अखिल भारतीय समन्वित खरपतवार प्रबंधन अनुसंधान परियोजना

All India Coordinated Research Project on Weed Management

वार्षिक प्रतिवेदन

ANNUAL REPORT 2021

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

ICAR - Directorate of Weed Research, Jabalpur

ISO 9001:2015 Certified

AICRP-WM in the NEWS

स्वदेश — ग्वालियर - मुख्य संस्करण — 22 Aug 2021

गाजर घास पहुंचाती है नुकसान

गाजरघास से नुकसान के प्रति किया जागरूक

ग्वालियर, न.सं.। गाजरघास के एक पौधे में लगभग 300 से 400 फूल होते हैं और हर फूल में एक से दो हजार बीज होते हैं जो कि जमीन में पुनः नमी पाकर उग आते हैं। इस तरह से अकसलीय क्षेत्र के साथ-साथ फसलीय क्षेत्र को भी नुकसान पहुँचा रहे हैं। यह जानकारी राजमाता विजयाराजे सिंधिया कृषि विश्वविद्यालय ग्वालियर के वैज्ञानिकों ने विवेकानंद नीड़म ग्वालियर में बच्चों के साथ कार्यक्रम करते हुए साझा की। कार्यक्रम में पूर्व महापौर श्रीमती समीक्षा गुप्ता ने गाजरघास से होने वाले नुकसानों पर चिंता व्यक्त की। इस मौके पर गाजरघास से होने वाले नुकसानों व उससे मुक्ति पाने के उपायों पर चर्चा हुई। इस मौके पर डॉ. दीप सिंह सासोडे, वर्षा गुप्ता, डॉ. एकता जोशी, डॉ. रजनी सिंह आदि

कृषि वैज्ञानिकों ने गांव-गांव जाकर किया किसानों को जागरुक

गेंदे से खत्म हो जाती है गाजरघास

बीमारी का भी खतरा

समाजसेवियों-बच्चों को भी दी ट्रेनिंग

आपने कहा

अन्य वनस्पति के लिए खतरा

नैनीताल | बुधवार, 18 अगस्त 2021

गाजर घास के दुष्प्रभावों की जानकारी दी

हरिभूमि — रायपुर - कांकेर भूमि — Date 18 Aug 2021

गाजर घास उन्मूलन जागरूकता सह कृषक प्रशिक्षण

बिना पराली जलाए उत्पादकता बढ़ाएं

कम खपत में सुपर सीडर से करें बुवाई

सुपर सीडर से बुआई कर किसान बढ़ाएं उत्पादकता

खेती से ही चलता है परिवार

बेटियां न्याय व शिक्षा विभाग में दे रही सेवाएं

25000 बीज उत्पन्न करने की क्षमता रखता है एक पौधा

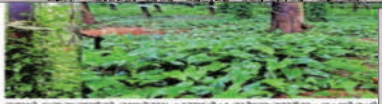
दैनिक जागरण 20.8.2021

पंजाब केसरी 20.8.2021

अवैरी में गाजर घास जागरूकता सप्ताह शुरू

কামৰূপ কৃষি বিজ্ঞান কেন্দ্ৰত ভাৰ্চুৱেলযোগে পাৰ্থেনিয়াম অপতৃণৰ সজাগতা অনুষ্ঠান

মহানগৰীত উচাহহীনভাৱে পালন পৱিত্ৰ ৰাখী বন্ধন



അലങ്കാരം കഴിഞ്ഞു: അലമ്പായി സിങ്കോണിയം

Submerged weeds pose threat to paddy

Impact deemed more severe in transplanted crops

നെല്ല് കളയും, അക്വേറിയം സസ്യം

ଗାଜର ଘାସ ଭବିଷ୍ୟତ ଲାଗି ବିପଦ

ସୋଆ ଏନ୍‌ଏସ୍‌ଏସ୍ ପକ୍ଷରୁ ଗାଜର ଘାସ ନିରାକରଣ ସଚେତନତା

లేత దశలోనే కలుపు నివారించాలి

కలుపు మొక్కతో రైతుకు తీవ్ర నష్టం

IN THE COURT OF THE HON'BLE I ADDL.JUNIOR CIVIL JUDGE-CUM XV ADDL.METROPOLITAN MAGISTRATE AT RAJENDRANGAR, R.R.DISTRICT O.S.NO. 354 OF 2021

റബ്ബർ തോട്ടങ്ങളിൽ ശല്യക്കാരനായി സിംഗോണിയം സസ്യം

● വിദഗ്ധ സംഘം മഴുവന്നൂരിലെത്തി പഠനം നടത്തി

early TIMES

Explaining Truth Believe in Possibilities

Vol: 20 | No.: 229 | Jammu | SATURDAY, August 21, 2021 | Pages: 12 | Price ₹ 3.00

Parthenium awareness camp organized at Khandwal village

अखिल भारतीय समन्वित खरपतवार प्रबंधन अनुसंधान परियोजना

All India Coordinated Research Project on Weed Management

वार्षिक प्रतिवेदन
Annual Report
2021

भाकृअनुप
ICAR

भा.कृ.अनु.प.– खरपतवार अनुसंधान निदेशालय
ICAR - Directorate of Weed Research
जबलपुर, मध्य प्रदेश
Jabalpur, Madhya Pradesh
ISO 9001: 2015 Certified

खरपतवार अनुसंधान निदेशालय, जबलपुर (म.प्र.)
D W R

Correct citation: Annual Report 2021. AICRP-Weed Management, ICAR-Directorate of Weed Research, Jabalpur, 133 p.

Published by
Director
ICAR-Directorate of Weed Research
Jabalpur-482004 (M.P.)

Coordination and editing
Dr. R.P. Dubey
Dr. J.S. Mishra

Compilation
Dr. P.K. Singh
Dr. Sushil Kumar
Dr. Shobha Sondhia
Dr. P.K. Mukherjee
Dr. V.K. Choudhary
Dr. D. Shrikanth

Technical Assistance
Mr. Pankaj Shukla
Mr. Sandeep Dhagat

Published in
May, 2022

Further information
ICAR-Directorate of Weed Research
Jabalpur-482004 (M.P.)
Phone: 0761-2353101, 2353934, 2353787
Fax: 0761-2353129
e-mail: **aicrpwm@icar.gov.in**; **aicrpwcjbp@gmail.com**
Website: https://dwr.icar.gov.in

Preface

All India Coordinated Research Project on Weed Management (AICRP-WM) has been carrying out location-specific research on weed management with its 24 cooperating centers (17 regular and 7 voluntary) for the last more than four decades. Efforts by cooperating centers have resulted in generation of site-specific technologies in the areas of sustainable weed management in diverse cropping systems, weed management in organically-grown crops, management of herbicide-resistant weeds, integrated weed management, estimation of herbicide residues in soil, water and crop produce, biological control of invasive weeds, on-farm research & demonstrations to refine and disseminate improved weed management technologies for ensuring wider adoption.

The Annual Report (2021) of AICRP-WM is a comprehensive document with compiled information based on 221 on-station and 232 OFRs & FLDs across the country. This report contains salient findings of on-station experiments and technologies assessed and up-scaled under on-farm/on-station situations in various production systems. I hope the information contained in this report is useful to all the research institutes, agricultural universities, farmers and other stakeholders including NGOs involved in development & dissemination of weed management technologies.

During the period, different initiatives were taken for improving the quality of AICRP-WM work, and up scaling of doable weed management technologies in collaboration with different stakeholders. As a part of *Azadi ka Amrut Mahotsav* celebrations, Webinars, *Sangosthies* and training programmes (in regional languages) were organized on various aspects of weed management. To monitor the progress, quarterly review meetings were organized virtually. Success stories from progressive farmers across the country have been documented.

I am grateful to Dr. Trilochan Mohapatra, Secretary, DARE & Director General, ICAR, Dr. S.K. Chaudhari, DDG (NRM) and Dr. S. Bhaskar, ADG (A, AF&CC), ICAR for their guidance, support and encouragement in implementing this project successfully. I wish to place on record the contributions and cooperation by the Principal Investigators & Scientists from the cooperating centers and also help extended by authorities of the respective State Agricultural Universities, and ultimately farmers. I wish to compliment the efforts of Dr.R.P. Dubey, Principal Scientist & Incharge, AICRP-WM, for coordination, monitoring and evaluation of the technical programme. I acknowledge the cooperation received from Dr. P.K. Singh, Dr. Sushil Kumar, Dr. Shobha Sondhia, Dr. P.K. Mukharjee, Pr. Scientist, Dr. V.K. Choudhary, Dr. Yogita Gharde, Sr. Scientist, Dr. D. Shrikanth, Scientist, Mr. Pankaj Shukla, ACTO, and Mr. Sandeep Dhagat, CTO in bringing out this report.

(J.S. Mishra)
Director
ICAR-DWR, Jabalpur

Contents

Executive Summary

The All India Coordinated Research Project on Weed Management (AICRP-WM) is operational at the Directorate which coordinates its network research programme through 17 regular centres and 7 voluntary centres at SAU's under different agro-climatic zones. The salient achievements during the year 2021 are given below:

WP-1: Development of location-specific sustainable weed management practices

- *Phalaris minor* populations showed differential resistance to sulfosulfuron, clodinafop, mesosulfuron + iodosulfuron and/or pinoxaden but not to pendimethalin, pyroxasulfone and metribuzin. Pyroxasulfone sole or mixture with pendimethalin provided best control in wheat.
- Studies at Hisar showed development of resistance to the *P. minor* populations against the recommended dose of sulfosulfuron (25 g/ha), mesosulfuron + iodosulfuron (RM) (14.4 g/ha) and pinoxaden (50 g/ha) herbicides.
- Under pot studies at Hisar, only three populations out of the 12 populations under the testing shows $\geqslant$ 70 % control to the recommended dose of sulfosulfuron (25 g/ha), five to mesosulfuron + iodosulfuron (RM) (14.4 g/ha) and three to pinoxaden (50 g/ha). It shows the development of resistance to the *P. minor* populations against these tested herbicides.
- Pre-emergence application of pyroxasulfone + pendimethalin (TM) at (127.5 + 1500 g/ha) followed by PoE application of meso + iodosulfuron 14.4 g/ha and pinoxaden 50 g/ha at farmers' fields in rice –wheat growing areas of Haryana provided 91.3 and 90% control of *P. minor*.
- In cotton-greengram cropping system under conservation agriculture at Anand, significantly lower density and dry biomass of monocot (5.74/m^2 and 6.29 g/m^2, respectively) was observed under zero tillage with residue followed by zero tillage with residue. Seed cotton equivalent yield was recorded significantly the highest (2.87 t/ha) under zero tillage with residue followed by zero tillage with residue.
- In *Bt* cotton application of 125% recommended dose of N and K in five splits (P as basal) through drip and directed spray of paraquat 0.3 kg/ha at 30 DAS *fb* 1 HW 15 days after spraying and paraquat 0.6 kg/ha 60 DAS *fb* 1 HW 30 days after spraying found to be best for maximizing the weed control efficiency, seed cotton yield and net returns in Maharashtra.
- In sugarcane ratoon crop, the lowest weed dry weight of grasses was recorded by sequential application of atrazine *fb* topramezone, whereas for BLWs and sedges, with sulfentrazone *fb* 2,4-D EE 38% EC and metribuzine + halosulfuron. The highest cane yield (79.6 t/ha), net return (₹ 186400/ha) and BC ratio (2.7) was found under atrazine *fb* topramezone at Pantnagar.
- Application of oxyfluorfen (6%)+ quizalofop-p-ethyl (4%) RM 35 g/ha at 15 DAS was found to be the best combination in controlling the complex weed flora of onion at Bhubaneshwar.
- The highest seed yield of rainfed chickpea was observed under mechanical weeding at 20 and 40 DAS which was at par with imazethapyr + pendimethalin (RM) 1000 g/ha as PE and topramezone 25.2 g/ha at 20-25 DAS with higher net returns, BC ratio at Jammu.
- In organically grown cabbage at Hyderabad, the highest weed control efficiency was observed with polymulch + intra row HW at 30 DAT and it was followed by rice straw mulch and groundnut shell mulch at 25 and 50 DAT. The highest cabbage head diameter was recorded with groundnut shell mulching and significantly superior to hoeing and unweeded check but at par with other treatments.
- In organic cultivation of knoll-khol (variety of the species *Brassica oleracea*), paddy straw mulch 6/ha or 8 t/ha was found suitable for weed management at Jammu.
- At Bhubaneshwar, application of same proportion of organics through FYM, Vermicompost and Neem cake + Azotobacter + PSB to tomato with one mechanical weeding at 25 DAS/DAT and one manual weeding at 50 DAS/DAT in tomato resulted in the maximum fruit yield of tomato (17.79 t/ha).
- Application of glyphosate 25 g/ha at 30 DAS followed by 50 g/ha at 50-60 DAS caused 70% control of *Orobanche* in mustard with yield gain of 25% over untreated control at different demonstrations on farmers' fields of Haryana.

WP-2: Management of weeds in non-cropped and aquatic areas

- An ecofriendly and economic technique for management of submerged aquatic weed Indian star wort *(Hydrilla vertcillata)* was developed which has to be further refined. It was found that lime application either as quick lime or hydrated lime to increase the pH of water to neutrality can give more than 90 % control within 4 days of liming. This was field tested in farmers field and results are promising with same effectiveness as in artificial tanks.

- Biology and management of *Leptochloa chinensis* was studied in detail. It is a C4 grass. Seeds did not germinate under submerged conditions and hence not a serious weed in transplanted rice. However, it can pose serious competition in semi-dry rice, where a dry seed bed condition is available during initial phase of rice crop. In fields where *Leptochloa* is a problem, farmers can opt either pre emergence herbicides like oxyfluorfen or pretilachlor or pyrazosulfuron. For post-emergence control, graminicides like fenoxaprop or cyhalofop may be used.

WP-3: Fate of herbicide residues in different agroecosystem

- The half-lives (DT50) of pyroxasulfone ranged from 20.43 to 40.83 days at application rates of 76.5, 102, 127.5, 204 and 255 g/ ha.
- Initial residues of metribuzin in soil ranged from 0.035 to 0.101 and 0.031 to 0.092 μg/g in recommended herbicide and IWM treatments, respectively. Residues of metribuzin (<0.01 μg/g) and clodinafop-propargyl (<0.05 μg/g) were below the detectable limit in soil and wheat at harvest at Ludhiana.
- At Hyderabad, the initial residues of atrazine varied from 0.403 to 0.412 μg/g in the soil samples 4 hours after herbicide application. In the soil sample and maize grain/plant samples collected at the time of harvest, the atrazine residues were below the detection limit of 0.05 μg/g in all the soil samples.
- At Coimbatore, residues of different herbicides during *Rabi* 2021(*Baby corn*) was analyzed at different periods *viz.*, 0,3,7 15,30 45 and at harvest. The conventional tillage plots recorded lower residues when compared to zero tillage with and without residue. The dissipation of all the herbicide molecule was found to follow first order reaction kinetics (R2 > 0.90) with the half-life of 12.8-17.6 days for atrazine, 10.0 to 11.4 days for tembotrione, 7.9 to 9.7 days for topramezone and 5.9 to 6.7 days for 2,4-D, irrespective of tillage practices and weed management methods.
- At Hyderabad, recovery of oxyfluorfen in soil varied from 88.2 to 94.2%. In cabbage, the recovery varied from 84.1 to 86.6 %, respectively. LOQ of oxyfluorfen in soil was 0.05 mg/kg, and in onion bulb LOQ was 0.05 mg/kg. Residues of oxyfluorfen in soil and cabbage samples and soil at the time of harvest were below the detection limit of 0.05 mg/kg.
- Clodinafop and metsulfuron-methyl residues in soil and grain samples from farmers field of Kangra district were analyzed by HPLC-DAD for their residue content which were found below detectable limits. Similarly residues of different herbicides *i.e.* alachlor (0.01-0.04 ppm), pendimethalin (0.012- 0.10 ppm) and metribuzin (0.007- 0.014 ppm) in the samples collected from the farmers fields in the Kullu district were detected in less than 10% of samples and were below MRL values..

WP-4: Demonstration and impact assessment of weed management technologies

- In groundnut at Anand, fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% (premix) *fb* IC+HW at 40 DAS and imazethapyr 35% + imazamox 35% WG 70 g/ha *fb* IC+HW at 40 DAS were found equally effective for weed control as IC *fb* HW at 20 and 40 DAS (farmers practice) with higher B:C (2.87, 2.74, respectively) compared to farmer's practice (2.66).
- On-farm weed management technology demonstration at Palampur revealed 40.7% increase in yield of wheat, 38.7% increase in pod yield of peas, 64% increase in yield of rice, 25.6% increase in yield of maize, 53.5% increase in yield of soybean and 31.3% increase in yield of turmeric over the farmer's technique of weed control.
- In OFR, in wheat, pyroxasulfone 127.5 g/ha proved effective against resistant *P. minor*. In maize, integration of tembotrione (band spray) and inter-culture provided similar weed control to tembotrione (blanket) at Ludhiana.
- In direct-seeded rice, the highest grain yield and BC ratio were recorded in pendimethalin 1000 g/ha (PE) *fb* bispyribac-sodium 25 g/ha + ethoxysulfuron-ethyl 18 g/ha as post-emergence at farmers fields in OFR trials at Jammu.
- Wheat seeds distributed to 200 SC Farmers and herbicide clodinafop + metsulfuron to 150 SC farmers and knapsack sprayer to 8 farmers at Chak Jagtu village of Jammu.
- 'KAU weed wiper' developed by AICRP-WM, KAU Thissur has been awarded Indian Patent and this technology is being popularized through SCSP scheme, also supplying weed wiper to SC farmers and organizing field level demonstrations.
- On the whole 232 OFTs and FLDs were carried out during the year 2021.

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 Management by the ICAR in collaboration with the United States Department of Agriculture (USDA) at six locations, 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.P.); and Himachal Pradesh Krishi Vishwa Vidyalaya, Palampur (H.P.). The project came into operation in April, 1978 with the financial outlay of Rs. 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.

The activities of the project were extended covering 7 more cooperating centres, 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 Rs 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, 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, Bhubaneswar (Orissa); Acharya N.G. Ranga Agricultural University, Hyderabad (Andhra Pradesh) and ICAR Research Complex, Barapani (Meghalaya) were initiated at total outlay of Rs. 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, 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), XI plan (2007-2012) and XII plan (2012-17) the total expenditure incurred under AICRP-WM was Rs. 823.79, 1696.57, 3548.78 and 4007.26 lakhs, respectively. During XII Plan (2012-17), four AICRP on Weed Management centres, 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 Sciences, Raichur; Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola; Bidhan Chandra Krishi Viswavidyalaya, Kalyani; Sher-eKashmir University of Agricultural Sciences and Technology, Jammu and Central Agricultural University, Pasighat by redeployment of existing manpower were opened. As per the approval of SFC (2017-20), another six coordinating centres (NDUAT, Faizabad; CAU, Pasighat; RAU, Pusa; BAU, Ranchi; DBSKKV, Dapoli and UAS, Raichur) were closed w.e.f. 1.4.2018.

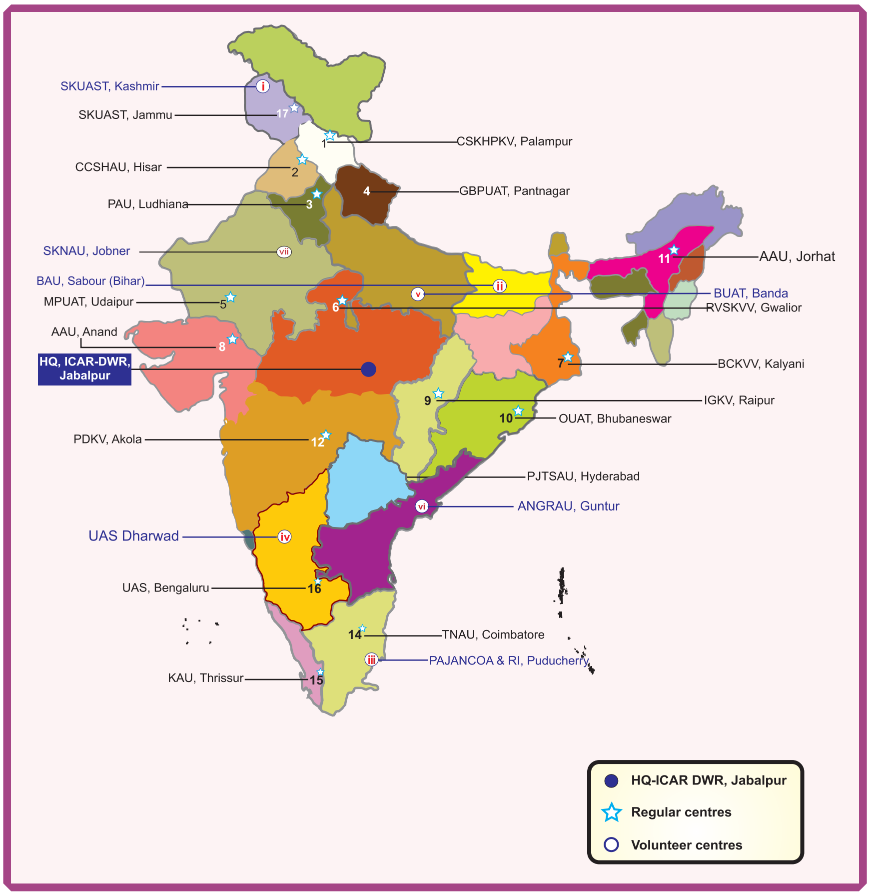
The coordinating unit of the project was located initially at Central Rice Research Institute, Cuttack, and shifted to National Research Centre for Weed Science in 1989. Later in 2009, NRC for Weed Science was upgraded to Directorate of Weed Science Research. During XII Plan (2012-17), it has renamed 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 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.



Regular Centre

1	CSKHPKV, Palampur
2	CCSHAU, Hisar
3	PAU, Ludhiana
4	GBPUAT, Pantnagar
5	MPUAT, Udaipur
6	RVSKVV, Gwalior
7	BCKV, Kalyani
8	AAU, Anand
9	IGKV, Raipur
10	OUAT, Bhubaneswar
11	AAU, Jorhat
12	PDKV, Akola
13	PJTSAU, Hyderabad
14	TNAU, Coimbatore
15	KAU, Thrissur
16	UAS, Bengaluru
17	SKUAST, Jammu

Volunteer Centres

i	SKUAST, Kashmir
ii	BAU, Sabour
iii	PAJNCOA & RI Punducherry
iv	UAS, Dharwad
v	BUAT, Banda
vi	ANGRAU, Guntur
vii	SK NAU, Jobner

2. STAFF POSITION AND EXPENDITURE

AICRP on Weed Management is presently under operation in 17 State Agricultural Universities in the country and represent diverse agro-ecological regions. Altogether, 34 scientists of Agronomy, Residue Chemistry and Taxonomy are working in inter-disciplinary mode. Besides 17 main centres, 7 volunteer centres are also in operation. The details of staff position and funds allocated in the financial year 2021-22 are given below:

Staff position at different coordinating centres during 2021-22

S.No.	Centre	Scientific		Technical		Driver	
		Sanctioned	Filled	Sanctioned	Filled	Sanctioned	Filled
1.	PAU, Ludhiana	2	2	1	1	-	-
2.	UAS, Bengaluru	2	2	1	1	1	1
3.	RVSKVV, Gwalior	2	2	1	1	-	-
4.	GBPUAT, Pantnagar	2	2	1	1	-	-
5.	CSKHPKV, Palampur	2	1	1	1	1	1
6.	AAU, Jorhat	2	2	1	1	1	1
7.	AAU, Anand	2	1	1	1	1	1
8.	TNAU, Coimbatore	2	2	1	1	1	1
9.	KAU, Thrissur	2	2	1	1	1	1
10.	OUAT, Bhubaneshwar	2	2	1	1	1	1
11.	PJTSAU, Hyderabad	2	2	1	-	1	-
12.	CCSHAU, Hisar	2	2	1	-	-	-
13.	IGKVV, Raipur	2	2	1	1	-	-
14.	PDKV, Akola	2	2	1	1	-	-
15.	MPUAT, Udaipur	2	2	1	-	-	-
16.	SKUAST, Jammu	2	2	1	1	-	-
17.	BCKV, Kalyani	2	2	1	1	-	-
	Total	**34**	**32**	**17**	**14**	**08**	**07**

Funds released to different coordinating centres during the financial year 2021-22

(₹ in lakh)

S.N.	Centre name	Capital		Grant in aid Salary	Grant in aid General					Total	Total ICAR share
		Other than NEH and TSP	SCSP	Pay & Allowances	TA	Research Expenses	Operational Expenses	HRD	SCSP		
1	PAU, Ludhiana	3.00	0.10	33.64	0.30	4.82	2.25	0.30	2.38	10.05	46.79
2	UAS, Bengaluru	2.36	0.05	42.79	0.30	4.33	2.33	0.30	2.33	9.59	54.79
3	RVSKVV, Gwalior	3.95	0.14	32.84	0.30	4.33	2.25	0.30	2.37	9.55	46.48
4	GBPUAT, Pantnagar	1.19	0.07	41.47	0.30	4.33	2.88	0.00	2.33	9.84	52.57
5	CSKHPKV, Palampur	2.38	0.05	52.57	0.30	4.81	3.00	0.30	2.33	10.74	65.74
6	AAU, Jorhat	2.34	0.00	49.80	0.30	4.33	2.25	0.30	0.00	7.18	59.32
7	AAU, Anand	0.30	0.00	37.45	0.30	4.33	2.25	0.30	0.00	7.18	44.93
8	TNAU, Coimbatore	1.40	0.17	39.43	0.30	4.81	2.25	0.30	2.33	9.99	50.99
9	KAU, Thrissur	2.80	0.10	35.24	0.30	4.33	2.57	0.00	2.33	9.53	47.67
10	OUAT, Bhubaneshwar	2.96	0.15	37.27	0.30	4.33	2.25	0.30	2.41	9.59	49.97
11	PJTSAU, Hyderabad	0.00	0.00	46.76	0.30	4.81	2.25	0.30	0.00	7.66	54.42
12	CCSHAU, Hisar	0.00	0.05	23.55	0.30	4.33	2.25	0.00	2.33	9.21	32.81
13	IGKV, Raipur	0.00	0.00	36.86	0.30	4.33	2.25	0.00	0.00	6.88	43.74
14	PDKV, Akola	0.00	0.00	30.18	0.30	4.33	2.25	0.30	0.00	7.18	37.36
15	BCKV, Kalyani	0.00	0.10	36.11	0.30	4.31	2.25	0.30	2.33	9.49	45.70
16	MPUAT, Udaipur	0.00	0.05	37.23	0.30	4.30	3.00	0.30	2.33	10.23	47.51
17	SKUAST, Jammu	0.00	0.05	40.66	0.30	4.30	2.25	0.00	2.33	9.18	49.89
	PC, Unit, Jabalpur	0.25	0.00	0.00	0.00	3.98*	0.00	0.00	0.00	3.98	4.23
	Total	**22.93**	**1.08**	**653.85**	**5.10**	**79.44**	**40.78**	**3.60**	**28.13**	**157.05**	**834.91**

* Rs. 0.60 lakh each to 6 volunteer centres viz. SKUAST, Kashmir; BUAT, Banda; PAJANCOA&RI, Karaikal, Puducherry; UAS, Dharward; SKNAU, Jobner; ANRAU, Guntur and Rs. 0.30 lakh to BAU, Sabour were released.

