by application of atrazine in *Kharif*. Whereas, broad leaved weeds were reduced with application of atrazine during *Kharif* and was similar to hand weeding. Leaf extract of *Derris indica* 25 g /liter recorded reduced narrow leaved weeds, it was similar to leaf extract of *Derris indica* 50 g/liter, while leaf extract of *Hyptis suaveolens* 50 g/liter recorded reduced broad leaved weeds. Leaf extract of *Derris indica* 25 g /liter recorded reduced sedges weeds and was similar to leaf extract of *Derris indica* 50 g /liter and leaf extract of *Hyptis suaveolens* 10 g /liter. Leaf extract of *Hyptis suaveolens* 50 g /liter and *Derris indica* 25 g /liter affect similarly in reducing.

Effect on yield: Maximum seed and straw yield were recorded with application of atrazine in *Kharif* and was similar to hand weeding. Leaf extract of *Hyptis suaveolens* and *Derris indica* did not affect seed and straw yield of lentil.

WP 3.4.1 Biological control of water hyacinth by *Neochetina* spp.

RVSKVV, Gwalior released 500 numbers of *Neochetina* spp. adults in September 2015 and again in 2017 in a pond severely infested with water hyacinth near Pilua dam at Moorena. The water hyacinth density of the selected pond where weevil released was 15/m^2. After two years of release of bioagents, attack of *Neochetina* spp. on water hyacinth was observed in 90% area. On an average 80-90 feeding scars/leaf were observed and leaves were found dried due to attack of the weevils.

View of water hyacinth before releasing the weevils

N*eochetina* spp. attack after two years of release

AICRP-WM TNAU, Coimbatore centre released the weevils obtained from ICAR-DWR in water hyacinth infested ponds on 10.09.2015 in Krishnampathy tank near wetland farm of TNAU. There was good multiplication of weevil in the pond resulting dieback symptoms by the end of 2017. In beginning of 2018, whole tank was cleaned by municipality and the experiment was closed.

At Hyderabad centre, weevils released in 2014 in Mylardevpally tank caused one waive of control of water hyacinth by action of weevil, but again water hyacinth has germinated in the form of second waive and has occupied the whole pond again. During fresh sampling, low population of weevil were recorded. It is hoped that with the increase of the population, second waive of water hyaienth will also be killed by bioagent. Observations taken at Mir Alam pond reveled complete control of water hyacinth due to the release of *Neochetina* spp. in 2013-14. Now pond is infested on the bank side by alligator weed.

In Mylardevpally tank, culture of *Alternaria alternata* pathogen in talk powder formulation obtained from DWR was sprayed on water hyacinth revealed no symptoms of infestation and control of water hyacinth in next six months after application. In Shivarampally tank, inspite of several attempts for introduction of *Neochetina* weevil, the population buildup was not observed.

AICRP-WM MPUAT, Udaipur centre released the weevils in 2017 in Bhoion ki pancholi of Udai Sagar Lake. There were no significant build-up in the population of the weevil on the water hyacinth. Only about 20-25% defoliation was observed on water hyacinth plants.

AICRP-WM SKUAST, Jammu centre released the *Neochetina* beetles obtained from DWR on 07.09.2016 in a perennial pond at Tanda village. Observations were recorded on quarterly basis. After one year of release of beetles on an average 23 feeding scars/leaf were observed in water hyacinth infested pond. After one year of release, feeding of leaves was low and caused only scars on water hyacinth leaves. Only 12-17% die back symptoms were observed on water hyacinth.

At AAU, Anand, experiment was started by selecting one pond infested with water hyacinth at village Bakrol, Anand. The water hyacinth density was taken by three random samples of 1 m^2 each from the site. Release of adult weevils was done on 08/08/2017. So far no damage has been observed.

AICRP-WM, PAU, Ludhiana selected one perennial pond in villages Kheri Jhameri and Dolon in district Ludhiana were selected for this study and released the weevil. However, weevil were aleady present in the pond. Die back symptoms were observed on water hyacinth but clear water appearance was not observed.

Talc formulation of *A. alternata* isolates DWSR was sprayed on water hyacinth plants established in cemented tanks at PAU Ludhiana. Like last year, clear water appearance was not observed after spray of bio-control fungus.

At AICRP-WM, SKUAST, Jammu centre, talc formulation of *Alternaria alternata* was sprayed in perennial pond infested with water hyacinth in Rattian village, district Jammu by adopting procedure described in technical programme. Observations were taken on quarterly intervals. Growth of water hyacinth plants was not affected and clear water appearance was also not observed even after 12 months of spray.

At RAU, Pusa, two perennial ponds at two different locations were selected i.e. one at Biraul in Darbhanga district and the other at Pusa in Samastipur district. One hundred adults per square meter were released at both the sites in the first week of April 2017. To enhance the effectiveness of the bio agent again in the first week of December 2017, 100 adults per square meter were released at both the sites again. Observations were taken regularly to assess the impact. At both the sites leaves were affected up to 50 to 60% showed dieback symptoms / scars.

Table 3.4.1 Effect of *Neochetina bruchi* on water hyacinth (*Eichhornia crassipes*)

Fortnights / months	Dieback Symptoms (as per 0-4 scale) and no. of weevils per leaf (man of 10 plants)			
	Pusa		Biraul	
	Dieback symptoms (0-4scale)	No. of weevils/ leaf	Dieback symptoms (0-4scale)	No. of weevils/ leaf
Second fort night of Sept., 2016	Negligible	0.5	Negligible	0.4
First fortnight of Oct., 2016	2	1.0	1	0.8
Second fortnight of Oct., 2016	2	1.5	2	1.1
First fortnight of Nov., 2016	3	1.7	2	1.4
Second fortnight of Nov., 2016	3	1.9	3	1.6
First fortnight of Dec., 2016	3	1.9	3	1.9
Second fortnight of Dec., 2016	3	1.9	3	1.9

WP 4 Monitoring, degradation and mitigation of herbicide residues and other pollutants in the environment

WP 4.1 Study on herbicide residues in the long-term conservation agriculture experiment

OUAT, Bhubaneswar

Long term experiment on weed management in conservation agriculture system was initiated in *Kharif* to monitor herbicide residues, changes in physico-chemical and biological properties of soil health. Soil was sandy clay loam, acidic, low in available N, P and medium in available K. Since this experiment was initiated during *Kharif* 2013 in rice. In *Rabi*, maize crop and in summer cow pea have been taken up. Persistence was almost equal in both the herbicides in all the treatments but it was steeper in case of pretilachlor. After about 30 DAA pretilachlor were not detected. Addition of organic matter decreased residues rapidly. The crop residue increases the organic carbon content in the soil which enhanced degradation of residue. Initially the carbon content of the soil was low but continuous application of crop residue increases gradually the organic carbon content of the concerned treatment plots. The soil belongs to order *Alfisols*. Application of herbicides did not have any significant effect on BD, pH, organic carbon and other available indices except available P and S. Lower urease activity and higher phosphatase activity with herbicide application in rice strongly support this result. Application of herbicides to rice significantly reduced some of the microbial attributes like fungal and bacterial population by 6.0 - 9.0 % and 7.0 - 9.0 %, respectively. In general, an increasing trend in microbial population and enzyme activities was observed since the initial year of study (2013-14). Addition of organic matter (crop residue) could not significantly influence BD, pH, OC, and nutrients like available N, available K and available S. However, available nutrients status of the soils showed an increasing trend over the years in treatments with organic matter, which justifies the role of organic amendments in stabilizing soil properties.

TNAU, Coimbatore

During *Rabi* 2016-17 and *Kharif* 2017, sunflower and maize were grown, respectively as test crops which received pendimethalin and atrazine as pre-emergence herbicides, respectively to control weeds. Soil and crop produce samples were collected from the herbicides applied and hand weeding plots on 0, 15, 45 and at harvest stages and were subjected to residue analysis to find out the persistence and residue in soil as influenced by the tillage practices. Residues of atrazine and pendimethalin were determined by HPLC. LOD of both the molecules were found to be 0.01 mg / kg. Dissipation of both the molecules was found to follow first order reaction kinetics (R^2 > 0.90) irrespective of tillage practices under both the weed control methods with the half life of 14.8–20 days and 16.6 - 24.9 days for pendimethalin and atrazine, respectively. Irrespective of tillage practices and weed management methods more than 80% of both the herbicides were dissipated from the soil. Residues of atrazine and pendimethalin in soil, maize grain and straw from different plots were below 0.01 mg / kg irrespective of the tillage management practices followed for weed control (Table 4.1.1 and 4.1.2).

Table 4.1.1 Influence of conservation tillage and weed management practices on residues of atrazine(mg / kg) in soil with maize (*Kharif'17*) in maize –sunflower system

Treatments	W_1 (Atrazine 0.5 kg/ha)				W_2 (Atrazine 0.5 kg/ha + HW on 45 DAS)			
	0 day	15 day	45 day	Harvest	0 day	15 day	45 day	Harvest
T1(CT-CT)	0.252	0.142	0.075	BDL	0.268	0.158	0.062	BDL
T2(CT-ZT)	0.286	0.151	0.081	BDL	0.290	0.171	0.083	BDL
T3(ZT+R - ZT)	0.225	0.103	0.062	BDL	0.232	0.135	0.054	BDL
T4(ZT – ZT+R)	0.233	0.097	0.055	BDL	0.254	0.102	0.050	BDL
T5(ZT+R – ZT+R)	0.249	0.075	0.048	BDL	0.261	0.079	0.040	BDL

CCSHAU, Hisar

A permanent field experiment in conservation agriculture under rice-wheat cropping system was initiated during *Kharif* 2015. Herbicides applied in different treatments were pretilachlor 1000 g / ha at 3 DAT in T4, T5, and pendimethalin 1000 g / ha *fb* bispyribac sodium 25 g / ha + pyrazosulfuron 25 g / ha at 25 DAS in T1, T2 and T3. Determination of pretilachlor and pendimethalin residues in soil, grain and straw at harvest of the crop was done by GCMS / MS Triple Quadrupole, however, bispyribac -Na and pyrazosulfuron were analyzed by HPLC-PDA. Residues of pendimethalin in soil, grain and straw were detected within range of 0.01 to 0.043 µg / g which were below MRL value of 0.05 µg / g in all treatments for paddy grains and straw. Residues of pretilachlor, bispyribac-sodium and pyrazosulfuron were not detected in the soil, grain and straw samples (Table 4.1.2).

Table 4.1.2 Residues in pendimethalin (µg/g) in paddy grains, straw and soil samples taken from conservation agriculture under rice-wheat cropping system

Treatments	Pendimethalin residues* (µg/g)		
	Soil	Paddy grains	Straw
T1: ZTDSR+R -ZTW+R	0.043	0.022	0.038
T2: ZTDSR-ZTW+R	0.026	0.015	0.030
T3: CTDSR-CTW	0.01	0.01	0.016
T4: CTR (PTR)-ZTW	BDL	BDL	BDL
T5: CTR (PTR)-CTW	BDL	BDL	BDL

**Average of three replicates*

PAU, Ludhiana

Persistence of pendimethalin, fenoxaprop-p-ethyl in rice and metribuzin, clodinafop propargyl in wheat under different tillage and residue management techniques was studied. In rice, pendimethalin and fenoxaprop-p-ethyl from soil / rice grain samples was extracted by matrix solid phase dispersion (MSPD) method. The residues were analysed using HPLC system equipped UV/Vis detector. Initial residues of pendimethalin ranged from 0.208 to 0.198 µg/g and 0.201 to 0.198 µg/g in recommended and integrated weed management treatments, respectively. Residues were below the detectable limit (<0.01 µg/g) in soil and rice grain at the harvest of crop. Under recommended herbicide and IWM treatments, residues of fenoxaprop-p-ethyl under zero tillage treatment ZT(T)-ZT+R-ZT and ZT (DSR)+R-ZT+R-ZT and conventional tillage treatment CT(DSR)-CT-ZT in soil and rice grain were below detectable limit (0.05 µg/g) at the time of harvest.

In wheat 2016-17, metribuzin and clodinafop-propargyl in soil / wheat grain samples was extracted by MSPD. Initial residues of metribuzin ranged from 0.149 to 0.155 µg/g and 0.142 to 0.148 µg/g in recommended and integrated weed management treatments, respectively. Residues were below the detectable limit (0.05 µg/g) in soil and wheat grain at the harvest of crop. Residues of clodinafop-propargyl in soil and wheat grain at harvest under recommended herbicide and IWM treatments were below detectable limit (<0.05 µg / g).

CSKHPKV, Palampur

In *Rabi* 2016-17, persistence of isoproturon under different tillage and residue management techniques was studied in soil (0-15 cm) and wheat grain samples at harvest. Soil samples were analyzed by spectrophotometer at 555 nm. The soil and wheat grain samples under different tillage and residue management techniques were found to be below the detectable limits of isoproturon at the time of harvest. In *Kharif* 2017, persistence of atrazine and pendimethalin under different tillage and residue management techniques was studied in soil (0-15 cm), maize and soybean grain samples at harvest. Atrazine residues in soil and maize grain under different tillage and residue management techniques were below detectable limits at the time of harvest. Pendimethalin residues in soybean cropped soil and crop were under different tillage and residue management techniques were below detectable limits at the time of harvest .

PJTSAU, Hyderabad

A field study was conducted on conservation agriculture in rice (*Kharif, 2017*) – maize (*Rabi 2016-17*) – green manure (Summer) cropping system to study the influence of herbicides on different soil properties and also to assess the carryover of the herbicide residues. Pendimethalin, pretilachlor and bispyribac sodium (rice) and atrazine (maize) were studied in this experiment. Along with the herbicide persistence, impact of different methods of rice establishment/ tillage and weed management were studied. Initial soil samples before transplanting / sowing of rice were collected from different herbicide treatments for analysis of soil physico-chemical properties and nutrient status analysis. Rice grain and straw samples were collected from all the treatment plots at harvest and analyzed by either HPLC or GC. The experimental soil was very dark greyish brown in colour. Bulk density and particle density of the soil were 1.38 and 2.59 Mg/m^3, respectively. Soils were moderately alkaline in reaction, non-saline with a CEC of 23.12 cmol (p^+) / kg. Organic carbon content of the soil was medium. Dehydrogenase, urease and phosphatase activity was assayed in the soil. There were no significant changes in physico-chemical (pH) and fertility properties of the soil (Available N, P_2O_5 and K_2O) due to different treatments after harvest of the rice crop in different methods of establishment. Organic carbon content of the soil was found to be significantly influenced by the method of establishment of rice. Aerobic rice-maize soils showed slightly higher organic carbon content in the soil compared to the transplanted rice-maize system soils. However, method of weed management did not influence the OC content of the soil.

There were no significant changes in physico-chemical (pH, EC) and fertility properties of the soil (Available N, P_2O_5 and K_2O) due to different treatments after harvest of the rice crop in different methods of establishment. However, significant changes in organic carbon content of the soil was observed as influenced by method of establishment of rice. The organic carbon content in the aerobic rice soils after three years was significantly higher than that of the transplanted rice treatments and rice (rice) - maize (ZT) + residues and green manure plots have shown significantly higher organic carbon content compared to all other treatments. However, method of weed management (IWM, chemical or control) did not significantly influence the organic carbon status of the soils. Different methods of establishment of rice (transplanted and DSR) and residue retention had shown significant influenced urease and dehydrogenase activity of the soil. However, weed management treatments impact on urease activity was not-significant. In case of the *Rabi* maize establishment, ZT maize treatments showed significantly higher urease activity compared to the conventional tillage treatment.

Initial residues of pretilachlor were 0.248 and 0.232 mg / kg in T1W1 and T2W1 treatments, respectively. In transplanted rice soils, initial detected amount (IDA) of bispyribac-sodium varied from 0.011 to 0.013 mg / kg. In aerobic rice soils, IDA varied from 0.016 to 0.018 mg / kg. The variation in the initial soil concentration of the bispyribac-sodium was due to the presence of large quantity of the weeds and green manure residue on the surface. The residues of pretilachlor and bispyribac-sodium in rice grain and straw collected at harvest was below detectable level. Initial residues of pendimethalin in aerobic rice soils varied from 0.398, 0.203 and 0.221 mg / kg on 0 DAA (at four hours after application of the herbicide) in T3, T4 and T5, respectively, presence of the green manure residues and weed biomass might have resulted in lower initial concentration of pendimethalin in soil. In all the treatments residues of pendimethalin were below detection limit of 0.05 mg / kg in rice grain, plant and soil at the time of harvest. Higher concentration of atrazine was recorded in T1 and T3 and lowest concentration was recorded in T5. Residues of atrazine in the soil samples, maize grain and straw samples collected at the time of harvest were below the detectable limit of 0.05 mg / kg in aerobic and transplanted rice main treatments.

GBPUAT, Pantnagar

A long-term trial to study the effect of herbicides on persistence and residues buildup in rice-wheat cropping system under different tillage conditions is in progress since 2011-12. Isoproturon at 1.0 kg / ha in wheat and anilofos and pendimethalin at 0.4 and 1.0 kg / ha, respectively, were applied in rice which was changed in 2012-13 with clodinafop-propargyl + metsulfuron-methyl at 64 g / ha in wheat and bispyribac-sodium at 25 g / ha in rice. These herbicides were applied continuously in every season. At the time of harvest, samples of soil, grain and straw of wheat or rice were collected from all the treated and control plots and analysed for residues present in their components. In wheat, clodinafop-propargyl, metsulfuron-methyl and bispyribac-sodium were determind by HPLC. Residues of clodinafop-propargyl and metsulfuron-methyl were detected up to 7 and 10 days, respectively after which it was not detected in soil. Residues were below MRL (0.1 g / g) at the time of harvest in soil, wheat grain and wheat straw in both tillage and residue management techniques. In rice, bispyribac-sodium residues were detected up to 15 days after which it was not detected in soil. Residues were below detectable at MRL (0.02 g / g) at the time of harvest in soil, rice grain and rice straw in both tillage and residue management techniques.

RVSKVV, Gwalior

A field experiment was conducted during *Rabi* 2016-17 in long-term conservation agriculture experiment on mustard under pearlmillet - mustard cropping system. This was third year of the trial. Persistence of herbicide in soil applied to mustard was carried out by bioassay method. The treatments consisted of combination of five tillage practices with three weed control practices *viz*. pendimethalin 1.0 kg / ha PE, oxyfluorfen 0.230 kg / ha PE + one hand weeding 25-30 DAS and weedy check.

Soil samples (0-15 cm depth) were collected at 0, 15, 30, 45, and 60 DAA and after harvest of mustard. Maize was used as indicator plant. Observations on plant height, fresh weight and dry weight / plant of maize were recorded after 21 days of sowing. Plant height of test plant maize reduced significantly up to 60 DAA of herbicide while fresh and dry weight were reduced up to 45 days only. Pendimethalin 1.0 kg / ha and oxyfluorfen 0.230 kg / ha reduced the plant height of maize plant upto 60 and 45 days, respectively. The fresh weight and dry weight of maize plant was significantly reduced up to 45 DAS by both the herbicides. No Significant reduction in growth of maize was recorded in soil after harvest of mustard. Pendimethalin 1.0 kg / ha PE and oxyfluorfen 0.23 kg / ha PE + one HW applied in mustard crop persisted in soil for 60 and 45 DAA, respectively. No residues of herbicides were left after hervest of crop as per bioassay method using maize as test crop.

Another field experiment was conducted during *Kharif* 2017 to study the impact of combinations of conventional and ZT practices with weed control measures on productivity and weed dynamics of pearlmillet under pearlmillet – mustard – cowpea cropping system. The main treatments consisted of five different tillage practices and three sub treatments comprised of atrazine 500 g / ha PE + 2,4-D 500 g / ha POE, atrazine 500 g / ha PE + 1 HW at 25 DAS and weedy check applied in pearlmillet. Soil samples (0-15 cm depth) were collected at 0, 15, 30, 45, 60 DAA and after harvest of pearlmillet. Persistence of herbicides in the soil was determined by barley as indicator plant and observations on plant height, fresh weight and dry weight / plant of barley were recorded after 15 DAS of sowing.

A significant reduction in plant height, fresh weight and dry weight of test plant was recorded up to 45 days in both the treatments of atrazine 500 g / ha PE + 2, 4-D 500g / ha POE and atrazine 500 g / ha PE + one HW. No significant reduction in growth of barley was recorded in soil after harvest of pearlmillet. Herbicides, atrazine 500 g / ha PE + 2, 4-D 500 g / ha PoE and atrazine 500 g / ha PE + 1HW applied to pearlmillet persisted in soil for 45 days. No residues of herbicides were left after harvest of crop as per bioassay method using barley as test crop. Different tillage practices in pearlmiillet - mustard cropping system could not affect the persistence of herbicides applied to pearlmillet.

AAU, Jorhat

Pretilachlor and pendimethalin are popular rice herbicide of Assam, used as pre-emergence weed control in rice under rice-mustard cropping sequence in the conservation agriculture experiment. This experiment was initiated during the year 2016 in soils acidic in reaction. Representative surface sandy loam soil samples (0 – 15 cm) were collected periodically as well as starting from on the day of herbicide application (within 4 hours of herbicide application) to after harvesting of winter rice from 2nd rice crop and dried under shade.

Pretilachlor and pendimethalin residue in paddy grain, straw and soil sample were determined by in GC. The dissipation of pretilachlor in soil followed a pseudo first order equation. The pretilachlor residue level ranged 0.382–0.586 μg / g on the day of application of pretilachlor and observed up to the ranged 0.005–0.024 μg / g on the 30th day of application of pretilachlor. In case of minimum tillage, the pretilachlor residue level was observed at BDL from 45th day of application of pretilachlor. However, lowest level of pretilachlor residue was resulted from the combination treatments of minimum tillage with direct seeding rice. The regression equation and coefficient of determination (R^2) for pendimethalin over the range 0.05 – 1.0 μg / mL was Y = 77.26479 X + 12.1768, R^2 - 0.99. Dissipation of pendimethalin in soil followed a pseudo first order equation (Table 4.1.3). Pendimethalin residue level in soil samples ranged 0.689 – 0.816 μg / g on the day of application of pendimethalin and observed up to the ranged

0.006 – 0.025 µg / g on the 30[th] day of application of pendimethalin. Pendimethalin residue level was observed at BDL in case of minimum tillage from 45[th] day of application of pendimethalin However; lower level of pendimethalin residue was resulted from the combination treatments of minimum tillage with direct seeding rice.

Table 4.1.3 Half life (days) and dissociation coefficient of herbicides during degradation in rice mustard sequence

Treatment	Pretilachlor		Treatment	Pendimethalin	
	Half life (days)	K (days^{-1})		Half life (days)	K(days^{-1})
CT + Transplanted	6.25a	0.11c	CT	5.86b	0.12b
CT + Transplanted	5.04c	0.13a	MT	6.89a	0.10c
CT+Direct seeded	5.99b	0.12b	CT	5.53b	0.13b
MT+Direct seeded	4.93c	0.14a	MT + R	4.38c	0.16a
MT+Direct seeded	5.38b	0.13a	MT	4.50c	0.15a

KAU, Thrissur

WP 4.1 Herbicide residues in organic farming system

Biological analysis was carried out to determine the persistence of herbicides. Effect of seven weed control treatments on biological properties of soil *viz.*, microbial population and dehydrogenase activity, were studied from the field experiment conducted in brinjal.

The bacterial population showed higher values in the organically mulched plots followed by unweeded plots, and lowest counts were recorded in pendimethalin plots throughout the crop period, indicated that the herbicide persisted in the soil for more than 90 days. At 90 DAP, polythene mulched, hand weeded, spade weeded and coir fibre mulched plots also recorded lower population. Herbicide sprayed plots showed lowest number of fungal counts throughout the crop period. Organic mulching (with leaves) recorded highest count of fungi. The plots with unweeded control treatments also maintained higher fungal population. Polythene sheet and coir fibre mulch did not exhibit much variation from hand weeding. At 90 DAP no significant difference was noticed among the treatments with respect to fungal population. Lack of adequate soil moisture and organic carbon towards the end of the crop season would have been responsible for considerable reduction in the soil microflora in all the treatments at 90 DAP. Herbicide affected bacterial population to a greater extent than the fungal population. The initial dehydrogenase activity i.e. before planting, ranged from 43.7 to 47.2 µg TPF h / g of soil. Dehydrogenase activity increased from sowing to 30 DAP and reduced from 30 DAP to harvest. Organically mulched plots registered highest dehydrogenase activity followed by unweeded plots because of the higher microbial population. Lowest enzyme activity was registered by pendimethalin plots because of lower microbial population resulting from the harmful effect of chemical on soil organisms. Enzyme activity was influenced by the amount of microbial population present in the soil.