3. RESEARCH ACHIEVEMENTS

WP 1 Development of location-specific sustainable weed management practices

WP 1.1 Weed management in major crops and cropping systems

TNAU, Coimbatore

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

The experiment was conducted in RBD. The rice variety CO(R) 51 was grown in the experimental field during *Kharif* and *Rabi* seasons. Among the grasses, *Echinocloa crus-galli* and *Leptochloa chinensis* were predominant, and *Ludwigia parviflora* was dominant species in broadleaf weeds both during *Rabi* (2020-21) and *Kharif (2021)* season.

During *Rabi* season, significantly higher grain yield of 7832 kg/ha was recorded with pyrasosulfuron-ethyl (10% WP) PE *fb* penoxsulam+ cyhalofop butyl POE at 30 DAT (T_3) followed by bensulfuron-methyl PE *fb* bispyribac sodium (10% EC) POE. Higher net returns of Rs. 59365 and B C ratio (2.15) was recorded with pyrasosulfuron-ethyl (10% WP) PE *fb* penoxsulam+ cyhalofop butyl POE **(Table 1.1.1)**. The total energy requirement of various treatments ranged from 22599 MJ/ha to 103172 MJ/ha. The energy use efficiency was higher in pyrasosulfuron-ethyl (10% WP) PE *fb* penoxsulam+cyhalofop butyl POE followed by pyrasosulfuron ethyl PE *fb* bispyribac sodium POE treatments.

Table 1.1.1 Effect of treatments on total weed density, total weed dry weight, grain yield and net returns in transplanted lowland rice-rice cropping system during *Rabi* season (2020-21).

Treatment	30 DAT			60 DAT			Grain yield (kg/ha)	Net returns (Rs./ha)
	Total weed density (No/m²)	Total weed dry weight (g/m²)	WCE (%)	Total weed density (No/m²)	Total weed dry weight (g/m²)	WCE (%)		
T1	2.92 (10.9)	2.37 (6.8)	62.6	3.92 (14.21)	2.16 (4.83)	59.8	6034	30028
T2	1.43 (3.1)	1.33 (1.5)	62.7	1.22 (1.43)	1.58 (0.34)	75.7	6489	39251
T3	1.41 (0.0)	1.41 (0.0)	90.8	1.86 (4.1)	1.00 (1.0)	85.6	7832	59365
T4	3.42 (11.97)	2.77 (6.4)	60.2	5.33 (25.41)	4.08 (11.21)	65.7	7417	50397
T5	3.81 (16.11)	2.21 (4.31)	54.0	5.87 (29.9)	3.84 (9.98)	56.4	6621	42129
T6	7.08 (50.2)	2.85 (12.4)	-	9.56 (99.1)	4.81 (22.4)	-	2330	4236
SEm±	**0.10**	**0.09**	**-**	**0.10**	**0.09**	**-**	**180**	
LSD (P=0.05)	**0.33**	**0.19**	**-**	**0.23**	**0.23**	**-**	**379**	

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

T_1: Pyrasosulfuron-ethyl @ 20 g/ha at 3 DAT *fb* One HW at 30 DAT (*Kharif* and *Rabi*)
T_2: Pyrasosulfuron-ethyl @ 20 g/ha at 3 DAT One HW at 30 DAT (*Kharif*)
Bensulfuron- methyl + pretilachlor @ 20 + 660 g/ha at 30 DAT *fb* One HW at 30 DAT (*Rabi*)
T_3: Pyrasosulfuron-ethyl @ 20 g/ha at 3 DAT *fb* penoxsulam+ cyhalofop butyl (RM) @ 135 g/ha at 25 (*Kharif* and *Rabi*)
T_4: Pyrasosulfuron-ethyl @ 20 g/ha at 3 DAT *fb* Bispyribac-Na @ 25 g/ha at 3 DAT (*Kharif*)
Bensulfuron-methyl 600 g/ha at 3 DAT *fb* bispyribac-sodium @ 25 g/ha at 3 DAT (*Rabi*)
T_5: Hand weeding twice
T_6: Unweeded check

In *Kharif* 2021, significantly higher grain yield of 7755 kg/ha was recorded with pyrasosulfuron-ethyl (10% WP) PE *fb* penoxsulam+ cyhalofop butyl POE at 30 DAT (T_3) followed by pyrasosulfuron ethyl (10% WP) PE *fb* bispyribac sodium (10% EC) POE. Higher net return of Rs. 58783 and B C ratio (2.13) was recorded with pyrasosulfuron-ethyl (10% WP) PE *fb* penoxsulam+ cyhalofop butyl POE **(Table 1.1.2)**. During *Kharif* 2021, the total energy requirement of various treatments ranged from 22261 MJ/ha to 102040 MJ/ha. The energy use efficiency was recorded higher in pyrasosulfuron-ethyl (10% WP) PE *fb* penoxsulam+ cyhalofop butyl POE followed by pyrasosulfuron ethyl PE *fb* bispyribac sodium POE treatments.

Table 1.1.2 Effect of treatments on total weed density, total weed dry weight, grain yield and net returns in transplanted lowland rice-rice cropping system during *Kharif* season (2021)

Treatment	30 DAT			60 DAT			Grain Yield (kg/ha)	Net returns (Rs./ha)
	Total weed density (No/m²)	Total weed dry weight (g/m²)	WCE (%)	Total weed density (No/m²)	Total weed dry weight (g/m²)	WCE (%)		
T1	2.93 (10.9)	2.38 (6.8)	64.6	3.62 (13.21)	2.14 (4.63)	60.1	5975	29733
T2	1.43 (3.1)	1.34 (1.6)	61.5	1.67 (3.0)	1.57 (0.33)	74.8	6426	38866
T3	1.41 (0.0)	1.41 (0.0)	92.5	1.21 (1.41)	1.00 (1.0)	87.2	7755	58783
T4	3.32 (11.77)	2.79 (6.6)	61.7	4.81 (23.31)	3.67 (12.41)	66.4	7345	49903
T5	3.82 (16.21)	2.31 (4.41)	54.1	5.87 (29.9)	3.83 (9.97)	57.1	6556	41716
T6	7.09 (50.3)	2.84 (12.5)	-	9.55 (99.0)	4.65 (21.3)	-	2307	4195
SEm±	**0.11**	**0.08**	**-**	**0.11**	**0.11**	**-**	**178**	
LSD (P=0.05)	**0.35**	**0.19**	**-**	**0.24**	**0.22**	**-**	**376**	

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

T_1: Pyrasosulfuron-ethyl @ 20 g/ha at 3 DAT *fb* One HW at 30 DAT (*Kharif* and *Rabi*)
T_2: Pyrasosulfuron-ethyl @ 20 g/ha at 3 DAT One HW at 30 DAT (*Kharif*)
Bensulfuron- methyl + pretilachlor @ 20 + 660 g/ha at 30 DAT *fb* One HW at 30 DAT (*Rabi*)
T_3: Pyrasosulfuron-ethyl @ 20 g/ha at 3 DAT *fb* penoxsulam+ cyhalofop butyl (RM) @ 135 g/ha at 25 (*Kharif* and *Rabi*)
T_4: Pyrasosulfuron-ethyl @ 20 g/ha at 3 DAT *fb* Bispyribac-Na @ 25 g/ha at 3 DAT (*Kharif*)
Bensulfuron-methyl 600 g/ha at 3 DAT *fb* bispyribac-sodium @ 25 g/ha at 3 DAT (*Rabi*)
T_5: Hand weeding twice
T_6: Unweeded check

AAU, Jorhat

Long-term herbicidal trial in rice-rice cropping sequence

The initial weed flora in the autumn rice cropping was composed of grasses like *Echinochloa crusgalli, Hymanachne acutigluma, Isachne himalaica, Leersia hexandra, Oryza rufipogon, Paspalum conanjugatum;* sedges like *Cyperus iria, Eleocharis acutangula, Eleocharia dulcis* and *Scirpus maritimus,* and other than grasses and sedges were *Alternanthera philoxeroides, Ceratophyllum utricularia* complex, *Hydrolea zeylanica, Marsilia minuta, Monochoria vaginalis.*

Three weed species migrated and established in the experimental site were broadleaved herbs *Alternanthera sessilis* and *Limnophylla* spp., and the rhizomatious invasive perennial grass *Panicum repens*.

The autumn rice has been found to be more vulnerable to weed problem than *Kharif* rice and that might be due to gradual increase in atmospheric temperature as well as fluctuating rain and draught condition leading to enhanced germination of weed seeds available in soil seed bank.Weeds which are successfully controlled by continuous application of pertilachlor with 100% chemical fertilizer (T_1) and not reappeared in the field were *Cuphea balsamona, Ludwigia adscendens, Ludwigia linifolia* and *Marsilia minuta* among the broadleaf species, *Echinochloa crusgalli, Hymanachne acutigluma* and *Sacciolepis interrupta* among the grasses and the sedge *Eleocharis dulcis.* However, most of these species survivied in the field despite of application of pertilachlor when 25% fertilizer was substituted by organic source (T_2). Treatments that received pyrazosulfuron 25g/ha *fb* 2,4-D 0.5kg/ha (bispyribec sodium 25g/ha instead of 2,4-D since 2019) with 100% chemical fertilizer (T_3) and 25% fertilizer substituted by organic sources (T_4) have successfully controlled *Cuphea balsamona, Ludwigia linifolia, Marsilia minuta* and *Oxalis corniculata* among the broadleaf weeds, the grass species *Sacciolepis interrupta* and the sedge *Eleocharis dulcis.* However, these treatments could not control most of the grasses, sedges like *Cyperus iria* and *Scirpus* spp. and broadleaf species like *Alternanthera philoxeroides, Ceratphyllum-Utricularia* complex, *Hydrilla verticillata, Hydrolea zeylanica, Ludwigia adscendens* and *Monochoria vaginalis*.

Treatments (T5 & T6) where pyrazosulfuron 25g/ha has been rotated with pretilachlor, followed by 2,4-D 0.5 kg/ha (bispyribec sodium 25 g/ha instead of 2,4-D since 2019) were found effective in elimination of several weed species. Weed species which were not seen after 2018 in the plots that received these chemical combinations, along with 100% chemical fertilizers were *Ludwigia adscendens* and *Hydrilla verticillata* amongst the broadleaved species, and *Echinochloa crusgalli, Eleocharis acutangula, Eleocharis dulcis* and *Hymanachne acutigluma* amongst the narrow leaved species.

AAU, Jorhat

Weed management in rice-pea-rice cropping sequence

Weed density in pea was the highest in plots where previous *Kharif* rice established by direct seeding with 50% reduced tillage as compared to that of transplanting and direct seeding with drum seeder in puddle soil. Lowest weed density in pea at 30 DAS was observed in plots treated with pretilachlor 0.75 kg/ha PE in *Kharif* crop. However, the lowest weed density in pea at 60 DAS and weed dry-weight both at 30 and 60 DAS were recorded in plots treated with pyrazosulfuron-ethyl 25g/ha PE *fb* bispyribac-sodium 25 g/ha as POE at 30 DAS/DAP of previous *Kharif* rice. Among the yield attributing characters of pea the numbers of pods per pant and seed yield of relay pea crop were significantly influenced due to both main and sub-plot treatments applied to *Kharif* rice.

Among the crop establishment methods, conventional transplanting of *Kharif* rice (M_1) resulted in significantly higher number of pods per plant and seed yield of pea. While among the weed management practices, the highest number of pods/plant and seed yield of pea was observed in plots treated with pyrazosulfuron-ethyl 25g/ha PE *fb* bispyribac-sodium 25 g/ha POE at 30 DAS/DAP and pretilachlor 0.75 kg/ha as PE *fb* working with grubber/paddy weeder at 30DAS/DAP of *Kharif* rice, respectively.

AAU, Anand

Weed management in dry direct-seeded rice (DSR)

The experiment has been conducted in RBD with 3 replications with variety 'GAR 13' was grown. Major weeds observed in the experimental field were *Dactyloctenium aegyptium* (20.8%), *Digitaria sanguinalis* (6.93%), *Echinochloa colona* (6.93%), *Echinochloa crus-galli* (4.11%) in monocot weeds category whereas, *Phyllanthus niruri* (18.2%), *Oldenlandia umbellata* (15.6%), *Trianthema monogyna* (8.66%) and *Amaranthus viridis* (2.60%) in dicot weed category and *Cyperus rotundus* (7.14%) in sedge category.

Among the treatments, mechanical weeding at 20 and 40 DAS registered significantly higher grain yield (3.12 t/ha) as compared to rest of the treatment except application of pretilachlor 30% + pyrazosulfuron-ethyl 0.75% WG (600+15 g/ha) PE (Premix) *fb* 1 HW at 30 DAS, penoxsulam 1.02% + cyhalofop-butyl 5.1% OD 120 g/ha EPOE (PM) *fb* HW at 30 DAS, triafamone 20% + ethoxysulfuron 10% WG (44.0+22.5 g/ha) EPOE (PM) *fb* mechanical weeding at

30 DAS and bispyribac-sodium 10% SC 25 g/ha EPOE *fb* 1 HW at 30 DAS **(Table 1.1.3)**. Yield reduction due to presence of weed was recorded maximum under weed check treatment (74.7%). Maximum net returns of Rs 30,874/ha with B C ratio of 1.79 was recorded in penoxsulam 1.02% + cyhalofop-butyl 5.1% OD 120 g/ha EPOE (PM) *fb* 1 HW at 30 DAS with lowest weed index value of 0.96%.

Table.1.1.3 Effect of the treatments on weed control efficiency (WCE), grain yield, weed index, net returns and B C ratio of DSR.

	Treatment	WCE (%)		Grain yield (t/ha)	Weed Index (%)	Net returns (Rs/ha)	B:C
		30 DAS	60 DAS				
T_1	Pretilachlor 30% + pyrazosulfuron-ethyl 0.75% WG (600+15 g/ha) PE (PM)	85.2	70.5	1.74	44.2	5144	1.14
T_2	Pretilachlor 30% + pyrazosulfuron-ethyl 0.75% WG (600+15 g/ha) PE (PM) fb HW at 30 DAS	85.5	87.9	3.09	0.96	28474	1.68
T_3	Pretilachlor 50% EC 600 g/ha PE fb bispyribac-sodium 10% SC 25 g/ha PoE	84.7	72.8	2.56	17.9	20103	1.53
T_4	Bentazone 480 g/l SL 960 g/ha + bispyribac-sodium 10% SC 25 g/ha EPoE (TM)	66.1	41.2	1.33	57.4	-5063	0.86
T_5	Bispyribac-sodium 10% SC 25 g/ha EPoE *fb* HW at 30 DAS	75.0	90.0	2.92	6.41	25379	1.62
T_6	Metsulfuron-methyl 10% + chlorimuron-ethyl 10% WP 4 g/ha EPoE (PM)	43.4	28.3	0.95	69.6	-11642	0.66
T_7	Triafamone 20% + ethoxysulfuron 10% WG (44.0+22.5 g/ha) PoE (PM)	47.9	73.0	1.47	52.9	-2697	0.93
T_8	Triafamone 20% + ethoxysulfuron 10% WG (44.0+22.5 g/ha) EPoE (PM) *fb* mechanical weeding at 30 DAS	85.7	98.4	3.06	1.92	28490	1.70
T_9	Penoxsulam 1.02% + cyhalofop-butyl 5.1% OD 120 g/ha PoE (PM)	27.6	61.0	1.42	54.5	-2384	0.93
T_{10}	Penoxsulam 1.02% + cyhalofop-butyl 5.1% OD 120 g/ha EPoE (PM) *fb* HW at 30 DAS	91.1	89.5	3.09	0.96	30874	1.79
T_{11}	Mechanical weeding at 20 & 40 DAS	93.3	92.3	3.12	0.0	21988	1.45
T_{12}	Weedy check			0.79	74.7	-13234	0.60
	S. Em. ±			**0.09**	**-**		
	LSD (P=0.05)			**0.25**	**-**		

PAJANCOA & RI, Punducherry (Volunteer centre)

Weed management options for control of complex weed flora in dry direct- seeded rice (*Rabi* 2020-21)

Experimental field was dominated by sedges (36.3%), broad-leaf weeds (34.1%) and grasses (29.6%). Predominant weeds of the experimental field were *Echinochloa colona* Link., *Leptochloa chinensis* (L.) Nees., *Echinochola crus-galli* (L.), *Cyperus iria* L., *Cyperus difformis* L., *Fimbristylis miliaceae* L., *Bergia capensis* L., *Ludwigia parviflora* L., *Eclipta alba* (L.) Hassk, *Marsilea quadrifolia* L., *Sphaeranthus indicus* L. and *Aeschynomene indica* L. at 60 DAS.

Among the seed rate, 100 kg/ha reduced the population of grasses, sedges, broad-leaved weeds and total weed density compared to 75 and 50 kg/ha, however, there was no significant difference among them. Weed management practices significantly reduced the weed density at 60 DAS. Sequential application of pendimethalin 1 kg/ha PE *fb* bispyribac-sodium 20 g/ha POE at 20 DAS recorded lower total weed density, higher grain yield of 3.59 t/ha, higher net returns of Rs 40180/ha with B C ratio of 1.65.

SKUAST, Jammu

Effect of green manures and herbicides on weed dynamics and yield of transplanted rice-wheat cropping system

The weed flora included *Phalaris minor, Rumex* spp., *Anagalis arvesnsis and Medicago* spp., as major weeds and other weeds like *Vicia* spp., and *Melilotus* spp. etc. were also observed in wheat.

Among the nutrient levels, the lowest weed density and weed biomass of grassy (*P. minor*) and broadleaf weeds were observed in 125% RDF, which was statistically at par with 100% RDF and significantly lower than 75% RDF. The higher nutrient levels significantly influenced the total weed density and weed biomass. Among the herbicidal treatments, lower *P. minor* density and biomass was recorded in clodinafop propargyl + metribuzin (54+120 g/ha) at 30-35 DAS, which was statistically at par with clodinafop propargyl+metsulfuron (60 +4 g/ha) at 30-35 DAS and significantly lower than sulfosulfuron + carfentrazone (25+20 g/ha) at 30-35 DAS and mesoulfuron-methyl + iodosulfuron- methyl sodium 14.4 g/ha at 30-35 DAS. The herbicidal treatments recorded non-significant effect on broadleaved weed density, total weed density, broadleaved weed biomass and total biomass of weeds. Among the nutrient levels, highest grain and straw yields were observed in 125% RDF, which was statistically at par with 100% RDF and significantly higher than 75% RDF. 125% RDF also recorded highest gross, net returns and B C ratio. The herbicidal treatments registered non-significant effect on grain and straw yields of wheat. However, highest grain yield (4.55 t/ha) was recorded with clodinafop propargyl + metsulfuron-methyl (60+4 g/ha) at 30-35 DAS however, highest net returns and B C ratio were recorded in clodinafop propargyl + metribuzin (54+120 g/ha) at 30-35 DAS **(Table 1.1.4)**.

Table 1.1.4 Effect of nutrient levels and herbicides on grain yield and economics of wheat (*Rabi* 2020-21)

Treatments	Grain yield (t/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B:C
Nutrient Levels				
75% RDF	3.98	94174	69274	2.78
100% RDF	4.64	109242	83038	3.17
125% RDF	4.89	114805	87468	3.18
SEm ±	0.09	-	-	-
LSD (p=0.05)	0.34	-	-	-
Herbicides				
Sulfosulfuron + carfentrazone-ethyl 25+20 g/ha at 30-35 DAS	4.52	106424	80369	3.08
Clodinafop propargyl + metsulfuron- methyl 60+4 g/ha	4.55	107315	80885	3.05
Clodinafop propargyl + metribuzin 54+120 g/ha	4.52	106510	81086	3.15
Mesoulfuron-methyl + iodosulfuron- methyl sodium 14.4 g/ha	4.41	104046	77366	2.90
SEm ±	**0.09**	**-**	**-**	**-**
LSD (p=0.05)	**NS**	**-**	**-**	**-**
Interaction	**NS**	**-**	**-**	**-**

Transplanted rice (*Kharif* 2021)

The weed flora *Echinochloa* spp., *Alternanthera philoxeroides, Caesulia axilaris,* and *Cyperus* spp. were recorded as major weeds in the experimental site.

Different green manure crops recorded non-significant effect on weed density and weed biomass at 60 DAT and at harvest. Among the herbicidal treatments, lowest total weed density and biomass were recorded with triafamone + ethoxysulfuron 66.5 g/ha at 25 DAT and it was significantly superior to bispyribac-sodium 25 g/ha at 25 DAT and pretilachlor + pyrazosulfuron-ethyl 615 g/ha PE. Different green manure crops showed non-significant effect on yield attributes and yields of transplanted rice. Among the herbicidal treatments, higher yield attributes and yields of rice were recorded with triafamone + ethoxysulfuron 66.5 g/ha at 25 DAT and it was statistically at par with bispyribac-sodium 25 g/ha at 25 DAT and two mechanical weeding at 20 and 40 DAT. Among the green manures, highest B C ratio was recorded with green manuring of dhaincha and among the weed management treatments, B C ratio was recorded with application of triafamone + ethoxysulfuron 66.5 g/ha at 25 DAT **(Table 1.1.5)**.

Table : 1.1.5 Effect of nutrient levels and herbicides on grain yield and economics of transplanted rice (*Kharif* 2021)

Treatments	Grain yield (t/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B:C
In-situ green manuring				
Cowpea	2.69	109087	69015	1.73
Dhaincha	2.75	111579	71181	1.77
Cluster bean	2.70	109448	69369	1.74
SEm ±	**0.06**	-	-	-
LSD (p=0.05)	**NS**	-	-	-
Herbicides				
Pretilachlor+pyrazosulfuron -ethyl 600+15 g/ha as PE	2.58	104761	65602	1.68
Bispyribac-sodium 25 g/ha at 25 DAT	2.69	109090	70205	1.81
Triafamone + ethoxysulfuron 66.5 g/ha at 25 DAT	2.72	110346	72880	1.95
Mechanical weeding at 20 & 40 DAT	2.86	115954	70733	1.56
SEm ±	**0.07**	-	-	-
LSD (p=0.05)	**0.19**	-	-	-
Interaction	**NS**	-	-	-

SKUAST, Jammu

Effect of green manures and herbicides on weed dynamics and yield of direct-seeded rice-wheat cropping system

Wheat (*Rabi* 2020-21):

The weed flora included *Phalaris minor*, *Ranunculus arvensis, Rumex* spp., *Anagalis arvensis* and *Medicago* spp., as major weeds and other weeds like *Vicia* spp., and *Melilotus* spp. etc were observed in wheat.

Significantly lower weed density of *A. arvensis* was observed in zero-tillage wheat than the conventional tillage and FIRB method, however; significantly higher density of *Medicago* spp., other weeds and total weed were recorded in zero-tillage as compared to the conventional tillage and FIRB method. The conventional tillage recorded significantly lower biomass of BLWs than other establishment methods. Highest weed control efficiency was observed in pendimethalin 1 kg/ha PE. Among wheat establishment, the highest grain yield was observed in conventional tillage followed by FIRB without having any significant difference among the establishment techniques and herbicidal treatments. However, highest values of net returns and B C ratio were recorded in zero-tillage and in pendimethalin 1 kg/ha PE **(Table 1.1.6)**.

Table 1.1.6 Effect of establishments and pre-emergence herbicides on grain yield and economics of wheat (*Rabi* 2020-21)

Treatments	Grain yield (t/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B:C
Wheat establishment				
Conventional tillage	4.70	108984	82476	3.17
Zero tillage	4.38	101622	78214	3.38
FIRB	4.61	106895	79087	2.89
SEm ±	**0.08**	-	-	-
LSD (p=0.05)	**NS**	-	-	-
Herbicides				
Pendimethalin 1 kg/ha as PE	4.77	110704	87489	3.81
Flumioxazin 125 g/ha as PE	4.75	110466	86791	3.69
Pyroxasulfone 127.5 g/ha as PE	4.76	110725	82875	2.99
Weed free	5.11	118393	84493	2.50
Weedy check	3.43	78882	57982	2.75
SEm ±	**0.11**	-	-	-
LSD (p=0.05)	**0.31**	-	-	-
Interaction	**S**	-	-	-

Direct-seeded rice (*Kharif* 2021)

The weed flora *Echinochloa* spp., among grassy weeds, *Digera arvensis, Physalis minima* and *Caesulia axilaris* amongst broadleaf weeds and *Cyperus* spp. were mainly recorded as major weeds and other weeds *like Digitaria sanguinalis, Dactyloctenium aegyptium, Cyanodon dactylon*, *Solanum nigrum* and *Phyllanthus niruri* were recorded as other weeds.

Table :1.1.7 Effect of in-situ green manuring and herbicides on economics of direct-seeded rice (*Kharif*-2021)

Treatments	Grain yield (t/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B:C
In-situ green manuring				
Cowpea	2.44	99055	65903	1.99
Dhaincha	2.51	101929	68328	2.03
Stale seed bed	2.03	82821	53220	1.79
SEm ±	**0.05**	-	-	-
LSD (p=0.05)	**0.20**	-	-	-
Herbicides				
Pendimethalin 1.0 kg/ha as PE	1.77	72782	41357	1.31
Bispyribac-sodium 25 g/ha at 25 DAS	2.33	94697	62771	1.95
Triafamone + ethoxysulfuron 66.5 g/ha at 25 DAS	2.35	95474	64966	2.11
Pendimethalin 1 kg/ha as PE *fb* bispyribac-sodium 25 g/ha at 25 DAS	2.59	104775	70701	2.08
Pendimethalin 1 kg/ha as PE *fb* triafamone + ethoxysulfuron 66.5 g/ha at 25 DAS	2.60	105280	72624	2.23
SEm ±	**0.05**	-	-	-
LSD (p=0.05)	**0.15**	-	-	-
Interaction	**S**	-	-	-

Different green manure crops and stale seedbed registered non-significant effect on weed total density and weed biomass at 60 DAS and at harvest. Among the weed management treatments the lowest total weed density and biomass were recorded in pendimethalin 1 kg/ha PE *fb* triafamone + ethoxysulfuron 66.5 g/ha at 25 DAS, which were statistically at par among each other. Among the *in-situ* green manuring and herbicidal treatments highest grain yield, net returns and B C ratio were obtained in dhaincha and sequential application of pendimethalin 1 kg/ha PE *fb* triafamone + ethoxysulfuron 66.5 g/ha at 25 DAS **(Table 1.1.7)**.