Chemical properties of the soil samples, *viz.*, pH, organic carbon and available K were only slightly affected by the weed control treatments (Table 4.1.4). Organic mulching with green leaves showed superiority over other treatments, except in the case of available K. Organic mulching treatments significantly improved the organic carbon and available nitrogen content of the soil, while polythene mulching showed the reverse trend. Available K was significantly higher under coir pith treatment which might be due to the higher K content in the coir pith. Significant differences in available P of the soil samples were noticed after the harvest of brinjal crop. Highest content of available P (45 kg / ha) was noticed in the unweeded control followed by polythene mulching and the lowest value of 21 kg / ha was in coir pith mulching. Soil pH was significantly lower under polythene mulching than in hand weeding, unweeded control and pendimethalin treatments. No significant differences were noticed in the content of secondary nutrients Ca and Mg as well as micronutrients Fe, Mn, Cu and Zn throughout the crop period.

Table 4.1.4 Effect of treatments on soil organic carbon andavailable nitrogen

Treatments	Before planting		30 DAP		90 DAP	
	OC (%)	Available nitrogen	OC (%)	Available nitrogen	OC (%)	Available nitrogen
Hand weeding	0.64	250.84	0.80[c]	217.14[b]	0.45[bc]	83.16[c]
Spade weeding	0.67	246.38	0.83[c]	220.68[b]	0.45[bc]	120.7[b]
Chemical weed control (Pendimethalin 1.5 kg/ha)	0.58	249.46	0.79[cd]	221.76[b]	0.47[b]	141.6[b]
Organic mulching (green leaves)	0.63	252.55	1.29[a]	244.84[a]	0.66[a]	186.31[a]
Polythene mulching (Silver top black bottom, 30 micron)	0.60	249.44	0.73[d]	192.50[c]	0.41[c]	73.92[c]
Unweeded control	0.61	251.07	0.96[b]	170.94[d]	0.48[b]	140.1[b]
Mulching with coir pith	0.59	249.29	0.82[c]	218.67[b]	0.47[b]	127.8[b]
LSD (P=0.05)	NS	NS	0.058	11.16	0.057	32.98

* In a column, means followed by common alphabets do not differ significantly at 5% level in DMRT

WP 4.2 Herbicide residues in high-value crops / organic farming system

TNAU, Coimbatore

A field experiment in conservation agriculture in turmeric was initiated during *Kharif* 2017. Sampling of soil for residue analysis of herbicides was done at 0, 120 and 150 DAA of pendimethalin and from other plots having mulch residue detailed as above. Soil samples collected on 0 day (4 hours of pendimethalin application) were found to contain pendimethalin residues as 1.15 µg/g of soil. Residues of pendimethalin were below detectable level after 150 DAA. In other plots with different amount of applied straw mulch, there were no residues.

WP 4.2 (a) Herbicide residues in high-value crop (onion) at farmers' field

Samples of onion bulb, leaf and soil under onion crops were collected from different regions of Karnal, Ambala and Panchkula district for analysis of pendimethalin and oxyfluorfen residues. Pendimethalin and oxyflourdfen residues in onion bulb and onion leaves samples (chopped finely) were analysed by GCMS/MS Triple Quadrupole. Soil samples from all the 18 locations were having pendimethalin residues between 0.011 to 0.354 µg/g, whereas the onion bulbs and leaf samples were having pendimethalin residues below MRL of 0.05 µg/g. None of the soil, onion bulb and onion leaf samples were having oxyfluorfen residues (Table 4.2.1).

Table 4.2.1 Residues in onion leaf, bulb and soil under onion crop collected at farmers' fields from various regions of Haryana

Name & address of farmer	Herbicide/s sprayed	Dose	Residues * (µg/g)		
			Soil	Bulb	Leaf
Vinod, Dhantori, Shahbad, Kurukshetra (2)	Pendimethalin + oxyfluorfen	X	0.185	BDL	0.003
Vinod, Dhantori, Shahbad, Kurukshetra (3)	Pendimethalin + oxyfluorfen	X	0.121	BDL	0.01
Karnail Singh, Chinarthal, Shahbad, Kurukshetra (1)	Pendimethalin + oxyfluorfen	X	0.230	BDL	BDL

Dharam Singh, Chinarthal, Shahbad, Kurukshetra	Pendimethalin + oxyfluorfen	X	0.093	BDL	BDL
Robin Saini, Dhantori, Shahbad, Kurukshetra	Pendimethalin + oxyfluorfen	X	0.114	BDL	0.013
Ramesh Saini, Dhantori, Shahbad, Kurukshetra	Pendimethalin + oxyfluorfen	X	0.012	BDL	0.005
Sanjeev, Morthala, Shahbad, Kurukshetra (1)	Pendimethalin + oxyfluorfen	X	0.011	BDL	BDL
Sanjeev, Morthala, Shahbad, Kurukshetra (2)	Pendimethalin + oxyfluorfen	X	0.026	BDL	0.003
Harbans, Ram Nagar, Shahbad, Kurukshetra	Pendimethalin + oxyfluorfen	X	0.125	BDL	BDL
Jasbeer, Bhagwanpur, Shahbad, Kurukshetra	Pendimethalin + oxyfluorfen	X	0.065	BDL	0.005

CSKHPKV, Palampur

Soil samples and crop produce after the harvest of garlic crop in *Rabi* 2016-17 and maize crop in *Kharif* 2017 were collected from a chemical treatment of recommended herbicide *i.e* pendimethalin and atrazine, respectively. HPLC analysis of samples revealed that atrazine (BDL >0.05 μg/g) and pendimethalin (>0.01 μg/g) residues in soil and crop produce were found below detectable levels.

PJTSAU, Hyderabad

Study was done to estimate herbicide (pendimethalin) residues in okra-carrot organic farming system and to monitor impact of weed management practices on physical and chemical properties. Initial soil samples before sowing of okra were collected for analysis of soil physico-chemical properties and nutrient status analysis. For residue analysis, soil samples were collected from 6-7 spots at 4 hours after pendimethalin application and at harvest. Dehydrogenase activity, urease activity and phosphatase activity in the soil was measured. No significant effect of organic weed management practices was noticed on any of the soil physico-chemical and fertility properties of the soils at the time of harvest of the first crop (okra).

At flowering, highest urease activity (UA) and dehydrogenase activity (DHA) was recorded in straw mulch treatment followed by the intercropping with green-leafy vegetable treatment which were significantly different from each other. Lowest urease activity, at flowering was recorded in hand weeding treatment. No adverse effect of pendimethalin spray was detected on urease activity at both flowering and harvest stages. Highest soil dehydrogenase activity (DHA) in soil at the time of flowering was recorded in straw mulch treatment. Lower dehydrogenase activity at flowering was noticed in pendimethalin applied treatment, compared to all other weed management options, but it was higher than unweeded control treatment. At harvest stage, enzyme activity recorded was lower than at the flowering stage in all the treatments. At the time of harvest also, highest DHA was noticed in straw mulch treatment followed by poly mulch treatment. Highest acid phosphatase activity was recorded in green-leafy vegetable intercropping treatment followed straw-mulch treatment at the time of flowering as well as at harvest. No adverse effect of pendimethalin was noticed on phosphatase activity of the soil at the time of flowering or harvest. Highest alkaline phosphatase activity was recorded in green-leafy vegetable intercropping treatment followed straw-mulch treatment at the time of flowering as well as at harvest (Table 4.4.2).

Table 4.2.2 Soil dehydrogenase, urease and phophatases activity as influenced by different organic weed management practices in okra crop

Treatments	Urease (µg NH_4^+/g/2h)		Dehydrogenase (µg TPF/ g/ day)		Acid phosphatase activity (µg PNP released g/ hour)		Alkaline phosphatase activity (µg PNP released g/ hour)	
	Flowering	Harvest	Flowering	Harvest	Flowering	Harvest	Flowering	Harvest
T1	77.0	46.8	5.49	2.81	175.5	137.3	85.1	59.5
T2	77.7	44.5	5.25	2.63	186.5	148.2	88.3	61.9
T3	74.5	46.7	4.95	2.97	158.9	140.0	82.1	54.5
T4	93.7	49.5	5.66	3.12	186.5	147.0	94.3	62.2
T5	71.0	46.8	4.62	2.78	169.1	133.1	80.1	60.0
T6	74.4	46.5	4.54	2.81	175.8	134.52	84.2	58.1
T7	83.1	47.1	4.86	2.94	189.5	148.26	96.1	65.1
T8	82.1	39.4	4.02	2.42	160.7	128.4	87.3	54.5
SEm±	3.07	1.70	0.203	0.077	6.04	5.373	2.61	2.31
LSD (P=0.05)	9.21	5.12	0.61	0.23	18.1	16.1	7.85	6.95

In all the soil samples collected at the time of harvest, pendimethalin residues were below the detection limit of 0.05 mg/kg. Residues of pendimethalin in okra fruit samples collected from pendimethalin sprayed plots was below the detection limit of 0.05 mg / kg.

AAU, Jorhat

A field trial was conducted with chilli as the test crop and metribuzin was applied as weed control measure. The rate of application of metribuzin was 500 g / ha. Composite surface soil samples (0 – 15 cm) were collected on the day of herbicide application (within 4 hours of herbicide application) and after harvesting of winter rice and dried under shade. Representative fruit and soil sample were analysed by GC with limit of detection (LOD) 0.003 mg / g.

Dissipation of metribuzin in soil followed a pseudo first order equation. Metribuzin residue level ranged 0.418 – 0.726 µg / g on the day of application of metribuzin and observed upto the ranged of 0.001 – 0.005 µg/g on the 30th day of application of metribuzin. Metribuzin residue level was observed at below detection limit from 45th day of application of metribuzin .

WP 4.3 Adsorption, degradation (new molecules only) and mitigation of selected persisting herbicides

KAU, Thrissur

Soil samples were collected from rice fields of two different locations viz., (i) *Alappad Kole* land in Thrissur district having high organic matter content (2.47%) and (ii) Agricultural Research Station, Mannuthy, Thrissur having low organic matter content (0.85%). The adsorption study was conducted by equilibrating the soil (2.5 g) with oxyfluorfen reference standard solution (10 mL) of two concentrations *viz*., 1.2 and 2.4 µg / mL (stock solution prepared in acetone was diluted with 0.01M Ca Cl_2) so as to achieve the herbicide levels *viz*., 4.8 and 9.6 µg / g soil. Oxyfluorfen remaining in the equilibrium solution after centrifugation was analysed by UV-Visible spectrophotometer at 213 nm. Difference between the amount of herbicide added and the quantity remaining in the equilibrium solution was taken as the amount of herbicide adsorbed by the soil. The extent of adsorption of oxyfluorfen in the two samples varied from 80.8 to 90%. Maagnitude of adsorption increased with concentration of the herbicide which indicated that adsorption of oxyfluorfen followed first order kinetics. Higher level of adsorption was noticed in high organic matter soil of Alappad Kole land. Desorption of oxyfluorfen in the soil samples was determined by 0.01M $CaCl_2$.

Table 4.2.3 Desorption of oxyfluorfen in two soil types

Treatments	Quantity desorbed/g soil(µg/g)	% of applied oxyfluorfen desorbed by the soil
Alappad Kole land (High OM) : 4.8 µg/g	0.017	1.77
Alappad Kole land (High OM) : 9.6 µg/g	0.017	1.72
ARS, Mannuthy (Low OM): 4.8 µg/g	0.021	2.17
ARS, Mannuthy (Low OM) : 9.6 µg/g	0.022	2.28

Desorption of oxyfluorfen ranged from 1.72 to 2.28% which indicated that the chemical was tightly adsorbed by the soils under study and the chance of herbicide loss through leaching is less. Desorption was higher in low organic matter soil collected from ARS, Mannuthy. Higher bioefficacy of oxyfluorfen observed in the field experiments can be substantiated with the above result (Table 4.2.3).

TNAU, Coimbatore

The surface (0-15 cm) sandy clay loam soil samples were collected from pesticide free zone was used to conduct the sorption study. The soil has pH of 7.4, EC of 0.42 ds/m and OC of 0.30%. Adsorption-desorption of quizalofop-ethyl in soil was conducted by imposing the treatments following the standard OECD guidelines (no. 106). The amount of quizalofop- ethyl adsorbed in soil ranged from 0.031 to 43.61 mg/g and the amount adsorbed on soil increased with rise in the initial concentration (C_i). The quantity desorbed from the adsorbed amount varied from 0.008 to 14.7 and the desorption percentage increased with increasing concentrations. R^2 value of 0.99 indicated the best fit of the Freundlich adsoption isotherm.

In another experiement, surface (0-15 cm) soil samples were collected for studying degradation of quizalofop-ethyl under X (50 g / ha) and 2X (100 g / ha) doses. Soil was sandy clay loam in texture and has pH of 8.15, EC of 0.62 dS/m and OC of 0.33%. Soil samples were collected at periodical interval and analyzed for quizalofop-ethyl residues and to study the dissipation pattern in soil. After the application of quizalofop-ethyl, residues were found to vary with the applied concentration (Table 4.2.4) from 0.014 to 0.208 mg/kg in soil and 0.031 to 0.327 mg/kg in soil for 50 and 100 g/ha application of quizalofop-ethyl respectively. Quizalofop-ethyl in soil declined sharply and persisted up to 30 days after application (Fig 4.2.1).

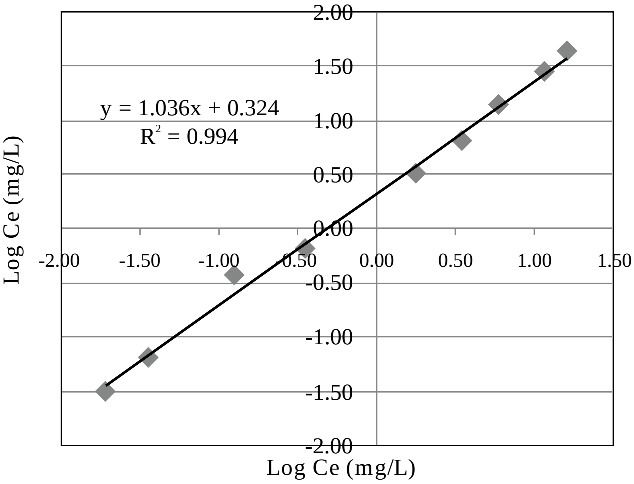


Fig 4.2.1 Freundlich adsorption isotherm for quizalofop-ethyl in sandy loam soil

Table 4.2.4 Persistence, half- lives and statistical parameters for quizalofop dissipation in soil

Dose (g/ha)	Days after quizalofop application (mg/kg)						k	R^2	DT_{50} (days)
	0	3	7	10	15	30			
50	0.208	0.125	0.078	0.048	0.036	0.014	0.031	0.947	3.21
100	0.327	0.214	0.131	0.088	0.054	0.031	0.039	0.965	5.84

Disappearance parameters for quizalofop- ethyl residues were calculated using first order reaction kinetics equation and found that its dissipation fit the first order degradation with the R^2 values of >0.94 at both the doses of 50 and 100 g /ha. Increase in concentration of application increased the half life of quizalofop-ethyl with DT_{50} values of 3.21 and 5.84 days, respectively at 50 and 100 g/ha applied treatments.

Soil samples were collected from the field which didn't receive the atrazine previously and used for conducting the pot study. Treatments were imposed 3 days before sowing of maize. On 3rd day after maize sowing, atrazine was applied to each pot at 0.5 kg / ha. Soil samples were collected from a depth of 0-15 cm on 0, 1, 3, 5, 10, 15, 30 and 45 DAA and analysed for atrazine residues. Residue of atrazine was extracted using acetonitrile and determined by HPLC.

The soil used for the study was calcareous sandy clay loam in texture having pH 8.28, EC 1.2 dS / m, OC 0.46 %, available N, P, K of 145.6, 17.8 and 621 kg / ha. Atrazine residue was analysed from soil samples collected from the pot grown with maize as test crop at periodic intervals and found thatinitial deposition on day zero (Table 4.2.5) ranged from 0.423-0.721 mg / kg across different treatments sources consisting of cultural and microbes application to enhance the degradation of atrazine from the soil. Irrespective of the treatments atrazine residues persisted upto 45 DAS.

Table 4.2.5 Persistence of atrazine in soil as influenced by the organic sources and microbial application under pot study

Treatments		Atrazine residues (mg/kg) in soil					
		0 day	5day	10 day	15 day	45 day	R^2
T1	FYM 10 t / ha	0.49	0.20	0.12	0.01	0.96	0.96
T2	Vermicompost 5 t / ha	0.56	0.31	0.14	0.02	0.98	0.98
T3	Biochar 5 t / ha	0.42	0.24	0.13	0.01	0.99	0.99
T4	Phosphobacteria 10 kg / ha	0.57	0.20	0.20	0.02	0.92	0.92
T5	Trichoderma 10 kg / ha	0.52	0.30	0.21	0.03	0.98	0.98
T6	VAM 10 kg / ha	0.50	0.19	0.12	0.01	0.94	0.94
T7	Pseudomonas 10 kg / ha	0.55	0.26	0.16	0.02	0.99	0.99
T8	Urea 100 kg / ha	0.67	0.27	0.17	0.03	0.98	0.98
T9	Crop residue (maize straw) incorporation 5 t / ha	0.53	0.27	0.20	0.03	0.94	0.94
T10	Control (no manure / bioagents)	0.72	0.31	0.23	0.03	0.97	0.97

Dissipation was faster under FYM, VAM and biochar applied treatments and the slowest degradation was noticed in control. It was found that the FYM 10 t / ha or vermicompost 5 / ha or biochar 5.0 t / ha is efficient in reducing the residual concentration of atrazine in the maize grown soil. This could be due to the enhanced adsorption of the compounds by these sources. The application of FYM degraded the atrazine fast and slow degradation by microbes could be ascribed to the low quantity of application when compared to FYM.

CCSHAU, Hisar

Caly loam soil sampling was done on 0, 1, 3, 7, 15, 30, 45, 60 and 90 days after application of oxyfluorfen. Residues in soil were analyzed by GCMS / MS. Average initial deposit of oxyfluorfen applied at 300 g / ha was found to be 0.75 mg / kg. Initially rate of dissipation was quite fast. On 7 day, residues level reached to 0.29 mg / kg with dissipation of 61.3%. It was observed that residues reached below detection limit (0.003 kg / ha) on 45 days of application showed 100% dissipation. The half life was observed to be 5.1 days at single dose application. Dissipation up to 7 day was 52%. Residues reached below detectable level on 45 days. The half-life of oxyfluorfen was found to be 6.1 days following first order kinetics.

Oxyfluorfen was applied at 300 g / ha (single dose) and 600 g / ha (double dose) along with mulching of both treatments with paddy straw residue at application rate of 10 tones / ha. Soil sampling was done on 0, 1, 3, 7, 15, 30, 45 and 60 days after application of herbicide. Average initial deposit of oxyfluorfen applied at 300 g / ha was found to be 1.35 mg / kg. Initially rate of dissipation was slow. On 7 the day, dissipation was fast and residues dissipiated to 0.49 mg / kg with dissipation of 66.7%. It was observed that residues dissipation was 97.8% on 15 days of application. The half life was observed to be 4.4 days which was less than the half life without straw mulching (5.1 days) at single dose application without straw mulching. The residues showed 90.9% dissipation on 15th days after application. Half-life of oxyfluorfen was found to be 5.3 days which was lesser than 6.1 days at double dose application without mulching. The dissipation followed first order kinetics.

PAU, Ludhiana

The study was planned to investigate the adsorption and desorption behaviour of penoxsulam in soils of Punjab. Five soils having different textures were collected from 0-20 cm depth. Soil was air-dried, ground and passed through a 2 mm sieve and analyzed for its physico-chemical properties (Table 4.2.6). Preliminary adsorption experiments revealed that adsorption equilibrium was attained within 24 hours and beyond that the amount of penoxsulam adsorbed by soil remained almost steady. Adsorption study was carried out with concentrations of penoxsulam ranging from 0.1 to 100 µg / mL at 25, 35 and 45°C.

Table 4.2.6 Amount of penoxsulam adsorbed in three soils at 25°C

C_i	Loamy sand		Sandy loam		Loam		Silt loam		Clay loam	
	C_e	C_s	C_e	C_s	C_e	C_s	C_e	C_s	C_e	C_s
0.1	0.05	0.47	0.03	0.64	0.02	0.68	0.01	0.84	0.01	0.81
0.5	0.35	1.31	0.31	1.67	0.30	1.84	0.20	2.71	0.13	3.28
1	0.51	4.45	0.33	6.01	0.32	6.12	0.29	6.36	0.28	6.43
5	2.34	23.94	2.16	25.51	1.96	27.35	1.78	29.02	1.63	30.30
10	5.95	36.45	5.25	42.78	5.23	42.95	4.72	47.49	3.72	56.54
20	12.70	65.73	9.07	98.38	8.86	100.29	8.38	104.57	6.83	118.54
40	22.09	161.18	16.58	210.75	15.68	218.86	15.10	224.13	12.84	244.46
60	31.02	260.80	21.95	342.41	19.85	361.34	17.69	380.82	17.59	381.68
80	42.05	341.51	31.08	440.27	28.78	460.95	26.50	481.53	25.19	493.33
100	54.61	408.51	41.11	529.97	36.76	569.14	35.43	581.10	33.53	598.21

C_i (µg/mL) in the initial concentration; C_e (µg/mL) in the equilibrium concentration; C_s (µg/g) in the amount adsorbed

Amount of penoxsulam adsorbed on soils increased with increase in initial concentration, temperature, organic matter and clay content. In order to find the mathematical model that best describes the adsorption process of penoxsulam in five soils, four isotherm models namely Freundlich, Langmuir, Temkin and Dubinin-Radushkevich (D-R) were used. On the basis of the measured R^2 values, penoxsulam adsorption conformity to different isotherms can be arranged as: Freundlich> Langmuir >Temkin> D-R model. logK_{Fads} in five soils ranged from 0.858 to 1.397 $\mu g^{1-1/n}\ g^{-1} ml^{1/n}$, 0.992 to 1.492 $\mu g^{1-1/n}\ g^{-1} ml^{1/n}$ and 1.204 to 1.58 $\mu g^{1-1/n}\ g^{-1}\ ml^{1/n}$ at 25, 35 and 45^{0}C, respectively indicated strong binding of penoxsulam on studied soils and order of adsorption was: clay loam > silt loam > loam > sandy loam> loamy sand.

Desorption studies were carried out for initial concentrations of 5, 10, 20, 40, 60, 80 and 100 µg / mL of penoxsulam. After adsorption studies, removed supernatant were replenished with 9 mL distilled water. The tubes were again shaken for 24 h, centrifuged and the supernatant solution was analyzed. The amount of penoxsulam desorbed increased with increase in initial concentration and desorption data fitted well into Freundlich equation. *log*K_{Fdes}values increased with increase in temperature and ranged from 1.298 to 2.474 $\mu g^{1-1/n}\ g^{-1}\ ml^{1/n}$ at 25°C, 1.357 to 2.742 $\mu g^{1-1/n} g^{-1} ml^{1/n}$ at 35°C and 1.438 to 2.781 $\mu g^{1-1/n} g^{-1} ml^{1/n}$ at 45°C and the order of desorption was loamy sand > sandy loam > loam > silt loam>clay loam. The hysteresis coefficient (H) varied from 0.016 to 0.207 at studied temperatures.

The ? G° decreased with increase in temperature and ranged from -4.89 to -9.80 kJ/mol in the studied soils, (Table 4.2.7) indicating that adsorption of penoxsulam in soils was a feasible, spontaneous and endothermic process becoming more favourable at higher temperature. The ΔH of penoxsulam was positive and ranged from 15.28 to 31.47 kJ/mol indicating physisorption. The entropy (ΔS_{ads}) values were positive reflecting the affinity of tested soils towards penoxsulam molecule.

Table 4.2.7 Thermodynamic parameters for adsorption of penoxsulam

Soil	ΔG_{ads}(kJ mol^{-1})			ΔS_{ads} (J mol^{-1} K^{-1})	ΔH_{ads} (kJ mol^{-1})
	25°C	35°C	45°C		
Loamy sand	-4.89	-5.85	-7.33	0.121	31.47
Sandy loam	-6.29	-7.33	-8.41	0.106	25.31
Loam	-6.59	-7.55	-8.88	0.114	27.54
Silt loam	-7.75	-8.10	-9.28	0.076	15.28
Clay loam	-7.97	-8.80	-9.65	0.084	17.05

WP 4.3.2 Degradation of candidate herbicides of state

At AICRP-WM PAU Ludhiana in the effect of herbicide application rate, soil type and moisture conditions on dissipation behaviour of penoxsulam was evaluated under laboratory conditions. Penoxsulam was applied to soils at an application rate of 22.5 and 45 g/ha under field capacity and submergence conditions. Soil samples were collected at 0 (5 h), 3, 15, 30, 45 and 60 days after herbicide application from treated and untreated pots. MSPD was used for the extraction of penoxsulam from soil and residues were quantified using HPLC. The initial residues of penoxsulam (3 h after application) under field capacity ranged from 2.83 ± 0.14 to 3.15 ± 0.11 µg/g at 22.5 g/ha while residues were comparatively higher at 45 g/ha and varied from 3.84 ± 0.13 to 3.98 ± 0.13 µg/g. With the passage of time, residues decreased successively in all the treatments. Decline of penoxsulam residues in soils over time followed the first-order kinetics with R^2> 0.90.