BUAT, Banda (Volunteer Centre)

Study on weed dynamics and weed management strategies in wheat under rice-wheat crop sequence of Buldelkhand region of U.P.

The major weeds species recorded in experimental site were *Chenopodium album*, *Chenopodium murale, Anagalis arvensis, Spergula arvensis, Trifolium repens, Lathyrus aphaca, Vicia sativa*, etc.

Data on weed population revealed more weed population in conventional tillage plots in comparison to zero tillage plots. Application of premix herbicide sulfosulfuron + metsulfuron-methyl 32 g/ha POE controlled the weeds effectively and recorded highest B C ratio of 2.6 under zero tillage. Zero tillage recoded highest grain yield of 4.2 t/ha.

BCKV, Kalyani

Study on weed dynamics and weed management strategies in rice-wheat-green manure cropping system under new alluvial soils

Transplanted rice (*Kharif* 2021)

Major weed flora recorded in the experimental field were *Echinochloa crusgalli, E. colona, Chloris barbata* among the grasses, *Cyperus iria, C. rotundus* among the sedges and *Commelina benghalensis, Marsilea quadrifolia, Ludwigia parviflora, Monochoria vaginalis, Alternanthera sessilis* and *Ammannia baccifera* among the broadleaf weeds.

Among the treatments pretilachlor 0.70 kg/ha PE *fb* passing of cono-weeder has been found most effective for controlling grasses and broadleaf weeds with highest value of weed control efficiency (81.09%). It was closely followed by pretilachlor 0.70 kg/ha PE *fb* triafamone + ethoxysulfuron 44.0+22.5 g/ha (79.05%). Maximum grain yield of 4.9 t/ha was recorded with the treatment pretilachlor 0.70 kg/ha PE *fb* passing of cono-weeder.

IGKV, Raipur

Weed management in transplanted rice-chickpea cropping system

Major weed flora observed in the experimental field of transplanted rice during rainy seasons were *Echinochloa colona, Ischeamum rugosum* among grasses; *Alternanthera triandra, Cyanotis axillaris* among broadleaf weeds and *Cyperus iria* among sedges. Other weeds present in lower density were *Commelina benghalensis, Croton bonplandianus, Spilanthus acmella, Ludwigia parviflora. Ischeamum rugosum* appeared during later stage of the crop.

The lowest weed biomass (21.17 g/m^2) and the highest WCE (72.30%) were registered under the treatment of pretilachlor+bensulfuron 660 g/ha EPoE (10-12 DAT) *fb* penoxsulam + cyhalofop 135 g/ha PoE (25-30 DAS). Maximum grain yield (6.08 t/ha), highest net returns (Rs. 80317/ha) and higher B C ratio (3.13) were recorded with the treatment pretilachlor+ bensulfuron 660 g/ha EPoE (10-12 DAT) *fb* penoxsulam + cyhalofop 135 g/ha PoE (25-30 DAS).

Among the 12 different weed management treatments, topramezone 25.28 g/ha as POST (18-20 DAS) has been recoded as best treatment in terms of lowest weed dry weight and highest weed control efficiency of 82.93 and 81.08% at 60 DAS and at harvest, respectively. Significantly higher seed yield (1.49 t/ha) was recorded with the treatment topramezone 25.28 g/ha as POST (18-20 DAS) over the other chemical weed control treatments except oxyfluorfen 140 g/ha as PE (1.29 t/ha), flauzifop-p-butyl + fomesafen 250 g/ha POST (1.28 t/ha) and flauzifop-p-butyl + fomesafen 125 g/ha POST (1.24 t/ha). Topramezone 25.28 g/ha as POST (18-20 DAS) also registered highest net return (Rs. 53290/ha) and B C ratio (3.35) **(Table 1.1.8)**.

Table 1.1.8 Effect of treatment on WCE, seed yield, net returns and B C ratio of chickpea.

Treatments	WCE (%) 60 DAS	WCE (%) At Harvest	Seed yield (t/ha)	Net returns (₹/ha)	B:C
Pendimethalin 678 g/ha PE	49.60	43.92	1.12	36165	2.75
Pendimethalin + imazethapyr 1000 g/ha as PE	53.88	46.69	1.13	36930	2.78
Oxyfluorfen 140 g/ha as PE	65.42	55.82	1.29	45090	3.18
Topramezone 25.28 g/ha as POST (18-20 DAS)	82.93	81.08	1.49	53290	3.35
Pendimethalin 678 g/ha PE fb quizalofop 50 g/ha POST	59.01	53.70	1.18	37725	2.70
Pendimethalin 678 g/ha PE fb propaquizofop 50 g/ha POST	56.69	50.40	1.17	38055	2.75
Flauzifop-p-butyl + fomesafen 125 g/ha POST	72.33	68.43	1.24	42285	2.04
Flauzifop-p-butyl + fomesafen 250 g/ha POST	76.31	72.76	1.28	44050	3.06
Propaquizafop + imazethapyr 125 g/ha POST	42.62	38.08	1.11	35995	2.74
Mechanical weeding at 20 fb 40 DAS	81.56	71.38	1.31	45610	3.15
Hand weeding at 30 DAS/Farmers practice	88.86	78.21	1.39	44860	2.71
Weedy check	0.00	0.00	0.53	8830	1.49
SEm±			**0.10**	**-**	**-**
LSD (P= 0.05)			**0.30**	**-**	**-**

PDKV, Akola

Productivity and economics of rice-chickpea cropping sequence under different fertigation level and weed management practices

Rice (*Kharif* 2021)

The weed dry matter production was significantly influenced by different fertigation levels. At all the growth stages of rice crop lowest weed dry matter was recorded with all fertigation levels over 100% RDF (120:60:60 NPK kg/ha) where N was applied in 3 equal splits at basal, 20 and 40 DAS. Among different fertigation levels lowest weed dry matter accumulation was recorded with fertigation level of 75% RDNK, however, it showed increasing trend with further increase in fertigation levels i.e., 100 and 125% RDNK. Among the different herbicidal treatments, minimum weed dry matter was recorded with pretilachlor + pyrazosulfuron-ethyl 0.615 kg/ha PE *fb* bispyribac-sodium 0.025 kg/ha POE (25 DAS) followed by pretilachlor 0.75 kg/ha PE *fb* bispyribac-sodium 0.025 kg/ha POE (25 DAS) (**Table 1.1.9**). An interaction effect of dufferent fertigation levels and weed management practices on dry matter accumulation by weed was found non-significant at all the growth stages of rice. Highest weed control efficiency was recorded with fertigation levels with 75% RDNK in 5 splits. Among the weed management treatments maximum values of weed control efficiency at all the growth stages of rice were recorded with farmers' practice treatment where hoeing and hand weeding practices were carried out. The second-best treatment was pretilachlor + pyrazosulfuron-ethyl 0.615 kg/ha PE *fb*

Table 1.1.9 Grain yield and economics of direct-seeded rice as influenced by different fertigation levels and weed management practices

Treatment	Grain yield (t/ha)	Net returns (₹/ha)	B:C
A) Fertigation levels			
F_1 : 100% RDF soil application (120:60:60) NPK kg ha^{-1} (N in 3 Spilts)	4.82	43046	1.89
F_2 : 75% RDNK in 5 Splits	4.60	39567	1.84
F_3 : 100% RDNK in 5 Splits	5.00	47708	1.97
F_4 : 125% RDNK in 5 Splits	5.12	51484	2.02
SE(m)±	0.03	-	-
LSD (P=0.05)	0.10	-	-
B) Weed management practices			
W_1: Pendimethalin 1 kg/ha PE *fb* bispyribac sodium 0.025 kg/ha at 25 DAS.	5.11	46092	1.91
W_2: Pretilachlor 6% + pyrazosulfuron-ethyl 0.15%, 0.615 kg/ha PE *fb* bispyribac sodium 0.025 kg/ha at 25 DAS.	5.35	51758	2.00
W_3: Pretilachlor 0.45 kg/ha PE *fb* bispyribac- sodium 0.025 kg/ha at 25 DAS.	5.26	48609	1.98
W_4 :Farmer practices –2 hoeing at 15-20 days interval after sowing *fb* 2 HW.	5.67	56852	2.15
W_5 :Weedy check	2.91	23943	1.61
SE(m)±	0.05	-	-
LSD (P=0.05)	0.13	-	-
C) Interaction (AXB)			
SE (m)±	0.07	-	-
LSD (P=0.05)	0.27	-	-

bispyribac sodium 0.025 kg/ha POE (25 DAS). Significantly highest grain and straw yield (5.12 and 7.26 t/ha) was recorded with 125% RDNK in 5 splits [at basal (10%), 20 DAS (20%), 25% each at 40 and 60 DAS, and 20% at 80 DAS] than rest of fertigation levels. Under weed management practices, farmers' practice recorded significantly highest grain yield (5.67 t/ha) over rest of fertigation levels with highest net returns (Rs. 51484/ha) and B C ratio (2.02). Application of pretilachlor 6%+pyrazosulfuron-ethyl 0.15%, 0.615 kg/ha PE *fb* bispyribac sodium 0.025 kg/ha POE (25 DAS) recorded statistically on par grain yield (5.35 t/ha) with faremrs practice and recorded net returns and B C ration of Rs 51758/ha and 2.00, respectively (**Table 1.1.9**).

125% RDNK (Recommended dose of N & K) in 5 splits integrated with sequential application of herbicides (Pretilachlor 6% + pyrazosulfuron-ethyl 0.15%, 0.615 kg/ha PE *fb* bispyribac sodium 0.025 kg/ha at 25 DAS) resulted in better weed control and that led to record higher grain yield and higher economic benefits in direct-seeded rice.

Chickpea (*Rabi* 2020-21)

Significantly minimum number of total weed count was recorded in treatment farmers practice i.e., 1 hoeing and two hand weeding (20 and 40 DAS) than rest of the treatments from 40 DAS up to harvest. Among the herbicidal treatments Oxyfluorfen 0.140 kg/ha PE recorded minimum total weed count over pendimethalin at 20 DAS, however, in subsequently PoE treatment topramezone 0.017 kg/ha at 30-35 DAS recorded reduction in weed population followed by the treatment propaquizafop + imazethapyr 0.125 kg/ha at 20-25 DAS showed effective control of weed. Although both these herbicides are promising in reducing the weed population in chickpea, however, these herbicides express phytotoxicity on chickpea plants. Phytotoxicity with topramezone recorded 5 days after application of herbicides was minimal (<3) with satisfactory toxicity on weeds viz., *Cynodon dactylon, Parthenium hysterophorus, Euphorbia geniculata, Cardiospermum halicacabum, Tribulus terrestris, Datura metel, Digeria arvensis,* etc. whereas, phtotoxicty of propaquizafop + imazethapyr was prolonged and weeds especially *E. geniculta*, and *P. hysterophorus* were not controlled effectively. Among the fertigation levels the highest weed control efficiency (61.57% at 40 DAS) and lowest weed index (1.48 %) values were recorded with 100% RDNK fertigation in 3 splits. Among the herbicidal treatments highest weed control efficiency (69.19% at 60 DAS) and lowest weed index (6.06%) values were recorded with pendimethalin 1 kg/ha PE *fb* topramezone 0.017 kg/ha PoE (30-35 DAS). The seed yield (1.92 t/ha) was recorded significantly higher under fertigation of 100% RDNK thorugh drip in 3 splits (as basal 40% of RDNK, 30% each of RDNK at 20 and 40 DAS) with highest net returns (Rs 49850/ha) and B C ratio (2.03). Maximum seed yield (1.95 t/ha) was observed in farmers' practice i.e., 2 hand weedings *fb* 2 hoeing treatment with highest net returns of Rs 49190/ha and B C ratio of 1.98. These values were followed by the treatment pendimethalin 1 kg/ha PE *fb* topramezone 0.017 kg/ha POE (30-35 DAS), which registered the seed yield of 1.84 t/ha, net returns of Rs 45416/ha and B C ratio of 1.94.

AAU, Jorhat

Integrated weed management in potato-maize cropping sequence

Weed flora recoded in potato crop were *Sacciolepis interrupta, Oryza rufipogon, Paspalum distichum and Leersia hexandra* among the grasses, *Scirpus maritimus* and *Eleocharia dulcis* among the sedges and *Alternanthera sessilis, Cuphea balsomona, Hydrolea zeylanica. Monochoria vaginalis* and *Ceratophyllum utricularia* among the broadleaf weeds.

Significantly higher and results in tuber yield were recorded in plots containing rice straw mulch or water hyacinth 6 t/ha, use of cultivator 30 days and metribuzine 500 g/ha PE + mulching with plant biomass.

SKUAST, Jammu

Effect of herbicides on weed dynamics and yield of maize-chickpea cropping system (Collaboration Advanced Centre for Rainfed Agriculture (ACRA), SKUAST-J)

Chickpea (*Rabi* 2020-21)

In chickpea (2020-21), the lowest weed density and weed biomass was observed in propaquizafop + imazethapyr 50 + 75 g/ha POE (20-25 DAS), which was statistically at par with imazethapyr + pendimethalin (RM) 1000 g/ha PE and topramezone 25.2 g/ha POE (20-25 DAS). Highest weed control efficiency was recorded with the treatment propaquizafop + imazethapyr 50 + 75 g/ha POE (20-25 DAS) closely followed by topramezone 25.2 g/ha POE (20-25 DAS) and imazethapyr + pendimethalin (RM) 1000 g/ha PE. .

The highest seed yield (925 kg/ha) was observed in mechanical weeding at 20 and 40 DAS, which was statistically at par with and topramezone 25.2 g/ha POE (20-25 DAS) (897 kg/ha) and imazethapyr + pendimethalin (RM) 1000 g/ha PE (878 kg/ha). However, highest net returns of Rs. 22369/ha was obtained with the treatment imazethapyr + pendimethalin (RM) 1000 g/ha PE closely followed by the treatment topramezone 25.2 g/ha POE (20-25 DAS) (Rs. 20815/ha).

Maize (*Kharif* 2021)

In subsequent *Kharif* season major weeds were *Amaranthus viridis, Commelina benghalensis, Solanum nigrum, Cyperus spp., Physalis minima, Digitaria sangunalis, Echinochloa colona, Cynodon dactylon, Acrache racemosa, Eragrostis tenella* and *Eleusine* spp.

Among different weed management practices, the lowest weed density and weed biomass were recorded with mechanical weeding at 20 & 40 DAS. Among the herbicidal treatments topramezone + atrazine 25.2 + 500 g/ha PoE recorded lowest weed density and weed biomass at 60 DAS.. The highest weed control efficiency was recorded in treatment mechanical weeding at 20 & 40 DAS followed by herbicidal treatment topramezone + atrazine 25.2 + 500 g/ha EPoE. Among the herbicidal treatment topramezone + atrazine 25.2 + 500 g/ha PoE registered higher grain (3.36 t/ha) and stover yields (6.53 t/ha), which was statistically at par with tembotrione + atrazine 120 + 500 g/ha as EPoE (Grain and stover yield of 3.36 and 6.53 t/ha, respectively). Highest net returns (Rs 45316/ha) and B C ratio (1.19) were recorded with the treatment two mechanical weeding at 20 and 40 DAS closely followed by the treatment topramezone + atrazine 25.2 + 500 g/ha EPoE (Net returns and B C ratio of Rs 42276/ha and 1.14, respectively).

OUAT, Bhubaneshwar

Weed management with new generation herbicides in maize (sweet corn) in maize –blackgram cropping system.

Sweet corn: *Kharif*

In maize the weed flora recorded in the experimental field were *Cynodon dactylon, Digitaria sanguinalis, Eleusine indica, Dactyloctenium aegyptium, Sporobolus diander among the grasses, Cyperus rotundus* and *Cyperus iria* among the sedges and *Cleome viscosa, Cleome rutidosperma, Celosia argentea, Melochia chorchorifolia, Amaranths viridis, Phylanthus niruri* and *Spilanthes acmella* among the broadleaf weeds.

At 30 DAS, total weed population was lowest in post-emergence application of topramezone (25 g/ha) at 20 DAS (4.47/m^2) followed by post-emergence application of tembotrione (115 g/ha) at 20 DAS (5.30/m^2) and 2HW at 20 and 40 DAS (5.91/m^2), which were at par among each other. Maximum green cob yield of 18.05 t/ha was obtained with the treatment IC + 2 HW at 20 and 40 DAS which was followed by the treatment topramezone 25 g/ha EPoE (16.27 t/ha).

Blackgram

Among the grassy weeds, *Cynodon dactylon, Digitaria ciliaris, Echinochloa colona, Dactyloctenium aegyptium, Eleusine indica* were the most observed species. *Cyperus iria* was the dominant sedge. The broadleaf weeds such as *Cleome rutidosperma, Cleome viscosa, Phyllanthus niruri, Celosia argentea, Ludwigia parviflora, Commelina benghalensis, Ageratum conyzoides, Melochia chorchorifolia* were found during the different growth stages of blackgram.

At 20 DAS, pendimethalin (38.7EC) 678 g/ha PE, oxyfluorfen 140 g/ha PE and pendimethalin + imazethapyr (Ready-mix) 1.00 kg/ha PE significantly reduced weed density. The highest seed yield (866.33 kg/ha) was recorded with the treatment fluazifop-p-butyl + fomesafen (Ready-mix) 125 g/ha closely followed by the treatments pendimethalin 1.0 kg/ha PE *fb* propaquizafop 50 g/ha PoE (840.33 kg/ha) and pendimethalin 1.0 kg/ha PE *fb* quazifop-ethyl 50 g/ha PoE (835.00 kg/ha) without having any significant difference.

PAU, Ludhiana

Integrated weed management in maize

Digitaria sanguinalis, Dactyloctenium aegyptium, Acrachne racemosa, Commelina benghalensis, Echinochloa colona, Cyperus rotundus and Trianthema portulacastrum were the major weeds recorded during the experiment.

Pyroxasulfone 102 and 127.5 g/ha PE provided effective control of annual and broadleaf weeds, which was similar to tembotrione 120 g/ha PoE. Maximum maize grain yield of 5889 kg/ha was recorded with the treatment tembotrione 110 g/ha PoE closely followed by the treatment pyroxasulfone 102 g/ha PE (5825 kg/ha).

UAS, Dharwad (Volunteer Centre)

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

Maize (*Kharif* 2021)

Cynodon dactylon, Euphorbia geniculata, Cyperus rotundus, Phyllanthus maderas, Mollugo pentaphylla Dinebra retroflexa, and *Panicum isachne* among the grasses, *Digera arvensis, Ageratum conyzoides, Commelina benghalensis, Cyanotis, Corchorus olitorius* among the broadleaf weeds were recorded as dominant weeds in maize during *Kharif* season.

Lowest weed density was recorded with the treatment topramezone + atrazine (25.2 + 500 g/ha) EPoE *fb* IC + HW at 30 DAS. The highest maize grain yield was recorded with the treatment topramezone + atrazine (25.2 + 500 g/ha) EPoE *fb* IC + HW at 30 DAS (6520 kg/ha), followed by the treatment tembotrione 120 g/ha EPoE (6247 kg/ha). Among the herbicides, atrazine 1.0 kg/ha PE *fb* 1 HW at 40 DAS registered lowest grain yield of 4006 kg/ha. Among the herbicideds the plots received the combination of topramezone + atrazine (25.2 + 500 g/ha) EPoE *fb* IC + HW recorded highest dehydrogenase and phospatase activity.

Topramezone + atrazine (25.2 + 500 g/ha) EPoE *fb* IC + HW at 30 DAS

Weedy check

PDKV, Akola

Productivity and economics of maize-chickpea cropping sequence under different fertigation levels and weed management practices.

***Kharif* maize :**

Among the different herbicidal treatments, minimum values of weed density and weed dry biomass were recorded at all the growth stages with the treatment atrazine 0.75 kg/ha PE *fb* topramezone 25.2 g/ha PoE. However, lowest values of weed density and weed dry biomass were recorded at all the growth stages with Farmers' practices comprising 2 hoeing 15-20 days interval after sowing *fb* 2 HW. At 20 DAS, highest weed control efficiency (69.22%) was recorded with the treatment 75% RDNK in 5 splits. However, the lowest weed control efficiency (66.90%) was recorded with the treatment 100% RDF as soil application.

Among the herbicidal treatments highest weed control efficiency was recorded with the treatment atrazine 0.75 kg/ha PE *fb* topramezone 25.2 g/ha PoE (72.08, 70.05 and 68.53% at 40, 60 DAS and at harvest, respectively) with lowest value of weed index (4.53%). However, among the weed management treatments Farmers' practices registered the highest weed control efficiency at all the growth stages (95.64, 96.04 and 96.18% at 40, 60 DAS and at harvest, respectively) with lowest value of weed index (1.64%). Among the fertigation levels, grain and stover yields were significantly higher under higher level of fertigation. The best treatment was 125% RDNK in 5 splits which was recorded significantly highest grain (8.17 t/ha) and stover yield (10.28 t/ha) with highest net returns of Rs 85023/ha and B C ratio of 2.23. The lower grain and stover yields were recorded with the treatments of 100% RDF as soil application. Among the weed management treatments Farmers' practices recorded significant highest grain (8.11 t/ha) and stover yields (12.07 t/ha) with highest net returns of Rs 80070/ha and B C ration of 2.10. These values were followed by the herbicidal treatment atrazine 0.75 kg/ha PE *fb* topramezone 25.2 g/ha PoE (Grain yield 6.79 t/ha, stover yield 9.47 t/ha, net returns Rs 62740/ha and B C ratio 1.96).

In succeeding chickpea the highest weed control efficiency (69.19%) at 30 DAS with lowest weed index value (1.57%) was recorded with fertigation level of 100% RDNK in 3 splits. However, the lowest weed control efficiency (44.60%) was noticed with treatment of 100% RDF as soil application.

Among the weed management treatments the highest weed control efficiency was observed under farmers' practices (2 HW and 2 hoeing) from 30 DAS up to at harvest. Among the herbicidal treatments, highest weed control efficiency (93.76%) at 30 DAS and lowest weed index value (6.39%) were recorded with the treatment pendimethalin 1 kg /ha PE *fb* topramezone 17 g/ha at 30-35 DAS. Among the fertigation levels, the seed (1.82 t/ha) and straw yields (2.37 t/ha) were significantly higher under 100% RDNK in 3 splits with highest net returns of Rs 44495/ha and B C ratio of 1.91. Among the weed management treatments Farmers' practices comprising 1 hoeing at 30 DAS *fb* 2 HW at 20 & 40 DAS recorded highest seed (1.85 t/ha) and straw yields (2.40 t/ha) with highest net returns of Rs 43835/ha and B C ratio of 1.87. These values were followed by the herbicidal treatment pendimethalin 1 kg/ha PE *fb* topramezone 17 g/ha POE (30-35 DAS) (Seed yield 1.73 t/ha, straw yield 2.25 t/ha, net returns Rs 40061/ha and B C ratio 1.83).

MPUAT, Udaipur

Evaluation of pre- and post-emergence herbicides against complex weed flora in blackgram (*Vigna mungo* (L.) Hepper) *Kharif* season

The experimental plot was infested with grasses, sedges and broadleaf weeds. The dominant weed species were *Echinochloa colona* (30.1%), *Dinebra retroflexa* (11.7%), *Digera arvensis* (7.4%), *Commelina benghalensis* (22.9%), *Trianthema portulacastrum* (15.6%) and *Amaranthus viridis* (12.4%).

Among herbicidal treatments the maximum weed control efficiency (WCE) at 60 DAS of total weed flora (90.91%) was recorded with imazethapyr+ Imazamox 60 g/ha at 15-20 DAS *fb* mechanical weeding at 40 DAS and it was followed by imazethapyr 10% SL 60 g/ha + propaquizafop 10% EC 75 g/ha (Tank mix) at 15-20 DAS with 90.64% WCE. Maximum seed yield (759 kg/ha) of blackgram was recorded with imazethapyr 10% SL 60 g/ha+ propaquizafop 10% EC 75 g/ha (Tank mix) at 15-20 DAS which was found at par with IC *fb* hand weeding at 20 and 40 DAS. The highest net returns (Rs. 37518/ha) and B C ratio (1.90) were realized with the treatment imazethapyr 10% SL + propaquizafop 10% EC 75 g /ha EPoE (Tank mix) at 15- 20 DAS.

BAU, Sabour (Volunteer Centre)

Evaluation of herbicide doses and application time of topramezone on different chickpea varieties.

The weed flora recorded in the experiment field were *Cynodon dactylon*, *Phalaris minor*, *Fumaria parviflora* among the grasses, *Cyperus rotundus* the sedge and *Argemone mexicana, Solanum nigrum*, *Anagallis arvensis,Chenopodium album, Rumex dentatus,Melilotus indica, Vicia sativa* among the broadleaf weeds.

The lowest weed density and weed dry weight were recorded under variety GCP105 and topramezone 35g/ha POE at 25 DAS. However, the effect of topramezone 25 g/ha was at par with topramezone 30 and 35 g/ha. Highest weed control efficiency (89.25%) was recorded with the treatment topramezone 35 g/ha. Growing of variety GCP105 registered yield advantage of 6.79% in comparision to the variety PG 186. Herbicide topramezone 25 g/ha significantly increased seed yield as compared to control but remained statistically at par with 30 g/ha applied 25 DAS. Net returns and B C ratio were higher under GCP105 and topramezone 25 g/ha POE at 25 DAS.

BUAT, Banda (Volunteer Centre)

Studies on herbicidal effect of imazethapyr and its ready-mix with imazemox and pendimethalin against weeds in blackgram and their residual effect on succeeding mustard crop.

The experimental field was infested with several grasses, sedges and broadleaf weeds. The major weeds species were *Cyperus rotundus*, *Digera arvensis, Phyllanthus niruri, Leucas aspera, Eclipta alba, Tridax procumbance, Commelina benghalensis, Cynodon dactylon*, etc.