DT_{50} of penoxsulam in four soils varied from 15.7 to 28.9 days at both application rates and dissipation was observed to be comparatively slower in clay loam soil followed by loam, sandy loam and loamy sand soil. To study the effect of moisture conditions, dissipation was also carried out under submerged conditions. The initial deposits of penoxsulam varied from 2.53 ± 0.13 to 3.89 ± 0.10 µg/g in loamy sand, sandy loam, loam and clay loam soil at both

Table 4.2.8 Half-lives and other kinetic parameters of penoxsulam dissipation

Soil	Moisture	Dose (g/ha)	k/(days)	DT_{50} (days)	R^2
Clay loam	Field capacity	22.50	0.03	24.07	0.92
		45.00	0.02	28.96	0.98
	Submergence	22.50	0.03	20.98	0.93
		45.00	0.03	23.47	0.01
Loam	Field capacity	22.50	0.03	21.33	0.99
		45.00	0.03	24.10	0.98
	Submergence	22.50	0.04	16.49	0.99
		45.00	0.03	20.59	0.99
Sandy loam	Field capacity	22.50	0.04	17.44	0.99
		45.00	0.03	22.71	0.98
	Submergence	22.50	0.05	15.11	0.99
		45.00	0.04	17.77	0.98
Loamy sand	Field capacity	22.50	0.04	15.77	0.96
		45.00	0.04	18.84	0.97
	Submergence	22.50	0.05	13.61	0.97
		45.00	0.05	15.07	0.93

application rates. Dissipation followed first order kinetics and DT_{50} varied from 13.6 to 23.4 (Table 4.2.8) under submerged conditions, dissipation of penoxsulam in soil was comparatively faster under submerged conditions as compared to field capacity conditions.

In another experiment mitigation of penoxsulam in s0il was determined. Soil samples were amended with farmyard manure 6.0 t/ha and 12.0 t/ha, vermicompost 6.0 t/ha and 12.0 t/ha, poultry manure 2.5 t/ha and 5 t/ha and press mud 6 t/ha and 12 t/ha and incubated at 30°C for one week. Penoxsulam was applied at 22.5 g/ha and soil was mixed to ensure adequate distribution of herbicide. Samples were collected at 0 (3 h after application), 3, 7, 10, 15, 30, 45 and 60 days after penoxsulam application. MSPD was used for the extraction of penoxsulam from soil and residues were quantified using HPLC.

Initial residues of penoxsulam (3 hr after application) ranged from 2.23 to 2.98 µg/g in all the treatments (Fig. 4.2.2) and the residues decreased successively with time. After 60 day of incubation period 84.7% degradation was observed in press mud amended soil while 58.0, 38.8 and 22.0% degradation was observed in poultry manure, farmyard manure and vermicompost amended soil, respectively. The half life in amended soils varied from 9.8 to 14.8 days, which was lower than unamended soil where half life of 17.0 days was observed (Table 4.2.9).

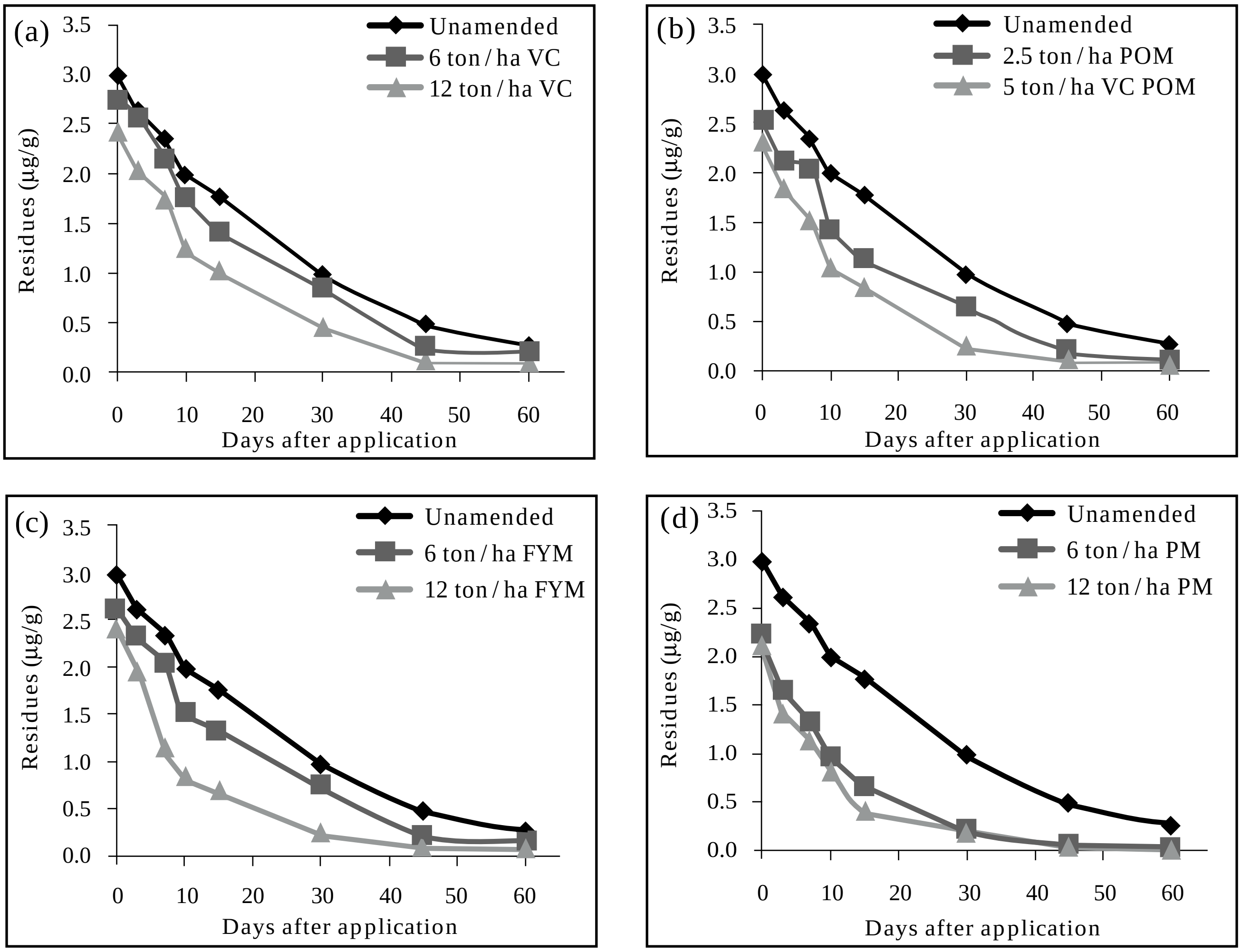


Figure 4.2.2 Residues of penoxsulam in soils amended with (a) vermicompost (VC) (b) poultry manure (PoM) (c) farmyard manure (FYM) (d) press mud (PM) at different dose

Table 4.2.9. Regression equation and half life correlation coefficients

Treatments	Amendment dose (t/ha)	Regression equation	DT_{50}	R^2	k
Farmyard manure	6	Y= -0.0216x + 2.4311	13.92	0.97	0.049
	12	Y= -0.0253x + 2.2647	11.88	0.95	0.058
Vermicompost	6	Y= -0.0202x + 2.4576	14.86	0.97	0.046
	12	Y= -0.0255x + 2.382	11.79	0.97	0.058
Poultry manure	2.5	Y= -0.0234 + 2.4174	12.86	0.98	0.053
	5	Y= -0.0277x + 2.3308	10.88	0.98	0.063
Press mud	6	Y= -0.0305x + 2.2993	9.88	0.98	0.070
	12	Y= -0.0337x + 2.2514	8.92	0.99	0.077
Unamended treatment	0	Y= -0.0176x + 2.4869	17.09	0.99	0.040

CSKHPKV, Palampur

A laboratory experiment was conducted to study the adsorption behaviour of bispyribac-sodium in silty clay loam soil of Palampur. Batch adsorption experiments were conducted to determine the adsorption of bispyribac-sodium on three soil at concentrations of 2.5, 5.0, 10.0, 15.0, 20.0 and 25.0 mg/L. Total amount of bispyribac-sodium adsorbed increased with increasing initial concentration from 2.5 to 25 µg/mL of equilibrium solution (25 - 250 g µg/soil). The amount of bispyribac-sodium adsorbed varied from 20.2 to 154.62 µg/g, 19.0 to 151.3 µg/g and 13.5 to 134.8 µg/g for silty clay loam, silt loam and sandy loam soil respectively. Adsorption isotherms expressed an increasing trend in the adsorbed content Cs (µg/g) with respect to increase in the equilibrium concentration of bispyribac-sodium Ce (µg/mL) in solution. Degradation of bispyribac-sodium was studied in rice cropped soil. Samples of soil (0-15 cm) at monthly interval were collected replication wise from a station rice field trial where two treatments of bispyribac-sodium 10 g/ha, 20 g/ha and 40 g/ha were imposed. Bispyribac-sodium residues in extracts were quantified on HPLC. Initial concentrations at day one after herbicide bispyribac-sodium application at 10, 20 and 40 g/ha were found to be 0.089, 0.023 and 0.179 mg/kg, respectively. No bispyribac-sodium residues (could be detected in soil at 15, 45 and 60 days, respectively).

PJTSAU, Hyderabad

Pyrithiobac-sodium is the most widely used selective herbicide by the cotton farmers for control of broad-leaf weeds at application rate of 250 mL/acre. Pyrithiobac, which is a weak acidic herbicide with a *pKa* of 2.34, behave as a singly charged anion at typical soil solution pH values (pH > 5). Adsorption studies were carried out using the batch equilibrium method (OECD protocol) in red and black soil samples collected from the farmers fields at various concentrations ranging from 0 to 50 µg/mL. Red soil was neutral with low organic carbon status, sandy loam texture. CEC was 15.91c mol (P^+)/kg. Whereas black soil was slightly alkaline in reaction with higher clay content, higher CEC (24.2 c mol (P^+)/kg) and medium organic carbon status. The extent of adsorption of pyrithiobac-sodium on the soil samples at initial concentration of 5.0 µg/mL was 1.06 µg/ g to 1.62 µg/g in red and black soils, respectively. While at highest concentration (50.0 µg/mL), adsorbed pyrithiobac-sodium was 7.41 µg/g to 14.4 µg/g in red and black soils, respectively. Pyrithiobac-sodium adsorption was higher in black soil with higher clay content and higher organic matter content compared to the red soil which had relatively lower clay and organic carbon. The adsorption was slower at the lower initial concentrations (<15 µg/mL) and increased rapidly at the intermediate concentrations and tend to slow down at higher concentrations of >40 µg/mL. The adsorption isotherms were mainly parabolic in nature with 'S' shaped character in both the soil samples. The adsorption data fitted well with Freundlich equation.

Freundlich equation has been used effectively to determine the adsorption of herbicides on soil, where the fraction of adsorbed herbicide was low. The co-efficient of determination (R^2 values) for the log x/m and log Ce plots were greater than 0.97, indicated excellent fit of the adsorption data by Freundlich equation. The values of 1/n suggested the existence of non-linear adsorption. There could be a decrease in available sites as the adsorption increases. This is particularly true in soils with low organic matter and clay content. Adsorption was not linear (1/n <1) and the shape of the isotherms showed that adsorption decreased at higher concentrations which could be explained by a decrease in affinity of adsorption sites or competition with water molecules for the same adsorption sites. Similar 'S' shaped isotherms for soils low in organic carbon content have been obtained for various herbicides by several workers. The lower K_{doc} value in case of red soil (47.6) and higher K_{doc} value in black soils (88.3) indicated higher affinity of the pyrithiobac towards organic matter and clay-humus complexes, which are more readily formed in black soils due to the presence higher amount of clay and high-active (smectitic) clay compared to the red soils (low active clays with less sur. Hence higher clay content, presence of active clays, higher organic matter content, stable clay-humus complexes might have resulted in higher adsorption of pyrithiobac in black soils.

WP 4.3.2 Degradation of herbicide in soil

In another study persistence nature of pyrithiobac in soil under fifty percent field capacity was determined. Samples after moisture treatment were incubated at 27±0.2°C and the soil samples were analyzed at 0, 15, 30, 45, 60, 75, 90, 120 and 135 days intervals for the amount of herbicide retained in the soil solution. In case of red soil water holding capacity at field capacity and 50% field capacity were 14% and 7% respectively. Initial detected amount (IDA) of pyrithiobac-sodium extractable from soil sample at 2.0 hours after application of the herbicide was 93.21 µg / 10 g and 90.2 µg / 10 g in red soil; 91.1 µg / 10 g and 92.2 µg / 10 g at field capacity and 50% field capacity respectively in red and black soils. Dissipation of herbicide in soil was estimated upto 135 days after incubation. At 135 days after incubation the detected amount pyrithiobac residues in soil varied from 15.2 µg / 10 g and 14.3 µg / 10 g in red soil; 15.8 µg / 10 g and 14.5 µg / 10 g in black soil at field capacity and 50% field capacity respectively.

Among the models tested (Linear, polynomial, logarithmic and exponential) the exponential model was found to give better fit for field dissipation of the pyrithiobac sodium at both moisture levels in red and black soils. DT_{50} calculated for the red soil at field capacity was 46.2 days and at 50% field capacity was 53.3 days, where as in black soil the persistence half-life was 57.7 days field capacity and 63 days at 50% field capacity. Prolonged half life of pyrithiobac in experimental conditions revealed the herbicides carryover capacity and probability for damage to crop grown in rotational sequence.

GBPUAT, Pantnagar

A batch experiment was conducted to determine adsorption in soil. Herbicide solutions were prepared directly in a solution of 0.01 M $CaCl_2$ and 10^{-4} M NaN_3 to keep ionic strength constant and to prevent biological activity, respectively. Concentration range of imazethapyr (0.5-2.0 mg/L) was used in the sorption tests. Adsorption and desorption coefficients were calculated using the Freundlich, isotherm. Adsorption increased from 0.12 to 0.49 mg/g showed that the adsorption increases with increase in concentration. The adsorption intensity was found to be 0.995. Desorption was noticeable at higher concentrations and tend to decrease as concentration decreases.

Imazethapyr was applied at the rate of 100 g/ ha and 200 g/ha, respectively. Soil samples were collected at different time intervals after 0 (4 h), 1, 3, 5, 7, 10, 15, 30, 60, 90, 120 and 150 days after herbicide application. Soil moisture was maintained throughout the experiment. Soil was kept at 28±2 ^{0}C in dark. Samples were extracted and analyzed for imazethapyr residues through HPLC. Dissipation of herbicide in soil treated at 100 g/ha increased from 0 to 2.16% from 0^{th} day (4.0 h after application) to 1^{st} day and then it gradually increases up to 12.44% till 5^{th} day. On 15^{th} and 60^{th} day of application, the dissipation was 38.4 and 60.1%, respectively and dissipated up till 90^{th} day after application (83.5%). However, no detectable residue (<0.01 g/g) was found on 120^{th} day of application. At 200 g/ha application rate imazethapyr, the dissipation of herbicide in soil increased from 0 to 6.33% from 0^{th} day (4 hr after application) to 1^{st} day on 30^{th} and 90^{th} day of application, the dissipation of herbicide increased to 54.6% and 86.2%, respectively and dissipated up till 120^{th} day (94.00%) after application. No detectable residue (<0.01 µg/g soil) was observed on 150^{th} day of application.

Different herbicides butachlor, pretilachlor, quizalofop-p-ethyl, pendimethalin and metribuzin *viz.* were used by the farmers in the crops like rice, mustard, potato, vegetables and fruit crops. A laboratory pot culture study was conducted by collecting soil from fields after harvesting of the crop from the AAU, Jorhat. In pot, quizalofop-p-ethyl was applied 50 g / ha (X= recommended level) and 100g / ha (2X = double recommended level). Composite soil samples were collected on the day of herbicide application (within 4 h of herbicide application) and periodically taken up to 45 days after application.

The dissipation of herbicides in soil followed a pseudo first order equation. Quizalofop-p-ethyl residue recorded 0.586 µg / g in case of single dose and 0.782 µg / g in case of double dose on the day of application and observed up to 0.002 µg / g and 0.008 µg / g on the 30th day of application of quizalofop-p-ethyl in single and double dose of application. Butachlor residue recorded 0.91 µg / g in case of single dose and 1.41µg / g in case of double dose on the day of application of butachlor and observed up to 30th day of application. The pretilachlor residue recorded 0.68 µg / g in case of single dose and 1.31 µg / g in case of double dose and 0.002 µg / g and 0.005 µg / g residues were found on the 30th day of application of pretilachlor both in single and double dose of application, respectively. Pendimethalin residue recorded 0.92 µg / g in case of single dose and 0.98 µg / g in case of double dose on the day of application of pendimethalin. Metribuzin residue were 0.506 µg / g in case of single dose and 0.826 µg / g in case of double dose on the day of application of metribuzin and dissipated to 0.002 µg / g and 0.006 µg / g on the 30th day of application. Herbicide residue was observed at BDL from 45th day of application in case of all the herbicides.

WP 4 .3.3 Mitigation of candidate herbicides of state

Field experiment was conducted in soybean crop at Pantnagar. For mitigation of imazethapyr, soil was amended with FYM at 5.0 t / ha in field. Imazethapyr was applied at the rate of 100 g / ha and 200 g / ha. Soil samples (0-20 cm depth) were collected at different time intervals after 0 (4 h), 1, 3, 5, 7, 10, 15, 30, 60, 90, 120 and 150 days after herbicide application. Samples were analyzed for imazethapyr residues through HPLC. Persistence / dissipation studies of imazethapyr in soil at two different concentrations with FYM were performed.

Dissipation of herbicide in FYM treated soil at 100 g / ha increased from 0 to 8.15% from 0th day (4 h after application) to 3rd day and then it gradually increases up to 26.7% till 7th day. On 10th day and 30th day of application, the dissipation was 34.68% and 55.00% respectively and dissipated up till 90 DAS application (93.5%). However, no detectable residue (<0.01 g / g) was found on 100th day of application. At 200 g imazethapyr / ha application rate with FYM, the dissipation of herbicide in soil increased from 0 to 10.2% from 0th day (4 h after application) to 1st day and then it gradually increased up to 24.0% till 5rd day. On 15th and 60th day of application, the dissipation of herbicide increased to 57.5% and 80.2% respectively. On 90th day of application, the dissipation of herbicide increased to 92.9% and dissipated up till 100th day (98.2%) after application. No detectable residue (<0.01 g / g soil) was observed on 120th day of application. Addition of FYM showed rapid degradation of imazethapyr in soil and imazethapyr persisted for 90 days. The rapid degradation would be due to high organic carbon content and high microbes population in soil which has resulted in rapid mitigation of herbicide.

A laboratory pot culture study was conducted by incorporating bacterial consortium on the pot containing to reveal the affect of microbes on the degradation behaviour and persistence extent of butachlor in the soil and the environment at Jorhat.

Two kg of air dried soil with 50 g of vermicompost was put in each pot and 30% moisture level was maintained by sprinkling water frequently to the pot. Bacteria isolated from varied locations of Assam were grouped into five bacterial consortia named as consortia isolated from oil fields-1, consortia isolated from coal fields-2, consortia isolated from brick fields-3, consortia isolated from paper industry-4, consortia isolated from cement industry-5. Hericides were applied to the pots at recommended (X) and double the recommended (2X) rate of application. Bacterial consortia were applied to the pots at 10 ml per 6 kg soil with the range of dilution CFU of (55.42 – 74.4) x 10^6 CFU / g soil were collected periodically from the day of application of herbicide (after four h of application) till 45th day of application.

Composite soil samples were collected from each pot on 0 (4 h after application), 3, 7, 15, 21, 30 and 45 days after application. Residues in the soil were determined by GC-ECD. All the five bacterial isolates showed effective against the herbicides *viz,* butachlor, pretilachlor, pendimethalin, metribuzin and quizalofop-p-ethyl. Highest degradation resulted in case of bacterial consortia isolated from oil field followed by consortia isolated from coal field. Out of five herbicides, quizalofop-p-ethyl responded highest to all the bacterial consortia. On the basis of degradation pattern of herbicides, the bacterial consortia can be rated as – soil field bacterial consortia > coal field bacterial consortia > paper industry bacterial consortia > brick field bacterial consortia > cement industry consortia.

Table 4.3.3.2 Effect of bacterial consortium on different herbicides with recommended (x) and double the recommended (2x) dose of application on $T_{1/2}$

Herbicide	Bacterial consortium									
	Oil field		Coal field		Brick field		Paper industry		Cement industry	
	x	2x	x	2x	x	2x	x	2x	x	2x
Butachlor	1.57c	2.03b	1.75b	2.01b	2.01b	2.35b	1.56c	2.08b	2.08c	2.39b
Pretilachlor	2.02a	2.05b	1.91a	1.99c	2.31a	2.37b	2.13a	2.19b	2.36a	2.36b
Metribuzin	1.78b	2.22a	1.76b	2.27a	2.05b	2.50a	1.97b	2.36a	2.04c	2.55a
Pendimethalin	1.77b	2.07b	1.76b	1.95c	2.04b	2.34b	1.89b	2.20a	2.11b	2.37b
Quizalofop-p-ethyl	1.81b	2.13a	1.78b	2.22a	2.24a	2.34b	1.98b	2.27a	2.10b	2.37b

Table 4.3.3.3 Effect of bacterial consortium on different herbicides with recommended (x) and double the recommended (2x) dose of application on k

Herbicide	Bacterial consortium									
	Oil field		Coal field		Brick field		Paper industry		Cement industry	
	x	2x	x	2x	x	2x	x	2x	x	2x
Butachlor	0.44a	0.34a	0.39a	0.34a	0.34a	0.29a	0.44a	0.33a	0.33a	0.29a
Pretilachlor	0.34b	0.34a	0.36b	0.34a	0.30b	0.29a	0.32c	0.32a	0.29b	0.29a
Metribuzin	0.39b	0.31b	0.39a	0.30b	0.34a	0.28a	0.35b	0.29b	0.34a	0.27b
Pendimethalin	0.39b	0.33a	0.39a	0.35a	0.34a	0.29a	0.37b	0.31b	0.33a	0.29a
Quizalofop-p-ethyl	0.38b	0.32b	0.39a	0.31b	0.31b	0.29a	0.35b	0.30a	0.33a	0.29a

KAU, Thrissur

Glyphosate is widely used in rubber and tea plantations as well as in many other crops of the state. There is an increasing public concern over the use of glyphosate and particularly the most popular formulation Roundup® in the cropping systems. Therefore, experiments were conducted to determine dissipation pattern of glyphosate and the surfactant POEA (polyethoxylated tallow amine) in the soil environment.

C labeled glyphosate of specific activity 1.0 mCi/mmole obtained from Board of Radiation and Isotope Technology, Mumbai mixed with 99.9% pure glyphosate (Pestanal® of Sigma Aldrich Laborchemikalien Gmbh) was dissolved in distilled water and required quantity was added to the mud pot tanks as per the treatments. Mud pots of 30 cm diameter and 25 cm depth were taken and filled to $3/4^{th}$ with laterite soil (7.0 kg soil). Soil moisture was maintained at field capacity and ^{14}C glyphosate was sprayed over the soil surface as per treatments.

Treatments:

T1 : Labelled glyphosate: 1.0 ppm (barren soil)

T2 : Labelled glyphosate: 1.0 ppm (with weeds)

T3 : Control (barren soil)

T4 : Control (with weeds)

Soil samples were taken at 1, 7, 15, 30, 60 and 90 days after spraying and subjected to analysis of ^{14}C glyphosate.

Radioactivity studies in soil (mud pots) showed that 9-16 % of the applied herbicide remained in soil at 1 DAS (Table 4.3.3.4). Differences in activity was noticed between the treatments with and without weed, as the treatment without weeds registered almost double the activity as that of the treatment with weeds. However at 15 DAS, no ^{14}Cactivity was registered in soil by any treatment. The data showed that glyphosate is quickly inactivated in soil by adsorption and the release of chemical from the bound form is difficult. ^{14}C activity in the weeds was only 4.8% at 1 DAS, which dissipated completely by 30 DAS. The radiotracer study showed that weeds contained lesser quantity of glyphosate than soil.

In order to compare the behavior of non radioactive glyphosate and POEA in soil, another pot culture experiment was conducted in mud pots. The dehydrogenase enzyme activity is commonly used as an indicator of biological activity in soils which in turn reflects the soil health. Soil samples were taken at 1, 7, 15, 30, 60 and 90 days after spraying and subjected to analysis *viz*., dehydrogenase enzyme activity in soil, so as to estimate their persistence in soil The enzyme activity expressed as µg TPF formed per hour per gram soil.