Application of imazethapyr + pendimethalin (RM) 1000 g/ha PE and imazethapyr + imazamox (RM) 60 g/ha at 3-4 leaf stage significantly reduced weed dry weight and registered highest weed control efficiency (86.6%). Highest seed and biological yields as well as harvest index were recorded with weed free treatment closely followed by the treatment imazethapyr + pendimethalin (RM) 1000 g/ha PE. Highest net return of Rs15000/ha and B C ratio of 1.7 were obtained with the treatment imazethapyr + pendimethalin (RM) 1000 g/ha PE.

Weed dynamics and productivity of chickpea (*Cicer arietinum*) under pre- and post-emergence application of herbicides

Weed flora recorded in the experimental field were *Cynodon dactylon, Phalaris minor, Fumaria parviflora* among the grasses, *Cyperus rotundus* the sedge and *Argemone mexicana, Solanum nigrum, Anagallis arvensis, Chenopodium album, Rumex dentatus, Melilotus indica, Vicia sativa* among the broadleaf weeds.

Among the herbicidal treatments the highest weed control efficiency at 60 DAS was recorded with pendimethalin 1.0 kg/ha PE *fb* 1HW at 30 DAS (88.63%), closely followed by the treatments oxyfluorfen 100 g/ha PE *fb* 1 HW at 30 DAS (87.45%) and topramezone 25 g/ha POE (85.65%). However, lowest weed Index value was recorded with the treatments pendimethalin 1.0 kg/ha PE *fb* 1HW at 30 DAS (1.88%). Clodinafop-propargyl+Na-aciflurofen 500g/ha (Ready-mix) caused phytotoxicity up to 06 level. Among the weed management treatments pendimethalin 1.0 kg/ha PE *fb* 1HW at 30 DAS recorded highest seed yield of 1.77 t/ha, highest net returns of Rs.73036/ha and B C ratio of Rs.2.40.

KAU, Thrissur

Integrated weed management in green gram in summer rice fallows

At 30 DAS, all the integrated weed management practices recorded very high weed control efficiency. The lowest weed control efficiency (85%) was recorded with stale seed bed, whereas all the other treatments registered almost 100% weed control efficiency. At 45 DAS, a sharp decline was observed in weed control efficiency of stale seed bed (11.69%). Stale seed bed *fb* oxyfluorfen also recorded a decreased weed control efficiency of 82.90%. The highest weed control efficiency (98.94%) was recorded with 2 HW. Integration of any of the pre-emergence herbicides (oxyfluorfen, imazethapyr, imazethapyr + imazamox, and diclosulam) with hand weeding at 25 DAS also recorded high weed control efficiencies with the values ranging from 95.55% to 97.38%. Among the herbicidal treatments, the highest weed control efficiency (97.38%) was recorded with diclosulam *fb* HW, which was closely followed by the treatment imazethapyr + imazamox 80 g/ha PE *fb* HW. The lowest weed index value (5.82%) was recorded with imazethapyr + imazamox *fb* HW closely followed by diclosulam *fb* HW (8.22%). The highest seed yield of 583 kg/ha was recorded with HW. It was followed by the treatment imazethapyr + imazamox 80 g/ha PE *fb* HW with the seed yield of 549 kg/ha and diclosulam *fb* HW, which registered 535 kg/ha of seed yield. Highest net returns (Rs 9126 /ha) and B C ratio (1.28) were recorded with the treatment imazethapyr + imazamox (RM) 80 g/ha PE *fb* HW at 25 DAS.

Stale seed bed for 14 days followed by shallow digging

Imazethapyr + imazamox (Pre-mix) 80 g/ha PE *fb* HW at 25 DAS

CCSHAU, Hisar

Evaluation of herbicides against complex weed flora in pigeonpea

The experimental field was infested with *Digera arvensis, Cyperus rotundus* and *Trianthema portulacastrum*. All the ready-mix and sequential application of herbicides provided satisfactory control of *Digera arvensis* and *Cyperus rotundus* while alone application of pendimethalin did not provide the control of *Digera arvensis* and *Cyperus rotundus.* The treatment pendimethalin + imazethapyr (Ready-mix) 1000 g/ha PE *fb* by HW at 45 DAS registered WCE of 71% at 30 DAS, however, tank-mix application pendimethalin + imazethapyr (1000 + 75 g/ha) as PE recorded highest WCE of 73.4% at 30 DAS as compared to other treatments.

(The data on yield parameters and yields were not recorded due to complete failure of crop associated with heavy rainfall on 22nd and 23rd of September, 2021 and subsequent water logging for more than fifteen days.)

OUAT, Bhubaneshwar

Weed management and fertility levels on growth, yield and soil health in okra – groundnut cropping system

Okra (*Kharif*) – groundnut (*Rabi*)

The dominant weed flora of the site were *Cynodon dactylon*, *Digitaria sanguinalis, Eleusine indica, Dactyloctenium aegypticum* among the grasses, *Cyeprus rotundus* the sedge and *Celosia argeantea*, *Ludwigia parviflora, Heliotropium indicum* among broadleaf weeds.

Among fertility levels, application of 50 % RDF along with 50 % N through FYM significantly reduced the weed population and dry matter accumulation in comparison to other treatments. Application of 50 % RDF along with 50 % N through FYM significantly increased the pod yield and economics in comparison to other treatments. Among weed control measures, application of pendimethalin 0.75 kg/ha PE significantly reduced the weed population and dry matter accumulation and that resulted in significantly increased pod yield and economics in comparison to other treatments both in case of okra and groundnut crops.

MPUAT, Udaipur

Integrated weed management in groundnut-wheat cropping system

Groundnut (*Kharif* 2020)

The experimental area was infested with *Echinochloa colona* (46.4%), *Dinebra retorflexa* (12.1%), *Commelina benghalensis* (8.4%) and *Dactyloctenium aegyptium* (8.7%) among the monocot weeds, whereas, *Digera arvensis* (8.8%), *Amaranthus viridis* (6.6%), and *Physillis minima* (9.1%) were dicot weeds.

At 30 DAS highest WCE of monocots (97.84%) was recorded by Oxyfluorfen *fb* imazethapyr + imazamox (RM) and this was followed by pendimethalin + imazethapyr (RM) (96.72 per cent), IC *fb* HW at 20 and 40 DAS (96.62 per cent). In case of WCE of dicots highest value was registered by IC *fb* HW at 20 and 40 DAS (98.90 per cent), it was followed by pendimethalin + imazethapyr (RM) (92.25 per cent), Oxyfluorfen *fb* imazethapyr + imazamox (RM) (91.49 per cent). The highest total weed control efficiency was recorded by IC *fb* HW at 20 and 40 DAS (98.39 per cent). At 60 DAS, highest WCE values of monocot, dicot and total weeds were recorded by IC *fb* HW at 20 and 40 DAS by 97.46, 93.97 and 96.69%, respectively. Among the treatments, highest pod yield (1793 kg/ha) was obtained by controlling weeds through IC *fb* HW at 20 and 40 DAS, which was statistically at par with fluzitop-p-bultyl + fomesafen (RM) *fb* HW at 40 DAS, imazethapyr + propaquizafop (RM) *fb* IC *fb* HW at 40 DAS, imazethapyr + imazamox (Pre-mix) *fb* HW at 40 and imazethapyr *fb* IC + HW at 40 DAS. The maximum net returns (Rs. 78172/ha) and B C ratio (2.44) were recorded with the treatment imazethapyr + propaquizafop (RM) *fb* IC *fb* HW at 40 DAS.

Imazethapyr + propaquizafop (RM) 125 g/ha PoE *fb* IC + HW at 40 DAS

Weedy check

Wheat (*Rabi*, 2020-21)

The experimental area was infested with *Phalaris minor* (9.8%) among the grassy weeds, whereas, *Chenopodium album* (19.04%), *Chenopodium murale* (21.42%), *Malwa parviflora* (11.39%), *Fumaria parviflora* (5.84 %), *Melilotus indica* (4.17%) and *Convolvulus arvensis* (6.13%) and *Launaea asplenifolia* (5.57%) among broadleaf weeds.

At 60 DAS the highest value of total WCE (98.57%) was registered by pinoxaden + carfentrazone (Tank mix) 60+20 g/ha PoE. Application of herbicides in combination with either as premix or tank mix resulted in significantly higher grain yield of wheat over single application of herbicides. Among the treatments, highest grain yield (4.62 t ha^{-1}) was obtained by controlling weeds through 2 HW, which was statistically at par with carfentrazone-ethyl + sulfosulfuron (4.54 t/ha) followed by mesosulfuron + iodosulfuron (4.48 t/ha). The maximum net returns (Rs 67337 /ha) and B C ratio (2.18) were recorded by the treatment carfentrazone-ethyl + sulfosulfuron 500 g/ha PoE (35 DAS). Visual phytotoxicity scoring revealed that at 10 DAHA, the herbicides sulfosulfuron, carfentrazone, carfentrazone + sulfosulfuron, pinoxaden + carfentrazone (Tank mix), clodinafop-propargyl + carfentrazone (Tank mix), sulfosulfuron + metsulfuron (Premix), pinoxaden + metsulfuron (Tank mix) and mesosulfuron + iodosulfuron (Premix) gave setback to wheat crop by causing mild injury and discolouration to wheat plants, however, at 20 DAHA the crop plants under all these treatments had recovered and no symptoms of phytotoxicity were seen at this stage and onwards.

PJTSAU, Hyderabad

Integrated weed management in cotton-based intercropping system

The lowest weed density was recorded in cotton+dhaincha intercropping due to the smothering effect of dhaincha and it was superior to sole cotton and cotton+sesame but at par with cotton+soybean. The highest weed count was recorded in sole cotton. Among the weed management treatments, the lowest weed density was recorded in herbicidal treatments, which was superior to IWM or HW/MW treatments. However, at 60 DAS, the highest weed count was observed with cotton+dhaincha as new flush of weeds emerged after the incorporation of dhaincha. It was at par with sole cotton. Cotton+sesame and cotton+soybean were at par with each other. At 30 DAS, the highest smothering efficiency was found in cotton+dhaincha *fb* cotton+ sesame and cotton+soybean. However, at 60 DAS, the weed smothering efficiency was higher in soybean than sesame intercropping. Germination of sesame was adversely affected due to the application of pendimethalin in W_1 and W_2 plots compared to control plot. Significantly higher cotton equivalent yield was recorded in cotton+soybean intercropping system over sole cotton and other intercropping systems. It was 14% higher than the sole cotton yield. Similarly, a higher cotton equivalent yield was recorded in IWM (PE herbicide *fb* intercultivation at 30 & 45 DAS) among the weed management methods. Herbicides and HW/MW were at par with each other.

PAJNCOA & RI, Punducherry (Volunteer Centre)

Integrated weed management in cotton based intercropping system (summer 2021)

Cotton+greengram intercropping system resulted in significant reduction in weed density of grasses and total weeds (121.0 and 130.7 no./m^2, respectively) compared to sole cotton at 60 DAS. Among the weed management treatments, herbicidal management significantly reduced the grasses and total weed density (96.0 and 120.3 no./m^2, respectively) compared to unweeded control (207.4 and 213.3 no./m^2, respectively). Intercropping system and weed management showed significant effect in terms of seed cotton yield. Among the intercropping system, cotton+ greengram recorded higher seed cotton yield of 1695 kg/ha. Among the weed management treatments, herbicidal management significantly recorded higher seed cotton yield (1797 kg/ha) compared to unweeded control (725 kg/ha). Uncontrolled weeds result in 59.6% yield losses.

PJTSAU, Hyderabad

Bio-efficacy and phytotoxicity of herbicides and herbicide mixtures for weed control in finger millet.

Complete failure of germination of finger millet was recorded in all three herbicides treated plots applied as PE i.e., oxyfluorfen, oxadiargyl and bensulfuron methyl + pretilachlor compared to control. The same trial was repeated at another site and the PE herbicides were applied on the next day of sowing at their X dose and 0.5 X dose described in the treatments. Total failure of the finger millet germination was recorded even at 0.5 X dose along with X dose, and the trial was discontinued.

PAJNCOA & RI, Punducheery (Volunteer Centre)

Weed management in transplanted finger millet

The dominant weed flora observed in the study area were *Echinochloa colona* (L), *Dactyloctenium aegyptium* (L.), *Eclipta prostrata* (L.), *Cleome viscosa* (L.), *Cyperus rotundus* (L.) and *Cyperus iria* (L.). The experimental field was infested with diverse weed flora comprising 32.8% grasses [(*Echinochloa colona* (L.), *Panicum repens* (L.)], 64.2% sedges (*Cyperus irria* (L.)) and 3.0% broad leaf weeds (BLW) (*Aeschynomene indica* (L.).

2 HW significantly reduced the weed density (122 no./m^2) and resulted in higher weed control efficiency (67.7%). However, employing stale seed bed alone for weed management resulted in poor weed control efficiency (4.5%) but with the application of bensulfuron methyl + pretilachlor either with stale seed bed or 1 HW resulted in higher weed control efficiencies of 62.0 to 65.5, respectively. Pre-emergence application of bensulfuron methyl + pretilachlor or post-emergence application of bispyribac-sodium alone resulted in poor weed control (23 to 34%). Plants under stale seed bed technique was shorter (75.6 cm) and produced lesser number of tillers, which resulted in yield loss of 44.2% compared to other weed management plots. Weedy check treatment accounted for 43.8% yield losses of finger millet.

BCKV, Kalyani

Identification of suitable weed management strategy in lentil under rainfed situation

At 30 DAS, highest WCE (85.79 %) was recorded with the treatment metolachlor 50EC 1.0 kg/ha PE *fb* 1 HW at 25 DAS. At 45 DAS and 60 DAS, the highest WCE values (83.79 and 88.40% at 45 and 60 DAS, respectively) were recorded with the treatment mechanical weeding by hand grubber at 20 and 40 DAS. Better weed management with the treatment mechanical weeding by hand grubber at 20 and 40 DAS led to obtain highest seed yield of 1762 kg/ha. However, highest net returns (Rs 59544/ha) and B C ratio (2.18) were recorded with the treatment pendimethalin 30 EC 1000 g/ha PE *fb* quizalofop-ethyl 5EC 50 g/ha PoE because of higher cost of cultivation involved with mechanical weeding by hand grubber at 20 and 40 DAS.

GBPUAT, Pantnagar

Management and in situ utilization of weeds in different cropping systems

The experiment was conducted for in situ management and utilization of weeds under agri - horti cropping system as blackgram- maize and sugarcane-maize during *Kharif* 2021. In blackgram, herbicidal treatments were imazethapyr 10% SL 100 g/ha PoE and pendimethalin 30% EC 1000 g/ha PE. In maize the herbicidal treatments were topramezone 33.6 g/ha fb 1 HW and atrazine 50% WP 500 g/ha PE *fb* 1 HW. In sugarcane the treatments were comprised by sugarcane paired row with hoeing *fb* atrazine 50% 1000 g/ha PE fb topramezone 25 g/ha PoE, sugarcane single row with hoeing *fb* atrazine 50% 1000 g/ha PE and sugarcane single row weedy check.

In blackgram, application of imazethapyr 10% SL at 100 g/ha PoE completely controlled *Echinochloa colona* among the grasses and *Celosia argentia*, *Celome viscosa* and *Phyllathus niruri* among the broadleaf weeds. Similarly, the lowest density of *Cyperus rotundus* was also recorded with imazethapyr 10% SL at 100 g/ha and was also effective to record overall lowest total weed density and dry weight of all recorded weeds among all the treatments at 40 DAS. The highest weed control efficiency (74.0%) and seed yield (1250 kg/ha) were also recorded with imazethapyr 10% SL at 100 g/ha. In maize, all the grassy weeds (*E. colona, Eleusine indica* and *Digitaria sanguinalis*) and *Celome viscose* and *Eclipta alba* among broadleaf weeds, were completely controlled with application of topramezone 33.6 g/ha PoE *fb* 1 HW, which also recorded lowest weed density of *Cyperus rotundus* at 40 DAS. Similarly, overall lowest total weed density, dry weight and highest weed control efficiency (75.0%) and grain yield (5.6 t/ha) were also registered with the treatment topramezone 33.6 g/ha PoE *fb* 1 HW.

In sugarcane, among the grasses *Echinochloa colona*, *Eleusine indica* and *Digitaria sanguinalis* were completely controlled with DAR. The sugarcane paired row with hoeing *fb* atrazine 50% 1000 g/ha PE *fb* topramezone 25 g/ha PoE at 90 DAP controlled the broadleaf weeds effectively. Lowest density of all the broadleaf weeds and *Cyperus rotundus* the only sedge was recorded with sugarcane paired row with hoeing *fb* atrazine 50% 1000 g/ha PE *fb* topramezone 25 g/ha PoE resulted in overall, lowest total weed dry weight and highest weed control efficiency (77.1%) as compared to sugarcane single row with hoeing *fb* atrazine 50% 1000 g/ha PE.

SKUAST, Jammu

Effect of different weed management practices in marigold

Among the various weed management treatments, lowest weed density and weed biomass were observed in mechanical weeding at 20 & 40 DAS followed by pendimethalin 1.5 kg/ha PE *fb* 1 HW and oxyfluorfen 200 g/ha PE *fb* 1 HW. The highest flower yield of marigold was recorded in mechanical weeding at 20 & 40 DAS (12.74 t/ha), which was statistically at par with pendimethalin 1.5 kg/ha PE *fb* 1 HW (12.53 t/ha), oxyfluorfen 200 g/ha PE *fb* 1 HW (12.40 t/ha) and quizalofop-ethyl 50 g/ ha POE *fb* 1 HW (12.14 t/ha).

UAS, Bengaluru

Evaluation of herbicides against weed complex of French bean (*Kharif*) – Field bean (*Rabi*) cropping system

The major weed species appeared in the crops were *Cynodon dactylon, Digitaria marginata, Brachiaria ramose, Dactyloctenium aegyptium, Eleucine indica, Echinochloa colona* and *Ergrostris pilosa*, among the grasses, *Cyperus rotundus* the sedge and *Chloris barbata, Borreria hispida, Commelina benghalensis*, *Mimosa pudica, Oldenlandia corymbosa, Phyllanthus niruri, Lonadium supfruiticesum*; *Ageratum conyzoides, Acanthospermum hispida, Alternanthera sessilis, Sida acuta, Tridax procumbense; Euphorbia hirta, Amaranthus viridis, Silanthus acmella*, and *Emilia sonchifolia* among boad-leaf weeds.

Among the pre-emergence herbicides diclosulum at both the dosages gave excellent control of weeds followed by pendimethalin at higher dose 1000 g /ha. Pendimethalin at lower dose (750 g/ha) has failed to achieve complete control over the weeds. Among the early post-emergence herbicides, all the herbicides registered good control over the weeds, however, though fluazifop-p- butyl 11.1% + fomesafen 11.1 % SL - EPOE recorded excellent control over weeds, due to phytotoxic effect of herbicides on field bean plants, this combination of herbicides cannot not be recommended for controlling weeds in field bean crop. Highest pod yield was recorded in HW (3.25 t/ha) and imazethypyr 10SL + surfactant-EPOE (3.25 t/ha) treatments, among them imazethypyr 10SL + surfactant-EPOE recorded lowest weed index of 3.2% in comparison to weedy check (65%).

WP 1.2 Weed management in different cropping systems under conservation agriculture systems

Weed management in rice-based cropping systems

Cooperating centres:

PAU, Ludhiana, CCSHAU, Hisar, SKUAST, Jammu, GBPUAT, Pantnagar, AAU, Jorhat, BCKV, Kalyani, IGKVV, Raipur and OUAT, Bhubaneswar

Treatment details

Treatments	*Kharif*	*Rabi*	Summer
Tillage and residue management			
T_1	CT(Transplanted)	CT	CT
T_2	CT (Transplanted)	ZT	ZT
T_3	CT (Direct-seeded)	CT	ZT
T_4	ZT (Direct-seeded)	ZT+R	ZT
T_5	ZT (Direct-seeded)+R	ZT+R	ZT+R
Weed management			
W_1	Recommended herbicide		
W_2	IWM (herbicide+manual weeding)		
W_3	Weedy check or one hand weeding		

CT : Conventional tillage (3-4 harrowing/cultivation),
ZT : No-tillage, opening of the slice for placing seeds/fertilizers leaving inter-row undisturbed,
R : Previous crop residues,
IWM : Integrated weed management

PAU, Ludhiana

Weed management in rice-wheat cropping system under conservation agriculture

During *Rabi* 2020-21 in wheat, the major weeds were *Phalaris minor, Rumex dentatus, Coronopus didymus, Anagallis arvensis* and *Medicago denticulata* and *Avena ludoviciana*. As compared to the previous year 2019-20, there was a shift in weed flora where MB plough plots recorded with the highest *P. minor* which was least in the previous year.

Among tillage and residue management, CT (DSR)-ZT (HS) had the lowest density of *P. minor* and

BLWs and the highest density of *A. ludoviciana* at 30 and 60 DAS. PTR-CT (MB plough) had the highest density of *P. minor* and BLWs at 30 and 60 DAS. At 60 DAS, PTR-CT (MB plough) had the highest grass weed biomass and PTR- CT (rotavator) had the lowest grass weed biomass. Contrarily, PTR- ZT (HS) had the highest BLWs biomass while CT (DSR)-ZT (HS) had the lowest BLWs biomass. The highest grain yield and B: C was recorded with PTR-CT (rotavator) which was comparable with CT (DSR)-ZT (HS); however, wheat grain yield under all tillage and residue management treatments were at par.

Among weed control, weed density and biomass were significantly less in RH and IWM than weedy check; however, IWM considerably controlled the weeds over others. IWM and herbicides recorded similar wheat grain yield and yield attributes which were significantly higher than weedy check; RH had the highest B: C followed by IWM (**Table 1.2.1**). Interaction effect revealed that under RH and IWM, all tillage and residue management treatments were at par.

Table 1.2.1 Effect of tillage, residue and weed management on weed biomass, crop growth, yield and economics of wheat under different treatments (*Rabi* 2020-21).

Treatment	Weed biomass (g/m^2) at 60 DAS		Crop biomass (g/m^2)	Grain yield (t/ha)	Biological yield (t/ha)	Net returns (Rs./ha)	B:C
	Grass	Broadleaf					
Tillage & residue management							
PTR-CT	5.26 (52.5)	7.02 (93.4)	1092.6	3.98	9.47	43309	2.23
PTR- CT (MB)	6.29 (80.4)	5.81 (51.5)	1178.6	4.1908	9.75	44533	2.17
PTR- ZT (HS)	5.78 (56.7)	7.34 (96.1)	1170.5	4.12	9.69	48552	2.48
ZT - ZT (HS)	5.46 (50.2)	5.96 (51.2)	1106.5	4.41	9.66	54450	2.66
PTR- CT (Rotavator)	4.83 (32.5)	6.76 (76.9)	1234.8	4.53	10.99	56280	2.69
SEm±	**0.41**	**0.46**	**27.7**	**0.20**	**0.34**		
LSD (p=0.05)	**NS**	**1.06**	**63.8**	**NS**	**0.79**		
Weed management practices							
Weedy check	12.3 (155.7)	14.09 (204.1)	1036.7	2.13	8.05	10976	1.35
RH	2.35 (4.7)	3.22 (11)	1206.1	5.26	10.65	70875	3.14
IWM	1.93 (3)	2.43 (6.3)	1227.0	5.34	11.04	66424	2.70
SEm ±	**0.52**	**0.18**	**45.5**	**0.08**	**0.32**		
LSD (p=0.05)	**1.09**	**0.38**	**95.0**	**0.16**	**0.67**		
Interaction LSD(p=0.05)	**NS**	**NS**	**NS**	**0.53**	**NS**		

Phalaris minor and *R. dentatus* were major weeds in soil weed seed bank. PTR-CT (rotavator) plot had the lowest seed bank of *P. minor* which was similar to CT (DSR)-ZT (HS). In case of *R. dentatus*, PTR-ZT (HS) plot had the lowest density which was similar to CD (DSR)-ZT (HS). Among weed control, IWM had a significantly low density of both weed seeds in the soil than RH; both had significantly low density than weedy check.

At harvest, residues of metribuzin and clodinafop-propargyl under RH and IWM treatments were below the detectable limit (<0.05 µg/g) in soil and wheat grains. Dehydrogenase, urease, APA activity and microbial population increased significantly ($p<0.05$) from 31 DAT to till harvest. Total bacterial, actinomycetes and fungal counts ranged from 70.7 to 131.6, 71.1 to 123.5 and 36.0 to 84.3 cfu/g, respectively which indicated that the bacterial colonies emerged more rapidly than those of actinomycetes and fungi. In tillage and residue management practices, enzymatic and microbial counts were significantly higher in ZT treatment as compared to CT on different days after herbicide treatment while in weed management practices, IWM had a higher microbial population than RH alone and weedy check.

PTR-CT (rotavator) and ZT-ZT (HS) had a comparable density of *P. minor*, whereas R. dentatus recorded the least number of seeds/m^2 up to 10 cm depths in PTR-ZT (HS) and comparable to ZT-ZT (HS). The highest density of *P. minor* was recorded with PTR-CT and *R. dentatus* with PTR-CT (rotavator). Among weed control, weedy check had a significantly higher seed bank of *P. minor* and *R. dentatus* followed by RH; IWM had the lt soil weed bank of both weeds **(Table 1.2.2)**.

Table 1.2.2 Effect of tillage, residue and weed management on weed seed bank in wheat during *Rabi* 2020-21.

Treatment	No. of seeds/m² up to the depth of 10 cm	
	P. minor	*R. dentatus*
Tillage & Residue Management		
PTR-CT	22.71 (539)	21.09 (478)
PTR- CT (MB)	21.35 (483)	20.94 (473)
PTR- ZT (HS)	20.16 (440)	18.71 (381)
ZT - ZT (HS)	19.24 (410)	19.14 (394)
PTR- CT (Rotavator)	18.40 (382)	22.01 (496)
SEm±	0.69	0.64
LSD (p=0.05)	1.45	1.33
Weed management practices		
Weedy check	26.95 (729)	26.35(697)
RH	20.42 (428)	20.48 (423)
IWM	13.74 (196)	14.31 (213)
SEm±	**0.60**	**0.63**
LSD (p=0.05)	**1.23**	**1.26**
Interaction LSD (p=0.05)	**NS**	**NS**

Data subjected to square root transformation; figure in parenthesis are means of original value

In rice during 2021, *Echinochloa colona*, *Echinochloa crus-galli*, *Cyperus rotundus*, *C. compressus*, *Ammania baccifera* and *Dactyloctenum aegyptium* were major weeds. As compared to previous year there was shift toward *Echinochloa colona*, *Cyperus rotundus*, *C. compressus* and *Ammania baccifera*. Among tillage and residue management treatments, at 60 DAT, PTR-ZT (HS) had significantly lower density and biomass of grass and sedge weeds than all other treatments; D. aegyptium density was highest under DSR. This resulted in PTR-ZT (HS) gave significantly higher rice grain yield and net returns than all other tillage and residue management treatments. However, B: C was recorded higher under ZT- ZT (HS). Among weed control, IWM had lower weed density and biomass than RH, both had significantly low weed density and biomass than weedy check. This resulted in IWM and RH recorded statistically similar grain yield which was significantly higher than weedy check. But, RH gave the highest net returns and B: C (**Table 1.2.3**).

Table 1.2.3 Effect of tillage, residue and weed management on weed biomass, crop growth, yield and economics of rice under different treatments (*Kharif* 2021).

Treatment	Weed biomass (g/m²) at 60 DAT			Crop biomass (g/m²)	Grain yield (t/ha)	Biological yield (t/ha)	Net returns (Rs./ha	B:C
	Grass	Sedge	Broad leaf					
Tillage & residue management								
PTR-CT	10.29 (109.4)	4.64 (22.9)	2.17 (4.5)	654.0	5.89	12.21	57899	2.08
PTR- CT (MB)	15.39 (306.7)	5.96 (40.6)	2.12 (4.1)	636.0	5.74	11.69	55039	2.03
PTR- ZT (HS)	7.38 (68.6)	4.57 (25.4)	1.81 (2.5)	674.7	6.24	13.78	64511	2.21
ZT - ZT (HS)	16.86 (296.9)	4.15 (16.6)	2.44 (7.4)	561.8	5.61	10.89	63830	2.52
PTR- CT (Rotavator)	15.62 (313.5)	4.57 (24.2)	1.68 (2.1)	583.8	5.31	11.60	46820	1.88
SEm±	**1.54**	**0.64**	**0.52**	**26.3**	**0.09**	**0.72**		
LSD (p=0.05)	**3.56**	**NS**	**NS**	**60.5**	**0.21**	**2.33**		
Weed management practices								
Weedy check	20 (445)	6.71 (48.1)	2.68 (7.2)	538.7	3.95	10.58	28519	1.62
RH	10.71 (125.5)	4.03 (16.3)	2 (3.9)	653.7	6.58	12.23	73629	2.45
IWM	8.61 (86.5)	3.59 (13.3)	1.44 (1.2)	673.8	6.75	13.29	70710	2.25
SEm±	**0.19**	**0.51**	**0.23**	**25.7**	**0.11**	**0.50**		
LSD (p=0.05)	**0.40**	**1.07**	**0.47**	**53.7**	**0.24**	**1.90**		
Interaction LSD (p=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**		

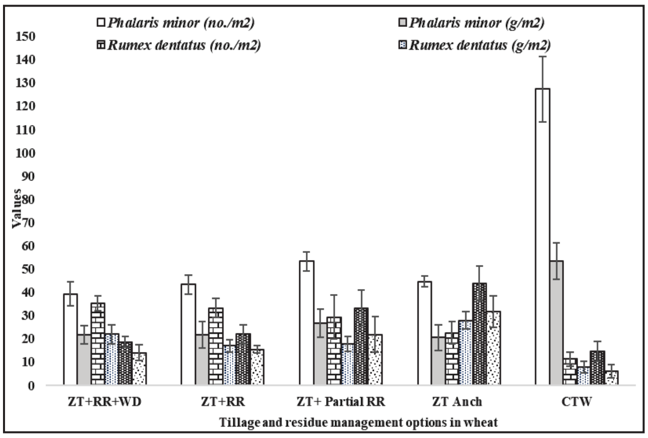


Fig 1.2.1. Effect of tillage and residue management on weed infestation in wheat during 2020-21

At harvest, residues of pendimethalin, penoxsulam and cyhalofop-butyl in soil and rice grains were below the detectable limit. The shift from conventional to conservation agriculture practices significantly enhanced soil parameters. Soil dehydrogenase activity and it increased significantly from 31 DAT till crop harvest. In tillage and residue management practices, soil dehydrogenase activity was significantly higher in ZT treatment as compared to CT on different days after herbicide treatment while in weed management practices, IWM had higher DHA than RH alone and weedy check.

Kharif 2021, was the third season of the rice and in all the plots it was transplanted under conventional puddled conditions (CT-PTR). The grain yields of rice were similar amongst all the treatments (6138-6663 kg/ha) mainly due to a similar planting method of rice establishment. However, higher grain yield recorded with ZTW + Full Residue (Happy seeder) - CT (PTR) **(Table 1.2.4)**.

Table 1.2.4 Effect of tillage and residue management treatments on yield and yield attributes of wheat and rice

Treatments	Wheat			Rice	
	Plant height (cm)	Effective spikes/ mrl	Grain yield (kg/ha)	Effective tillers/ mrl	Grain yield (kg/ha)
Tillage & residue management					
ZTW + Full Residue (Happy seeder) + WD-CT (PTR)	99.6	87	5238	73	6588
ZTW + Full Residue (Happy seeder) - CT (PTR)	98.8	84	5264	75	6663
ZTW + Partial Residue (Happy seeder)-CT (PTR)	99.4	84	5113	71	6432
ZTW + Anchored Stubbles (Happy seeder)- CT (PTR)	98.3	79	4714	67	6138
CTW (Drill sown)- CT (PTR)	96.2	74	4244	66	6168
CD 5%	1.5	8.2	256	4	256
Weed management practices					
Recommended herbicides	97.8	88	5655		
Integrated weed management	98.5	86	5633		
Weedy check	99.0	70	3456		
LSD (P=0.05)	**NS**	**3.7**	**137**		

GBPUAT, Pantnagar

Weed management in rice-wheat-sesbania cropping system under conservation agriculture

In wheat (2020-21), an experimental plot comprised of *Phalaris minor* (24.4%), *Medicago denticulata* (22.8%), *Melilotus indica* (23.4%), *Melilotus alba* (18.5%), were the dominant weed species at 60 DAS, along with other weeds like *Chenopodium album*, *Coronopus didymus*, *Fumaria parviflora*, *Solanum nigrum*, *Vicia sativa* and *Rumex acetosella w*ere recorded in less density.

Among establishment methods, rice (DSR) + R-wheat (ZTW) + RR-*Sesbania* (Inc) recorded a significantly lower density of *P. minor* over others. Whereas, *C. album*, *F. parviflora* and *V. sativa* were completely controlled with rice (TPR) + RC- wheat (ZTW) + RR-*Sesbania* (Inc) and rice (DSR) + R-wheat (ZTW) + RR-*Sesbania* (Inc). *Solanum nigrum* was also completely controlled but with only rice (TPR) + RC-wheat (ZTW) + RR-*Sesbania* (Inc). It had also significantly reduced the density of *R. acetosella, M. denticulata, M. indica* and *M. alba*. The density of *C. didymus* was significantly suppressed with rice (DSR)-wheat (CTW) among all the establishment methods. Rice (DSR) + R-wheat (ZTW) + RR-*Sesbania* (Inc) recorded the lowest density and biomass of grasses, whereas BLWs were less in rice (TPR) + RC-wheat (ZTW) + RR-*Sesbania* (Inc).

The significantly highest no. of shoots/m^2 and grains/spike were attained with rice (DSR) + R-wheat (CTW)+R-*Sesbania* (Inc) and rice (DSR) + R-wheat (ZTW) + RR-*Sesbania* (Inc), respectively. The highest grain yield (4.3 t/ha), net returns (Rs. 79,542/ha) and B: C (3.2) were achieved with both the rice (TPR) + RC-wheat (ZTW)+ RR-*Sesbania* (Inc) and only grain yield was comparable with rice (DSR) + R-wheat (CTW)+R-*Sesbania* (Inc) (**Table 1.2.5**).

Among weed management practices, complete control of weeds was recorded with IWM (recommended herbicides *fb* hand weeding at 60 DAS) followed by RH [clodinafop propargyl + metsulfuron-methyl 60+4 g/ha (PoE)] except *M. indica*. IWM was recorded with the significantly lowest density and biomass of both grasses and BLWs over weedy check and recommended herbicide. Weed management practices were significantly affected yield attributing characters of wheat except for plant height and grains/spike. IWM was found significantly superior with the highest no. of shoots/m^2, 1000-grain weight, grain yield (4.7 t/ha) and straw yield (7.0 t/ha) as compared to the rest of the weed management practices. The interaction effects of the establishment methods and weed management practices on weed density of different grassy and broadleaf weeds had been found significant at 60 DAS.

Table 1.2.5 Effect of establishment methods and weed management on weed biomass at 60 DAS, yield and economics in wheat crop in the rice-wheat cropping system (*Rabi* 2020-21).

Treatment	Weed dry biomass (g/m^2)		Grain yield (t/ha)	Straw yield (t/ha)	Net returns (Rs/ha)	B:C
	Grassy	BLWs				
Tillage & residue management						
Rice (TPR)-Wheat (CTW)	2.8(12.9)	3.4(17.5)	4.1	6.2	70342	2.7
Rice (TPR) + RC- Wheat (CTW)+R-*Sesbenia* (INC)	2.3(6.6)	3.8(22.8)	4.2	6.4	73317	2.8
Rice (TPR) + RC- Wheat (ZTW)+RR-*Sesbenia* (INC)	1.9(3.6)	1.8(2.8)	4.3	6.4	79542	3.2
Rice (DSR) -Wheat (CTW)	3.0(16.5)	3.5(19.6)	4.1	6.2	70842	2.7
Rice (DSR) + R-Wheat (CTW)+R-*Sesbenia* (INC)	2.1(5.5)	3.6(20.8)	4.3	6.4	75792	2.8
Rice (DSR) + R- Wheat (ZTW)+RR-*Sesbenia* (INC)	1.3(1.0)	2.7(9.2)	4.1	6.1	75092	3.0
SEm±	**0.06**	**0.05**	**0.1**	**0.1**		
LSD (P=0.05)	**0.20**	**0.17**	**NS**	**NS**		
Weed management practices						
Rec.herb. (Clodinafop (15%) + MSM(1%) @ 60+4 g/ha)	1.1(0.3)	2.0(3.1)	4.3	6.4	78017	3.0
IWM (Rec. herbicide + one hand weeding)	1.0(0.00)	1.0(0.0)	4.7	7.0	82917	2.8
Unweeded	4.6(22.8)	6.4(43.3)	3.6	5.4	62267	2.7
SEm±	**0.05**	**0.05**	**0.1**	**0.1**		
LSD (P=0.05)	**0.17**	**0.13**	**0.2**	**0.3**		

DSR: direct seeded rice; TPR- transplanted rice; CT- conventional tillage, ZT- zero tillage, RC- residue incorporation, RR-residue retention, INC- Incorporation, Value in parentheses are original and transformed to square root $\sqrt{\ }$X+1 for analysis.

In rice during *Kharif* 2021, an experimental field comprised of *E. colona*, *E. crus-galli, L. chinensis, I. rugosum*, *P. maximum*, *A. baccifera*, *A. sessilis*, *C. axillaris*, *C. rotundus*, *C. iria*, and *C. difformis* and the major weed species recorded were *L. chinensis* (6.6%), *A. baccifera* (6.7%), *C. iria* (47.7%) and *C. rotundus* (10.7%).

At 60 DAS/T, among tillage methods, the lowest density and biomass of grassy weeds were observed with rice (TPR) incorporated with residue – wheat ZT+R- *Sesbania* incorporation, whereas BLWs and sedges were recorded in rice (TPR) – wheat (CT)-*Sesbania*. However, the lowest sedges were observed with rice (TPR) incorporation of residues-wheat (CT+R)-Sesbania. *Cyperus difformis* was completely controlled in rice (DSR) incorporated with residues-wheat (CT+R)-*Sesbania* and rice (DSR)- wheat (CT). The highest grain and straw yield (4.6 and 8.0 t/ha, respectively) was achieved with rice (TPR) – wheat (CT+R) - *Sesbania* incorporation which was statistically at par with rice (TPR) – wheat (CT) and rice (TPR) – wheat ZT+R) - *Sesbania* incorporation. The highest net returns (Rs. 30,498/ha) and B: C (1.6) were recorded in the plots of rice (TPR) with incorporation of residue-wheat (CT+R)-*Sesbania* incorporation **(Table 1.2.6)**.

Among weed management, IWM (recommended herbicide *fb* HW at 45 DAS/DAT) achieved the lowest total weed density and total weed biomass, whereas *Echinochloa colona* and *Ischaemum rugosum* and *Cyperus difformis* have been completely controlled. Similarly, IWM was found superior towards recording the highest yield attributing characters and yield of rice which was significantly superior to recommended herbicide practice and un-weeded situation. This resulted in IWM recorded the highest net return (Rs.26,927/ha), but B:C was comparable in IWM and recommended herbicide (penoxsulam + cyhalofop –butyl 135g/ha) (1.5). Rice (TPR) + RC- Wheat (CTW)+RR along with *Sesbania* (Inc) as well as residue retention recorded maximum grain yield of rice with the integration of IWM practices (5.0 t/ha) which was superior to the rest of the establishment systems in combination with other weed management practices

Table 1.2.6 Effect of establishment methods and weed management practices on total weed density, biomass at 60 DAS/DAT and yield of rice in the rice-wheat cropping system.

Treatments	Grassy		BLWs		Sedges		Grain yield (t/ha)	Straw yield (t/ha)
	Density (no./m²)	Dry biomass (g/m²)	Density (no./m²)	Dry biomass (g/m²)	Density (no./m²)	Dry biomass (g/m²)		
Tillage & residue management								
Rice (TPR)-Wheat (CTW)	3.1 (10.2)	6.6 (53.8)	3.0 (10.7)	3.3 (12.6)	2.0 (4.9)	1.9 (4.4)	4.3	7.6
Rice (TPR) + RC- Wheat (CTW)+R-*Sesbenia* (INC)	3.0 (10.2)	4.9 (29.2)	4.3 (23.1)	2.5 (6.3)	3.7 (23.6)	3.1 (15.4)	4.6	8.0
Rice (TPR) + RC- Wheat (ZTW)+RR-*Sesbenia* (INC)	2.0 (5.3)	3.0 (16.5)	4.6 (29.6)	2.9 (7.9)	3.4 (21.3)	2.9 (14.6)	4.3	7.6
Rice (DSR) -Wheat (CTW)	4.8 (36.0)	8.8 (137.1)	3.5 (12.4)	3.0 (9.9)	7.5 (91.3)	5.2 (45.7)	2.9	5.2
Rice (DSR) + R-Wheat (CTW)+R-*Sesbenia* (INC)	5.1 (33.8)	10.8 (196.9)	3.8 (14.4)	2.8 (7.8)	8.7 (113.8)	6.2 (57.7)	3.1	5.4
Rice (DSR) + R- Wheat (ZTW)+RR-*Sesbenia* (INC)	4.1 (28.0)	10.0 (198.0)	4.9 (24.9)	3.7 (13.6)	9.6 (149.3)	7.3 (84.8)	3.1	5.5
SEm±	**0.1**	**0.3**	**0.1**	**0.1**	**0.2**	**0.1**	**0.1**	**0.2**
LSD (P=0.05)	**0.4**	**1.0**	**0.2**	**0.2**	**0.5**	**0.3**	**0.3**	**0.5**
Weed management prctice								
Rec.herb. (Penoxsulam + cyhalofop –butyl 135 g/ha (15-20DAS/DAT)	2.4 (5.6)	4.3 (19.8)	3.6 (15.4)	2.8 (7.2)	3.4 (15.4)	2.5 (6.9)	4.0	7.0
IWM (Rec. herbicide *fb* one HW at 45 DAS/DAT)	1.6 (1.8)	2.1 (4.4)	2.1 (3.1)	1.8 (2.4)	1.7 (4.1)	1.5 (1.6)	4.5	8.0
Un-weeded	7.0 (54.4)	15.6 (291.5)	6.3 (40.9)	4.5 (19.5)	12.3 (183.6)	9.4 (102.8)	2.7	4.7
SEm±	**0.1**	**0.1**	**0.1**	**0.0**	**0.1**	**0.1**	**0.0**	**0.1**
LSD (P=0.05)	**0.2**	**0.4**	**0.2**	**0.1**	**0.4**	**0.2**	**0.1**	**0.2**

DSR: direct seeded rice; TPR- transplanted rice; CT- conventional tillage, ZT- zero tillage, R- residue retention, Value in parentheses are original and transformed to square root $\sqrt{X+1}$ for analysis

SKUAST, Jammu

Weed management in rice-wheat-greengram cropping system under conservation agriculture

During *Rabi* 2020-21, *Phalaris minor, Rumex* spp., *Anagalis arvesnsis, Medicago* spp., *Ranunculus arvensis, Melilotus* spp. and other weeds *like Vicia* spp., were major weeds observed in wheat. At 60 DAS, the density of *Phalaris minor* in ZT wheat was significantly lower than CT wheat. Among the tillage and residue management treatments, ZTDSR/ZTDSR+R-wheat (ZT)+R plots recorded lesser weed density and biomass of grassy weed, BLWs and total weed density over CT or ZT. However, *Medicago* spp. was recorded lower in CT (TPR)-wheat (CT) and CTDSR-wheat (CT). Lesser weeds lead to synthesizing better growth and yield attributes resulting in higher grain and straw yield, and B: C under ZTDSR/ZTDSR+R-wheat (ZT)+R and were significantly higher than in CT (TPR)-wheat (CT).

Among the weed management treatments, all the weed management treatments recorded significantly lower weed density and weed biomass over weedy check. Sulfosulfuron + metsulfuron 30+2 g/ha at 30 DAS fb HW at 45 DAS (IWM) recorded significantly lower density and biomass of weeds over weedy check and herbicidal treatment [sulfosulfuron + metsulfuron (30+2 g/ha) at 30 DAS]. Significant interactions were found between tillage and weed management treatments for weed density and weed biomass at 60 DAS and at harvest (**Table 1.2.7**). The IWM recorded significantly higher panicles/m^2, grains/panicle, test weight, grain and straw yields, and B: C of wheat over weedy check and sulfosulfuron + metsulfuron (30+2 g/ha) at 30 DAS.

Table 1.2.7 Effect of tillage and weed management practices on weed biomass in wheat (*Rabi* 2020-21)

Treatments	Weed biomass (g/m²) at 60 DAS				Weed biomass (g/m²) at harvest				Grain yield (t/ha)
	Grassy	BLWs	Total	WCE	Grassy	BLWs	Total	WCE	
Tillage and residue management									
TRM 1	5.02 (24.18)	6.41 (40.14)	8.08 (64.33)	58.51	7.79 (59.72)	8.56 (72.20)	11.53 (131.92)	59.8	3.86
TRM 2	4.25 (17.02)	7.25 (51.51)	8.34 (68.53)	58.80	6.96 (47.38)	9.64 (91.93)	11.85 (139.31)	60.0	3.66
TRM 3	4.74 (21.42)	6.27 (38.25)	7.79 (59.68)	58.71	7.44 (54.38)	8.10 (64.55)	10.95 (118.93)	59.7	4.05
TRM 4	2.92 (7.53)	5.00 (23.99)	5.70 (31.52)	62.32	4.82 (22.19)	7.14 (50.05)	8.56 (72.23)	61.7	4.27
TRM 5	2.86 (7.21)	4.91 (23.07)	5.59 (30.28)	62.21	4.60 (20.19)	6.89 (46.49)	8.23 (66.68)	61.4	4.35
SEm ±	**0.06**	**0.11**	**0.10**	**-**	**0.08**	**0.16**	**0.11**		**0.12**
LSD (p=0.05)	**0.18**	**0.35**	**0.31**	**-**	**0.26**	**0.52**	**0.36**		**0.39**
Weed management practices									
Herbicide	2.96 (7.75)	4.00 (14.97)	4.87 (22.72)	83.05	4.77 (21.71)	4.85 (22.57)	6.73 (44.28)	83.7	4.34
IWM	1.63 (1.64)	1.82 (2.31)	2.22 (3.95)	97.28	2.02 (3.10)	2.13 (3.55)	2.76 (6.64)	97.8	4.72
Weedy	6.17 (37.03)	9.48 (88.90)	11.27 (125.93)	0.00	9.92 (97.50)	13.04 (169.02)	16.36 (266.52)	0.00	3.05
SEm ±	**0.05**	**0.06**	**0.06**		**0.08**	**0.08**	**0.09**	**-**	**0.07**
LSD (p=0.05)	**0.15**	**0.18**	**0.17**		**0.22**	**0.25**	**0.27**	**-**	**0.22**
Interaction	**S**	**S**	**S**		**S**	**S**	**S**	**-**	**NS**

Data were subjected to square root transformation $\sqrt{X+1}$. Original values are in parenthesis

During *Kharif* 2021 in rice, the study area comprised of *Echinochloa* spp., *Cynodon dactylon* and *Digitaria sanguinalis* amongst grassy weeds; *Alternanthera philoxeroides, Caesulia axilaris, Phyllanthus niruri* and *Physalis minima* amongst broad-leaved weeds and *Cyperus* spp. were mainly infested in rice. *Dactyloctenium aegyptium, Ammannia baccifera* and *Commelina benghalensis* were recorded as other weeds. Among the tillage and residue management treatments significantly lower grassy, BLWs, sedges, total weed density and weed biomass were recorded in TPR as compared to DSR (ZT+R), DSR (ZT) and DSR (CT). The *Alternanthera philoxeroides* and *Caesulia axilaris* were significantly higher in TPR as compared to DSR either under ZT and CT. However, the density of *Phyllanthus niruri* and *Physalis minima* were significantly higher in DSR either under ZT and CT over TPR. A significantly higher number of panicles/m^2, grain and straw yields were recorded in TPR as compared to DSR (ZT+R), DSR (ZT) and DSR (CT) (**Table 1.2.8**).

The test weight was found to be non-significant among different tillage and residue management treatments.

Among the weed management treatments, all the weed management treatments recorded significantly lower weed density and weed biomass as compared to the weedy check. The pendimethalin 1 kg/ha fb bispyribac-sodium 25 g/ha fb 1 hand weeding in DSR (IWM) and bispyribac-sodium 25 g/ha fb 1 hand weeding in transplanted rice (IWM) recorded significantly lowest density and biomass of weeds as compared to weedy check and herbicidal treatment (pendimethalin 1 kg/ha fb bispyribac-sodium 25 g/ha in DSR and bispyribac-sodium 25 g/ha in transplanted rice). A significant interaction was found between tillage and weed management treatments for weed density and weed biomass. IWM recorded significantly higher panicles/m^2 and grain and straw yield of rice as compared to weedy check and herbicidal treatment. Amongst all the tillage and residue and weed management combinations, the highest net returns and B:C was recorded in DSR (ZT+R) and IWM treatment combination.

Table 1.2.8 Effect of tillage and weed management practices on weed biomass and yield in rice (*Kharif*-2021)

Treatment	Weed biomass (g/m²) at 60 DAS/DAT				WCE	Grain yield (t/ha)	Straw yield (t/ha)	B: C
	Grassy	BLWs	Sedges	Total				
Tillage & residue management								
TRM 1	3.94 (14.53)	3.17 (9.06)	3.01 (8.06)	5.71 (31.65)	55.62	3.90	5.15	1.52
TRM 2	4.00 (14.98)	3.17 (9.02)	3.08 (8.46)	5.78 (32.46)	55.21	3.84	5.02	1.49
TRM 3	6.82 (45.54)	4.15 (16.23)	4.59 (20.07)	9.10 (81.84)	57.64	2.86	4.11	0.97
TRM 4	7.30 (52.28)	4.37 (18.11)	4.42 (18.52)	9.48 (88.91)	57.21	2.81	3.55	1.09
TRM 5	6.10 (36.26)	3.64 (12.28)	4.28 (17.32)	8.18 (65.86)	59.09	3.08	4.32	1.33
SEm ±	**0.09**	**0.04**	**0.06**	**0.10**		**0.12**	**0.20**	
LSD (p=0.05)	**0.29**	**0.14**	**0.20**	**0.32**		**0.39**	**0.64**	
Weed management practices								
Herbicide	4.81 (22.11)	2.83 (7.01)	2.67 (6.15)	6.02 (35.28)	73.45	3.73	4.97	1.61
IWM	1.52 (1.32)	1.00 (0.00)	1.92 (2.68)	2.24 (4.00)	97.41	4.32	5.72	1.84
Weedy	8.70 (74.72)	5.73 (31.81)	5.97 (34.62)	11.92 (141.15)	0.00	1.85	2.59	0.40
SEm ±	**0.06**	**0.04**	**0.04**	**0.06**		**0.08**	**0.10**	
LSD (p=0.05)	**0.18**	**0.13**	**0.12**	**0.18**		**0.24**	**0.30**	
Interaction	**S**	**S**	**S**	**S**		**S**	**S**	

Data were subjected to square root transformation $\sqrt{X+1}$. Original values are in parenthesis

AAU, Jorhat

Weed Management in rice-mustard-green manure cropping system under conservation agriculture

In Indian mustard, among the tillage and residue management CT (S)-CT (TR)-CT (IM) resulted in significantly lower values of density and biomass of weeds per unit area. The highest values of these two weed parameters were recorded in plots receiving the treatment MT(S)-CT(DSR)-CT(IM) and MT(S)-MT(DSR)-MT+R(IM), respectively. Significantly highest number of siliqua/plant and seed yields of Indian mustard were recorded in CT(S)-CT(TR)-CT(IM). The number of siliqua/plant recorded under MT(S)-CT(TR)-MT(IM) was, however, remained at par with CT(S)-CT(TR)-CT(IM). The lowest number of siliqua/plant and seed yields were noted under MT(S)-MT(DSR)-MT+R(IM) and MT(S)-MT(DSR)-MT(IM) which remained statistically at par with each other.

Among the weed management treatments, the lowest weed density and biomass at 20 and 50 DAS were observed in IWM (pendimethalin 0.75 kg/ha PE in rapeseed + one mechanical weeding). Siliqua/plant did not vary with various weed management practices, however, the highest seed yield was recorded under IWM (679.3 kg/ha), whereas recommended herbicide (pendimethalin) and one hand weeding/hoeing were comparable to each other. The lowest seed yield was recorded in weedy check (**Table 1.2.9**).