Table 4.3.3.4 Effect of chemicals on dehydrogenase activity at 15 DAS

Treatments	With weed	Without weed	Reduction in enzyme activity (%)
Glyphosate	0.690* (14.5)	0.274 (18.6)	60.29
Roundup	0.657 (18.5)	0.233 (30.8)	64.53
POEA	0.720 (10.7)	0.283 (16.0)	60.69
Control	0.81	0.34	58.24
LSD (P=0.05) = 0.174			

*Percent reduction in enzyme activity compared to control are given in parentheses

Significant changes were observed between control and Round up®as well as control and glyphosate. Glyphosate and Roundup® were on par in reducing the enzyme activity indicated that the active ingredient glyphosate is toxic to micro-organisms. The adverse effect of POEA was lower than glyphosate and Roundup®. Significant changes were observed between control and glyphosate, and control and Round up (both the treatments with and without weeds). Significant differences between control and glyphosate, as well as control and Roundup® were observed at 60 DAS also (Table 4.3.3.5). Results indicated that glyphosate reduced the enzyme activity even at 60 days after spraying, showing its persistence in soil. The surfactant POEA also exerted some adverse effect on the enzyme activity at this stage indicating its persistence in soil. However, its effect was lower than that of glyphosate and Roundup®

Table 4.3.3.5 Effect of chemicals on dehydrogenase activity at 90 DAS

Treatments	With weed	Without weed	Reduction in enzyme activity (%)
Glyphosate	0.51*(-3.4)	0.33 (25.0)	36.5
Roundup	0.43 (13.4)	0.32 (27.2)	26.0
POEA	0.390 (22.0)	0.32 (26.5)	17.1
Control	0.50	0.44	12.0

*Percent reduction in enzyme activity compared to control are given in parentheses

At 90 DAS, enzyme activity in all the treatments was on par with control. Glyphosate and POEA dissipated completely from the soil by 90 days.

WP 4.4 Testing of persistence of herbicides in the farmers' field (soil and crop produce)

OUAT, Bhubaneswar

Soil Sandy loam (deltaic alluvial soil) and plant samples (maize) were collected from farmer's field at harvest, processed for residue analysis from Routpada, Begunia, Khorda district in *Kharif*, 2017 from East and South Eastern Coastal Plain. Soil samples collected from rice fields, under sandy loam soils did not contains residue from 20 days after application of pendimethalin.

TNAU, Coimbatore

Soil and crop samples were collected at harvest from three farmer's fields from Thondamuthur block of Coimbatore district from maize and pulses grown field to determine the extent of herbicides contamination in the soil, crop samples at harvest and water samples from bore well at periodic interval from one week after herbicide application. The collected soils were sandy loam in texture and the organic carbon content ranged from 0.27 to 0.33%, pH and EC ranged from 8.12 to 8.37 and 0.36 to 0.58 dS / m, respectively. NPK were applied as per the state recommendation to the particular crop. The soil and crop samples were extracted and residues of pendimethalin and atrazine in the samples was estimated by HPLC. Residue of these herbicides was found below detectable limit in all matrices namely soil, grain and water samples.

CCSHAU, Hisar

Soil, wheat grains and straw samples were collected from farmers' field at harvest from different rice-wheat growing regions of Haryana. Paddy grains, straw and soil samples were collected from farmers' field at harvest from paddy belt of Haryana. The samples were taken from the sites where farmers are continuously using the pretilachlor from many years. Pretilachlor, butachlor, pendimethalin, metribuzin and oxadiargyl were determined in soil, paddy grain and straw by GCMS / MS samples out of 16 locations were having metribuzin residues in soil ranged between 0.005 to 0.013 µg / g, whereas in straw, residues of metribuzin were observed in 7 samples ranged between 0.01 to 0.029 µg / g which were below MRL value of 0.05 µg / g. Sulfosulfuron residues were observed to be 0.038 and 0.028 µg / g in soil sample collected from Pipaltha and Danoda of Jind, respectively.

Table 4.4.1 Residues in soil, wheat grains and straw samples collected from farmers' field in major wheat growing regions of Haryana (*Rabi* 2016-17).

Name & address of farmer	Herbicide/s sprayed	Dose	Residues (µg/g)		
			Soil	Grain	Straw
Surender Nain, Danoda, Jind	Leader (sulfosulfuron)	X	0.028	BDL	BDL
Ramehar, Ujhana, Jind	Leader (sulfosulfuron) + Topik	X	BDL	BDL	BDL
Suddan, Kalwan, Jind	Platform (pendimethalin + metribuzin) + Pinoxadan	X	0.006	BDL	0.015
Swarn Singh, Ludas, Hisar	Leader (sulfosulfuron)	X	BDL	BDL	BDL
Tarshem, Nangla, Tohana (1)	Platform (pendimethalin +metribuzin) + Shagun (clodinafop+metribuzin)	X	0.007	0.007	0.023
Tarshem, Nangla, Tohana (2)	Platform (pendimethalin+ metribuzin) + Shagun (clodinafop+metribuzin)	X	BDL	BDL	0.029
Nek Singh s / o Rai Singh, Lamba Kheri, Kaithal	Platform (pendimethalin + metribuzin) + Leader (sulfosulfuron)	X	0.013	BDL	0.028
Surender Singh, Lamba Kheri, Kaithal (2)	Pendimethalin (2 l / ha) + Sencor (metribuzin, 150 g / ha)	X	0.007	BDL	0.017
Surender Singh, Lamba Kheri, Kaithal (4)	Dost (pendimetalin, 330 g / l) + Topik + Sencor (metribuzin, 150 g / ha)	X	BDL	BDL	0.02
Chatru, Teek, Kurukshetra	Shagun (clodina + metribuzin)	X	BDL	BDL	BDL

In *Kharif*, 11 out of 20 locations were having pretilachlor residues in the soil between 0.005 to 0.062 µg / g. Samples from village Samain and Baliala were having 0.021 and 0.032 µg / g residues in rice grains. Straw samples from two sites of village Nangla, Kalwan and two sites of village Dattasinghewala were between 0.005 to 0.04 μg/g. All the paddy grains and straw samples were having pretilachlor residues below MRL of 0.05 μg/g. There were no residues of oxadiargyl in any of the samples from 20 locations.

Table 4.4.2 Residues status in paddy grains, straw and soil at farmer's field in paddy belt of Haryana (*Kharif* 2017)

Farmers name and address	Herbicide sprayed	Residues (μg/g)		
		Soil	Grain	Straw
Surender, Danoda (Jind)	Erose	BDL	BDL	BDL
Sarpanch Harpal, Nangla (Tohana) 4	Butachlor	0.041	BDL	BDL
Babbu, Nangla (Tohana)	Pretilachlor	0.062	BDL	BDL
Daljeet, Nangla (Tohana)	Pretilachlor	0.055	0.021	0.005
Nafe Singh, Samain (Tohana)	Pretilachlor	0.022	BDL	BDL
Binder, Samain (Tohana)	Pretilachlor	BDL	BDL	BDL
Rakesh, Near Surya PG College, Baliala, Jind	Pretilachlor	0.040	0.032	BDL
Subhash S/o Amar Singh, Kalwan (Jind)	Pretilachlor	0.018	BDL	0.016
Narender, Rashida (Jind)	Pretilachlor	0.024	BDL	BDL
Parkash, Dabhi Tek Chand (Jind)	Pretilachlor	0.049	BDL	BDL
Daljeet, Dattasinghewala (Jind)	Pretilachlor	0.062	BDL	0.033

Tube-well water samples were collected from different regions or major wheat growing belt of Jind, Karnal, Ambala, Kurukshetra, Tohana of Hisar district and analyzed for herbicide residues of sulfosulfuron, meso + iodosulfuron, pendimethalin + metribuzin as per farmer's practice. It was observed that none out of 10 locations were having herbicide residues above detection limit as given below.

PAU, Ludhiana

Soil, water and crop samples were collected at harvest from farmer's fields from Ludhiana, Moga, and Kapurthala districts of Punjab in rice-wheat cropping system. The soils were sandy loam in texture having pH range between 7.8 to 9.3 and organic carbon from 0.15 to 1.08%. The soil, water and crop samples were extracted by standard methodologies for herbicide residues in the samples and estimated by HPLC. Residues of butachlor, pretilachlor, anilophos, clodinafop-propargyl, sulfosulfuron, metsulfuron-methyl and pendimethalinin soil, water and crop produce were below detectable limit.

CSKHPKV, Palampur

Soil and wheat grain samples were collected from the clodinafop-propagryl treated fields of eight farmers of Kangra district at the harvest of the crop and were analysed for clodinafop-propagryl residues in soil and wheat. The residues of clodinafop were quantified using HPLC. The recovery from soil at 0.5 and 1.0 μg/ g of clodinafop ranged between 82.1-84.0%. Recovery of clodinafop ester was 82.4-89.9% for grain sample at the fortification level of 0.5 and 1.0 μg/g. Residues in soil and grain samples were below detectable levels (< 0.03 μg/g).

PJTSAU, Hyderabad

Radish and coriander (green leafy vegetable) are short duration vegetable crops in which pre-emergence herbicides (pendimethalin) are commonly used by farmers. Four radish tuber samples and four coriander leaf and soil samples were collected from different farmers at the time of harvest in various villages located in vegetable growing areas of Ranga Reddy and Vikarabad districts. Residues of pendimethalin in tomato and brinjal fruit samples collected from the farmers fields in Ranga Reddy district of Telangana state were below the detection limit of 0.025 mg/kg. In all the soil samples from radish and coriander fields at the time of harvest, pendimethalin residues were below the detection limit of 0.05 mg/kg. Radish tubers/coriander plant samples did not show pendimethalin residues above the detection limit of 0.05 mg/kg.

AAU, Jorhat

Sandy loam soil samples at (0-15 cm), rice grain and straw were collected after harvest of summer and winter rice from farmers' field growing with butachlor and pretilachlor application as weed control and analysed for the herbicide residue. Butachlor and pretilachlor residue at 1.0 kg/ha and 0.75 kg/ha in soil, grain and straw after harvest of summer and winter rice were found at below detectable limit (BDL).

WP 5.1 On-farm research (OFR)

At Anand, OFTs conducted on farmers' fields showed that IC *fb* hand weeding carried out at 20 and 40 DAS was more effective for weed management in soybean as compared to post-emergence application of quizalofop-ethyl. However, less cost of herbicide made it more economical than hand weeding. At the centre, OFTs were also conducted in wheat on farmers' fields which showed that clodinafop propargyl + metsulfuron-methyl 64 g/ha POE was more effective than metsulfuron-methyl (FP) in terms of weed control efficiency as well as yield increase in wheat. Due to continuous use of 2,4-D and metsulfuron-methyl, monocot weed population like *Phalaris* and *Setaria* was increased in farmers' field. To manage complex weed flora in wheat premix herbicides performed better (Clodinafop-propargyl + metsulfuron-methyl 64 g/ha PoE).

At Jorhat, four on-farm trials were conducted in black gram and green gram. Application of pendimethalin 750 g/ha pre-em showed superiority over farmers' practice (2 hand weeding) in terms of weed control and seed yield of the crop. The treatment increased seed yield by 1.74 and 1.79 t/ha over farmers' practice in green gram and black gram respectively.

At Hisar, OFTs were conducted at 11 locations in rice-wheat growing regions of Haryana on pre-emergence use of pendimethalin 1.5 kg/ha alone or in combination with metribuzin followed by sequential use of post emergence herbicides at 35 DAS in wheat. Results revealed that pendimethalin integrated with post-emergence herbicides provided 84% control of resistant *P. minor*, whereas, its ready mixture with metribuzin gave 90% control with 5.9% yield increase over clodinafop + metribuzin (RM) 35 DAS. Although post-emergence use of clodinafop + metribuzin gave 84% control of *P. minor* but 5-10% toxicity to wheat crop was observed at 8 locations.

At Dapoli, three OFTs were conducted at Lanja tehsil of Ratnagiri district in rice. Tested weed management technology oxadiargyl PE gave overall effective results in terms of yield increase and net returns with higher B:C ratio as compared to other treatment and farmers' practice of weed management. In *Kharif* groundnut, two OFTs were conducted at the same locations. Application of pendimethalin at 1.0 kg/ha PE recorded higher yield than others.

At Pantnagar, four OFR trials on wheat crop were conducted at farmers' field of U.S. Nagar and Nainital district during *Rabi* of 2016-17. Readymix combination of applied at 30-35 DAS were taken under recommended practices whereas, clodinafop-propargyl 60 g/ha + 2, 4-D sodium salt 500 g/ha / carfentrazone 20 g/ha were taken as farmers practices. Among the herbicidal treatments, highest weed control efficiency was recorded with recommended practice clodinafop-propargyl + metsulfuron-methyl 60+4 g/ha followed by sulfosulfuron + metsulfuron methyl 30+2 g/ha (86.1 and 77.6%). Application of clodinafop-propargyl + metsulfuron-methyl recorded the highest grain yield of 4.6 t/ha, net return of ` 40897/ha and B:C ratio of 2.2 followed by sulfosulfuron + metsulfuron methyl 4.3 t/ha, net return of ` 36180/ha and B:C ratio of 2.1 in U.S. Nagar. In Nainital, increase in grain yield due to application of clodinafop-propargyl + metsulfuron methyl 60 + 4 g/ha was 27.8%, followed by sulfosulfuron + metsulfuron-methyl 30 + 2 g/ha (19.4%) and 11% in farmer's practice as compared to weedy check. Clodinafop-propargyl + metsulfuron methyl 60 + 4 g/ha recorded the highest grain yield (4.6 t/ha), gross return of ` 75238/ha, net return of ` 41382/ha and B:C ratio of 2.2 among all the treatments followed by sulfosulfuron + metsulfuron-methyl 30 + 2 g/ha recorded grain yield of 4.3 t/ha, gross return of ` 69875/ha, net return of ` 36180/ha and B:C ratio of 2.0 which was closely followed by farmer's practices which recorded 4.0 t/ha grain yield, ` 65000/ha gross return, ` 31305/ha net return and 1.9 B:C ratio. During *Kharif* 2017, two on-farm research trials were conducted on farmers' fields of Udham Singh Nagar district of Uttarakhand in transplanted rice. Among different weed management treatments, highest grain yield 6.63 t/ha, net return of ` 62399/ha and B:C ratio of 2.8 were recorded with bispyribac-Na 20 g/ha which was closely followed by application of pretilachlor which achieved grain yield of 6.55 t/ha, net return of ` 61653/ha and B:C ratio of 2.78. Similarly, two OFR trials on soybean were conducted at farmer's field in Nainital district. The highest grain yield 2.3 t/ha, gross return of ` 63525/ha, net return of ` 37598/ha and B:C ratio of 2.4 was recorded with imazethapyr 100 g/ha followed by farmer's practice (Imazethapyr + imazamox 70 g/ha) which produced grain yield of 2.2 t/ha, gross return of ` 61050/ha, net return of ` 35137/ha and B:C ratio of 2.3.

At Raipur, six on-farm trials were conducted in Nisda village (Arang) of Raipur district in transplanted rice with application of oxadiargyl 80 g/ha PE and bispyribac Na 25 g/ha at 20 DAS. There was 49.3% increase in grain yield due to recommended practice over farmers practice.

At Thrissur,the rice field of Sri. Ramachandran in Pullazhi Kole Padavu, Ayyanthole Panchayath of Thrissur district was selected for management of weedy rice using the KAU Weed Wiper. The area was severely infested with weedy rice and the wiper was used when weedy rice ear heads emerged *i.e* sixty days after sowing.

At Udaipur, two OFR trials on management of problematic weed, *Orobanche* on solanaceous vegetables at farmers field in village Shyampura, near Jaisamand have been sown in *Rabi*, 2017.

At Faizabad, on-farm research trials were conducted in three farmers' field of two villages in Faizabad district during *Rabi*, 2016-17. Among the herbicidal treatments, weed control efficiency was recorded higher under sulfosulfuron + metsulfuron-methyl 60 g/ha POE treatment. However, it was highest under weed free treatment due to follow up weeding done thrice at 20, 40 and 60 DAS. Among all treatments, sulfosulfuron (30 g) + metsulfuron-methyl (2g)/ha POE treatment recorded maximum net return (` 54992/ha) followed by farmers practice (` 5445/ha). On-farm research trials were also conducted in three farmers' fields of two villages in Faizabad district in transplanted rice during *Kharif*, 2017. Among the herbicidal treatments, weed control efficiency was recorded higher in pretilachlor + almix treatment. Among the different treatments, pretilachlor 1.0 kg/ha + almix 4g/ha recorded maximum net return (` 53876/ha) followed by weed free and bispyribac Na salt alone ` 51086 and ` 50561/-, respectively.

At Ludhiana, OFRs were conducted in wheat in four farmers' fields during *Rabi* 2016-17 where *Phalaris minor* has developed cross resistance to recommended herbicides like clodinafop, fenoxaprop and pinoxaden. In such fields, new chemical- premix of clodinafop + metribuzin was tested against pre-mix of mesosulfuron + iodosulfuron. Clodinafop + metribuzin recorded effective control of *P. minor* in wheat and significantly increased grain yield and economic returns as compared to unsprayed control and was at par with Atlantis. Similarly, four OFR were conducted to test the efficacy of three hebicides *viz*. premix of pendimethalin + metribuzin, pyroxasulfone, pendimethalin along with unsprayed control. Results revealed that premix of pendimethalin + metribuzin and pyroxasulfone recorded effective control of *P. minor* in wheat and increased wheat grain yield and economic returns compared to unsprayed control. Further, four OFR trials were conducted in farmers' fields to control the *P. minor* in wheat with early post-emergence application (before first irrigation) of sulfosulfuron. Results revealed that to control *P. minor* before first irrigation, application of sulfosulfuron at 14-21 days of crop growth, 1-2 days was safe to wheat crop and good weed control was achieved as compared to unsprayed check. Therefore, to control the early flush of *P. minor* in wheat, sulfosulfuron should be sprayed before first irrigation. Another four OFR trials were conducted in *Kharif*, 2017 to see the efficacy of herbicides in controlling weeds in puddled transplanted rice. Pre-mix herbicide pretilachlor + pyrazosulfuron 10 kg/ha as pre-emergence recorded effective control of grasses, broadleaf and sedges than pretilachlor and pyrazosulfuron used alone.

At Akola, two OFTs were carried out in cotton using pre-emergenceapplication of pendimethalin 1.0 kg/ha followed by directed spray (by using protective shield) of non-selective herbicide paraquat

0.6 kg / ha at 45 days after sowing. Weed control and crop yield in both the farmers' fields was relatively better due to improved technology as compared to their own practice (3-4 hoeing + 2-3 weeding).

At Hyderabad, OFR were conducted during *Rabi* 2017-18 on management of *Orobanche* in tomato and solanaceous (brinjal) crops. Among all the treatments, mulching with poly mulch recorded higher plant height, no. of branches and growth parameters of brinjal at 30 days after the application of the second dose of glyphosate.

At Gwalior, OFRs were conducted in wheat during *Rabi* 2016-17. Post emergence application of sulfosulfuron 25 g / ha, metsulfuron 4.0 g / ha, 2, 4-D 500 g / ha and metsulfuron + sulfosulfuron 16 g / ha were tested for chemical control of weeds and compared with farmer's practices at 10 locations. The maximum yield of 4.45 t / ha was obtained with the application of metsulfuron + sulfosulfuron 16 g / ha followed by sufosulfuron 25 g / ha PoE (4.29 t / ha) 2, 4-D 0.5 kg / ha (4.26 t / ha) and metsulfuron 4 g / ha (4.10 t / ha) which was 18.09, 13.79, 13.00 and 8.75% higher over farmers practice (3.77 t / ha). The B: C ratio was found 2.85 to 2.45 in these weed management practices as compared to 2.18 in weedy check. Similarly, OFR studies were also conducted on black gram at farmers' fields at three locations of Gwalior district. Herbicide imazethapyr + imazamox (RM) 80 g / ha, imazathapyr 80 g / ha and quizalofop 50 g / ha were tested on black gram 20–25 DAS after sowing and compared to farmers practice (weedy check). It was observed that all the chemical weed management practices gave higher grain yield over farmers practice. Maximum yield of 903 kg / ha was obtained with the application of imazathapyr + imazamox 80 g / ha PoE followed by imazathapyr 80 g / ha and quizalofop 50 g / ha, which was 50.8, 42.5 and 40.0% higher than farmers practice. Similarly highest B:C ratio of 2.22 was recorded in imazethapyr + imazamox 80 g / ha.

At Jammu, OFR was conducted in collaboration with KVK in farmer's field of R.S. Pura block of Jammu region during *Kharif* 2017 to study the effect of different weedy rice management strategies on weedy rice dynamics and crop productivity. Best treatments obtained through 3 years of experiment, *i.e.* stale seed-bed with glyphosate 1.5 kg / ha and stale seed-bed with paraqat 0.8 kg / ha before transplanting were tested in the farmer's fields. Weedy rice density as well as weedy rice biomass / m^2 was found to be lower in the stale seed-bed with glyphosate 1.5 kg / ha or stale seed-bed with paraqat 0.8 kg / ha before transplanting as compared to butachlor. The stale seed-bed with glyphosate 1.5 kg / ha or stale seed-bed with paraqat 0.8 kg / ha before transplanting recorded higher grain yield of rice as compared butachlor 30 kg / ha.

At Coimbatore, OFT was conducted at Devarayapuram village of Thondamuthur block during *Kharif* 2017-18 at the five farmers' fields to demonstrate the integrated weed management in okra. Application of PE oxyflourfen 200 g / ha + hand weeding on 30-35 DAS and PE pendimethalin 1000 g / ha + hand weeding on 30-35 DAS were compared with hand weeding twice as farmers practice. Total weed density and weed dry weight were considerably lower with application of PE oxyflourfen 200g / ha + hand weeding on 30-35 DAS in all five locations and it was higher than farmers practice. it also recorded higher fruit yield (251–263 q / ha). Net return were higher in the same treatment (` 2.26 – 2.54 lakh / ha).

At Bhubaneswar, four OFTs on transplanted rice were conducted during *Rabi* 2016-17 at Rout pada, Begunia, Khurda district. Two herbicides *viz*. oxadiargyl 75 g / ha and pretilachlor 0.75 kg / ha were tested against farmers practice (hand weeding at 25 and 40 DAP). Maximum yield of 3.6 t / ha was recorded in the plot with pretilachlor 0.75 kg / ha followed by oxadiargyl 75 g / ha (3.4 t / ha). A net saving of ` 2450 - 2550 / ha was observed in the plots treated with herbicides. During *Kharif,* 2017. Four OFTs on rice were conducted in Bhubasuni patna, Baghamari, Khurda area. Two treatments viz. penoxsulam 23.5 g / ha and bispyribac- Na 20 g / ha were tested against farmers practice. Results revealed that highest yield was obtained in the plots applied with bispyribac- Na 20 g / ha (4.5 t / ha) followed by penoxsulam 23.5 g / ha (4.3 t / ha). Similarly, saving in weeding cost over farmers practice was in the tune of ` 2600 - 2950 / ha.

At Pusa, ten OFRs were conducted using the chemical weed management technologies in rice crop (5 OFR) during *Kharif* and wheat (5 OFR) during *Rabi* at different farmers' fields. Pretilachlor 1000 g/ha as PE *fb* one hand weeding at 20 DAS in rice and clodinafop 60 g/ha at 5 WAS in wheat were found superior in terms of grain yield and B:C ratio over farmers practices.

WP 5.2 Front line demonstration (FLD)

At Anand,four FLDs were conducted on weed management technology in *Kharif* maize. Average yield in the recommended practice (Atrazine 1.0 kg/ha PE) was 3.23 t/ha with B: C ratio of 2.43 while the average yield in farmers practice was 2.84 t/ha with B: C ratio of 1.83. Overall performance of the technology demonstrated was accepted by the farmers in the paucity of labourers. Two FLDs were also conducted on weed management technology in summer green gram. Performance of imazethapyr 75 g/ha POE *fb* IC + HW at 30 DAS was shown against the farmers practice (IC+HW at 20 & 40 DAS). Application of imazethapyr 75 g/ha POE *fb* IC + HW at 30 DAS was found comparable with IC + HW at 20 and 40 DAS.

At Hisar, 5 FLDs were conducted on improved weed management technology in maize crop during *Kharif*. On the basis of 5 demonstrations, it was concluded that the tembotrione provided effective control of weeds (90-95%). Yield data showed that economics is in favour of use of tembotrione at all locations without any phytotoxic effect on the maize crop. B:C ratio with use of tembotrione varied 2.40-3.12 against 2.26-2.89 in farmer's practice. During *Kharif* 2017, fifteen demonstrations on bioefficacy of Eros-a ready mix combination of pretilachlor + pyrazosulfuron against complex weed flora in transplanted rice were conducted in various parts of state and compared with earlier recommended herbicide pretilachlor. On an average, Eros had an edge over pretilachlor as it provided more than 94% control of complex weed flora as against 82% by the use of pretilachlor with yield increase of 456 kg/ha, means 7.28% increase over farmers practice. Similarly, 425 demonstrations were conducted in Bhiwani, Hisar and Mahender Garh districts on the use of glyphosate for the control of *Orobanche* in mustard. Post-emergence application of glyphosate 25 g/ha at 30 DAS followed by its use at 50 g/ha at 50-60 DAS provided 75-84% control of *Orobanche* in mustard. Further, to demonstrate efficacy of sulfosulfuron and ethoxysulfuron against parasitic weed *Orobanche*, 8 demonstrations were conducted in village Rehna of Nuh tehsil of Mewat district. Application of ethoxysulfuron provided 85-90% control of *Orobanche* with 3.5-3.7 panicle of *Orobanche* at harvest with tomato yield of 27.0-27.6 t/ha as against 16.8-19.5 t/ha in untreated check. Percent control with use of sulfosulfuron was higher as compared to ethoxysulfuron which ranged from 90-100% with yield 23.8-26.5 t/ha. On an average use of herbicides provided 92.4% control of *Orobanche* resulted in 43% increase in tomato yield.

Five demonstrations were conducted during 2016-17. At Pantnagar, FLDs using herbicides for manageing weeds in rice, soybean, and wheat were conducted at farmers' fields in different locations of Bhabar and Tarai area. In wheat, ready-mix combination of clodinafop-propargyl + metsulfuron-methyl 60 + 4 g/ha at 30-35 DAS effectively controlled broad leaved weeds in all locations and increased grain yield, net return and B:C ratio compared to farmers practice. In rice, use of bispyribac-Na 20 g/ha gave broad leaved weed control in all locations and increased grain yield, net return and B:C ratio compared to farmers practice. Application of imazethapyr 100 g/ha increased the grain yield by 13.5% over farmer's practice which recorded 2.5 t/ha grain yield, ` 43703/ha net return and 2.7 B:C ratio and 75.1% weed control efficiency which was higher than farmer's practice.

At Raipur, 10 FLDs were conducted on chemical method of weed control in rice in a village of Kanker district during *Kharif* 2017 in collaboration with KVK, Kanker. The average yield of farmers practice and recommended practice was 4.04 and 4.87 t/ha, respectively. However, percent increase under recommended practice over farmers practice was 20.7%. The average benefit cost ratio was calculated to be 2.15 and 2.37 under farmers practice and recommended practice, respectively.

At Thrissur, three FLDs were conducted in wet seeded rice during *Rabi* 2017-18. Application of pre emergence herbicides for weed control in wet seeded rice were demonstrated against farmers practice. It was seen that yields did not vary much between farmer's practice and the demonstrated technology, but there was a great saving in the cost of cultivation in herbicide application. Thus, B:C ratio in farmer's practice was only 1.42, while in demonstrated fields, the ratio ranged from 2.26 to 2.66.

At Udaipur, ten FLDs on broad spectrum weed control in wheat (5) and maize (5) were conducted during *Rabi* 2016-17 and *Kharif* 2017, respectively, at farmers' fields of different localities. Premix application of sulfosulfuron + metsulfuron (30 + 2 g/ha) at 5 WAS was demonstrated as weed management technology in wheat. Results revealed that post emergence application of ready mix herbicide at 5 WAS increased the wheat grain yield by 18.9% over farmers practice (4.18 t/ha). Whereas, application of tembotrione in maize increased the grain yield by 22.2% over farmers practice (2.3 t/ha).

At Ludhiana, 11 demonstrations on use of (clodinafop + metribuzin), a new post-emergence herbicide were conducted to control *Phalaris minor* in wheat in Ludhiana district. Herbicide provided 15-25% higher control of *P. minor* and 6-11% higher wheat grain yield than the existing herbicides. Similarly, during *Kharif* 2017, 39 demonstrations were conducted on enhancing the weed control efficacy of applied pre-emergence herbicides (tank-mix of pendimethalin + pyrazosulfuron) through improved herbicide spray technology in direct seeded rice in Moga, Amritsar and Muktsar Sahib Districts. On an average, the improved spray technology recorded 15% higher weed control and 4.7% higher rice grain yield compared with normal spray technology which is hand operated power/gun sprayer.

At Akola, two FLDs were conducted in soybean at Alanda and Mhaispur villages of Akola using herbicide diclosulam 22 g/ha PE followed by imazethapyr + imazamox 100g/ha at 20-25 DAS for weed management. The higher grain yield (2.1 t/ha) and B: C ratio (2.6) were obtained in improved practice over farmers' practice (1.7 t/ha and 2.4).

At Hyderabad, five front line demonstrations were conducted in groundnut and rice crops each during *Rabi* 2016-17 and *Kharif* 2017 to popularize the integrated weed management technology at Palem village of Nagarkurnool district and Satyanarayanapuram village of Nalgonda district, respectively. The results of *Rabi* 2016-17 FLDs (5) on groundnut at Palem village showed that IWM practice *i.e.* early post-emergence application of imazethapyr + propaquizafop *fb* hand weeding at 35 DAS or clodinafop-propargyl + acifluorfen-sodium (PoE) *fb* hand weeding at 35 DAS resulted in timely and efficient weed control in groundnut crop with higher yield and net returns with a B:C of 2.9 to 2.52 compared to farmers practice wherein the B:C was 2.10 to 2.30. Results from FLDs on rice during *Kharif*, 2017 at Satyanarayanapuram village showed that IWM involving post-emergence application of penoxsulam *fb* hand weeding resulted efficient weed control and higher B: C ranging from 2.27 to 2.43. Whereas, farmers practice resulted in B:C varying from 1.94 to 2.13.

At Gwalior, five FLDs were conducted on pearlmillet crop during *Kharif* 2017 at farmer's fields in different villages of Gwalior district. Performance of atrazine 500 g/ha and 2, 4-D 500 g/ha were tested for weed management in pearlmillet 20 – 25 DAS after sowing and compared with farmers practice (weedy check). In farmers' field, application of atrazine PoE gave 54.4% increase of pearlmillet (2.22 t/ha) followed by 2,4-D (2.15 t/ha). The B:C ratio of 2.01 and 1.95 in were obtained in the treatments over 1.41 in farmers practices. The increase due to application of atrazine 500g/ha PoE and 2,4-D 0.5 kg/ha PoE was 54.4 and 49.1%, respectively.

At Coimbatore, FLDs were conducted in blackgram at five farmer's field of Periapatti village of Gudimangalam block of Tiruppur district. Results revealed that due to adoption of improved weed management technology (EPOE quizalofop-ethyl 50 g/ha and imazethapyr 50g/ha at 15-20 DAS), black gram yield increased by 17.6 to 32.3% higher over farmers practice (two hand weedings). The highest income was also obtained by improved practice over farmers practice. Farmers were fully satisfied with the performance of improved weed management technology.

At Bhubaneswar, ten FLDs were carried out in rice at Munida, Satyabadi of Puri district during *Kharif* 2017 using bispyribac-sodium 25 g/ha at 25 DAT for managing weeds. Higher grain yield (32%) and B:C ratio (2.45) were obtained over farmers practice.

At Pusa, ten FLDs were conducted in wheat during *Rabi* 2016-17 on farmer's field of Samastipur, Madhubani, Vaishali, Begusarai, Darbhanga and Muzaffarpur districts of Bihar using clodinafop 60 g/ha at 5 WAS for managing weeds. The result revealed that the mean highest grain yield of wheat (4.64 t/ha) was recorded by technology demonstrated and percentage increase in yield over farmer practice was 43%. On the other hand, the mean net return and B:C ratio of technology demonstrated were ` 47080 per hectare and 3.05 respectively as compared to ` 24184 per hectare and 1.93, respectively in farmers practice. Similarly, ten FLDs were conducted in rice on farmer's field during *Kharif* 2017 in Samastipur, Darbhanga, Vaishali, Muzaffarpur and Sitamarhi districts of Bihar to demonstrate the performance of pretilachlor 1000 g/ha as PE *fb* one hand weeding at 20 DAS. The result revealed that the mean highest grain yield of rice (4.56 t/ha) was recorded by technology demonstrated (pretilachlor 1000 g/ha as PE *fb* one hand weeding at 20 DAS) and percentage increase in yield over farmer practice was 39.3%. Mean net return and B:C ratio of technology demonstrated were ` 39014/ha and 2.57 respectively, whereas, they were ` 20076/ha and 1.76, respectively in farmers practice.

Table5.1 Extension activities undertaken by coordinating centres.

Centres	Training imparted	Radio talks	TV programmes	Kisan melas/Kisan Day	Handouts/folders/pamphlets	Bulletins/booklet	Training participated	On-farm trials	Frontline demonstrations	Parthenium awareness
PAU, Ludhiana	-	2	3	1	-	-	-	16	2	✓
UAS, Bengaluru	12	3	2	-	-	-	-	96	-	✓
RVSKVV, Gwalior	-	-	-	-	-	1	2	3	5	-
GBPUAT, Pantnagar	-	-	-	-	-	-	-	8	12	-
CSKHPKV, Palampur	7	2	-	-	-	1	-	-	-	✓
AAU, Jorhat	-	-	-	-	-	4	5	4	-	✓
AAU, Anand	1	1	2	2	2	-	7	4	4	✓
TNAU, Coimbatore	-	5	-	-	-	-	-	5	5	✓
NDUAT, Faizabad	-	2	-	-	-	3	2	-	-	✓
BAU, Ranchi	5	1	6	-	-	-	4	-	-	✓
KAU, Thrissur	-	-	-	-	-	-	-	1	1	✓
OUAT, Bhubaneshwar	2	-	-	-	-	2	-	8	2	✓
PJTSAU, Hyderabad	-	2	6	-	-	-	-	1	10	✓
CCSHAU, Hisar	7	4	1	3	-	-	1	11	453	✓
RAU, Pusa	-	-	5	1	-	-	-	10	20	✓
DrBSKKV, Dapoli	1	-	1	-	-	-	4	5	2	-
IGKV, Raipur	-	-	-	-	-	-	-	-	-	-
PDKV, Akola	-	2	-	1	5	-	3	1	2	-
BCKV, Kalyani	-	-	-	1	-	-	5	-	-	✓
CAU, Pasighat	3	-	-	-	-	-	-	-	-	✓
UAS, Raichur	-	-	-	-	-	-	-	-	-	-
MPUAT, Udaipur	3	2	-	1	-	-	-	2	10	-
SKUAST, Jammu	1	-	-	-	-	-	3	1	-	✓
Total	42	26	26	10	7	11	36	176	528	

4. RECOMMENDATIONS FOR PACKAGE OF PRACTICES

AAU, Anand

- Application of oxyfluorfen 240 g / ha PE *fb* HW at 60 DAP along with paddy straw mulch 5 t / ha was found effective to manage weeds and produce higher garlic bulb yield.
- Application of 20 t / ha FYM along with paddy straw mulch 10 t / ha *fb* HW at 30 and 60 DAT produces higher funnel equivalent yield under organic crop production system.
- In maize based cropping system application of atrazine + pendimethalin (500 + 250 g / ha) PE (tank mix) *fb* 2, 4-D 1000 g / ha LPoE found effective weed management practices. No adverse effect of herbicides on succeeding wheat crop was observed.
- Highest seed cotton yield was recorded under conventional tillage with application of pendimethalin 900 g / ha PE *fb* IC + HW at 30 and 60 DAS and highest green gram seed yield was obtained under zero tillage with crop residue incorporation and application of pendimethalin 500 g / ha PE *fb* IC+HW at 30 DAS in cotton-green gram cropping system under conservation agriculture.
- Application of premix broad spectrum herbicide clodinafop-propargyl + metsulfuron-methyl 64 g / ha or sulfosulfuron + metsulfuron-methyl 32 g / ha as post-emergence application (25-30 DAS) found effective to manage complex weed flora and higher net return. No adverse effect of herbicides on succeeding crops was observed.

BAU, Ranchi

- Pre-emergence application of (within 3 days after sowing of wheat) pendimethalin 1.0 kg / ha + metribuzin 0.175 kg / ha controls major wheat associated weed flora and reduce weed dry matter thereby produces higher grain, straw yield, higher net return and B:C ratio and is as good as two hand weedings performed at 25 and 55 days after sowing. Herbicides should be applied in wheat within two to three days after sowing. The field should have moisture at the time of herbicide application. The farmers should take care in removing old weeds while preparing land because herbicides will control germinating weeds and not grown up weeds. This technology is suitable for all three zones of Jharkhand.
- Application of atrazine 0.75 kg / ha pre-emergence (within three days after sowing) *fb* straw mulch at 10 DAP (days after planting) *fb* hand weeding at 75 DAP can be practiced for higher growth, productivity and profitability of turmeric. Atrazine restricts germination of grassy and broad leaf weed seeds lying on top 4-5 cm soil surface without hampering germination of turmeric rhizome. Hence care should be taken to sow turmeric rhizome well beneath surface atleast 6" below soil surface to avoid direct contact with herbicide. One hand weeding has to be performed at 75 days after sowing.
- Glyphosate 0.80 kg / ha + oxyfluorfen 0.2 kg / ha applied just before emergence of sprouts of ginger was more effective in controlling weeds (weed control efficiency 90%) of ginger in all the growth stages as a result it produced maximum ginger rhizome yield (27 t / ha), net return (` 872514 / -) and B:C ratio (4.20). Glyphosate, a non selective herbicide having persistence in soil for nearly 2 to 3 weeks is safe for application in ginger crop as it is applied few days prior to emergence of ginger. Some phytotoxicity on turmeric plants ore observed which recover later on. This technology is applicable for all three zones of Jharkhand.
- Imazethapyr 50 g / ha applied as pre-emergence (3 days after sowing) showed season-long control of many weeds without injuring blackgram. This recommendation is applicable for all three zones of Jharkhand.

- Integrated weed management (IWM) with intercropping of black gram and pre emergence application of pendimethalin 1.0 kg/ha + manual weeding at 30 DAS in maize and 2,4-D 0.5 kg/ha post emergence in wheat *fb* hand weeding at 40 DAS recorded higher maize and wheat as well system productivity, net return compared to recommended herbicide only. This particular technology is applicable for medium land situation under maize wheat cropping system. Non selective herbicide like paraquat or glyphosate should be sprayed for general killing of live weeds. Prior to sowing of wheat the wheat crop can be sown 3-4 days after application of paraquat or 20-25 days after application of glyphosate.
- For higher productivity, profitability and effective weed control in maize, atrazine + pendimethalin 0.50+0.50 kg/ha as pre emergence can be applied.
- Conventional tillage in rice and wheat sequences and application of butachlor 1.0 kg/ha as pre emergence + 2,4-D 0.5 kg/ha as post-emergence in rice and isoproturon 0.75 kg/ha + 2, 4-D 0.5 kg/ha post-emergence in wheat, was the most productive and remunerative approach in direct-seeded rice-wheat system.
- Application of pyrazosulfuron 20 g/ha 3 DAS *fb* bispyribac-sodium 25 g/ha 25 DAS can be practiced for better crop growth, higher productivity and profitability of direct seeded rice.

CSKHPKV, Palampur

- For higher productivity of maize-wheat system, zero tillage with or without residues followed by IWM (herbicide + mechanical weeding + intercropping) in both crops was found to be the effective treatment.
- Under organically managed maize – garlic cropping system, raised stale seed bed + mulch or intercropping was an effective mean of suppressing weeds and increasing garlic bulb equivalent yield.
- Pre-emergence application of metribuzin 0.7 kg/ha or pendimethalin 1.0 kg/ha *fb* mulch (2-5 DAP) *fb* hoeing (75 DAP) could be an effective integrated weed management strategy in turmeric.
- In transplanted rice, weeds can be effectively managed with pyrazosulfuron 30 g/ha.
- Early post-emergence application of imezethapyr 80 g/ha or pre-emergence pendimethalin + imezethapyr 900 g/ha are the effective treatments for controling weeds in peas.
- Post-emergence tank mix application of propaquizafop 50 g + imazethapyr 100 g/ha at 20 DAS is an effective alternative to hand weeding twice (20 & 40 DAS) or tank mix application of quizalofop-ethyl 60 g + chlorimuron-ethyl 4 g/ha at 15 DAS.
- New herbicide combination product (penoxsulam + butachlor) at 717.5 g/ha is an effective alternative for weed control in rice.
- Tembotrione 130 g/ha with surfactant at 14 and 21 DAS is an effective treatment in increasing yield attributes and grain and stover yield of maize.

IGKV, Raipur

- Oxadiargyl 80 g / ha *fb* post-emergence bispyribac – Na 25 g/ha in direct seeded rice
- Oxadiargyl 80 g/ha *fb* post-emergence pinoxsulam 22.5 g/ha in direct seeded rice

NDUAT, Faizabad

- In rice, anilophos at 1.65 lit/ha applied at 3-4 DAT found effective against annual grasses and BLWs. 2,4-D at 625 g/ha applied at 7-10 DAT or 20 DAS as post-emergence is effective against BLWs and sedges in rice. Bispyribac-Na applied at 0.025 kg/ha at 25-35 day after sowing or transplanting controls all type of weeds.
- Oxyfluorfen is recommended to use at 400-500 ml/ha applied at 0-3 DAS to control a wide spectrum of weeds in garlic, onion and mentha.

- Ouizalofop-ethyl at 800-1000 ml/ha applied at 15-30 DAS is being used by farmer's to control annual grasses, in pulses and oilseeds.
- Complex weed flora in wheat can be controlled very effectively by using pandimethalin (1.0 kg/ha) PE followed by metribuzin PoE (0.175 kg/ha) or pendimethalin PE (1.0 kg/ha) PE followed by sulfosulfuron PoE (0.018 kg/ha), respectively. This treatment recorded highest net return (` 54,668/ha) and B:C ratio (2.08) values.
- For control of kans, deep ploughing of field in summer or just before rainy season commended. After 35-40 days, glyphosate at 300 to 400 litres/ha is recommended to spray on fast growing kans plants (6-8 leaf stage) by using flat fan nozzle. Within 15-20 days kans plants are dried, if regrowth is seen, repeat the spray of herbicide.
- For control of Motha (*Cyperus rotundus*) leave the infested field fallow in ensuing rainy season. Glyphosate at 4.0 litres/ha along with 400-500 litres of water/ha is recommended to spray on fast growing motha plants in between mid August to mid September, Motha plants dried in the next 10-15 days. After one month period, succeeding crops can be grown.
- 2,4-D Na salt at 1.0 kg/ha along with 400 litres of water is recommended to spray on parthenium plants before the flowering. Paraqat at 4-5 litres/ha or glyphosate at 2-2.5 litres/ha along with 400-500 litres of water is recommended to spray on tenderous parthenium plants.
- For control of weeds in tobacco application of Neem cake 200 kg/ha (ppi) + soil drenching of metalaxyl (0.2%) at 20 DAP is recommended to control *Orabanchae.*
- Complex weed flora in turmeric can be control with the application of 10 t/ha paddy straw mulch.

PAU, Ludhiana

- Post-emergence application of pre-mix of metribuzin + clodinafop propargyl at 500 g/ha plus surfactant 1250 ml/ha at 30-35 days of sowing provides effective control of mixed weed flora in wheat (included in package of practices in 2017-18).
- Pre-emergence application of metribuzin at 500 g/ha within 2 days of sowing provides effective control of weeds (included in package of practices in 2017-18).
- Paraquat at 1.875 l/ha as early post-emergence (5-10% emergence of potato) provides effective control of weeds (included in package of practices in 2017-18).
- Pre-emergence application of pendimethalin at 2.5 l/ha within 2 days of sowing provides effective control of *P. minor* in wheat (included in package of practices in 2017-18).
- Post-emergence application of metsulfuron-methyl at 50 g/ha plus surfactant at 35 days after sowing for effective control of broadleaf weeds in wheat (included in package of practices in 2017-18).

PDKV, Akola

- Post emergence application of imazethapyr + imazamox 0.070 kg /ha PoE 15 DAS is the most remunerative and effective herbicide for controlling weed flora and getting higher yield and economic returns in soybean.
- In cotton pre-emergence application of pendimethalin 1.0 kg/ha followed by directed spray (by using protective shield) of non-selective herbicide paraquat 0.60/ha at 45 days after sowing is recommended for controlling weeds with higher yield and monetary returns.

PJTSAU, Hyderabad

- In maize, early post-emergence application of either topramezone (25.2 g/ha) or tembotrione (105.0 g/ha) in combination with atrazine (250.0 g/ha) can be recommended for broad-spectrum weed control and higher yield of maize.

RVSKVV, Gwalior

- Application of pinoxaden 40 g/ha (25 DAS) followed by carfentrazon 25 g/ha as post emergence (one week after pinoxaden spray) or sulfosulfuron 25 g/ha (30 DAS) 2,4-D 0.5 kg/ha + isoproturon 1.0 kg/ha as PoE may be used for controlling grassy and broad leaved weeds and gave higher yield and net return from wheat.

- Fluchloralin 1.0 kg/ha as PPI or oxadiargyl 90 g/ha or isoproturon 0.75 kg/ha as PE application controlled the majority of weeds under urid-mustard cropping system in mustard.
- Application of pendimethalin 1.0 kg/ha as pre emergence controlled almost all weeds and in turn gave the higher yield in gram.
- Application of fluchloralin 1.0 kg/ha as PPI or isoproturon 0.75 kg/ha as PE + one HW or pendimethalin 1.0 kg/ha + one HW or metribuzin 250 g/ha as EPoE performed better for controlling the weeds as well as getting higher seed yield of pea.
- For obtaining higher bulb yield of onion and net return 3 hand weedings at 30, 45 & 60 DAT (weed free) or pre emergence application of oxyfluorfen 250 g/ha + one HW at 40 DAT or oxadiargyl at 900 g/ha with one hand weeding at 45 DAT may be practiced. No residual effect observed in succeeding cucumber, maize and moong crops.
- Application of imazethapyr 100 g/ha as post emergence + 1 HW at 30 days after sowing of oxyfluorfen 120 g/ha as PoE + one hand weeding at 30 DAS or 2 hand weedings are effective for controlling the weeds in groundnut.
- Application of imazethapyr 100 g/ha PoE for controlling broad leaved weeds and quizalofop-ethyl 50 g/ha as PE for controlling grassy weeds as well as 2 hand weedings could be used in soybean.
- Application of quizalofop-ethyl 0.05 kg/ha as PE or trifluralin 0.75 kg/ha as PPI or pendimethalin 0.75 kg/ha alone or in combination with one hand weeding at 30 DAS may be used for good control of weeds and higher yield in sesame.
- Alachlor 2.0 kg/ha as PE or imazethapyr 100 g/ha as PoE or imazethapyr + imazamox (pre mix) 50 g/ha as PoE pendimethalin + imazethapyr (pre mix) 1000 g/ha PE could be applied for controlling weeds in blackgram and to obtain higher yield in black gram.

SKUAST, Jammu

- Imazethapyr + pendimethalin (RM) 1000 g/ha as pre-emergence or imazethapyr 70 g/ha as post emergence is recommended for most effective control of weeds in summer blackgram in blackgram-rice cropping system.
- Stale seed-bed technique with glyphosate 1.5 kg/ha or paraquat 0.8 kg/ha is recommended for most effective control of the weedy rice in transplanted rice.

TNAU, Coimbatore

- In transplanted rice pre-emergence application of pretilachlor at 750 g/ha *fb* POE (Chlorimuron + metsulfuron) at 4 g/ha recorded higher grain yield.
- System of rice intensification and pre-emergence application of pyrazosulfuron-ethyl 30 g /ha at 3 DAT + weeding with finger type double row rotary weeder at 40 DAT recommended for higher grain yield
- In direct seeded rice pre-emergence application of pyrazosulfron-ethyl 25 g /ha *fb* POE bispyribac sodium 20 *fb* 25 g /ha recorded higher grain yield. For higher grain yield of rice, sowing after onset of monsoon with POE application of almix 4 g /ha.
- In direct seeded rice - PE of pretilachlor (S) 0.45 kg/ha + mechanical weeding 35 to 40 DAS/ T + inter crop with daincha incorporated at 35 to 40 DAS/T) recorded higher grain and straw yields of transplanted and direct seeded rice.
- Pre-emergence application of oxyflourfen 250 g /ha followed by POE- imazethapyr 100g /ha + quizalofop-ethyl 50 g/ha on 15 DAS for broad spectrum weed control and higher seed yield and economic returns in groundnut.
- Pre-emergence application oxyflourfen at 250 g /ha on 3 DAS followed by twin wheel hoe weeder on 45 DAS for broad spectrum weed control and higher onion bulb yield and economic returns in onion.

- PE metribuzin 0.7 kg/ha followed by two hand weedings on 45 DAS and 90 DAS recommended for higher rhizome yield and economic returns in Turmeric.
- Post emergence application of glufosinate ammonium at 1000 g/ha recorded higher weed control efficiency and leaf yield in Tea
- Pre-emergence application of atrazine 1.0 kg/ha on 3 DAP + HW on 45 DAP + earthing up on 60 DAP + POE 2,4-D Na salt 5g/L + urea 20g/L on 90 DAP *fb* trash mulching at 5 t/ha on 120 DAP is effective for control of *Striga* in sugarcane
- Application of glyphosate 1.5 kg/ha + 2% jaggery was found effective in reducing density and dry weight of *Cyperus rotundus* and with no regeneration even after 60 days after herbicide application.