Table 1.2.9 Effect of tillage practices and weed management on weeds and yield of Indian mustard

Tr. No.	Treatments in *Kharif* Rice & Indian Mustard	Weed Population (No./m²)		Dry weight of weeds (g/m²)		No. of siliqua/plant	Seed yield (kg/ha)
		20DAS	50DAS	20DAS	50DAS		
Tillage practices (MPT)							
T_1	CT(S)-CT(TR)-CT(IM)	26.00	32.08	4.54	13.11	44.9	770.4
T_2	MT(S)-CT(TR)-MT(IM)	30.83	35.50	4.66	13.90	42.7	647.9
T_3	MT(S)-CT(DSR)-CT(IM)	33.58	47.00	5.51	12.42	38.7	576.7
T_4	MT(S)-MT(DSR)-MT+R(IM)	28.92	43.83	5.92	15.33	36.8	537.5
T_5	MT(S)-MT(DSR)-MT(IM)	47.17	49.58	9.33	16.33	36.8	499.2
	SEm (±)	**1.88**	**1.86**	**0.30**	**0.74**	**0.89**	**22.11**
	C.D. (P=0.05)	**7.38**	**7.31**	**1.18**	**2.89**	**3.50**	**86.78**
Weed management practices							
W_1	Recommended herbicide (pendimethalin)	32.13	39.47	5.72	15.20	40.1	596.0
W_2	IWM = W_1 + one mechanical weeding	27.87	31.93	5.13	11.24	42.5	679.3
W_3	One hand weeding/hoeing	33.87	45.00	6.31	13.39	39.8	599.0
W_4	Weedy check	39.33	50.00	6.79	17.05	37.6	551.0
	Sem (±)	**1.12**	**1.45**	**0.20**	**0.61**	**1.55**	**17.02**
	C. D. (P-0.05)	**3.22**	**4.18**	**0.57**	**1.77**	**NS**	**49.16**

BCKV, Kalyani

Weed management in rice- rapeseed- greengram cropping system under conservation agriculture

In Rapeseed 2020-21 at 60 DAS, field comprised of *Amaranthus viridis, Physalis minima, Trianthema portulacastrum, Phyllanthus niruri* among BLWs; in grassy weeds *Cynodon dactylon, Digitaria sanguinalis, Dactyloctenium aegyptium* etc., and *Cyperus rotundus, Cyperus difformis* among sedges.

At 60 DAS, CTTP-MT recorded the lowest weed density and weed biomass (27 no./m^2 and 14.3 g/m^2, respectively) and the highest with MT-MT-MT (40.0 no./m^2 and 22.8 g/m^2, respectively). CTTP-MT recorded with better growth and yield attributes resulted in higher seed and stalk yield (1.24 and 3.77 t/ha, respectively), whereas the lowest yield was recorded with MT-MT-MT treatment (1.00 and 3.63 t/ha, respectively). Similarly, the B: C was found highest with CTTP-MT (1.53).

Among weed management practices, at 60 DAS, one hand weeding at 30 DAS recorded the least weed density (49.8/m^2), whereas weed biomass was least under IWM [pendimethalin 1.0 kg/ha (PE) fb mechanical weeding at 30 DAS] (15.9 g/m^2). The IWM recorded better growth and yield attributes resulting in higher seed and stalk yield (1.24 and 3.84 t/ha, respectively). However higher B: C (1.49) was recorded in pendimethalin at 1.0 kg/ha. The lowest yield and returns were recorded with one hand weeding at 30 DAS (**Table 1.2.10**).

Table 1.2.10 Effect of tillage, residue and weed management practices on weeds, yield attributes, yield and economics of rapseed during *Rabi*, 2020-21

Treatments	Weed density (no./m^2) at 60 DAS	Weed biomass (g/m^2) at 60 DAS	Seeds/ siliqua	No. of siliqua/plant	Seed yield (t/ha)	Stalk yield (t/ha)	B: C
Tillage &residue management							
CTTP-CT	5.36 (28.28)	4.07 (16.07)	22.24	90.77	1.19	3.73	1.34
CTTP-MT	5.24 (27.01)	3.85 (14.31)	24.68	93.11	1.24	3.77	1.51
CTDSR-CT	5.63 (31.21)	4.42 (18.99)	19.51	84.55	1.16	3.65	1.31
MT-MT	6.36 (39.98)	4.83 (22.81)	16.87	77.11	1.00	3.57	1.23
MT+R-MT+R	5.93 (34.66)	4.56 (20.33)	18.47	81.88	1.12	3.63	1.11
SEm±	**-**	**-**	**0.314**	**0.697**	**0.003**	**0.005**	**-**
LSD (P=0.05)	**-**	**-**	**1.039**	**2.307**	**0.009**	**0.017**	**-**
Weed management practices							
Pendimethalin 1.0 kg/ha PRE	7.69 (58.59)	4.09 (16.22)	20.73	89.26	1.19	3.80	1.49
Pendimethalin 1.0 kg/ha PRE + mechanical weeding at 30 DAS	7.64 (57.92)	4.05 (15.92)	23.66	93.20	1.24	3.84	1.28
One hand weeding at 30 DAS	7.09 (49.82)	4.88 (23.36)	16.68	74.00	0.99	3.38	1.13
SEm±	**-**	**-**	**0.173**	**0.338**	**0.003**	**0.002**	**-**
LSD (P=0.05)	**-**	**-**	**0.515**	**1.003**	**0.01**	**70.01**	**-**

In greengram 2021, field comprised with *Cynodon dactylon, Digitaria sanguinalis* and *Dactyloctenium aegyptium* as major grassy weed, *Cyperus rotundus* as sedge, *Trianthema portulacastrum, Phylanthus niruri* and *Physalis minima* as BLWs. CTTP-MT-MT recorded the lowest weed density and weed biomass with higher WCE and the highest density and biomass with MT-MT-MT at 60 DAS. CTTP-MT-MT recorded with better growth and more yield attributes resulted in higher seed and stover yield (0.92 and 2.49 t/ha, respectively), whereas the lowest yield was recorded with MT-MT-MT treatment (0.84 and 2.22 t/ha, respectively). Similarly, the economic parameters viz., net returns and B: C was found highest with CTTP-MT-MT (Rs. 31008/ha and 1.78, respectively).

Similarly, the economic parameters viz., net returns and B: C was found highest with CTTP-MT-MT (Rs. 31008/ha and 1.78, respectively). Among weed management practices, at 60 DAS, quizalofop-ethyl 50 g/ha at 20DAS + mechanical weeding at 30 DAS (IWM) recorded least weed density and weed biomass, resulted in the highest WCE (73.2%) followed by quizalofop-ethyl 50 g/ha at 20 DAS. The IWM recorded better growth and yield attributes resulted in higher seed and stover yield (0.97 and 2.64 t/ha, respectively). However, quizalofop-ethyl 50 g/ha at 20 DAS was recorded with a higher net returns (28136 Rs./ha), whereas B: C was highest with quizalofop-ethyl 50g/ha at 20DAS (1.66). The lowest yield and return were recorded with one hand weeding at 30 DAS (**Table 1.2.11**).

Table 1.2.11 Effect of tillage, residue and weed management practices on yield attributes, yield and economics of greengram during *Pre-Kharif*, 2021.

Treatments	Pods/ plant	Seeds/ pod	Seed yield (t/ha)	Straw yield (t/ha)	Total cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B: C
Tillage & residue management								
T_1 (CTTP-CT-CT)	28.0	9.41	0.917	2.45	48107	70003	21896	1.46
T_2 (CTTP-MT-MT)	29.0	9.50	0.927	2.49	39738	70746	31008	1.78
T_3 (CTDSR-CT-MT)	25.2	9.00	0.856	2.29	40973	65321	24348	1.59
T_4 (MT-MT-MT)	23.9	8.87	0.837	2.22	41172	63909	22738	1.55
T_5 (MT+R-MT+R-MT+R)	20.5	9.18	0.888	2.35	44259	67751	23492	1.53
SEm±	**0.33**	**0.014**	**0.38**	**1.64**	**-**	**-**	**-**	**-**
LSD (P=0.05)	**1.11**	**0.057**	**1.26**	**4.54**	**-**	**-**	**-**	**-**
Weed management practices								
W_1 Quizalofop-ethyl 50g/ha at 20 DAS	25.6	9.08	0.874	2.31	40264	66735	26471	1.66
W_2 Quizalofop-ethyl 50g/ha at 20 DAS + mechanical weeding at 30 DAS	27.6	9.74	0.967	2.64	45710	73846	28136	1.62
W_3 One hand weeding at 30 DAS	22.8	8.76	0.813	2.13	42575	62057	19482	1.46
SEm±	**0.24**	**0.010**	**0.47**	**1.12**	**-**	**-**	**-**	**-**
LSD (P=0.05)	**0.85**	**0.034**	**1.49**	**4.13**	**-**	**-**	**-**	**-**

Kharif 2021, the experimental field dominated by *Echinochloa crusgalli*, *E. colona among grasses, C. rotundus, Cyperus iria, C. difformis, Fimbritylis miliaceae* among sedges, *Ammannia baccifera*, *Monochoria vaginalis, Commelina benghalensis Marsilea quadrifolia, Ludwigia parviflora* and *Alternanthera sessilis* amongst BLWs. At 60 DAS, CTTP-MT-MT was observed with a lower density of grassy, sedges and BLWs (3.9, 27.0, 16.4 no./m^2, respectively) and biomass (0.8, 17.3 and 21.9 g/m^2, respectively) whereas the highest density and biomass was recorded in MT-MT-MT. Reduction in density and biomass of weeds leads to maximum grain (2.52 t/ha) and straw yield (5.34 t/ha) with CTTP-MT-MT followed by CTTP-CT-CT (2.49 and 5.26 t/ha, respectively) over MT DSR-MT-MT (2.32 and 4.96 t/ha, respectively). Among weed management practices, pretilachlor 0.75 kg/ha fb bispyribac-Na 25 g/ha at 25 DAT fb mechanical weeding at 50 DAT showed the least weed density (3.3, 19.4 and 13.4/m^2, respectively) and weed biomass (0.5, 12.8 and 17.8 g/m^2, respectively) as compared to other treatments. This resulted in higher yield attributes, grain and straw yield (2.60 and 5.44 t/ha, respectively) and higher net return (Rs. 128530/ha) and B: C (1.93) under pretilachlor 0.75 kg/ha fb bispyribac-Na 25 g/ha at 25 DAT (**Table 1.2.12**).

Table 1.2.12 Effect of tillage, residue and weed management practices on weeds, yield and economics of rice during *Kharif*, 2021

Treatments	Weed density (no./m²)			Weed density (g./m²)			Grain yield (t/ha)	Straw yield (t/ha)	Net returns (Rs./ha)	B: C
	Grasses	Sedges	BLW	Grasses	Sedges	BLW				
Tillage and residue management										
CT-TR	2.15 (4.18)	5.50 (30.73)	4.34 (18.85)	1.18 (0.93)	4.36 (19.10)	4.96 (24.84)	2.49	5.26	113127	1.80
CT-TR	2.07 (3.87)	5.12 (26.98)	4.05 (16.42)	1.11 (0.78)	4.14 (17.30)	4.68 (21.93)	2.52	5.34	116112	1.82
CT-DSR	2.42 (5.47)	6.60 (45.00)	4.95 (24.58)	1.33 (1.30)	5.25 (28.15)	5.67 (32.38)	2.35	4.99	105866	1.82
MT-DSR	2.48 (5.75)	6.82 (47.74)	5.27 (28.07)	1.36 (1.41)	5.62 (32.62)	5.98 (36.27)	2.32	4.96	111692	1.90
MT-DSR + R	2.27 (4.77)	5.96 (36.63)	4.61 (21.29)	1.25 (1.11)	4.69 (22.37)	5.28 (28.04)	2.43	5.12	119713	1.93
SEm±	**0.021**	**0.073**	**0.047**	**0.006**	**0.090**	**0.041**	**0.015**	**0.012**	**-**	**-**
LSD (P=0.05)	**0.070**	**0.240**	**0.153**	**0.022**	**0.294**	**0.135**	**0.047**	**0.033**	**-**	**-**
Weed management practices										
Pretilachlor 0.75 kg/ha PRE *fb* bispyribac-Na 25 g/ha at 25 DAT	2.32 (4.94)	6.30 (39.78)	4.79 (22.65)	1.29 (1.20)	4.95 (24.39)	5.48 (29.84)	2.43	5.07	117098	1.89
Pretilachlor 0.75 kg/ha PRE *fb* bispyribac-Na 25 g/ha at 25 DAT + mechanical weeding at 50 DAT	1.95 (3.33)	4.43 (19.41)	3.70 (13.37)	1.01 (0.54)	3.61 (12.77)	4.25 (17.79)	2.60	5.44	128530	1.93
One hand weeding at 30 DAS	2.57 (6.15)	7.27 (53.06)	5.45 (29.52)	1.43 (1.58)	5.86 (34.57)	6.21 (38.46)	2.24	4.90	94279	1.70
SEm±	**0.014**	**0.049**	**0.032**	**0.005**	**0.066**	**0.029**	**0.011**	**0.016**	**-**	**-**
LSD (P=0.05)	**0.043**	**0.148**	**0.098**	**0.015**	**0.198**	**0.089**	**0.043**	**0.046**	**-**	**-**

IGKV, Raipur

Weed management in rice-wheat-cowpea fodder cropping system under conservation agriculture systems

In wheat 2020-21, the experimental field was heavily infested with *Medicago denticulata,* followed by *Echinochloa colona* and *Chenopodium album*. The other weed flora was *Anagalis arvensis, Melilotus indica, Rumex dentatus* etc. in a lower number. The *Medicago denticulata* was the most serious weed.

At 60 DAS, weed density and biomass were recorded lowest in ZT (DSR) +R-ZT+R followed by ZT+R as compared to CT-CT and CT-ZT. The higher grain yield (2.96 t/ha) was obtained under ZT (DSR)+R-ZT+R followed by ZT(DSR)-ZT without residue tillage (2.87 t/ha). However, CT (TPR) – CT / ZT and CT (DSR) - CT are comparable with each other, although it was a significantly lower yield than that of ZT (DSR)+R-ZT+R. Similarly, the net returns and B: C was also high under ZT+R.

Among weed management practices, weed density and biomass were recorded lowest under IWM (clodinofop 60 g/ha + metsulfuron 4 g/ha PoE *fb* HW 40 DAS) and recommended herbicide (clodinafop 60 g/ha + metsulfuron 4 g/ha) over control. The higher grain yield was recorded under IWM followed by recommended practice and both were significantly superior to control. The IWM was found more profitable in terms of net return as well as B: C than recommended herbicide practice (**Table 1.2.13**). The RUE was compared between CT and ZT+R, CT and ZT with no residue, unweeded and chemical weed control and unweeded with IWM. It was found that ZT+R had 9.00% higher efficiency over CT, ZT with no residue had shown 1.97% higher efficiency over CT, chemical weed control by 118.45% over unweeded and IWM proved to be 147.46% more efficient over unweeded, respectively.

Table 1.2.13 Weed dry biomass, grain yield and economics as influenced by weed management practices in conservation agriculture in wheat, *Rabi* 2019-20

Treatments	Weed dry biomass (g/m^2)	Grain yield (t/ ha)	Net return (Rs/ha)	B: C
Tillage & residue management				
CT (Transplanted) -CT-CT	5.71 (32.1)	2.50	26336	2.04
CT (Transplanted) -ZT-ZT	5.06 (25.1)	2.83	35319	2.91
CT (Direct seeded)-CT-ZT	5.45 (29.3)	2.71	30391	2.41
ZT (Direct seeded)-ZT+R-ZT	4.61 (20.7)	2.87	36832	2.92
ZT (Direct seeded)+R - ZT+R-ZT+R	4.46 (19.4)	2.96	38614	3.02
SEm±	**0.25**	**0.05**	-	-
LSD (P= 0.05)	**0.81**	**0.15**	-	-
Weed management practices				
Clodinofop 60 g/ha + metsulfuron 4 g/ha	4.57 (20.4)	3.10	39312	2.72
Integrated (clodinofop 60 g/ha + metsulfuron 4 g/ha *fb* HW 40 DAS)	4.15 (16.7)	3.54	48470	3.52
Weedy check	6.27 (38.9)	1.69	12714	1.74
SEm±	**0.15**	**0.03**	-	-
LSD (P= 0.05)	**0.47**	**0.10**	-	-

In cowpea 2021, the experimental field was dominated by *Echinochloa colona* and *Cynodon dactylon* among grasses and *Alternanthera triandra* was major BLW. *Cyperus iria, Brachiaria ramose,* etc were the other weeds present in small numbers. Significantly lower weed biomass at 40 DAS was recorded under ZT (DSR) + R-ZT+R-ZT+R than other crop establishment methods. Green fodder yield was remarkably higher under ZT (DSR) + R-ZT+R-ZT+R (11.84 t/ha) than CT/ZT without residue. Highest net returns and B: C was obtained under ZT (DSR) +R-ZT +R-ZT+R followed by ZT (DSR)-ZT+R-ZT. It was found that ZT+R had 14.8% higher resource use efficiency over CT, and ZT with no residue had shown 3.9% higher efficiency over CT.

Application of pendimethalin 1.0 kg/ha *fb* HW at 20 DAS kept the weed density and biomass considerably lower than other weed management practices. This leads to a higher fodder yield recorded under the recommended practice of application of pendimethalin 1.0 kg/ha *fb* HW at 20 DAS (16.35 t/ha) than rest. Similarly, net returns and B: C was highest under the IWM. The IWM recorded resource use efficiency by 226.1% followed by recommended herbicide 176.6% over un-weeded.

In rice 2021, Weed flora of the experimental field consisted of *Echinochloa colona* among grasses, *Cyperus iria* among sedges and *Alternanthera triandra* among broadleaf weeds. Broadleaf weeds and sedges dominated the weed flora at all the growth stages as compared to grasses and other weeds. Other weeds like *Brachiaria ramosa*, *Sporobolus diander*, *Cynotis axillaris, Commelina benghalensis, Ludwigia parviflora* etc. were also found in irregular and less numbers. *Cyanotis axillaris* and *Sporobolus diander* being late *Kharif* weeds dominated the weed flora during the maturity of crop.

The lowest weed density and biomass was found under CT (TPR) over CT (DSR), ZT (DSR) and ZT (DSR) with residue at all the stages. However, in case of DSR, weed density and biomass were lower in ZT (DSR) +R as compared to ZT alone, this might be due to retaining crop residues between rows. Lower weed parameters lead to better yield attributes resulted in higher seed and straw yield found under CT (TPR). The net income was higher under ZT (DSR) + R followed by ZT (DSR). While highest B: C (3.45) was also achieved in ZT(DSR) closely followed by ZT (DRS) + R.

As regards to weed management, the lower density and biomass of total weeds were less under IWM (oxadiargyl 80 g/ha *fb* HW at 25 DAT/S) followed by recommended herbicide (pyrazosulfuron 20 g/ha *fb* penoxsulam 22.5 g/ha) over control. Although, significant variation in seed yield was obtained and significantly higher seed yield was recorded under IWM practices followed by pyrazosulfuron 20 g/ha *fb* penoxsulam 22.5 g/ha. Both the weed management practices were significantly superior to untreated control. Lower weed parameters and higher yield resulted in higher net return and B: C was IWM followed by pyrazosulfuron 20 g/ha *fb* penoxsulam 22.5 g/ha (**Table 1.2.14**).

It was found that ZT had 3.67% higher resource use efficiency over CT, transplanting had 10.93% higher over DSR, chemical weed control had 70.26% over unweeded and IWM proved to be 87.19% more efficient over unweeded, respectively.

Table 1.2.14 Weed biomass, seed yield and economics of rice as influenced by weed management practices in rice under conservation agriculture, *Kharif* 2021.

Treatment	Weed biomass (g/m^2)	Grain Yield (t/ha)	Net income (Rs/ha)	B:C
Tillage & residue management				
CT (Transplanted)-CT-CT	5.12 (25.68)	5.22	58510	2.33
CT (Transplanted)-ZT-ZT	5.55 (30.25)	5.01	54480	2.23
CT (Direct Seeded)-CT-ZT	6.47(41.36)	4.08	48303	2.49
ZT (Direct Seeded)-ZT+R-ZT	6.02(35.71)	4.79	66573	3.45
ZT(Direct Seeded)+ R-ZT+R-ZT+R	5.86 (33.88)	4.90	65749	3.14
SEm±	**0.18**	**0.08**	**-**	**-**
LSD (P= 0.05)	**0.59**	**0.25**	**-**	**-**
Weed management practices				
Recommended (pyrazosulfuron 20 g/ha *fb* penoxsulam 22.5 g/ha PoE	4.46 (19.36)	5.57	71775	3.07
Integrated weed management (oxadiargyl 80 g *fb* HW at 25 DAT/S	3.30 (10.42)	6.11	80889	3.27
Unweeded	9.65 (92.58)	2.73	23506	1.91
SEm±	**0.12**	**0.04**	**-**	**-**
LSD (P= 0.05)	**0.35**	**0.12**	**-**	**-**

OUAT, Bhubaneswar

Weed management in rice- maize-cowpea under conservation agriculture systems

In *Kharif* 2021, the experimental field was dominated by grasses (55%) followed by BLWs (30%) and sedges (15%). The weed populations followed a decreasing trend from the base year. *Panicum repens* (21%), *Echinochloa crusgalli* (17%) and *Echinochloa colona* (14%) were observed to be the dominant grasses. *Marselia quadrifolia* (18%) and *Alternanthera sessilis* (27%) were the major broadleaf weeds. *Cyperus difformis* (12%) and *Cyperus iria* (3%) were the important sedges observed at the experimental site. Other minor weeds observed were *Ludwigia parviflora, Leptochloa chinensis*, *Sphenochloa zeylanica*, *Cyperus rotundus, Paspalum scrobiculatum* and *Dactyloctenium aegyptium*.

At 60 DAP, CT (transplanted) plots had considerably lower weeds over CT (DSR). The average weed density and biomass of weeds were lowest with CT (transplanting)-CT system (79.4/m^2 and 32.5 g/m^2, respectively) followed by CT (transplanting)-ZT-ZT system. Adoption of CT (transplanting) tillage methods reduced the weed densities over ZT (DSR) in the *Kharif* rice to the tune of 29%. The rest of the treatments had significantly higher weed density and biomass, however, weed values were lowest in CT (transplanting)-CT system. The grain yield and returns were statistically different among tillage systems. The highest grain yield (4.30 t/ha) was recorded with CT (transplanting) -CT system followed by CT (transplanting)-ZT-ZT system (4.23 t/ha) with the highest net returns (**Table 1.2.15**).

Among weed management practices, application of pretilachlor 0.75 kg/ha *fb* hand weeding

(IWM) recorded fewer weeds and lesser weed biomass followed by pretilachlor 0.75 kg/ha over one hand weeding (113.4/m^2 and 38.5 g/m^2, respectively). Weeds were 60% controlled in IWM and 40% in recommended herbicide over control. Lower weed density and biomass under IWM resulted in higher grain yield (4.33 t/ha) followed by pretilachlor 0.75 kg/ha (4.17 t/ha) and proved better than weedy check. However, pretilachlor 1.0 kg/ha obtained the highest net returns (Rs 12987/ha) over one hand weeding. The composition of weed seed bank in ZT was dominated by grasses (54%) followed by BLWs (26%) and sedges (20%) and the corresponding values in CT were 48%, 35% and 17%.

Table 1.2.15 Effect of tillage and weed management practices on weed density and biomass at 60 DAS and grain yield of rice under conservation agriculture

Treatments	Rice				Maize	
	Total weed density (no./m^2)	Total weed biomass (g/m^2)	Grain yield (t/ha)	Net return (Rs./ha)	Total weed density (no./m^2)	Total weed biomass (g/m^2)
Tillage & residue management						
CT (Transplanted)-CT	79.4	32.45	4.30	11782	48.56	16.13
CT (Transplanted)-ZT-ZT	81.3	33.64	4.23	11231	39.37	13.61
CT (Direct -seeded)-CT-ZT	98.7	41.42	4.05	10245	44.18	14.54
ZT (Direct -seeded)-ZT-ZT	108.4	47.32	3.79	10895	33.53	11.79
ZT(Direct –seeded) + R-ZT+R-ZT	102..6	44.6	3.92	9895	0.258	0.067
LSD (P=0.05)	**8.4**	**6.89**	**0.21**	**-**	**0.89**	**0.23**
Weed management practices						
Recommended herbicides	48.4	25.8	4.17	11354	32.07	7.86
IWM (herbicide + mechanical weeding)	40.8	27.1	4.33	12987	17.94	9.42
One hand weeeding	113.4	38.5	3.50	9542	74.22	24.77
LSD (P=0.05)	**21.07**	**9.45**	**0.19**	**-**	**0.46**	**0.25**

In *Rabi* maize, the experimental field was comprised of grasses (55%) followed by broadleaf weeds (30%) and sedges (15%). There was a decreasing trend observed in different categories of weeds from the year of initiation of the experiment. *Panicum repens* (21%), *Echinochloa crusgalli* (17%) and *Echinochloa colona* (14%) were observed to be the dominant grasses. *Marselia quadrifolia* (18%) and *Alternanthera sessilis* (27%) were the major broadleaf weeds. *Cyperus difformis* (12%) and *Cyperus iria* (3%) were the important sedges observed at the experimental site. Other minor weeds observed were *Ludwigia parviflora, Leptochloa chinensis, Sphenochloa zeylanica, Cyperus rotundus, Paspalum scrobiculatum* and *Dactyloctenium aegyptium*.

At 60 DAS, the lowest weed density and biomass was recorded in ZT (DSR)-ZT+R-ZT (33.5 no./m^2 and 11.8 g/m^2, respectively) followed by CT (transplanting)-ZT-ZT (39.4/m^2 and 13.6 g/m^2, respectively). The highest density and biomass were recorded in CT (transplanting)-CT (48.6/m^2 and 16.1 g/m^2, respectively). The practice of CT (transplanting)-ZT-ZT system of tillage recorded significantly higher grain yield in *Rabi* maize (6.5 t/ha). The practice of ZT (DSR)-ZT+R-ZT+R system resulted in the lowest grain yield and the yield reduction was in the tune of 25 & 22% as compared to CT-CT-ZT & CT-ZT-ZT methods respectively. The economic parameters were highest in CT(trans)-ZT-ZT with the highest B: C (3.5) followed by CT(DSR)-CT-ZT (2.8). The lowest value was observed in ZT(DSR)-ZT+R-ZT method (2.5).

Application of atrazine+pendimethalin 0.5+0.5 kg/ha *fb* one manual weeding recorded the lowest weed density (17.9/m^2) as compared to the sole recommended herbicide application pendimethalin 1.0 kg/ha (32.1/m^2) over weedy check (74.2/m^2). However, weed biomass was recorded lowest in pendimethalin at

1.0 kg/ha (7.9 g/m^2) followed by IWM (9.42 g/m^2) than that of weedy check (24.8 g/m^2). Among the weed management practices, IWM (herbicide+manual weeding) recorded the highest yield (6.0 t/ha) in comparison to the sole herbicide with yields of (4.2 t/ha). Weed index values were observed to be maximum in ZT-ZT-ZT system (24.7%) in comparison to CT (transplanting)-ZT-ZT system (6.7%). IWM was recorded with higher B: C (3.78) over sole herbicide application (2.57). The ZT-ZT-ZT system along with the use of herbicide obtained the maximum B: C of 2.87 over other combinations of tillage and weed management practices.