CAU, Pasighat

- For effective management of weeds under sweet corn-frenchbean and okra–vegetable pea cropping sequence integrated weed management approaches like growing of soybean as inter crop with maize (1:1), use of plastic mulch for French bean, okra and pea is more efficient and economically viable.

OUAT, Bhubanewar

- In groundnut, pre-emergenc application of oxyfluorfen 80 g/ ha in 500 litre of water at 1-2 days after sowing is recommended to control grassy weeds along with the problematic weed like *Celosia argentea*
- Application of quizalofop-ethyl 0.05 kg/ha in 500 litres of water at 20-25 DAS effectively controls most of the grassy weeds.

5. TRIBAL SUB-PLAN PROGRAMME

RVSKVV, Gwalior

Thirty FLDs on wheat were conducted on weed management practices under TSP programme during *Rabi* 2016-17. Demonstration of wheat was conducted each in one acre area. Wheat demonstrations were conducted in Rotla, Padalghati, Mundat (Rama block) and Kushalpura Villages (Jhabua block). Inputs like seed and herbicides were provided to these farmes. Common weeds found in the field were *Chenopodium* sp., *Anagallis arvensis, Convolvulus arvensis, Melilotus alba, Phalaris minor, Avena fatua, etc.* and generally farmers uprooted these weeds manually. Average yield in the demonstration plots of wheat (Metsulfuron methyl + clodinafop-propargyl) was 4.2 t/ha while in farmers field average yield was 2.9 t/ha. Yield of demonstration plot were higher by 43.22% as compared to farmers field. Maximum yield in the demonstration plot was 4.42 t/ha while minimum was 3.97 t/ha. Average B:C ratio generated in FLD's was 3.30 as against 2.39 in farmers practices.

Fifteen FLDs on chickpea were conducted on weed management practices under TSP programme during *Rabi* 2016-17. Demonstration of chickpea was conducted each in one acre area. Chickpea demonstrations were conducted in Neemthal (Jobat block of Alirajpur Dist) and Khermal (Ranapur block) villages. Inputs like seed and herbicides were provided to these farmers. Average yield in the demonstration plots of gram were 1.25 t/ha while in farmers field average field were 910 kg/ha. Yield of demonstration plot were higher by 38.5% as compared to farmers field. Maximum yield in the demonstration plot was 1.32 t/ha while mimimum was 1.21 t/ha. Average B:C ratio generated in FLD's was 3.22 as against 2.45 in farmers practices.

Distribution of sprayer, spiral grader, storage bin and seed treatment drum to tribal farmers at Jhabua

CSKHPKV, Palampur

Training programme on agriculture and horticultural crops were organized at tribal dominating villages Chanouta, Tiari, Kuleth, Khani, Chobia and Ghureth (Durgathi) of Bharmour Tehsil in Chamba district during 6-4-2017 to 10-4-2017 and a total 269 tribal farmers were benefitted.

AAU, Anand

In tribal area, programme on weed management were conducted in which folders, leaflets and booklets of weed management technologies were distributed. On farm trials (OFT) were also conducted in Dahod district. Special lectures were delivered by the scientists of the project in farmer's day and meetings organize by TFWTC, Devgadh Baria.

OUAT, Bhubaneswar

The programme has been operated in two tribal dominated villages of Sundargarh and Keonjhar districts for the overall development of their livelihood by supplying different farm machineries implements and agricultural inputs. About 225 farmers were directly benefitted under this programme.

IGKV, Raipur

Under TSP programme, front line demonstrations were laid down in tribal village Bhaisakatta in district Kanker. Ten demonstrations were conducted on weed management in line sown rice by chemical weed control with rice cultivar IGKVV-R1. Aaverage yield of farmers practice and recommended practice was 4.38 and 4.86 t/ha, respectively. However, percent increase under recommended practice over farmers practice was 20.7%. The average benefit cost ratio was calculated to be 2.15 and 2.37 under farmers practice and recommended practice, respectively.

6. LINKAGES AND COLLABORATION

All India Coordinated Research Project on Weed Management has effective collaboration with state agriculture universities, ICAR institutes such as IIPR, Kanpur, IISS, Bhopal, IVRI, Izatnagar, IIFSR, Modipuram, and other AICRP's such as AICRP-IFS and Network Project on Organic farming (NIOF), IIFSR, Modipuram. Following collaborative research work was carried out during the year.

PAU, Ludhiana

Development of organic farming package for system based high value crops in maize-potato-onion cropping system was done. Different organic farming treatments recorded diverse weed flora included grasses, sedges and broadleaf weeds in all the three crops. In onion crop, six broadleaf weeds like *Oenothera laciniata, Coronopus didymus, Spergula arvensis, Veronica agrestis, Anagallis arvensis, Polygonum plebium*; one grass weed- *Poa annua* and perennial sedge – *Cyperus rotundus* were observed.

CSKHPKV, Palampur

Appraisal of weeds floristic diversity in rice based diversified cropping systems being tested in collaboration with AICRP-IFS Palampur Centre. Eight cropping systems, viz.C1: rice – wheat, C2: rice – pea – summer squash, C3: okra – radish – onion, C4: turmeric – pea – summer squash, C5: rice – lettuce – potato, C6: rice – palak – cucumber, C7: rice –broccoli – radish, and C8: colocasia – pea + coriander are being evaluated for their production potential from *Kharif* 2014. An appraisal of weed species associated with different cropping systems has been made month-wise during 2016-17. The appraisal has been presented species-wise of one of the stages investigated. *Monochoria*, typically a weed of lowland situations was found growing in rice only. It was absent in okra (C3), turmeric (C4) and colocasia (C8). Therefore, the population of *Monochoria* vaginalis was significantly affected due to cropping systems. Conversely, *Ageratum* is a weed of upland situations. Its population was significantly higher under C3, C4 and C8 cropping systems where upland crops viz. okra, turmeric and colocasia, respectively occupied the land. It invaded rice when the field dried out at a later part of the season. There was significant build up of *Cynodon dactylon* in turmeric (C4) followed by okra (C3) during mid when its suckers invades fields from bunds.

Another experiment influence of long-term application of fertilizers on weed floristic diversity in maize – wheat cropping system, an appraisal of weed flora associated in maize-wheat cropping system after the harvest of wheat during 2017 was done. In the experimental plot twelve weed species were found growing after the harvest of wheat (May end). *Digitaria* was the most dominating weed constituting 65% of the total weed flora. This was followed by *Polygonium plebegium* (9%), *Plantago lanceolata* (7%), wild dhania, *Scandix pecten* veneris L. (5%) and *Gallinsoga parviflora* (4.6%).

Long-term repetitive application of same nutrients year after year brings about conditions conducive for the growth of specific weed flora. Fertility treatments brought about significant variation in the count of *Digitaria sanguinalis*, *Plantago lanceolata* and *Gallinsoga parviflora* and thereby grasses and broad-leaved weeds together. Population of *Digitaria sanguinalis* was significantly low in T1 (50% NPK), T8 (100% NPK + FYM), T10 (100% NPK + lime) and T12 (Natural farming) treatments. Trend in the count of grassy weeds was similar to the count of *Digitaria sanguinalis*. Population of *Plantago lanceolata* was significantly higher in natural farming treatment being comparable to T1, T2, T3, T7 and T9 being at par with T4-T6 had significantly lower population of *Plantago lanceolata* over the other fertility treatments. Population of *Gallinsoga parviflora* was significantly lower in T7 (100% N) being at par with T2-T3, T5-T6 and T11-T12. Its population was significantly higher in T8 where FYM was applied. However, T1, T4 and T10 were comparable to T8 in influencing the population of *Gallinsoga parviflora*. T7 remainied at par with T2 and T9 had significantly lower population of broad-leaved weeds as compared to other treatments. T12 being at par with T1, T6, T8, T10 and T11 had significantly higher population of broad-leaved weeds (Table 6.1).

Table 6.1 Effect of fertility treatments on count of weeds after the harvest of wheat (May 2017)

Treatment	*Digitaria*	*Plantago*	*Gallinsoga*	Grassy weeds	BL weeds
T1-50% NPK	5.5(37)	5.8(35)	3.8(16)	5.5(37)	9.5(93)
T2-100% NPK	11.6(143)	0.7(0)	2.0(8)	11.8(148)	4.7(34)
T3-150% NPK	13.3(193)	0.7(0)	1.1(1)	13.3(193)	6.9(64)
T4-100% NPK + HW	10.7(128)	1.5(4)	3.3(12)	10.7(128)	6.8(54)
T5-100% NPK +Zn	10.1(104)	1.5(4)	1.8(4)	10.1(104)	6.4(56)
T6-100% NP	14.0(206)	2.1(10)	1.6(3)	14.0(206)	8.2(68)
T7-100% N	15.5(256)	0.7(0)	0.7(0)	16.0(273)	2.3(9)
T8-100% NPK + FYM	6.8(47)	3.6(14)	4.5(23)	7.1(54)	9.1(86)
T9-100% NPK (-S)	13.2(185)	0.7(0)	2.7(12)	13.4(190)	4.5(30)
T10- 100% NPK + lime	6.5(44)	3.9(16)	3.7(18)	6.5(44)	9.1(84)
T11- Control	12.0(154)	4.8(28)	1.8(4)	12.0(154)	9.0(92)
T12- Natural farming	6.2(49)	7.1(54)	2.2(8)	6.2(49)	11.5(138)
LSD (P=0.05)	4.5	2.4	2.0	4.6	4.1

Irrespective of the treatment *Digitaria sanguinalis* ranked first in importance followed by *Polygonum plebigium*, *Plantago lanceolata*, *Gallinsoga parvoflora*, wild dhania, *Artimissia*, *Cynodon dactylon*, *Polygonum hydropiper* and white clover. It is observed that fertility treatments could significantly influence weed flora shifts owing to conditions altered by them particularly of the soil environment. However, there need to be a comprehensive appraisal of the associated weed flora during the cropping seasons as well to devise means for their control. To minimize fertility depletions there is need of off-season weed management and the management tactics may be differing depending upon the weed flora associated with them.

TNAU, Copimbatore

An investigation was carried out to study the weed dynamics in the on station Integrated Farming System (IFS) Research in Irrigated Upland, Coimbatore centre. The cropping system followed in IFS in Irrigated Upland is given below.

Cropping system	Area (in ha)
1. Cowpea (veg.) - Cotton - Sunflower	0.25
2. Bhendi - Maize + Cowpea (F) – Sunflower	0.20
3. GM - Chillies -Maize	0.20
4. Maize -Cowpea(grain) – Tomato / Radish	0.20
5. Perennial fodder grass + Desmanthus (3:1)	0.17
Total area	1.02

The weed observations were made four times in a year from the cropping system. (January, April, July and October). The following are details of crops grown from June, 2016 – December, 2017.

Cropping System I (Cowpea (veg.)-cotton- sunflower)

For weed management, pendimethalin 1.0 kg / ha was applied. Hand weeding was carried out on 35 DAS. Major weed species were *Dactyloctenium aegyptium, Dinebera reteroflxa, Echinochloa colona, Chloris barbata* under grasses and *Cyperus rotundus* under sedge and *Trianthema portulacastrum, Digera arvensis, Portulaca quadrifida, Euphorbia prostrate, Parthenium hysterophorus* under broad leaved weed (BLW). In general, broad leaved weeds dominated in cowpea (veg.) - cotton - sunflower cropping systems in all time of observations. The relative density of BLW was 62.9, 60.8, 64.7 and 59.6% at January, April, July and October months of observations. Among the BLW, higher relative density was observed with *Trianthema portulacastrum* (41.1%) and was followed by *Digeria arvensis* (15.1%) at January and the same trend was observed in all time of observations. Among the grassy weeds, *Dactyloctenium aegyptium* recorded higher relative density. At all the stages of observation weed dry weight was higher in BLW and was followed by grasses.

Cropping System II (Okra - maize + cowpea (F) – sunflower)

Okra-maize + cowpea (F)–sunflower cropping system was raised with application of PE atrazine 0.5 kg/ha for maize and pendimethalin 1.0 kg/ha for sunflower along with hand weeding on 45 DAS for both the crops. Hand weeding was practiced to manage the weeds in okra. Predominant weeds observed in the okra field were *Dinebra retroflexa, Dactyloctenium aegyptium, Chloris barbata* under grasses, *Cyperus rotundus* was the only sedge observed and *Amaranthus polygamus, Trianthema portulacastrum, Digera arvensis, Euphorbia prostrata, Parthenium hysterophorus, Corchorus olitorius* under BLW. Broad leaved weeds dominated with higher relative density of 54.0% with higher dry weight (44.6 g/ha) during January, followed by grassy weeds (relative density 39.5% and dry weight 7.4 g/ha). Among the broad leaved weeds, *Amaranthus polygamus* was dominant BLW and was followed by *Trianthema portulacastrum* at during all the observations.

Cropping system III (Daincha - chillies –maize)

Chillies, daincha - chillies –maize cropping system was raised with application of PE atrazine 0.5 kg/ha for maize and without herbicide application for daincha and chillies. Major weed species were *Dactyloctenium aegyptium, Echinochloa colona, Chloris barbata* under grasses, *Cyperus rotundus* under sedge and *Trianthema protulacastrum, Digera arvensis, Amaranthus viridis, Portulaca quadrifida, Parthenium hysterophorus* under BLW. In daincha - chillies –maize cropping system, *Trianthima protulacastrum* was the dominating BLW at all the stages of observation and was followed by *Amaranthus viridis* another BLW. Among grass weeds, *Dinebra retroflexa* was the dominating weed. The weight of BLW was higher than grasses and sedge.

Cropping system IV (Maize – cowpea (grain) – tomato/radish

Maize crop was applied with atrazine 0.25 kg/ha as pre emergence. Predominant weeds that obseved in the fields were *Dinebra retroflexa, Dactyloctenium aegyptium* under grasses, C*yperus rotundus* under sedge and *Trianthema protulacastrum, Amaranthus viridis, Portulaca quadrifida, Parthenium hysterophorus, Corchorus olitorius* under BLW. *Amaranthus viridis* (relative density of 32.1, 32.3, 33.3 and 34.21%) was the dominant BLW irrespective of the time of observation. *Trianthema portulacastrum* was the next dominant BLW in the maize field. Among the group of weeds, BLW followed by grasses was in order for having higher relative density. Broad leaved weeds recorded higher weed dry weight than grasses and sedge at all the stages of observation.

7. PUBLICATIONS

AAU, Anand

Chaudhari, D.D., Patel, H.K., Mishra, A., Patel, V.J., Patel, B.D. and Patel, R.B. and Motka, G.N. 2017. Integrated weed management in cotton (*Gossypium hirsutum* L.) under irrigated condition of middle Gujarat. *Indian Journal of Weed Science* 49(2): 156–158.

Kadu, S.P., Patel, B.D., Patel, R.B., Desai, C.K. and Chaudhary, D.D. 2017. Weed management practices effect on weed flora and weed control efficiency in onion (*Allium cepa* L.) field. *Journal of Pharmacognosy and Phytochemistry* 6(4): 1218-1220.

Patel, B.D., Chaudhari, D.D., Patel, V.J., Patel, H.K., Mishra, A. and Parmar, D.J. 2017. Influence of broad spectrum herbicides on yield and complex weed flora of wheat (*Triticum aestivum* L.). *Research on Crop* 18(3) : 433-437.

Chaudhari, D.D., Patel, V.J., Patel, H.K., Mishra, A., Patel, B.D. and Patel, R.B. 2017. Assessment of pre-mix broad spectrum herbicides for weed management in wheat. *Indian Journal of Weed Science* 49(1): 33–35.

Chaudhari, D.D., Patel, V.J., Patel, H.K., Mishra, A., Patel, B.D. and Parmar, D.J. 2017. Integrated control of complex weed flora in garlic. *Research on Crop* 18(4): 668-674.

Gaikwad, V.P., Patel, J.J. and Patel, B.D. 2017. Effect of row ratios, phosphorus levels and weed management practices on weed population, growth and yield attributes of mustard - chickpea intercropping system. *Green Farming* 8(3): 559-565.

Patel, A.S., Shelat, H.N. and Patel, H.K. 2017. *cry* Gene profile of native entomopathogenic *Bacillus thuringiensis* from soil. *International Journal of Current Microbiology and Applied Sciences* 6(7): 2320-2326.

AAU, Jorhat

Barua, C. C., Patowary, P., Bordoloi, M. J., Dutta, P. P., Dutta, D.J., Purkayastha, A., and Barua, I.C. 2016. Attenuating effect of *Elsholtzia Communis* (Collett & Hemsl.) Diels on dysregulated HPA axis in stressful conditions. *International Journal of Pharmacognosy and Phytochemical Research* 8(4): 651-658.

Bordol, M., Bordoloi, P.K., Dutta, P.P., Singh, V., Nath, S., Narzary, B., Bhuyan, P.D., Rao, P.G. and Barua, I.C. 2016. Studies on some edible herbs: Antioxidant activity, phenolic content and antifungal properties. *Journal of Functional Food* 23: 220-229.

Barua, I. C., Sarmah, R. and Barua, K. N. 2016. “koth”- the Assam artisan mat from marsh-weeds: an ethnobotanical approach. *Research Inspiration* 1(3): 437-448.

Sarmah, R., Barua, I.C. and Deb, P. 2016. Occurrence of fringe-rush in *Kharif* rice in Assam. *Indian Journal of Weed Science* 48(4): 435–439.

Barua, I.C., Deka, J., Devi, M., Deka, R.L. and Moran, J. 2017. Weeds as emerging threat to biodiversity: a consequence of spread of *Ludwigia peruviana* in Dhansiri and Kopili catchment areas of Assam, North East India. *Current Science* 112(9): 1904-1914.

Deka, J., Kakati, P. and Barua, I.C. 2016. Weed dynamics in direct seeded autumn rice-transplanted winter rice sequence. *International J. Science, Environment and Technology* 5(6): 4179-4185.

Gogoi, B. and Deka, J. 2017. Effect of Integrated weed management on chilli (*Capsicum annum* L.) under rice fallow situation. *Indian Journal of Agronomy* 62(3): 348-353.

BAU, Ranchi

Bharty, S., Upasani, R.R., Barla, S., Agarwal, B.K. and Kumar, R. 2017. Effect of IWM on weed dynamics, dry matter accumulation, yield and economics of turmeric. *Indian Journal of Weed Science* 49(3): 300–302.

Barla, S., Upasani, R.R. and Puran, A.N. 2017. Herbicide combinations for control of complex weed flora in wheat. *Indian Journal of Weed Science* 49(1): 36–40.

Barla, S., Upasani, R.R., Puran, A.N. and Singh, S.K. 2016. Weed management in turmeric. *The Ecoscan* Special issue, IX: 1001-1007.

Upasani, R. R., Barla, S. and Puran, A.N., 2016. Productivity and profitability of maize (*Zea mays*) wheat (*Triticum aestivum*) cropping system under different tillage and weed control methods. *The Ecoscan* Special issue IX: 993-999.

Dewangan, P.K., Yadava, M.S., Upasani, R.R., Barla, S. and Chandra, P.S. 2016. Impact of weed management in maize (*Zea mays* L.). *The Ecoscan* Special issue IX: 971-976.

Bharty, S., Upasani, R.R. and Kumar, P. 2016. Effect of integrated weed management on growth attributes of turmeric (*Curcuma longa* L.). *The Ecoscan- An International Quarterly Journal of Environmental Science* 9 : 703-706.

Barla, S., Upasani, R.R., Puran, A.N. and Thakur, R. 2016. Weed management in maize. *Indian Journal of Weed Science* 48(1): 67-69.

Upasani, R.R., Barla, S., Puran, A.N., Thakur, R. and Singh, M.K. 2016. Effect of tillage and weed control methods on productivity and profitability of maize. *Indian Journal of Ecology* 43 : 98-102.

Bharty, S., Barla, S., Upasani, R.R. and Faruque, R. 2016. Integrated weed management in turmeric (*Curcuma longa* L.). *Indian Journal of Ecology* 43 522-525.

Barla, S., Upasani, R.R., Pandey, A.C. and Shambhu, S.K. 2016. Weed management through green manuring in direct seeded rice (*Oryza sativa*) under medium land condition at East Singhbhum District of Jharkhand, India. *Ecology, Environment and Conservation* 22(4): 227-230.

CCSHAU, Hisar

Punia, S.S., Yadav, D.B., Kaur, M. and Sindhu, V.K.2017. Post emergence herbicides for the control of resistant little seed canary grass in wheat. *Indian Journal of Weed Science* 49(1): 15-19.

Punia, S.S., Duhan, A., Yadav, D.B. and Sindhu,V.K. 2016. Use of herbicides against *Orobanch*e in tomato and their residual effect on succeeding crop. *Indian Journal of Weed Science* 48(4): 404-409.

Punia, R., Punia, S.S., Sangwan, M. and Thakral, S.K. 2017. Efficacy of imazethapyr applied alone and its mixture with other herbicides in green gram and their residual effect on mustard. *Indian Journal of Weed Science* 49(2): 151–155

Kaur, P., Randhawa, S.K., Duhan, A. and Bhullar, M.S. 2017. Influence of long term application of butachlor on its dissipation and harvest residues in soil and rice. *Bulletin of Environmental Contamination and Toxicology* 98: 874-880.

CSKHPKV, Palampur

Rana, S.S., Badiyala, D., Sharma, N., Kumar, R., Thakur, R., Kumar, S. and Pathania, P. 2016. Herbicide combinations for weed management under direct-seeded rice in Himachal Pradesh. *Indian Journal of Weed Science* 48(3): 266–271.

Kumar, R., Badiyala, D., Sharma, N., Rana, S.S. and Pathania, P. 2016. Microbiological properties of soil influenced by weed control methods in maize – pea cropping system under mid hill conditions of Himachal Pradesh. *Himachal Journal of Agricultural Research* 42(1): 1-5.

Sharma, R., Rana, M.C., Rana, S.S. and Sharma, G.D. 2016. Effect of herbicide combinations on nutrients depletion by weeds in wheat. *Himachal Journal of Agricultural Research* 42(1): 78-81.

Rana, M.C., Chand, S., Rana, S.S. and Sankhyan, N. 2016. Effect of time and method of post-emergence application of atrazine on nutrients depletion by weeds in maize. *Himachal Journal of Agricultural Research* 42 (1): 82-86.

Rana, S.S., Kumar, S., Sharma, N. and Angiras, N.N. 2017. Herbicidal management of *Parthenium hysterophorus* L. in grassland ecosystem of himachal pradesh. *Contemporary research in India* 7(1): 30-35.

Rana, S.S., Badiyala, D., Sharma, N., Kumar, R., and Pathania, P. 2017. Impact of *Tembotrione* on weed growth, yield and economics of maize (*Zea mays* L.) under mid hill conditions of

Himachal Pradesh. *Pesticide Research Journal* 29 (1): 27-34.

Kumar, A., Rana, M.C., Sharma, N. and Rana, S.S. 2017. Effect of post-emergence herbicide - tembotrione on yield, soil dehydrogenase activity and its phytotoxicity on maize (*Zea mays* L.) under mid hill conditions of Himachal Pradesh. *International Journal of current Microbial and Applied Science* 6(8): 2297-2303.

Rana, S.S., Sharma, N., Badiyala, D. and Kumar, R. 2017. Weed management in turmeric. *Indian Journal of Weed Science* 49(1): 51-57.

Sharma, N. and Bandana. 2017. Variation of shikimic acid and amino acids in tea leaves as influenced by glyphosate application. *Asian Journal of Chemistry* 29(6): 1189-1193.

Kumar, A., Rana, S.S. and Kumar, S. 2017. Management of diverse weed flora in maize under Kangra valley conditions of Himachal Pradesh. *Indian Journal of Weed Science* 49(3): 236-240.

GBPUAT, Pantnagar

Pratap, T., Singh, V.P., Singh, S.P and Rekha 2016. Herbicides combination for control of complex weed flora in transplanted rice (*Oryza sativa* L.). *Research on Crops* 17(4): 657-661.

Shalini, S., Singh, V. P. and Brijbhooshan, J. 2017. Yield and economics in direct seeded rice using organic manures and micronutrients. *International Journal of Chemical Studies* 5(3): 105-109.

Paliwal, A., Singh, V. P., Guru, S.K., Pratap, T., Singh, S.P., Chandra, S. and Kumar, R. 2017. Soil physical properties as influenced by different conservation agriculture practices in rice-wheat system. *International Journal of Chemical Studies* 5(4): 757-761.

Chilwal, A., Singh, S.P., Singh, V.P., Mahapatra, B.S. and Shukla, D.K. 2017. Determination of allelopathic effect of winter weeds on nutrient content and uptake in wheat. *Journal of Pharmacognosy and Phytochemistry* 6(6): 1121-1125.