In summer cowpea 2021, the experimental field was dominated by grasses (63%) followed BLWs (20%) and sedges (7%). *Dactyloctenium aegyptium* (11%), *Digitaria sanguinalis* (7%) and *Cynodon dactylon* (4%) were observed to be the dominant grasses. *Celosia argentea* (12%), *Euphorbia hirta* (8%) and *Heliotropium indicum* (6%) were the major BLWs. *Cyperus difformis* (12%) and *Cyperus iria* (3%) were the important sedges observed in the experimental site. Other minor weeds observed were *Ageratum conzoides, Chorchorus* sp., *Scoparia dulcis,Trianthema portulacastrum etc.*

The practice of CT (transplanted)-ZT-ZT system recorded significantly higher pod yield in cowpea (8.5 t/ha). Whereas ZT (DSR)-ZT+R-ZT+R system resulted in the lowest pod yield and the yield reduction was in the tune of 35 & 32% as compared to CT-CT-ZT & CT-ZT-ZT method, respectively. Weed index values were observed to be maximum in ZT-ZT-ZT system (34%) in comparison to CT (transplanted)-ZT-ZT system (11%). The economic parameter like B: C was higher in CT (transplanted)-ZT-ZT (4.2) followed by CT (DSR)-CT-ZT (3.0). The lowest B: C was recorded in ZT (DSR)-ZT+R-ZT (1.8).

Among the weed management practices, IWM (herbicide + manual weeding) recorded the highest yield (9.8 t/ha) in comparison to the sole herbicide with yields of (6.8 t/ha). Application of pendimethalin 0.5 kg/ha *fb m*anual weeding obtained with higher B: C (3.95) over sole herbicide application (2.35). The ZT-ZT-ZT system along with use of herbicide obtained the maximum B: C aof 3.57 in summer cowpea as compared to other combinations of tillage and weed management practices.

The floristic composition of weed seed bank was dominated by grasses (56%) followed by BLWs (32%) and sedges (12%). The dominant grasses observed are *Echinochloa colona*, *Dactyloctenium aegyptium*, *Digitaria ciliaris*, *Eleusine indica* and *Sporobolus diander*. The major BLWs were *Ludwigia parviflora*, *Alternanthera sessilis* and *Cleome viscosa*. Among sedges, *Cyperus rotundus*, *Cyperus iria* and *Fimbristylis miliaceae* dominate the weed seed bank. The weed densities were conspicuously higher in hand weeding plots (217 and 245/m^2). Application of herbicides with manual weeding reduced the weed densities by 42.5% over sole herbicide application.

Weed management in maize-based cropping systems

Cooperating centres: UAS, Bengaluru; MPUAT, Udaipur

UAS, Bengaluru

Weed management in maize-based cropping system in conservation agriculture

Greengram during *Rabi* 2020-21, major weed flora observed in the experimental plots was *Cyperus rotundus* (among sedges), *Cynodon dactylon, Digitaria marginata, Echinochloa colona*, (among grasses), *Spilanthes acmella, Commelina benghalensis, Alternenthera sessilis, Ageratum conyzoides, Euphorbia geniculata* were major BLWs. Total weed density did not differ significantly between tillage treatments. However, under a permanent bed tillage system, the overall density of sedges, grasses and BLWs was lower than in other tillage. Among tillage practices, adopting permanent bed tillage practices recorded significantly higher yields (0.89 t/ha) followed by CT (0.79 t/ha). The yield difference was due to differences in weed emergence being low under a permanent bed.

At 60 DAS, un-weeded plots were recorded with higher weed biomass of sedges followed by grasses and then BLWs with total density of 79.7/m^2. Application of pendimethalin 750 g/ha fb HW at 30 DAS recorded lower density (58.5 no/m^2) than that of herbicide alone (65.9 no/m^2). These led to achieve a higher seed yield (0.90 t/ha), whereas B: C (2.99) with pendimethalin 750 g/ha fb imazethapyr at 75 g/ha at 20 DAS. Un-weeded control lowered yield (0.59 t/ha) as a result of severe weed competition of weeds particularly sedges at early stages, grasses and BLWs at a later stage of crop growth (**Table 1.2.16**).

Table 1.2.16 **Effect of tillage and weed management practices on weed density (no./m^2) and weed biomass (g/m^2) in greengram at 60 days after sowing, during *Rabi*, 2020 at MRS, Hebbal, Bengaluru**

Treatments	Weed density (No./m²)	Weed biomass (g/m²)	Seed yield (t/ha)	Gross return (Rs/ha)	Net returns (Rs/ha)	B: C
Tillage & residue management						
T1 Conventional Tillage (CT) – Green gram (GG) (R)	8.82(77.7)	3.33(10.6)	0.79	72915	45638	2.66
T2 Zero Tillage (ZT)+ Maize residue (R)	9.10(82.8)	3.44(11.4)	0.75	68859	43699	2.72
T3 Minimum Tillage (MT) + Maize residue (R)	8.44(71.1)	3.26(10.1)	0.74	67701	42191	2.64
T4 Minimum Tillage + Maize Residue (R)	7.71(59.2)	2.95(8.25)	0.72	66121	40961	2.61
T5 Permanent Bed (PB)- Maize residue (R)	7.04(49.3)	2.74(7.03)	0.89	82289	52629	2.75
SEm+	**0.052**	**0.016**	**0.02**			
LSD (P=0.05)	**0.171**	**0.052**	**0.05**			
Weed management practices						
W1 Recommended herbicide-Pendimethalin 750 g/ha (PE) + *fb* imazethpyr 75 g/ha at 20 DAS POE	8.11(65.9)	3.11(9.27)	0.85	78339	51299	2.90
W2 IWM – *Pendimethalin 750 g/ha PE *fb* Hand weeding at 30 DAS	7.65(58.5)	2.95(8.27)	0.90	82506	53946	2.88
W3 Un weeded Control	8.92(79.7)	3.37(10.9)	0.59	53887	29827	2.24
SEm+	**0.058**	**0.018**	**0.02**			
LSD (P=0.05)	**0.152**	**0.046**	**0.04**			

MPUAT, Udaipur

Weed management in maize-wheat cropping system under conservation agriculture systems

In wheat (2020-21), the major weed flora observed during experimental fields were *Phalaris minor* (2.9%) whereas the dicot weeds were *Chenopodium album* (25.8%), *Chenopodium murale* (18.7%), *Fumaria parviflora* (18.1%), *Melilotus indica* (4.8%), *Convolvulus arvensis* (3.0%), *Launaea asplenifolia* (3.3%) and *Malwa parviflora* (23.3%).

Among tillage and residue management treatments, total weed density at 30 and 60 DAS attained maximum (96.4 and 91.9/m^2, respectively) in maize (CT)-wheat (ZT)- greengram (ZT) and minimum (86.6 and 74.4/m^2, respectively) in maize (ZT+R)-wheat (ZT)- greengram (ZT). Growth and yield attribute were better under CT-CT system than that of ZT+R-ZT+R-ZT+R. The maximum net returns (Rs 66966/ha) and B: C (2.83) were recorded with maize (ZT)-wheat (ZT)-greengram (ZT) (**Table 1.2.17**).

Minimum numbers of monocot and dicot weeds were observed with the application of sulfosulfuron 75% + metsulfuron 5% WG at 30 + 2 g/ha at 30 DAS followed by hand weeding at 50-55 DAS (IWM). Similar trends were observed by weed biomass at 60 DAS. Lower weed density and biomass led to better growth and more yield attributes. The maximum grain yield (4.36 t/ha) and stover yield (6.33 t/ha) were observed by controlling weeds through IWM that recorded an increase in grain and straw yields of 21.8% and 30.2% respectively, over weedy check. The maximum net returns (Rs 70656/ha) was recorded with IWM, whereas, higher B: C (2.79) was recorded with the application of sulfosulfuron 75% + metsulfuron 5% WG at 30 + 2 g/ha at 30 DAS.

In maize during *Kharif* 2021, dominant weed species in the experimental field were *Echinochloa colona* (30.7%), *Dinebra retroflexa* (17.0%), *Commelina benghalensis* (17.2%), *Digera arvensis* (14.8%), *Trianthema partulacastrum* (13.9%) and *Physalis minima* (7.1%). Among the different weeds, *Echinochloa colona* and *Commelina benghalensis* were found maximum with ZT and which was significantly higher than other establishment methods. Among tillage and residue management treatments, total weed density (34.1/m^2) was recorded maximum in maize (ZT)-wheat (ZT)-greengram (ZT), while the lowest weed density was recorded in maize (ZT+R)-wheat (ZT)- greengram (ZT+R) (30.8/m^2). Weed biomass followed the trend of weed density. Maize (CT) - wheat (CT)-green gram (CT) resulted in significant enhancement of cob length (27.9 cm), cob width (2.9 cm) and 1000 seed weight (277.9 g). Better growth and more yield attribute helped in higher grain and stover yield (3.56 and 5.33 t/ha, respectively). This resulted in maximum net returns (Rs 52752/ha) and B: C (2.07).

Among weed management treatments, both weed control treatments resulted in a significant decrease in density and biomass of monocot and dicot weeds over weedy check. Application atrazine 0.50 kg/ha + tembotrione 120 g/ha PoE at 20 DAS (tank mix) recorded the lowest density and biomass of weeds. The maximum grain yield (3.63 t/ha) and stover yield (5.29 t/ha) was obtained by application of atrazine 0.50 kg/ha + tembotrione 120 g/ha PoE at 20 DAS (tank mix). The magnitude of increase in grain and stover yield with this treatment was to the tune of 73.7% and 66.9% respectively, over weedy check, 2.28 and 2.99 t/ha respectively. This led to maximum net returns (Rs 53880/ha) and B: C (2.14). The interaction effect between tillage and residue management and weed control was non-significant on weed density and biomass.

Table 1.2.17 Effect of tillage, residue and weed management on yield and economics of wheat and maize

Treatment	Wheat				Maize			
	Grain yield (t/ha)	Stover yield (t/ha)	Net returns (Rs/ha)	B:C	Grain yield (t/ha)	Stover yield (t/ha)	Net returns (Rs/ha)	B:C
Tillage &residue management								
CT-CT	4.17	5.72	59716	2.07	3.56	5.33	52752	2.07
CT-ZT-ZT	3.94	5.59	62878	2.66	3.50	5.16	51280	2.01
ZT-ZT-ZT	4.14	5.76	66966	2.83	2.56	3.74	32194	1.34
ZT-ZTR-ZT	4.11	5.85	66758	2.82	2.85	4.18	38724	1.61
ZTR-ZTR-ZTR	3.82	5.51	55691	1.94	2.76	4.34	35412	1.37
S.Em.±	**0.12**	**0.20**			**0.08**	**0.10**		
LSD (P=0.05)	**NS**	**NS**			**0.25**	**0.34**		
Weed management practices								
IWM	4.14	5.88	64021	2.53	3.63	5.29	53880	2.14
Recommended herbicide	4.36	6.32	70656	2.79	3.42	5.19	48656	1.84
Weedy check	3.60	4.85	52529	2.07	2.09	3.17	23681	1.07
S.Em.±	**0.095**	**013**			**0.05**	**0.07**		
LSD (P=0.05)	**0.28**	**0.41**			**0.14**	**0.20**		

Weed management in pearlmillet based cropping system

RVSKVV, Gwalior

Weed management in pearlmillet– mustard–cowpea cropping system under conservation agriculture (year of commencement: *Kharif* 2019)

In mustard, the main weeds observed at the experimental site were *Phalaris minor, Spergula arvensis,* and *Cynodon dactylon* as grasses and *Chenopodium album, Anagallis arvensis, Convolvulus arvensis* and *Medicago hispida* as major BLWs. *Cyperus rotundus* was the most dominating sedges among all the weeds. The *Chenopodium murale* was seen for the first time in the Rabi 2020-21 up to 30 DAS and after that, it was suppressed by the tillage and different weed management practices whereas, *Phalaris minor* had not emerged up to 30 DAS in the same year and after that, it has emerged.

The significantly lowest weed density and respective biomass of weeds at 60 DAS were observed in ZT+R during the entire year in all three years (ZT+R–ZT+R–ZT+R). Resulting in the highest WCE (65.5%) followed by ZT (52.6%). The better growth and yield attributes were recorded under ZT+R–ZT+R–ZT+R during entire the year followed by CT-CT-fallow. The highest seed yield (2.25 t/ha) was recorded under ZT+R–ZT+R–ZT+R and it was at par with CT–CT-fallow. Stover yield followed the trend of seed yield. Economic parameters like net returns and B: C were highest in ZT+R–ZT+R–ZT+R (Rs 72132/ha and 4.29, respectively) followed by CT-CT-fallow. The lowest B: C (3.01) was found in ZT-ZT-ZT system (**Table 1.2.18**).

The highest weed density and biomass were recorded in weedy check while the lowest was recorded where oxyfluorfen 0.23 kg/ha PE fb one hand weeding was applied with 68% WCE followed by the application of oxyfluorfen 0.23 kg/ha PE alone (50%) at 60 DAS. The highest seed yield (2.01 t/ha) was recorded with the application of oxyfluorfen 0.23 kg/ha fb one hand weeding followed by oxyfluorfen 0.23 kg/ha (1.92 t/ha). The maximum net returns (Rs 84991/ha) was obtained in IWM and it was followed by oxyfluorfen 0.23 kg/ha PE (Rs.79184/ha). While, B: C was higher with the application of oxyfluorfen 0.23 kg/ha PE (4.96) followed by oxyfluorfen 0.23 kg/ha as PE fb one HW (4.91). The interaction effect of tillage and weed management approach was not significant for the grain yield of mustard. However, it was significant for the stover yield and total weed biomass at harvest stage.

Table 1.2.18 Effect of different weed management & conservation tillage practices on yield and economics in mustard under pearlmillet-based cropping system (2020-21).

S.N.	Treatment	Weed density (no./m²)	Weed biomass (g/m²)	Seed yield (t/ha)	Stover yield (t/ha)	Total cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs./ha)	B: C
Tillage & residue management									
T_1	CT	12.89 (195.44)	124.40	2.03	7.18	22249	98071	75822	4.39
T_2	ZT	13.51 (211.00)	118.38	1.72	5.87	21100	78355	57255	3.71
T_3	ZT	20.06 (417.67)	186.06	1.53	5.85	21100	59177	38077	2.76
T_4	ZT + R	9.81 (115.22)	71.29	1.88	6.62	22433	83667	61233	3.72
T_5	ZT + R	8.29 (83.22)	51.38	2.10	7.98	22422	111386	88964	4.94
	SEm (±)	**0.248**	**6.834**	**0.086**	**0.232**	**83.8**	**7921.2**	**7912.9**	**0.362**
	CD at 5 %	**0.808**	**22.287**	**0.249**	**0.656**	**273.4**	**25832.3**	**25805.4**	**1.181**
Weed management practices									
W_1	Oxyfluorfen 0.23 kg/ha as PE	10.49 (127.73)	64.70	1.95	6.87	21667	92078	70411	4.24
W_2	Oxyfluorfen 0.23 kg/ha as PE *fb* 1 HW at 35 – 40 DAS (IWM)	9.03 (100.47)	44.14	2.16	7.48	23969	99312	75343	4.13
W_3	Weedy check	19.22 (385.33)	222.07	1.44	5.74	19947	67004	47057	3.35
	SEm (±)	**0.377**	**1.545**	**0.041**	**0.069**	**113.7**	**3029.4**	**3018.6**	**0.136**
	CD at 5 %	**1.481**	**5.066**	**0.132**	**0.204**	**446.3**	**11893.1**	**11850.5**	**0.532**

In cowpea, the study area was dominated by *Dactyloctenium aegypticum* and *Cynodon dactylon* as grassy weed, *Convolvulus arvensis* and *Trianthema monogyna* as BLW and *Cyperus rotundus* as sedge. The weeds *Dactyloctenium aegypticum* and *Trianthema monogyna* were not seen this year. Adoption of ZT+R-ZT+R-ZT+R recorded the lowest weed density and biomass resulting in higher WCE (91%) than that of ZT-ZT-ZT at 40 DAS. Adoption of ZT+R eliminated the emergence of *Dactyloctenium aegypticum* and *Trianthema monogyna*; whereas the density of *Cyperus rotundus* was significantly lower in ZT+R. ZT+R provided an advantage to crop over weeds, resulted in better resource utilization and more suppression ability of weeds than the without residue treatments. Economic parameters like net returns and B: C was higher under

ZT+R-ZT+R-ZT+R system (**Table 1.2.19**).

All the weed control treatments proved effective in minimizing the density and biomass of weeds over weedy check. Total weed density/m^2 and biomass at harvest were significantly reduced with the application of pendimethalin + imazethapyr 900 g/ha with a higher value of WCE (81%) followed by pendimethalin + imazethapyr 900 g/ha PE fb one hand weeding at 35-40 DAS. Application of pendimethalin + imazethapyr 900 g/ha established its superiority by recording significantly higher seed yield and noted the increment by 26 and 25% of seed and stover yield as compared to weedy check. IWM was the next best treatment. This increase in yield might be due to effective control of weeds in the early stage, which smothered weed growth and gave higher yield attributes of cowpea and ultimately resulted in higher yields. Application of pendimethalin + imazethapyr 900 g/ha recorded significantly highest net returns (Rs.47124/ha) and B: C (3.50) and was followed by pendimethalin + imazethapyr 900 g/ha PE fb one hand weeding at 35-40 DAS.

Table 1.2.19 Effect of different weed management & conservation tillage practices on yield and economics in cowpea under pearlmillet-based cropping system (2020-21).

S.N.	Treatment	Weed density (no./m²)	Weed biomass (g/m²)	Seed yield (t/ha)	Stover yield (t/ha)	Gross returns (Rs/ha)	Net returns (Rs./ha)	B: C
Tillage & residue management								
T_1	Conventional tillage (CT-CT-F)	-	-	-	-	-	-	-
T_2	Zero tillage (CT-ZT-ZT)	42.44	23.64	0.97	5.50	74139	54808	3.20
T_3	Zero tillage (ZT-ZT-ZT)	45.65	27.98	0.65	3.68	49567	30357	2.26
T_4	Zero tillage (ZT-ZT+R-ZT)	43.48	24.38	1.06	6.03	81341	61915	3.36
T_5	Zero tillage+ Crop residue (ZT+R-ZT+R-ZT+R)	38.11	18.93	1.15	6.52	87907	68148	3.64
	SEm (±)	**1.18**	**1.31**	**0.034**	**0.197**	**2657.7**	**2618.4**	**0.073**
	CD at 5 %	**3.84**	**4.28**	**0.113**	**0.643**	**8667.2**	**8538.9**	**0.226**
Weed management practices								
W_1	Pendimethalin+Imazethapyr PE	31.76	16.12	0.90	5.11	68885	53580	3.50
W_2	Pendimethalin+Imazethapyr PE + 1 HW	29.53	13.90	0.79	4.52	61006	44429	3.20
W_3	Weedy check	40.52	26.94	0.60	3.40	45881	31128	2.64
	SEm (±)	**0.98**	**0.83**	**0.029**	**0.165**	**2224.2**	**2263.1**	**0.082**
	CD at 5 %	**3.20**	**2.69**	**0.95**	**0.538**	**7253.4**	**7380.4**	**0.236**

Weed management in soybean-based cropping systems

Cooperating centers: PDKV, Akola, UAS, Dharwad

PDKV, Akola

Weed management in soybean-wheat-greengram cropping system under conservation agriculture

The major weed flora during *Kharif* and *Rabi* season in soybean–wheat crop sequence in the selected area is comprised of *Cyperus rotundus*, *Commelina benghalensis*, *Euphorbia geniculate*, *Boerhavia diffusa*, *Parthenium hysterophorus*, *Phyllanthus niruri*, *Portulaca oleracae*, *Cynodon dactylon*, *Dinebra arabica*, *Digera arvensis*, *Amaranthis viridis*, *Celosia argentea*, *Euphorbia hirta*, *Abutilon indicum*, *Abelmoschus moschatus*, *Ageratum conyzoides*, *Bidens pilosa*, *Alternanathera triandra*, *Panicum spp.*, *Ischaemum pilosum*, *Digitaria sanguinalis*, *Poa annua*, *Xanthium strumarium*, etc. Both broad and narrow-leaved weeds were observed. Euphorbia geniculate

(650-710/m^2) and *Commelina benghalensis* (610-674/m^2) dominance are more than rest of the weeds.

In soybean 2021, CT plots recorded the lowest weed density and weed biomass (44.7 no./m^2 and 31.5 g/m^2, respectively) at 60 DAS and the highest with ZT (55.7 no./m^2 and 52.6 g/m^2, respectively). A similar trend was recorded in another stage of the crop, this resulted in the highest WCE in CT (60.0%) followed by reduced tillage (RT, 54.2%). The yield attributes were better with CT followed by RT, resulting in the higher grain and straw yield in CT (2.46 and 2.87 t/ha, respectively), whereas, the lowest yield was recorded with ZT (1.73 and 2.16 t/ha, respectively) (**Table 1.2.20**). The highest cost of cultivation was recorded in reducing sequence of CT>RT>MT>ZT. The net returns was higher in CT (Rs. 54350/ha) followed by RT (Rs. 51735/ha) and were comparable to CT and MT (Rs 48447/ha). However, B: C was more with RT (2.31) which was marginally superior to CT (2.26).

Among weed management practices, at 60 DAS, weed-free recorded the lowest weed density and biomass (6.8 no./m^2 and 6.8 g/m^2, respectively), whereas the higher weed values were recorded in un-weeded check (79.0 no./m^2 and 78.7 g/m^2, respectively). This resulted in higher WCE in weed-free (91.4%) over un-weeded checks. The yield attributes were better with weed-free, resulting in the higher grain and straw yield in weed-free (2.56 and 2.98 t/ha, respectively), whereas, the lowest yield was recorded with control (1.72 and 2.14 t/ha, respectively). Net returns was higher in weed-free (Rs 58373/ha) as a result of higher yield and was close to sequential application of herbicide (diclosulam 0.030 kg/ha PE fb propaquizafop + imazethapyr 0.125 kg/ha POE at 20 DAS). B: C followed the trend of yield and net returns.

Table 1.2.20 Weed parameters (at 60 DAS) and grain and straw yields as influenced by weed control treatments in soybean

Treatment	Weed density (no./m^2)	Weed dry biomass (g/m^2)	WCE (%)	Grain yield (t/ha)	Straw yield (t/ha)
Tillage & residue management					
T1 : Conventional Tillage (1 Plo +2 Hr by tc +1Hr by Blade harrow)	6.40 (44.66)	5.39 (31.47)	59.99	2.46	2.87
T2 : Reduced Tillage (1Hr by tc +1 Rototill)	6.65 (48.25)	5.77 (36.06)	54.15	2.30	2.71
T3 : Minimum Tillage (1 Rototill)	6.80 (50.33)	6.27 (43.72)	44.42	2.18	2.60
T4 : Zero Tillage (No tillage) +R	7.15 (55.70)	6.88 (52.58)	33.16	1.73	2.16
SE(m)±	**0.05**	**0.02**		**0.02**	**0.06**
CD at 5%	**0.18**	**0.08**		**0.07**	**0.19**
Weed management practices					
W1: Diclosulam.030 kg./ha PE	7.33 (53.28)	6.25 (38.97)	50.46	2.17	2.43
W2 : Propaquizafop + Imazethapyr 0.125Kg /ha POE at 20 DAS	7.88 (61.74)	7.13 (50.66)	35.60	2.02	2.56
W3: Diclosulam 0.030 kg ./ha PE fb Propaquizafop + Imazethapyr 0.125Kg /ha POE at 20 DAS	6.93 (47.87)	5.46 (29.71)	62.23	2.36	2.82
W4 : Weed free(2H at 15 & 30 DAS + 1HW at 20 DAS)	2.70 (6.83)	2.70 (6.79)	91.37	2.56	2.98
W5 : Weedy check	8.91 (78.97)	8.84 (78.66)	0.00	1.72	2.14
SE (m) ±	**0.06**	**0.04**		**0.02**	**0.04**
CD P= 0.05	**0.17**	**0.11**		**0.05**	**0.13**

UAS, Dharwad (Volunteer Centre)

Weed management in soybean-chickpea cropping system under conservation agriculture (Year of commencement: *Kharif* 2016)

In soybean 2021, the study area was comprised of weeds like *Digera arvensis*, *Commelina benghalensis*, *Knoxia mollis* among BLWs; *Dinebra retroflexa, Digitaria sanguinalis, Panicum isachne, Cynodon dactylon*, among grasses and *Cyperus rotundus* was only sedge recorded. Among the tillage practices, the plot received 2 harrowings by tyne cultivator + 1 harrowing by blade harrow + planking (CT) recorded the least weed density and weed biomass at 60 DAS (3.05/m^2 and 1.63 g/m^{-2}, respectively), while zero till (ZT+R) recorded highest weed density and weed biomass (27.7/m^2 and 31.29 g/m^2, respectively). CT plots were recorded with the highest seed yield (3.17 t/ha), while the lowest seed yield was recorded with ZT (2.24 t/ha) (**Table 1.2.21**).

Among the weed control methods, the plots that received IWM recorded least weed density and biomass (10.5/m^2 and 7.5 g/m^2, respectively) followed by recommended herbicide (12.2/m^2 and 9.8 g/m^2, respectively). The lowest weed values were recorded in control. IWM recorded the highest seed yield compared to alone herbicide (2.93 and 2.82 t/ha, respectively). The lowest seed yield was recorded with weedy check plots (2.41 t/ha).

The highest dehydrogenase activity was recorded with the plots that received zero herbicides, followed by IWM and the least was recorded with RH (16.62, 14.08 and 12.48 TPF formed/g soil/day, respectively) at 30 days. However, on 60 DAS highest dehydrogenase activity was recorded with IWM, followed by RH (22.55 and 19.83 TPF formed/g soil/day, respectively). Similar findings were also recorded with the rest of the microbiological parameters viz., phosphatase; urease; nodule parameters; Leghaemoglobin content in the nodule and mycorrhizal root colonization at 30 and 60 DAS (**Table 1.2.21**).