Chilwal, A., Singh, S.P., Singh, V.P., Mahapatra B.S., Shukla D.K. and Shirazzudin. 2017. Potential allelopathic interference of aqueous extracts of winter weeds on yield and yield attributing characters of wheat (*Triticum aestivum* L.). *Journal of Pharmacognosy and Phytochemistry* 6(6): 1117-1120.

Verma, H., Singh, S.P., Singh, V.P., Mahapatra B.S., Sirazuddin, J.N., Chilwal, A. 2017. Weed dynamics of aerobic rice (*Oryza sativa L.*) under chemical and non-chemical weed management practices in irrigated system. *International Journal of Current Microbial and Applied Science* 6(12): 3159-3165.

Verma, H., Singh, S.P., Singh, V.P., Mahapatra, B.S., Sirazuddin, J. N. and Chilwal, A. 2017. Nutrient uptake and soil health under chemical and non-chemical weed management practices in irrigated rice ecosystem. *International Journal of Current Microbial and Applied Science* 6(12): 3152-3158.

Singh, A., Tandon, S. and Sand N.K. 2017 . Dissipation kinetics study of clopyralid herbicide in water. *Asian Journal of Chemistry* 29(2): 271-273

Tandon, S. 2016. Dissipation of pendimethalin in soybean crop under field conditions. *Bulletin of Environmental Contamination and Toxicology* 96(5): 694-698.

Pratap, T., Singh, V.P., Singh, S.P. and Rekha. 2016. Effect of herbicides and their combinations on weed growth and yield of transplanted rice. *Indian Journal of Weed Science* 49(4): 356-359.

Pratap, T., Singh, V.P. and Rekha. 2017. Chemical control of weeds in dry seeded rice. *Indian Journal of Weed Science* 49(1): 98-99.

Pratap, T., Rekha and Singh, M. 2017. Effect of propanil on control of complex weed flora in direct seeded rice. *Journal of Hill Agriculture* 8(2): 191-194.

Pratap, T., Singh, V.P. and Rekha. 2016. Efficacy of herbicidal to control weeds in direct dry seeded rice. *Indian Journal of Weed Science* 48(3): 1-5.

Kumar, N., Guru, S.K. 2016. Herbicide resistance mechanism of *Phalaris minor* in Uttarakhand. *Journal of Crop and Weed* 12 (2): 129-133.

Bhandari, K. and Guru, S.K. 2017. Inhibitory effects of rice straw on the germination and seedling growth of some major weeds of wheat. *Indian Journal of Weed Science* 49(2): 194–197.

IGKV, Raipur

Ahmad, A., Chowdhury, T., Taunk, S K., Dewangan, D. and Singh, A.P. 2017. Pre and post-emergence application of imazthapyr on uptake, nodulation and microbial population of chickpea sown after rice in vertisols of C.G. *International Journal of Current Microbial and Applied Science* 6(6): 2844-2857

Bajaj, S. and Bhambri, M.C. 2017. Response of tillage and weed management practices on yield attributes and yield of rice under rice (*Oryza sative* L.) - maize (*Zea mays* L.) cropping system. *Research Journal of Agriculture Sciences* 8(5): 1162-1166.

Dipika, Chowdhury, T., Bhambri, M.C., Gupta, S.B., Soni, R. and Kevat, T.K. 2017. Changes in microbiological characteristics of rice soil by post-emergence herbicides. *Indian Journal of Weed Science* 49(2): 132–135.

Janghel, G. K., Chowdhury, T., Bhambri, M.C., Gupta, S.B., Tiwari, N. and Soni, R. 2017.Changes in soil physiological and chemical properties due to adoption of organic farming practice in scented rice. *Journal of Pharmacognosy and Phytochemistry* 6(6): 437-441

Pandey, P. and Bhambri, M.C. 2017. Effect of crop arrangement and nutrient management on growth response of soybean under maize (*Zea mays* L.)+ soybean (*Glycine max* L.) intercropping system. *Progressive Research* 12 :1142-1145.

Pandey, P. and Bhambri, M.C. 2017. Growth response of maize to different crop arrangement and nutrient managements under Maize (*Zea mays* L.) and soybean (*Glycine max* L.) inter cropping system. *Plant Archives* 17(2): 967-972.

Pandey, P., Bhambri, M.C. and Kolhe, S.S. 2017. Effect of nutrient and crop management on yield of component crops under maize + soybean intercropping system. *Green Farming* 8(1): 109-114.

Porte, D., Gupta, S.B., Singh, A.K., Chowdhury, T., Dash, D. and Soni, R. 2017. Evaluation of non symbiotic nitrogen fixing bacterial influence on *Rhizobium* nodulation behavior in bacterial consortia. *International Journal of Chemical Studies* 5(4): 1598-1602.

Rathore, A.K., Sharma, A.R., Sarathambal, C., Bhambri, M.C. and Shrivastava, G.K. 2016. Nitrogen and weed management effect on soil microbial properties in rice-based cropping system under conservation agriculture. *Indian Journal of Weed Science* 48(4) : 360-363.

Sahu, Y.K., Chaubey, A.K., Kumar, P., Kulhary, L.K. and Chowdhury, T. 2017. Effect of integrated nutrient management on soil biological properties and yield of rice in inceptisol. *Indian Journal of Ecology* 44(4): 804-807.

Uma, Chowdhury, T., Soni, R. and Sharma, G.L. 2017. Effective eco-friendly micro-flora for early degradation of herbicide and enhancing chickpea productivity. *Indian Journal of Ecology* 44(1): 7-11.

KAU, Thrissur

Aparna, K.K, Menon, M.V. and Prameela, P. 2017. Efficacy of pre and post-emergence herbicides on *Echinochloa* spp. *Journal of Tropical Agriculture* 55(1): 91-95.

Shamla, K., Sindhu, P.V. and Menon, M.V. 2017. Effect of weed management practices on growth and yield of okra [*Abelmoschus esculentus* (L.)] Moench. *Journal of Tropical Agriculture* 55(1): 57-62.

Durgadevi, K. M. and Amritha, K. 2017. Effect of pre and post emergence herbicides on microbial biomass carbon and dehydrogenase activity in soils. *Journal of Tropical Agriculture* 55(1): 114-118.

Durgadevi, K.M, Abraham, C.T. and Shitha, C.R. 2017. Impact of glyphosate and chlorpyriphos on chemical and biological properties of a lateritic soil. *Journal of Pesticide Research* 29(1): 68-74.

Jacob, G., Menon, M.V. and Abraham, C.T. 2017. Herbicidal management of Chinese sprangletop (*Leptochloa chinensis*) in direct seeded rice. *Indian Journal of Weed Science* 49(2): 176-178.

Atheena, A, Prameela, P. and Menon, M.V. 2017. Tank mix application of cyhalofop-butyl with selected herbicides for weed control in wet-seeded rice. *Indian Journal of Weed Science* 49(3): 283-286.

MPUAT, Udaipur

Choudhary, R., Sharma, S.K. and Choudhary, R.S. 2017. Effect of bio-herbal growth promoter on growth and yield of wheat grown under organic management. *Chemical Sciences Review and Letters* 6(22): 1022-1026.

Yadav, R.K., Verma, A., Nepalia, V., Sumariya, H.K. and Yadav, S. L. 2017. Impact of integrated nutrient management on mean single leaf area, SPAD chlorophyll readings, dry matter partitioning and yields of maize (*Zea mays* L.). *Environment and Ecology* 35(2) : 1395—1399.

Yadav, R.K., Verma, A., Yadav, S.L. and Sumariya, H. K. 2017. Drymatter partitioning at harvest and yield of maize (*Zea mays L.*) as influenced by integration of various nutrients. *International Journal of Current Microbiology and Applied Sciences* 6(6) : 2942 – 2945.

Yadav, T.K., Choudhary, R.S., Choudhary, R. and Kishor, K. 2017. Studies of weed management practices on weed dynamics and yield of maize. *International Journal of Chemical Studies* 5(4): 1957-1960.

Sharma, S.K., Choudhary, R., Trivedi, A., Choudhary, R.S. and Yadav, S.K. 2017. Response of organic nutrient management practices on soil properties and productivity of chickpea (*Cicer arietinum* L.) *International Journal of Bio-resource and Stress Management* 8(2): 196-200.

Meena, Sukh Ram, Sharma, S.K., Upadhayay, B. and Verma, A. 2017. Effect of long term application of fertilizer and manure on passive pool of organic carbon under maize-wheat sequences in Heplusteps. *Journal of Phamcognosy and Phytochemistry* 6(3): 498-501.

NDAUT, Faizabad

Kumar, R., Singh, R.S., Jaidev and Verma, B.K. 2016. Effect of tillage and weed control measures on microbial health of rhizospheric soil of wheat under rice-wheat cropping system. *Indian Journal of Weed Science* 48 (2): 220-221.

Kumar, R., Singh R.S., Jaidev and Kumar, M. 2017. Effect of herbicides on weeds grian yield and soil health in wheat. *Indian Journal of Weed Science* 49(1): 88-89.

Kumar, R., Singh, R.S., Kumar, M. and Deepak, P. 2017. Integrated weed management in garlic. *Indian Journal of weed Science* 49 (2): 266-268.

Singh, R.S., Kumar, R., Kumar, M. and Singh, R.P. 2017. Weed management in black gram. *Bulletin of environment pharmacology and life sciences v* 6(2):199-200.

Singh, R.P., Patel, V., Singh, A.K., Misra, A.N., Kumar, R. and Singh, R.S. 2017. Effect of INM on growth and yield of wheat under late sown condition. *Bulletin of Environment Pharmacology and Life Sciences* 6(2): 142-145.

Singh, R.P., Kumar, M., Singh, R.S. Singh, K.R. and Misra A.N., 2017. Effect of sequential application of herbicides on weed flora and grain yield in direct seeded rice. *Bulletin of Environment Pharmacology and Life Sciences* 6(2): 169-171.

PAU, Ludhiana

Kaur, N. and Bhullar, M.S. 2017. Regeneration potential of herbicide-treated purple nutsedge (*Cyperus rotundus* L.). *Agriculture Research Journal* 54 (2): 265-266.

Kaur, H., Kaur, N. and Sethi, R. 2017. Allelopathic potential of rice varieties against major weeds of rice and wheat. *Indian Journal of Weed Science* 49(2): 179-181.

Kaur, P., Randhawa, S.K., Duhan, A. and Bhullar, M. S. 2017. Influence of long term application of butachlor on its dissipation and harvest residues in soil and rice. *Bulletin of Environmental Contamination and Toxicology* 98(6): 874-80.

Kaur, S., Kaur, T. and Bhullar, M.S. 2017. Control of mixed weed flora in wheat with sequential application of pre- and post-emergence herbicides. *Indian Journal of Weed Science* 49(1): 29-32.

Kaur, T., Kaur, S. and Bhullar, M.S. 2017. Effectiveness of new herbicides in management of broadleaf weeds and sedges in transplanted rice. *Agricultural Research Journal* 54 (3): 329-334.

Singh, M., Bhullar, M.S. and Chauhan, B.S. 2017. Relative time of weed and crop emergence is crucial for managing weed seed production: A study under an aerobic rice system. *Crop Protection* 99: 33-38.

Patidar, J. and Kaur, S. 2016. Control of sedges and broadleaf weeds in dry seeded rice with post-emergence herbicides. *Agricultural Research Journal* 54(3): 418-419.

Rasool, R., Bhullar, M.S. and Gill, G. 2016. Growth stage of *Phalaris minor* Retz. and wheat determine weed control and crop tolerance of four post-emergence herbicides. *Spanish Journal Agriculture Research* 15(1): e1001(1-8).

Veena and Kaur, P. 2017. Spectrofluorometric determination of glyphosate in water. *Asian Journal of Chemistry* 29(4): 792-96.

Yadav, R., Bhullar, M.S., Kaur, S., Kaur, T. and Jhala, A.J. 2017. Weed control in conventional soybean with pendimethalin followed by imazethapyr+imazamox / quizalofop-*p*-ethyl. *Canadian Journal of Plant Science* 97: 654-664.

Yadav, V., Kaur, P. and Kaur, P. 2017. Effect of light conditions and chemical characteristics of water on dissipation of glyphosate in aqueous medium.*Environmental Monitoring and Assessment* 189(12): 613.

Kaur, P., Paawan, K., Kaur, T. and Bhullar, M.S. Persistence and dissipation kinetics of penoxsulam in soil of rice ecosystem. *Pesticide Research Journal* 29(2): 204-210.

PJTSAU, Hyderabad

Ramprakash, T. and Madhavi, M. 2017. Leaching behavior of metribuzin and pretilachlor. *International Journal of Chemical Studies* 5(6): 1584-1587.

Ramprakash, T. and Madhavi, M. 2017. Leaching behavior of oxyfluorfen and oxdiargyl in red and black soils. *Chemical Science Review and Letters* 6(21): 88-92.

Kumar, R.A, Madhavi, M., Pratibha, G. and Ramprakash, T. 2017. Effect of different crop establishment methods and weed management options on growth and control of weeds in rice. *International Journal of Chemical Studies* 5(5): 998-1002.

Anusha, S., Madhavi, M., Pratibha, G. and Ramprakash, T. 2017. Influence of pre-palnt and postemergence herbicides on weed control, yield and economics of transplanted rice. *The Journal of Research PJTSAU* 45(3): 38-40.

Saritha, J.D., Ram Prakash, T., Rao, P.C. and Madhavi, M. 2017. Sorption Behaviour of metribuzin In tomato growing soils. *Chemical Science Review and Letters* 6(21): 143-148.

Saritha, J.D., Ramprakash T., Madhavi, M. and Rao, P.C. 2017. Sorption of metribuzin in tomato growing soils. *International Journal of Chemical Studies* 5(5): 740-746.

Saritha, J. D., Ramprakash, T., Rao, P. C. and Madhavi, M. 2017. Persistence of Metribuzin in tomato growing soils and tomato fruits. *Nature Environment and Pollution Technology* 16: 2505-2508.

Saritha, J.D., Ramprakash T., Madhavi, M. and Rao, P.C. 2017. Leaching potential of metribuzin in agricultural soils. *International Journal of Chemical Studies* 5(5): 1459-1462.

Laxman, T., Ramprakash, T., Kumar, A.K. and Sinivas. A 2017. Bt cotton soils enzyme activity as influenced by fertility levels and foliar nutrition. *Multilogic in Science* 24: 17-18.

Srinivas, R.S., Suneetha, Devi K.B. and Madhavi, M. 2017. Growth and yield of aerobic rice (*Oryza sativa* L) as influenced by irrigation and weed management approaches. *Green Farming* 8(5): 1152-1156

Srinivasa, R.S., Suneetha Devi K.B., Madhavi, M., Ramprakash, T. and Ramesh, T. 2017. Yield and nutrients uptake of aerobic rice (*Oryza Sativa* L.) as influenced by irrigation and integrated weed management. *Journal of Rice Research* 9(2): 32-38.

Nalini, N., Srinivas, A., Ramprakash, T. and Praveen, R. V. 2017. Weed dynamics, growth, yield and economics of ajwain (*Trachyspermum ammi*) influenced of integrated weed management. *Agriculture Update* 12 (5) :1375-138.

Bharat, B.R., Hussain, C.H., Srinivas, A., and Ramprakash, T. 2017. Influence of integrated weed management practices and biofertilizers on nutrient uptake by weed flora and soybean [*Glycine max* (L.) Merill]. *Bulletin of Environment, Pharmacology and Life Sciences* 6(1): 13-16.

Nalini, N., Srinivas, A., Ramprakash, T. and Praveen Rao, V. 2017. Weed dynamics, yield and economic feasibility of integrated weed management practices on ajwain (*Trachyspermum* a*mmi*). *International Journal of applied and Pure Science and Agriculture* 3(7): 24-29.

RVSKVV, Gwalior

Arora, A. 2017. Leaching behavior of oxyfluorfen in FYM amended and un-amended sandy clay loam soil. *Indian Journal of Weed Science* 49(1): 100–101.

Gupta, S., Tomar, S.S., Rawat, G.S., Kushwah, S.S., Singh, V.B., Arora, A. and Singh, S.P. 2017. Effect of weed mamagements practices and crop geometries on yield attributes and yield of clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.] varieties. *Progressive Research- An International Journal* 12(2): 206-209.

Gupta, V., Sasode, D.S., Kansana, B.S., Arora, A., Joshi, E. and Dixit, J.P. 2017. Effect of pre and post emergence herbicides on weed flora in Black gram. *Indian Journal of Weed Science* 49(3): 256–259.

Joshi, E., Sasode D.S., Gupta, V. and Tiwari, S. 2017. Productivity and profitability of groundnut (*Arachis hypogea*) as influenced by crop geometry and plant nutrition. *Annals of Agricultural Research* 38(4): 1-6.

Sasode, D.S., Gupta, V., Joshi, E., Arora A., Dixit. J. P. and Panse R. 2017. Management of composite weed flora of wheat (*Triticum aestivum L.*) by herbicide mixtures. *Indian Journal of Weed Science* 49(2): 147–150.

SKUAST, Jammu

Stanzen, L., Kumar, A., Sharma, B.C., Puniya, R. and Sharma, A. 2016. Weed dynamics and productivity under different tillage and weed-management practices in maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping sequence. *Indian Journal of Agronomy* 61(4): 449-454.

Kumar, A., Puniya, R., Sharma, A., Mahajan, A. and Stanzen, L. 2016. Sedges management in bottle gourd with halosulfuron-methyl. *Indian Journal of Weed Science* 48(3): 297–299.

Bali, A., Bazaya, B.R. and Rawal, S. 2017. Weed control in soybean (*Glycine max* L.) through resource management strategies and its influence on yield and nutrient uptake. *Journal of Applied and Natural Science* 9(1): 539 - 543.

Chand, L. and Puniya, R. 2017. Bio-efficacy of alone and mixture of herbicides against complex weed flora in wheat (*Triticum aestivum*) under sub-tropical conditions. *Indian Journal of Agricultural Sciences* 87(9): 1149–1154.

Stanzen, L., Kumar, A., Puniya, R., Sharma, N., Mahajan, A. and Sharma, A. 2017. Tillage and weed management on yield and nutrient uptake of wheat under maize-wheat cropping system in Western Himalayas. *Indian Journal of Weed Science* 49(1): 20–22.

Stanzen, L., Kumar, A., Puniya, R., Sharma, N., Sharma, A., Mahajan, A. and Bana, R. C. 2017. Effect of tillage and weed management practices on weed dynamics and productivity in maize (*Zea mays*)-wheat (*Triticum aestivum*) system. *International Journal of Current Microbiology and Applied Sciences* 6(4): 1907-1913.

TNAU, Coimbatore

Dhananivetha, Amnullah, M.M., Arthanari, P.M. and Mariappan, S. 2017. Weed management in onion, *Agricultural Review* 38 (1) : 76-80.

Hariharasudhan, V. and Chinnusamy, C. 2017. Effect of different time of sowing and weed management methods on weed interference, productivity and profitability of Bt cotton in Western zone of Tamil Nadu. *Madras Agricultral Journal* 104 (1-3): 45-48.

Hariharasudhan, V., Chinnusamy, C. and Arthanari, P.M. 2017. Recent weed management techniques in microirrigation system: *Review Journal of Pharmacognosy and Phytochemistry* 6(6): 324-326.

Masilamani, P., Chinnusamy, C., Abert Alex, V. and Govindaraj, M. 2017. Compatibility and efficiency of pre-emergence herbicides on weed control and seedling growth of teak (*Tectona grandis L.f.*) nursery. *Indian Journal of Forestry* 40(1):9-13.

Arthanari, M., Gowthami P.S., Chinnusamy, C., Sathyapriya, C.R. and Hariharasudhan, V. 2017. Effect of low dose early post emergence herbicide on growth and yield of transplanted rice crop, *Chemical Science Review Letter*, 6(21): 231-236.

Sanbagavalli, S., Marimuthu, S. and Chinnusamy, C. 2016. Economic viability of weed management practices on productivity of blackgram (*Phaseolus mungo* L.). *International Journal of Agriculture Sciences* 8(58): 3167-3170.

Sanbagavalli, S., Chinnusamy, C., Marimuthu, S. and Sivamurugan, A.P. 2016. Weed management strategies in black gram (*Phaseolus mungo* L.) : A Review *International Journal of Agriculture Sciences* 8(61): 3481-3486.

Sanbagavalli S., Chinnusamy, C., Thiruvarassan, S. and Marimuthu, S. 2016. Evaluation of efficient weed management practices on growth and yield of groundnut *International Journal of Agriculture Sciences* 8(59): 3310-3313.

Sathya, P.R., Chinnusamy, C., Manickasundaram, P., Janaki and P. 2017. Bioefficiency of oxyfluorfen (23.5% EC) on weed control in groundnut and its effect on soil microorganism. *Environment and Ecology* 35 (1B): 501-505.

Sathya, P.R., Chinnusamy, C., Karthikeyan, R. and Kuttimani, R. 2017. Drip fertigation in vegetable crops for enhancing productivity and resource use efficiency: An overview. *International Journal of Current Microbiol and Applied Science* 6(11): 3215-3230.

Sathya, P.R., Chinnusamy, C., Janaki, P. and Arthanari, P. M., 2017. Persistence and carryover effect of oxyfluorfen residues in red sandy clay loam soil. *Journal of Pharmacognosy and Phytochemistry* 6(3): 527-532.

Sathya, P.R., Chinnusamy, C., Arthanari, P.M. and Janaki, P. 2017. Carryover effect and plant injury from oxyfluorfen herbicide applied in transplanted rice. *International Journal of Chemical Studies* 5(3): 535-539.

Sathya, P.R., Chinnusamy, C., Arthanari, P.M. and Janaki, P. 2017. Weed control in direct seeded rice using new herbicide combination under Indian Tropical Condition. *British Journal of Applied Science and Technology* 21(5): 1-14.

Sathya, P.R., Chinnusamy, C., Arthanari, P.M. and Hariharasudhan,V. 2017. A Review on weed management in onion under Indian tropical condition. *Chemical Science Review Letter* 6(21): 88-93.

Sathya, P.R., Chinnusamy, C., Arthanari, P. M. and Hariharasudhan, V. 2016. Soil microbial population and bulb yield of onion as influenced by new Formulation of oxyfluorfen (23.5% EC), *Progressive Research* 11(VI): 4293-4297.

Sathya, P.R., Chinnusamy, C., Arthanari, P. M., Janaki, P. and Babu, C. 2017. Evaluation of oxyfluorfen (23.5% EC) herbicide on weed control, economics and profitability of groundnut in the western zone of Tamil Nadu. *Chemical Science Review Letter* 2017 6(22): 662-666.

Thirumalaikumar, R., Kalpana, R., Janaki, P., Venkataraman, N.S. 2017. Bio-efficacy evaluation of flumioxazine 50% compare with variant herbicides in growth and yield of soybean and it's residual effect on succeeding crops. *Life Sciences International Research Journal* 4(1) : 81-86.

Uma M.M. and Arthanari, P.M. 2017. Nutrient removal by weeds and organic Brinjal (*Solanum melongena* L.) Through weed management interventions, *International Journal of Chemical Studies* 5(3): 705-707.

Uma M.M., Arthanari, P.M. and Somasundaram, E. 2016. Non chemical weed management in organic brinjal (*Solanum melongena L.*), *Progressive Research* 11(V) : 3278-3280.

Vinothini, G. and Arthanari, P.M. 2017. Pre emergence herbicide application and hand weeding for effective weed management in irrigated kodo millet (*Paspalum scrobiculatum* L.). *International Journal of Chemical Studies* 5(3): 366-369.

BCKV, Kalyani

Mukherjee, D., Mandal, B., Maji, A., and Biswas, B. 2017. Impact of various planting dates and suitable nutrient management practices for enhanced wheat productivity. *International Journal of Bioresource Science* 4(1): 29-34.

Sarkar, S. and Sarkar, A. 2017. Effect of irrigation and mulch on linseed (*Linum usitatissimum*) for improving growth, yield and water extraction pattern. *Indian Journal of Ecology* 44(4): 851-855.

OUAT, Bhubaneswar

Mishra, M.M., Dash, R. and Mishra, M. 2016. Integrated weed management indices of herbicides in direct sown rice. *Journal of Plant Protection and Environment 1*2(2): 74-79.

Sahoo, S. Pradhan, J. and Dash, R. 2017. Phytotoxic effect of pre emergence herbicides on oil content and yield componenets of ground nut (*Arachis hypogaea*). I*nternational Journal of Current Microbiological and Applied Sciences* 6(9): 1738-1748.

RAU, Pusa

Kumari, P. and Roy, D.K. 2017. Effect of Combined Organic and Inorganic Fertilizers and weed management for sustained productivity of aromatic rice. *Indian Journal of Ecology* 44: 120-123.

UAS, Begaluru

Sahoo, S., Dhanapal, G.N., Goudar, P., Sanjay, M.T. and Viswanath, A.P. 2016. Influence of weed control practices on growth and yield of blackgram [*Vigna mungo* (L.) Hepper] *Ecology Environment and Conservatopm 22: 5*53-557.

Prashant, Sanjay, M.T., Shrinivas, C.S. and Jagadish. 2017. Weed management in sunflower- a review. *Trends in Biosciences* 10(34): 7201-7207.

Prashant, Sanjay, M.T., Dhanapal, G.N., Manjanagouda, S., Sannagoudar and Kumar, R. 2017. Economics of herbicide use for the weed management in sunflower. *Trends in Biosciences* 10(34): 7243-7246.

PDKV, Akola

Kakade, S.U., Bhale, V.M. and Deshmukh, J.P. 2017. Soil moisture distribution, nutrient dynamics and yield of Bt cotton as influenced by split application of nutrients through fertigation. *International Journal Pure Applied Bioscience 5(2):* 1081-1088.

Tijare, B., Chorey, A., Bhale, V. and Kakade, S. 2017. Phenology and heat unit requirement of summer green gram varieties under different sowing windows. *International Journal of Current Microbiology and Applied Science* 6(4): 685-691.

Kakade, S.U., Bhale, V.M. and Deshmukh, J.P. 2017. Growth, Nutrient uptake and seed cotton yield as influenced by split application of nutrients through fertigation in Bt cotton. *International Journal of Current Microbiology and Applied Science* 6(9): 2982-2990.

Kakade, S.U., Mohurle, L.A., Bhale, V.M., Deshmukh, J.P. and Gaud, V.V. 2017. Response of split application of nutrients through fertigation on weed dynamics, nutrients uptake, nutrient and water use efficiency and yield of Pigeonpea. *International Journal of Current Microbiology and Applied Science* (Special Issue): 826-833.

Deshmukh, J.P., Kakade, S.U., Ingole, P.G., and Shingrup, P.V. 2017. Integrated weed management in turmeric. *International Journal of Current Microbiol and Applied Science (Special Issue):* 1894-1899.

Chirde, P. N., Deshmukh, J. P. Thakare, S., Shingrup, P.V. and Kakade, S.U. 2018. Weed flora and yield of sunflower (*Helianthus annus* L.) as influenced by pre and post-emergences application of herbicides. *International Journal of Pure and Apllied Biosciences* 5(6): 127-131.

Table 7.1 Publication by the coordinating centres

Centres	Research paper	Popular articles	Paper presented seminars/ symposia /conferences	Books	Book Chapter	Lecture delivered during training	Student guided	
							M.Sc.	Ph.D.
PAU, Ludhiana	12	4	6	-	1	14	12	4
UAS, Bengaluru	3	-	2	-	-	-	-	3
RVSKVV, Gwalior	5	-	6	-	-	-	4	1
GBPUAT, Pantnagar	15	3	13	-	-	4	7	2
CSKHPKV, Palampur	10	-	13	-	-	12	3	2
AAU, Jorhat	7	3	-	3	3	-	2	3
AAU, Anand	7	1	4	6	6	12	1	2
TNAU, Coimbatore	20	-	12	-	-	16	3	2
NDUAT, Faizabad	6	3	-	-	-	-	3	-
BAU, Ranchi	10	1	-	-	-	-	-	1
KAU, Thrissur	6	-	6	2	2	-	10	6
OUAT, Bhubaneshwar	2	-	-	1	1	-	3	-
PJTSAU, Hyderabad	14	5	4	9	9	28	2	-
CCSHAU, Hisar	4	1	17	-	-	-	4	3
RAU, Pusa	1	-	8	-	-	4	-	-
DrBSKKV, Dapoli	-	-	-	-	-	-	-	-
IGKV, Raipur	11	-	-	-	-	-	-	-
PDKV, Akola	6		6	-	-	1	-	-
BCKV, Kalyani	2	-	-	-	-	-	-	-
CAU, Pasighat	-	-	-	-	-	-	-	-
UAS, Raichur	-	-	-	-	-	-	-	-
MPUAT, Udaipur	6	5	6	2	2	4	-	-
SKUAST, Jammu	6	-	1	-	-	4	-	-
Total	153	31	104	23	24	99	54	29

8. AWARDS AND RECOGNITIONS

AAU, Anand

- Shri D. D. Chaidhari awarded with "Best Participant Award" for securing third position during ICAR-CAFT training on "Organic Production Management: Approaches and Practices" at CAFT on Organic Farming, DOR, MPUAT, Udaipur during 11/09/2017 to 01/10/2017.
- Dr. H. K. Patel awarded with "Best Participant Award" for securing second position during ICAR-CAFT training on "Organic Agriculture Intensification" at CAFT on Organic Farming, DOR, MPUAT, Udaipur during 22/11/2017 to 12/12/2017.

NDUAT, Faizabad

- Excellence in Life time achievement award provided to Dr. R.S. Singh for outstanding contribution in field of Agronomy by Science and Technology Society for Integrated Rural Improvement, Warangal, Telangana.
- Excellence in Research Award provided to Dr. R.K. Pathak for outstanding contribution in field of Soil Science and Agricultural Chemistry by Science and Technology Society for Integrated Rural Improvement Warangal, Telangana.

TNAU, Coimbatore

- TNAU, Coimbatore received Best AICRP-WM Centre Award-2016-17 by ICAR-DWR, Jabalpur.
- Dr. C. Chinnusamy recieved Achiever Award 2016 by SADHANA, Solan, HP

KAU, Thrissur

- Thrissur AICRP-WM team bagged the best poster award in the Biennial Conference of Indian Society of Weed Science held in February 2017 at MPUAT Udaipur, Rajasthan.

CCSHAU, Hisar

- Dr Anil Duhan has awarded with Endeavour Research Fellowship (PDF) of Australian Government's internationally competitive, merit based scholarship programme for 2018.
- Dr S.S. Punia has elected as Vice-President of the Indian Society of Weed Science for the Biennium 2017-2018.
- Dr Dharam Bir Yadav has conferred upon with ISWS Fellow 2014 Award by Indian Society of Weed Science in March 2017.
- Dr Dharam Bir Yadav has been nominated as 'Councilor for Haryana State' for the Biennium 2017-2018 in Indian Society of Weed Science.
- HAU, Hissar, received best 3rd Poster Paper Award for research paper on 'Degradation of imazethapyr and imazethapyr + imazamox (RM) in sandy loam soil of Hisar. In Biennial Conference of the Indian Society of Weed Science on "*Doubling Farmers' Income by 2022: The Role of Weed Science*", March 1-3, 2017, MPUA&T, Udaipur.
- Best 1st Paper Poster Award for research paper on 'Estimation of imazethapyr and imazamox using GCMS Tandem Mass Spectrometry to AICRP-WM In : National Conference on Analytical Techniques and Their Applications (NCATA 2017), March 16-17, 2017, GJUS&T Hisar, India

Foreign visits:

- Dr S S Punia and Dr Dharam Bir Yadav presented oral papers in 26th Asian-Pacific Weed Science Conference held during 19-22 September 2017 at Kyoto, Japan.
- Dr. Anil Duhan participated and presented oral paper in Agri Fish Conference held in Colombo Sri Lanka from 7-9 December, 2017.

MPUAT, Udaipur

- Received Two Best poster awards in the Biennial conference of Indian Society of weed science "Doubling farmer's income by 2022: The Role of weed science" held at MPUAT, Udaipur during 1-

3 March, 2017 for paper "Allelopathy: an environmentally friendly method for weed control" and second influence of herbicide combinations on weed control and productivity of wheat

- Dr. Roshan Choudhary recieved Young Scientist Award in 1st National Conference on Advances in Global Research in Agriculture and Technology during 19-20 March, 2017 at Agra.

CSKHPKV, Palampur

- CSKHPKV, Palampur recived Best Centre Award 2016-17 of AICRP on Weed Management- by Directorate of Weed Research (ICAR), Jabalpur during Annual Review, Udaipur, Rajasthan, 01-03 March 2017
- Dr Neelam Sharma recieved Fellow Award-ISWS by Indian Society of Weed Science during Biennial Conference of ISWS, Udaipur, Rajasthan, 01-03 March, 2017.

RVSKVV, Gwalior

- Dr. Deep Sing Sasode has received Distinguished Scientist Award by All India Agrcultural Student Association (AIASA) during 2nd National Agriculture Convention on "Agricultural Skill Development for Doubling Farmers Income" on 7th October, 2017 at RAJUVAS, Bikaner (Rajasthan).
- Dr. Varsha Gupta received Young Scientist Award by Agricultural Technology Development Society (ATDS) Ghaziabad, UP, during International Conference on Advances in Agricultural and Biodiversity Conservation for Sustainable Development (ABCD - 2017) 27 – 28 October, 2017.
- Appreciation award received by Dr. Deep Sing Sasode for best research and excellent teaching on the occasion of teacher's day by *"Jan Utthan Nyaas Society Gwalior"* on 5th September, 2017.
- Appreciation award received by Dr. Varsha Gupta for best research and excellent teaching on the occasion of teachers day by *"Jan Utthan Nyaas Society Gwalior"* on 5th September, 2017.
- AICRP-WM RVSKVV, Gwalior centre received best poster award 2017 on Effect of nutrient omission on productivity and economics of maize (*Zea mays* L.) in maize – wheat cropping system in "The National Forage Symposium 2017"at RVSKVV, Gwalior on March, 3-4, 2017.

SKUAST, Jammu

- Dr. R. Puniya received Young Scientist Award by Indian Society of Weed Science during Biennial Conference "*Doubling Farmers' Income by 2022: The Role of Weed Science*", MPUA&T, Udaipur, India during 1-3 March, 2017.

9. RECOMMENDATIONS OF XXIV ANNUAL REVIEW MEETING

Recommendations of XXIV Annual Review Meeting of All India Coordinated Research Project on Weed Management held at Maharana Pratap University of Agriculture & Technology, Udaipur (Rajasthan) during 27-28 February, 2017 are given below:

- In order to check resistance problem advice crop-rotation.
- Studies on weed management in organic farming systems should be continued in high-value crops.
- Usage of herbicide like pendimethalin should be restricted to control treatment alone in organic weed management and avoid its trials in blackgram and greengram for weed control.
- All the centres should work out and present weed density, weed dry matter, yield and economics. Weed intensity (%) can also be included along with table.
- Farmers' practice should be included in OFRs.
- Sensitive plants must be screened for bioassay studies.
- Publish in NAAS rated journals only.
- Kalyani centre was suggested to initiate research work on weed management in conservation agriculture and organic farming systems immediately.
- Some good recommendations should come out from research which is important from farmer's point of view.
- In CA, hand weeding after flowering of weeds should be done to reduce weed seed bank in soil.
- Too much herbicide load should be avoided in rhizomatous crops like turmeric. Study carryover effect of herbicides on turmeric.
- Studies on well established herbicide such as pendimethalin should be avoided.
- Doing repeated research on no detectable limit of herbicide molecule should be avoided
- Work on development of slow release herbicide should also be started.
- Number of slides and timeliness should be followed while presentation.
- Do not use abbreviation / short form of herbicides or commercial name in the presentation or compilation.
- Avoid too much running matter and data during presentation. Presentation of too much data on table should be avoided.

10. NEW INITIATIVES

- Six centres were closed during SFC for 2017-20.
- Research themes were reorganized and technical program was made in tune with the research programmes of the Directorate based on the emerging challenges in weed management.
- Network experiments related to weed management in conservation agriculture, organic farming, input-use efficiency and herbicide use in cropping systems were reorganized.
- Effective system of monitoring and evaluation of research and extension work was developed through Nodal Officers for different themes and regions.
- Collaboration with other AICRPs at the university like integrated farming systems, dryland agriculture, organic farming, pesticide residues, and others dealing with crops like rice, wheat, maize, soybean, sugarcane, pulses etc. was proposed.
- Compilation of the work done so far on herbicide residues, biology and management of major weeds of cropped and non-cropped lands in each state/region, long-term trials on herbicides/ tillage and technologies generated were undertaken.
- Evaluation of the centers based on score card and 'Best Centre Award' were continued. Additional grants and incentives were given to the better performing centre and winner of the Best Centre Award.
- Greater emphasis was given on publication of the research data generated over the years and bringing out quality publications in reputed journals.
- Salient achievements and happenings of the Directorate were presented and shared with the scientists of AICRP-Weed Management during the Annual Review Meeting. It was desired that all scientists of the project should attend the meeting every year.
- An initiative to maintain 'Parthenium-free campus' was taken with the involvement of students and other staff of the University.

11. STATUS OF EXPERIMENTS

Summary of experiments at different centres

		Network Programmes				
Sl. No.	Coordinating Centres	WP 1 Development of sustainable weed management practices in diversified cropping systems	WP 2 Weed dynamic and management under the regime of climate change and herbicide resistance	WP 3 Biology and management of problem weeds in cropped and non cropped areas	WP 4 Monitoring, degradation and mitigation of herbicide residues and other pollutants in the environment	WP 5 On- farm and demonstration of weed management technologies, their adoption and impact assessment
1.	PAU, Ludhiana	WP 1.1.1.9 WP 1.2.11 WP 1.3.5.3 WP 1.3.8.1 WP 1.5.5	WP 2.1 WP 2.2 WP 2.3 WP 2.4	WP 3.1 WP 3.2.1(f) WP 3.3.1 WP 3.4.1* WP 3.4.2	WP 4.1 WP 4.2* WP 4.3.1 WP 4.3.2 WP 4.3.3 WP 4.4	WP 5.1 WP 5.2
2.	UAS, Bengaluru	WP 1.1.1.1 WP 1.3.1.1(i) WP 1.3.1.1(ii) WP 1.3.10.1 WP 1.5.3	WP 2.1 WP 2.2	WP 3.2.1(b)** WP 3.2.1(f) WP 3.4.1**	WP 4.1* WP 4.2* WP 4.3.1* WP 4.3.2* WP 4.4*	WP 5.1 WP 5.2*
3.	RVSKKV, Gwalior	WP 1.1.3.1 WP 1.2.6 WP 1.3.5.1	WP 2.1 WP 2.2	WP 3.2.1(f) WP 3.4.1	WP 4.1 WP 4.2 * WP 4.3.1* WP 4.3.2* WP 4.3.3* WP 4.4	WP 5.1 WP 5.2
4.	GBPUAT, Pantnagar	WP 1.1.1.10 WP 1.2.13 WP 1.5.7(i) WP 1.5.7(ii)*	WP 2.1 WP 2.2 WP2.3	WP 3.2.1(f) WP 3.4.1	WP 4.1 WP 4.2 WP 4.3.1 WP 4.3.2 WP 4.3.3 WP 4.4	WP 5.1 WP 5.2
5.	CSKHPKV, Palampur	WP 1.1.2.2 WP 1.2.12 WP 1.3.9.2 WP 1.5.6	WP 2.1 WP2.2	WP 3.2.1(f) WP 3.4.1*	WP 4.1 WP 4.2 WP 4.3.1 WP 4.3.2 WP 4.3.3* WP 4.4	WP 5.1 WP5.2**
6.	AAU, Jorhat	WP 1.1.1.8 WP 1.2.10(i) WP 1.2.10(ii) WP1.3.1.5(i) WP 1.3.1.5(ii) WP 1.3.10.2 WP 1.4.3 WP 1.5.4(i)*	WP 2.1 WP 2.2 WP 2.4	WP 3.2.1(e) WP 3.2.1(f) WP 3.4.1* WP 3.4.2*	WP 4.1 WP 4.2 WP 4.3.1 WP 4.3.2 WP 4.3.3 WP 4.4	WP 5.1 WP 5.2*

Table contd...

		WP 1.5.4(ii)* WP 1.5(iii) New				
7.	AAU, Anand	WP 1.1.5.1 WP 1.2.1 WP 1.3.3.1 WP 1.5.2	WP 2.1 WP 2.2	WP 3.2.1(f) WP 3.4.1	WP 4.1* WP 4.2 * WP 4.3.1* WP 4.3.2 * WP 4.4*	WP 5.1 WP 5.2
8.	TNAU, Coimbatore	WP 1.1.2.1 WP 1.2.3(i) WP 1.2.3(ii) WP 1.3.1.2	WP 2.1 WP 2.2	WP 3.1 WP 3.2.1(b) WP 3.2.1(f) WP 3.4.1	WP 4.1 WP 4.2 WP 4.3.1 WP 4.3.2 WP 4.3.3 WP 4.4	WP 5.1 WP 5.2
9.	NDUAT, Faizabad	WP 1.1.1.4 WP 1.2.5 WP 1.3.1.3 WP 1.3.4.1	WP 2.1* WP 2.2*	WP 3.2.1(f) WP 3.4.1*	WP 4.1* WP 4.2* WP 4.3.1* WP 4.3.2* WP 4.3.3* WP 4.4*	WP 5.1 WP 5.2*
10.	BAU, Ranchi	WP 1.1.2.3 WP 1.2.16 WP 1.4.4	WP 2.1* WP 2.2*	WP 3.2.1(f) WP 3.3* WP 3.3.2 WP 3.4.1*		WP 5.1* WP 5.2*
11.	KAU, Thrissur	WP 1.1.1.14 WP 1.2.17(i) WP 1.2.17(ii)	WP 2.1* WP 2.2	WP 3.1 WP 3.4.1*	WP 4.1 WP 4.2 WP 4.3.1 WP 4.3.2 WP 4.4	WP 5.1** WP 5.2
12.	OUAT, Bhubaneshwar	WP 1.1.1.2 WP 1.2.2 WP 1.3.12.1*	WP 2.1 WP2.2	WP 3.2.1(f) WP 3.4.1*	WP 4.1 WP 4.2 * WP 4.3.1* WP 4.3.2* WP 4.4	WP5.1 WP 5.2
13.	PJTSAU, Hyderabad	WP 1.1.1.6 WP 1.2.8 WP 1.3.1.4 *	WP2.1 WP2.2	WP 3.1 WP 3.2.1(f) WP 3.4.1	WP 4.1 WP 4.2 WP 4.3.1 WP 4.3.2 WP 4.3.3 * WP 4.4	WP 5.1 WP 5.2
14.	CCSHAU, Hisar	WP 1.1.1.5 WP 1.2.7 WP 1.3.5.2 WP 1.3.13.1	WP 2.1 WP 2.2 WP 2.3	WP3.1* WP3.2.1(a) WP3.2.1(c)* WP3.2.1(f) WP3.4.1* WP3.4.2*	WP4.1 WP4.2 WP4.3.1* WP4.3.2 WP4.3.3 WP4.4	WP 5.1 WP 5.2
15.	RAU, Pusa	WP 1.1.1.11 WP 1.3.3.4 WP 1.3.7.1 WP 1.4.3(i) WP 1.4.3(ii) WP 1.4.3(iii) WP 1.5.8	WP 2.1 WP 2.2	WP 3.2.1(f) WP 3.4.1		WP 5.1 WP 5.2
16.	DBSKKV, Dapoli	WP 1.1.1.3 WP 1.2.4 WP 1.4.1*	WP 2.1* WP 2.2*	WP 3.2.1(f) * WP 3.4.1*		WP 5.1 WP 5.2

Table contd...

17.	IGKVV, Raipur	WP 1.1.1.13 WP 1.2.15 WP 1.5.9	WP 2.1 WP 2.2	WP 3.2.1(f)		WP 5.1 WP 5.2
18.	SKUAST, Jammu	WP 1.1.1.7 WP 1.2.9 WP 1.3.3.2 WP 1.3.13.1 WP 1.4.2 WP 1.5.3(I) WP 1.5.3(ii)	WP 2.1 WP 2.2	WP 3.2.1(d) WP 3.2.1(f) WP 3.4.1 WP 3.4.2		WP 5.1
19.	MPUAT, Udaipur	WP 1.1.2.4 WP 1.2.18 WP 1.3.5.5 WP 1.3.11.1	WP 2.1 WP 2.2	WP 3.2.1(a)** WP 3.2.1(f) WP 3.4.1		WP 5.1 WP 5.2
20.	UAS, Raichur (Report not submitted)	WP 1.1.1.12 WP 1.2.14 WP 1.3.5.4(i) WP 1.3.5.4(ii) WP 1.3.6.1 WP 1.3.7.2	WP 21 WP 2.2	WP 3.2.1(f) WP 3.3.3 WP 3.4.1		WP 5.1 WP 5.2
21.	PDKV, Akola	WP 1.1.4.1 WP 1.3.2.1 WP 1.3.9.1 WP 1.5.1(i)* WP 1.5.1(ii)* WP 1.5.1(iii)* WP 1.5.1(iv) WP 1.5.1(v)	WP 2.1 WP 2.2	WP 3.2.1(f) * WP 3.4.1*		WP 5.1 WP 5.2
22.	CAU, Pasighat	WP 1.3.3.3 WP 1.3.4.2 WP 1.3.10.2*	WP 21* WP 2.2*	WP 3.2.1(f)* WP 3.4.1*		WP 5.1* WP 5.2*
23.	BCKV, Kalyani	WP 1.1.1.15 WP1.2.18 (ii) WP1.3.14 WP1.5.12		WP3.2.1(f) WP3.4.1		

*Not reported
**Not concluded

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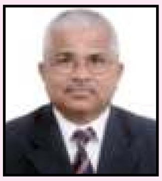

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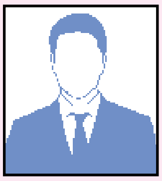

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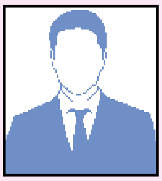

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13. STATUS OF SUBMISSION OF ANNUAL REPORT-2017

Sl No.	Centre's name	Received	
		Before due date (15.01.2018)	After due date
Regular centres			
1.	PAU, Ludhiana	-	16.1.2018
2.	UAS, Bengaluru	13.1.2018	-
3.	RVS KVV, Gwalior	15.1.2018	-
4.	GBPUAT, Pantnagar	15.1.2018	-
5.	CSKHPKVV, Palampur	-	26.1.2018
6.	AAU, Jorhat	15.1.2018	-
7.	AAU, Anand	7.1.2018	-
8.	TNAU, Coimbatore	5.1.2018	-
9.	NDUAT, Faizabad	14.1.2018	-
10.	BAU, Ranchi	-	17.1.2018
11.	KAU, Thrissur	5.1.2018	-
12.	OUAT, Bhubaneswar	15.1.2018	-
13.	PJTSAU, Hyderabad	-	24.1.2018
14.	CCSHAU, Hisar	15.1.2018	-
15.	RAU, Pusa	15.1.2018	-
16.	DBSKKV, Dapoli	15.1.2018	-
17.	IGKVV, Raipur	-	19.1.2018
18.	SKUAST-Jammu	-	17.1.2018
19.	PDKV, Akola	15.1.2018	-
20.	CAU, Pasighat	12.1.2018	-
21.	UAS, Raichur	-	-
22.	MPUAT, Udaipur	15.1.2018	-
23.	BCKV, Kalyani	-	17.1.2018
Volunteer centres			
1.	SVBPUAT, Meerut	-	-
2.	SKUAST-Kashmir	-	-
3.	PJNCA&RI, Karaikal	14.1.2018	-
4.	BAU, Sabour	-	-
5.	ICAR-CIAS, Port Blair	-	-
6.	UAS, Dharwad	-	4.4.2018

ACRONYMS

B:C	Benefit cost ratio
BCR	Benefit cost ratio
BD	Bulk density
BDL	Below detectable limit
BLW	Broad leaf weeds
CT	Conventional tillage
CT-DSR	Conventional tilled direct seeded rice
CT-TPR	Conventional tillage after transplanted rice
DAD	Days after disappearance
DAP	Days after planting
DAS	Days after sowing / spraying
DAT	Days after transplanting
DB	Development blocks
DHA	De-hydrogenese activity
DSR	Direct-seeded rice
DSR+R	Direct seeded rice+Residue
EPoE	Early post emergence
FYM	Farm yard manure
GA	Gibberellic acid
HHW	Hand hoeing weeding
HW	Hand weeding
IC	Inter cultivation / culture
IM	Indian mustard
IWM	Integrated weed management
K	Potassium
LPoE	Late post emergence
MBC	Microbial biomass carbon
MRL	Maximum residue limit
MT	Minimum tillage
MW	Mechanical weeding
N	Nitrogen
Na	Sodium
P	Phosphorus
PE	Pre-emergence
PM	Poultry manure
PSB	Phosphorus solubilizing bacteria
PTR	Puddled transplanted rice
RD	Recommended dose
RM	Ready mix
SMBC	Soil microbial biomass carbon
SSB	Sulfer solubilizing bacteria
SVI	Seedling vigour index
TM	Tank mixed
TPR	Transplanted residue
TPR	Transplanted puddled rice
VSD	Variable speed drive
ZT	Zero tillage
ZT+R	Zero tillage + Residue

AICRP-WM activities

HQ-ICAR DWR, Jabalpur

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Volunteer centres

Centres are closed w.e.f. 01.04.2018

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