Table 1.2.21 Total weed parameters (at 60 DAS) yield and enzymatic activities as influenced by weed control treatments in greengram

Treatment	Weed density (number/m²)	Weed biomass (g/m²)	Seed yield (t/ha)	Dehydrogenase (µg TPF formed/g soil /d)	Phosphatase activity (µg pnp released /g soil /h)	Urease µg NH_4^+ N/g soil/ day	Leghaemoglobin content
Tillage &residue management							
CT	3.05	1.63	2.80	20.93	25.67	15.99	0.23
CT+R	9.71	8.25	3.17	23.75	27.62	22.77	0.31
MT	7.37	3.83	2.82	21.05	21.52	18.64	0.26
MT+R	7.12	4.04	2.86	22.49	23.38	20.96	0.35
ZT	18.83	17.93	2.24	11.40	17.12	21.17	0.42
ZT+R	27.73	31.29	2.44	20.55	21.31	21.33	0.36
CD at 5%	**0.31**	**0.44**	**0.018**	**0.14**	**0.66**	**0.19**	**0.01**
Weed management practices							
RH	12.18	9.76	2.82	19.83	19.69	15.95	0.20
IWM	10.46	7.46	2.93	22.55	23.37	17.38	0.27
UW	14.25	16.28	2.41	17.70	25.26	27.09	0.50
CD at 5%	**0.08**	**0.31**	**0.013**	**0.10**	**0.47**	**0.14**	**0.008**

RH, diclosulam 30 g/ha PE imazethapyr 750-1000 g/ha POE; IWM, Integrated weed management (diclosulam 30 g/ha PE or imazethapyr 750-1000 g/ha POE + *fb* 1 hoeing + 1 HW 20DAS); UW, one hand weeding/hoeing

Weed management in cotton-based cropping systems

Cooperating centres: TNAU, Coimbatore; AAU, Anand; PJTSAU, Hyderabad,

TNAU, Coimbatore

Weed management in cotton – baby corn-based cropping system under conservation agriculture

The predominant BLWs were *Amaranthus viridis*, *Cleome viscose*, *Trianthema Portulacastrum* and *Parthenium hysterophorus*. Among the grass weeds, *Cynodon dactylon, Setaria verticiliata, Dactyloctenium aegyptium* and *Chloris barbata* were the dominant ones. *Cyperus rotundus* was the only sedge weed present in the experimental field. In babycorn, at 30 DAS, among tillage methods, significantly lower total weed density and biomass (15.7/m^2 and 6.1 g/m^2, respectively) were recorded in CT-ZT-ZT system with 78.7% WCE at 45 DAS. A significantly higher cob yield of 4.90 t/ha was recorded with ZT+R-ZT+R-ZT+R.

Among weed management practices, EPOE topramezone 12.5 g/ha + 2,4 D 500 g/ha at 20-25 DAS recorded lower weed density and biomass (14.5/m^2 and 5.1 g/m^2, respectively) and it was followed by atrazine at 1.0 kg/ha (PE) fb brush cutter weeding on 45 DAS with 81.3% WCE. EPOE application of topramezone 12.5 g/ha + 2, 4 D 500 g/ha at 20-25 DAS significantly recorded a higher yield 7.22 t/ha. Significantly lower grain yield was recorded with unweeded check (**Table 1.2.22**).

Treatments did not significantly affect the green biomass yield of sunhemp. The highest green biomass was recorded with zero tillage (15.3 t/ha) along with herbicide rotation (18.3 t/ha) though all were comparable to tillage and weed management practices.

In cotton, the predominant BLWs were *Amaranthus viridis*, *Cleome viscose*, *Trianthema Portulacastrum* and *Parthenium hysterophorus*. Among the grass weeds, *Cynodon dactylon*, *Setaria verticiliata*, *Dactyloctenium aegyptium* and Chloris barbata were the dominant ones. *Cyperus rotundus* was the only sedge weed present in the experimental field. Among tillage methods, significantly lower total weed density and biomass (7.9/m^2 and 2.2 g/m^2, respectively) were recorded in CT-ZT-ZT system at 30 DAS. At 60 DAS, a higher WCE of 81.7% was recorded in CT+ZT+ZT system (**Table 1.2.22**).

Among weed management practices, PE application of pendimethalin (CS) 680 g/ha fb directed spray of paraquat 0.6 kg/ha recorded lower weed density and biomass (13.16/m^2 and 4.78 g/m^2, respectively) and it was followed by PE pendimethalin at 680 g/ha + brush cutter weeder weeding on 60 DAS. This resulted in PE pendimethalin (CS) 680 g/ha followed by a directed spray of paraquat 0.6 kg/ha recorded higher WCE (81.3%) in cotton.

Table 1.2.22 Effect of tillage and weed management practices in cotton-based cropping system at Coimbatore centre

Treatment	Babycorn			Green manure biomass yield (t/ha)	Cotton		
	Plant height (cm)	DMP (kg/ha)	Cob Yield (kg/ha)		Total Weed density (No./m^2)	Total Weed dry weight (g/m^2)	WCE (%)
Tillage & residue management							
T1(CT-CT-ZT)	143.5	5773	3886	14.2	5.64 (27.4)	3.92 (11.5)	60.7
T2(CT-ZT-ZT)	139.9	5937	4107	15.3	3.27 (11.6)	2.45 (6.1)	81.7
T3(ZT+(R)- ZT+(R)- ZT+(R))	161.4	6307	4902	13.2	4.27 (18.2)	3.12 (9.7)	65.4
SEd	**3.8**	**185**	**167**	0.68	**0.03**	**0.04**	**-**
CD(P=0.05)	**11.3**	**312**	**276**	**NS**	**0.11**	**0.09**	**-**
Weed management practices							
W1- Recommended herbicides	164.7	6316	5054	14.7	3.52 (12.6)	2.69 (7.2)	81.3
W2- Herbicide + BC	165.9	6014	6121	17.1	4.73 (22.3)	2.97 (8..7)	73.2
W3- Herbicide Rotation	173.4	7037	7223	18.3	4.67 (21.7)	3.38 (11.4)	71.9
W4- (UWC)	79.6	4659	3058	15.9	11.4 (100.8)	5.37 (28.7)	-
SEd	**4.3**	**197**	**199**	**0.71**	**0.08**	**0.04**	**-**
CD(P=0.05)	**12.1**	**356**	**398**	**NS**	**0.18**	**0.10**	-

Baby corn: W1: Recommended herbicides (Pendimethalin 1.0 kg/ha); W2: PE Atrazine 1.0 kg/ha + BC on 45 DAS; W3: EPOE Topramezone 12.5 g/ha + 2,4 D 500 g/ha at 20-25 DAS; W4: Unweeded check

Green manuring: W1-W4: hand weeding at 20-25 DAS

Cotton W1: Recommended herbicides (PE Pendimethalin (CS) 680g/ha *fb* directed spray of paraquat 0.6 kg/ha; W2: PE Pendimethalin (CS) 680 g/ha + BC on 60 DAS; W3:PE Diuron 750 g/ha fb EPOE Pyrithiobac sodium 75g/ha at 20-25 DAS; W4: Unweeded check

PJTSAU, Hyderabad

Weed management in cotton – maize – green manure under conservation agriculture systems

In maize 2020-21, the experimental field was dominated by *Cynodon dactylon, Cyperus rotundus, Parthenium hysterophorus* and *Alternanthera sessalis.* The total weed count recorded at 30 and 60 DAS reveals no significant difference among tillage treatments because, in ZT plots, *Cynodon dactylon* and *Cyperus rotundus* dominated while in CT plots, BLWs occupied in large numbers. The weed biomass was significantly reduced in CT plots followed by ZT + R plots over ZT plots at 30 DAS. But at 60 DAS, both ZT+R and ZT were inferior to CT for reduction in weed growth. Maize yield (grain and stover) and economics in all the tillage practices was statistically similar.

Among the weed management methods, the weed density was significantly lower in chemical control (W_1), herbicide rotation (W_2) and IWM (W_3) than in control at 30 DAS. However, at 60 DAS, the weed count in the control plot (HW at 50 DAS, i.e., after the critical period of crop weed competition) was significantly lower than the remaining treatments, which were at par among themselves. Herbicide application either as PE (W_1 and W_2) or POE (W_3) was on par with each other at 30 DAS. While at 60 DAS, HW at 50 DAS (control) was superior to herbicides and IWM. In turn, weed biomass was reduced in IWM compared to herbicide only due to brush cutting at 40 DAS. Chemical weed management followed plots had similar yields, whereas IWM was the next best treatment which was also superior to HW at 50 DAS (control). The economic parameters in chemical weed management were better over IWM (**Table 1.2.23**).

Table 1.2.23 Weed density, biomass, yield and economics as influenced by tillage and weed management in maize under conservation agriculture (*Rabi*, 2020-21).

Treatment	Weed density at 30 DAS (no./m²)	Weed density at 60 DAS (no./m²)	Weed biomass at 30 DAS (g/m²)	Weed biomass at 60 DAS (g/m²)	Grain yield (kg/ha)	Stover yield (kg/ha)	Net Returns (Rs./ha)	B: C
Tillage & residue management								
T_1 :(CT-CT)	8.80	5.03	5.97	6.67	7370	9237	77635	2.30
T_2 :(CT-ZT-ZT)	8.65	5.28	7.73	7.89	6947	9310	72383	2.27
T_3 :(ZT+R- ZT+R- ZT+R)	9.02	5.06	7.00	7.91	7244	9056	77860	2.37
CD at 5%	**NS**	**NS**	**0.14**	**1.04**	**NS**	**NS**	**NS**	NS
Weed management practices								
W_1 – Chemical management	8.44	5.77	6.53	9.14	8420	9702	98646	2.71
W_2 –Herbicide rotation	8.09	6.35	6.91	9.25	7913	10090	89295	2.54
W_3– IWM	8.43	5.31	6.41	7.62	7013	9808	71022	2.19
W_4– HW at 50 DAS (control)	10.33	3.06	7.74	3.96	5402	7204	44875	1.81
CD at 5%	**0.58**	**0.83**	**0.42**	**0.67**	**684.5**	**591.0**	**12777**	**0.22**

In cotton, light yellowing of margins of cotyledon was observed due to diuron application, which later on disappeared. No phytotoxic symptoms were observed on true leaves. Among crop establishment methods, the highest weed density and biomass were recorded in ZT+R compared to CT plots. The seed cotton yield was equal between CT and ZR+R treatments. Among the weed management methods, the lowest weed density and biomass were observed in herbicide rotation i.e., with pendimethalin applied plots. The IWM treatment was ineffective as the weeds rejuvenated, especially grassy, immediately after brush cutting. Chemical weed control (diuron *fb* pyrthiobac+quizalofop ethyl *fb* paraquat) recorded the highest seed cotton yield which was at par with herbicide rotation (pendimethalin *fb* pyrthiobac + quizalofop ethyl *fb* paraquat) and superior to IWM (**Table 1.2.24**).

Table 1.2.24 Weed density, biomass and yield as influenced by tillage and weed management in cotton under conservation agriculture (*Kharif 2021*).

Treatment	Weed density at 30 DAS (no./m²)	Weed density at 60 DAS (no./m²)	Weed biomass at 30 DAS (g/m²)	Weed biomass at 60 DAS (g/m²)	Dry matter production at 60 DAS (kg/ha)	Kapas yield (kg/ha)
Tillage & residue management						
T_1- CT(cotton) - CT (maize)	6.80 (47.75)	5.82 (34.58)	5.78 (34.83)	6.64 (43.25)	696	1368
T_2- CT(cotton) - ZT (maize)- ZT (GM)	7.23 (53.58)	5.65 (31.83)	5.55 (31.50)	6.67 (43.67)	758	1409
T_3- ZT+R(cotton) - ZT+R(maize) - ZT+R(GM)	7.88 (64.67)	6.07 (38.08)	7.07 (52.92)	9.01 (82.92)	880	1398
CD at 5%	**0.68**	**0.22**	**0.49**	**0.32**	**66.0**	**NS**
Weed management practices						
W_1 – Chemical weed control	6.60 (43.00)	6.73 (44.44)	4.98 (24.44)	7.48 (57.67)	805	1625
W_2 – Herbicide rotation	5.69 (31.89)	5.98 (34.89)	4.35 (18.11)	7.53 (56.89)	816	1580
W_3 – IWM	7.14 (50.89)	6.85 (46.22)	6.97 (49.11)	8.37 (72.11)	813	1213
W_4- Control	9.79 (95.56)	3.84 (13.78)	8.22 (67.33)	6.38 (39.78)	678	1149
CD at 5%	**0.46**	**0.37**	**0.43**	**0.30**	**90.7**	**114.3**

AAU, Anand

Weed management in cotton-green gram cropping system under conservation agriculture

In cotton, at 90 DAS, among tillage, the significantly lower density and biomass of monocot (5.6/m^2 and 2.50 g/m^2, respectively), dicot (3.8/m^2 and 2.00 g/m^2, respectively) and total (6.8/m^2 and 2.97 g/m^2, respectively) was recorded under CT-CT system. Seed cotton yield recorded significantly the highest (2.16 t/ha) under ZT+R-ZT+. Further, ZT-ZT+R also recorded significantly higher seed cotton yield (1.81 t/ha) but it was at par with CT-CT (1.72 t/ha) and CT-ZT (1.70 t/ha) (**Table 1.2.25**).

Table 1.2.25 Yield and enzymatic activities as influenced by tillage and weed management practices in cotton– greengram cropping system

Sr. No.	Treatments		Cotton	Greengram		System Seed cotton equivalent yield (t/ha)	Dehydrogenase (µg TPF/g soil/24 h) cotton	Dehydrogenase (µg TPF/g soil/24 h) greengram	Organic carbon (%)
	Cotton	Greengram	Seed cotton yield (t/ha)	Seed yield (kg/ha)	Haulm yield (kg/ha)				
Tillage and residue management									
T_1	CT	CT	1.72	482	705	2.34	24.3	18.3	0.40
T_2	CT	ZT	1.70	478	647	2.31	24.3	19.6	0.42
T_3	ZT	ZT	1.64	471	628	2.25	24.5	20.9	0.50
T_4	ZT	ZT+R	1.81	553	740	2.52	25.3	21.3	0.53
T_5	ZT+R	ZT+R	2.16	558	800	2.87	25.7	23.1	0.59
	S. Em. ±		**0.045**	**21.6**	**21.4**	**0.097**	**0.250**	**0.590**	**0.04**
	LSD (P=0.05)		**0.142**	**67.5**	**66.9**	**0.178**	**0.800**	**1.90**	**0.11**
Weed Management practices									
W_1	Pendimethalin 900 g/ha PE *fb* quizalofop ethyl 50 g/ha +pyrithiobac sodium 62.5 g/ha PoE (tank mix)*fb* HW at 60 DAS	Imazethapyr 75 g/ha PoE *fb* HW at 30 DAS	1.98	495	691	2.61	24.6	19.8	0.50
W_2	Quizalofop ethyl 50 g/ha + pyrithiobac sodium 62.5 g/ha PoE (tank mix) *fb* HW at 40 and 60 DAS	Imazethapyr 75 g/ha PoE *fb* HW at 40 DAS	1.84	467	656	2.44	24.5	19.9	0.46
W_3	HW at 20, 40, 60 DAS	HW at 20 & 40 DAS	1.60	563	765	2.32	25.3	22.3	0.51
	S. Em. ±		**0.035**	**11.5**	**16.9**	**0.024**	**0.150**	**0.480**	**0.02**
	LSD (P=0.05)		**0.139**	**45.2**	**66.3**	**0.947**	**0.480**	**1.55**	**NS**

Among weed management practices, hand weeding carried out at 20, 40 and 60 DAS recorded significantly the lowest density and biomass of monocot weed (5.74/m^2 and 2.92 g/m^2, respectively) at 90 DAS. Further, density and biomass of dicot weed (4.81/m^2 and 2.40 g/m^2, respectively) were recorded lower under the application of quizalofop ethyl 50 g/ha + pyrithiobac sodium 62.5 g/ha PoE (tank mix) *fb* HW at 40 and 60 DAS. While biomass of total weed was recorded significantly lower (4.14 g/m^2) under quizalofop ethyl 50 g/ha + pyrithiobac sodium 62.5 g/ha PoE (tank mix) *fb* HW at 40 and 60 DAS but remained at par with pendimethalin 900 g/ha PE *fb* quizalofop ethyl 50 g/ha + pyrithiobac sodium 62.5 g/ha PoE (tank mix) *fb* HW at 60 DAS. Application of pendimethalin 900 g/ha PE *fb* quizalofop ethyl 50 g/ha + pyrithiobac sodium 62.5 g/ha PoE (tank mix) *fb* HW at 60 DAS recorded significantly higher seed cotton yield (1.98 t/ha) but it was at par with the application of quizalofop ethyl 50 g/ha + pyrithiobac sodium 62.5 g/ha PoE (tank mix) *fb* HW at 40 and 60 DAS (1.84 t/ha).

In greengram, at 30 DAS, the lowest density of monocot and total weed (6.67 and 7.72/m^2, respectively) was recorded significantly lower under ZT+R-ZT+R, whereas dicot was least (3.16/m^2) with CT-CT but it was at par with each other. With respect to weed biomass, significantly the lowest monocot and total weed (3.66 and 4.81 g/m^2, respectively) were recorded with ZT+R-ZT+R. These helped to harvest significantly the highest seed and haulm yield (558 and 800 kg/ha, respectively) was achieved under ZT+R-ZT+R, but was comparable with ZT-ZT+R (563 and 740 kg/ha, respectively) (**Table 1.2.25**).

Among weed management practices, 100% control of monocot, dicot and total weed was observed under the application of imazethapyr 75 g/ha PoE *fb* HW at 30 DAS, hence, weed biomass of monocot, dicot and total weed were not observed. Adoption of hand weeding at 20 and 40 DAS recorded significantly the highest seed and haulm yield (563 and 765 kg/ha, respectively) of greengram.

The highest improvement in soil microbial properties was recorded in treatment receiving zero tillage with residue incorporation. Additionally, ZT + R treatment showed a maximum increase in all microbial properties in comparison to initial properties, numerically. In case of weed management practices, total bacterial population, total fungi, soil DHA activity and nodule number were significantly influenced by weed management practices except, PSM population, actinobacterial population and nodule dry weight at harvest. Treatments for which, interculturing and hand weeding operations were performed at 20 and 40 DAS showed significant improvement in microbial properties in comparison with treatments receiving the application of herbicides at harvest.

WP 1.3 weed management strategies in organic agriculture

AAU, Anand

Weed management in organically grown ginger-sweet corn cropping system

Ginger (*Kharif* 2020-21)

Weed flora: *Eleusine indica, Dactyloctenium aegyptium, Commelina benghalensis, Digitaria sanguinalis, Eragrostis major, Chloris barbata* among monocots and *Phyllanthus niruri, Oldenlandia umbellata, Digera arvensis, Trianthema monogyna, Boerhavia erecta and Mollugo nudicaulis* among dicots.

Inter-cropping of cluster bean in between ginger *fb* HW at 20, 50 and 80 DAP recorded significantly lower dry biomass of monocot, dicot and total weed (4.81, 2.65 and 5.43 g/m^2, respectively) at 75 DAP but it was par with HW at 20, 50 and 80 DAP *fb* earthing-up for dry biomass of monocot weed and live mulch of sunnhemp *fb* mulching of sunnhemp at 45 DAP *fb* HW at 90 DAP for dry biomass of dicot weed at 75 DAP.

Weed control efficiency was recorded maximum under inter cropping of cluster bean in between ginger *fb* HW at 20, 50 and 80 DAP (94.6%) which was followed by live mulch of sunnhemp *fb* mulching of sunnhemp at 45 DAP *fb* HW at 90 DAP (79.7%), nail weeder at 20, 50 and 80 DAP (79.1%), HW at 20, 50 and 80 DAP *fb* earthing-up (76.5%) and wheat straw mulch 5 t/ha (0-3 DAP) *fb* HW at 45 and 90 DAP (71.3%) at 75 DAP.

GBPUAT, Pantnagar

Weed management in organically grown rice based cropping system (Rice -vegetable pea – sweet corn)

Vegetable Pea (*Rabi* 2020-21)

Among different establishment systems, the lowest total weed density at 20 DAS was recorded with *Sesbania* (GM)-transplanted rice; while, the total weed dry weight remained statistically indifferent. The lowest total weed density and dry matter accumulation were recorded with mechanical weeding with two pass of cono weeder among the different weed management practices adopted in preceding rice. The interaction effect of establishment methods and non-chemical weed management practices was found statistically significant on the total weed density and dry matter accumulation . The lowest weed density was recorded with the combination of *Sesbania* (GM)-Transplanted Rice and Mechanical weeding with two passes of cono weeder.

The highest pod yield (8.38 t/ha) was recorded in stale seed bed-direct seeded rice + *Sesbania* among the establishment systems. Mechanical weeding by hoe *fb* one hand weeding (S3) recorded numerically highest initial plant population (68.7/ m^2) whereas, mechanical weeding with two passes of cono weeder (S1) resulted highest pods per plant (8.7), grains per pod (6.2) and pod yield (8.28 t/ha).

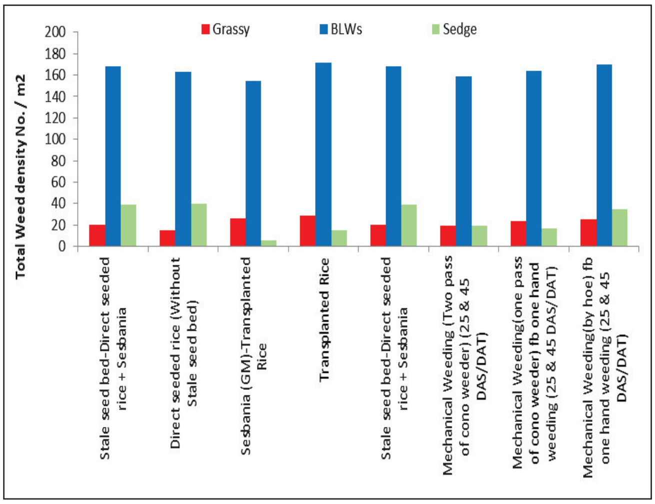


Fig. 1.3.1 Effect of establishment methods and weed management on total weeds density on grassy, broad leaf and sedges at 20 DAS in vegetable pea under rice-vegetable pea-sweet corn cropping system

Among different establishment methods, the highest net return (Rs.1,35,360/ha) was recorded with stale seed bed-direct seeded rice + *Sesbania* (M1), while, similar benefit cost ratio (2.8) was recorded with all the treatments except transplanted rice (M4). However, within non-chemical weed management practices, mechanical weeding with two passes of cono weeder (S1) recorded the highest net return (Rs.1,32,860/ha); while all the treatment showed similar benefit cost ratio (2.8).

Spring sweet corn (2020-21)

The total weed density and dry matter accumulation of weeds were significantly influenced by different establishment methods at 30 DAS. *Sesbania* (GM)-transplanted rice recorded the lowest total weed density and dry matter accumulation which was at par with transplanted rice among the establishment methods. However, none of the weed management practices adopted in rice had significant effect on the total weed density and weed dry matter accumulation at 30 DAS.

Yield attributing characters *viz.* final plant population, number of cobs and cob yield were found to be indifferent to all the main and subplot factors. However, individual cob weight was significantly affected by the establishment methods. Numerically, the highest final plant population (78.4'000/ha) was recorded with transplanted rice where as the highest number of cobs (30.7 '000/ha) was achieved with *Sesbania* (GM)-transplanted rice . Similar cob yields (7.6 t/ha) were recorded with all the treatments except transplanted rice (M4) among the establishment methods. None of the weed management practices adopted in rice, had significant effect on yield and yield attributes of sweet corn. The highest number of cobs (30.0 '000/ha) and cob yield (7.6 t/ha) were recorded with mechanical weeding with two pass of cono weeder.

Among different establishment methods, the highest net return of Rs.1,60,000/ha and benefit cost ratio of 6.33 were recorded with all establishment methods except transplanted rice. However, within non-chemical weed management practices, mechanical weeding with two pass of cono weeder recorded the highest net return of Rs.1,60,000/ha and benefit cost ratio of 6.33.

PAU, Ludhiana

Weed management in organically grown pea-brinjal cropping system

Pea (*Rabi* 2020-21):

Weed flora : *Phalaris minor*, *Poa annua*, *Coronopus didymus*, *Anagallis arvensis*, *Rumex dentatus*, *Medicago denticulate* and *Cyperus rotundus*.

Fertilization treatments did not have any significant influence on density of grass and sedge weeds; however, vermicompost sole had the lowest broadleaf weed density than FYM sole or its mixture with vermicompost at 30 and 60 days. Among weed control, plastic mulch had the lowest density of all weeds which was similar to PSM at 30 and 60 days. *C. rotundus* density did not show vary among weed control treatments.

Broad leaf weeds had higher contribution to total weed biomass. Vermicompost alone had significantly lower broadleaf weed biomass than FYM alone or its mixture with vermicompost. Plastic mulch had the biomass of all weeds which was similar to PSM.

Among fertilization treatments, pea crop supplied with vermicompost sole had the highest pod yield which was at par to FYM sole and its mixture with vermicompost. Among weed control, plastic mulch recorded the highest pea yield which significantly higher than all other weed control treatments. It was closely followed by PSM and both plastic and PSM had significantly higher yield than hand weeding **(Table 1.3.5)**.

Table 1.3.5 Effects of fertilization and weed control on weed biomass in organically raised pea (2020-21).

Treatments	Weed biomass (g/m²) at 60 DAS		
	Grass	Broad leaf	Sedge
Fertilization			
FYM	3.32 (14.0)	8.45 (111.5)	3.23 (13.3)
FYM+Vermicompost	3.17 (12.6)	7.79 (94.5)	3.01 (11.0)
Vermicompost	3.10 (11.9)	7.44 (84.2)	2.79 (9.2)
SEm±	**0.13**	**0.24**	**0.17**
LSD (p=0.05)	**NS**	**0.67**	**NS**
Weed control			
Weedy check	5.43 (29)	15.28 (234.1)	5.05 (24.9)
Intercropping (coriander)	4.91 (23)	12.48 (155.6)	4.41 (18.8)
Plastic mulch (25µ)	1.00 (0)	1.00 (0)	1.00 (0)
Paddy straw mulch	3.63 (12)	9.69 (94.3)	3.6 (12.2)
Hand weedings	1 (0)	1.00 (0)	1.00 (0)
SEm±	0.09	0.31	0.22
LSD (p=0.05)	0.20	0.63	0.45
Interaction	NS	NS	NS

* Data subjected to square root transformation. Figures in parenthesis are means of original value

Brinjal (*Kharif* 2021):

Weed flora: *Echinochloa colona*, *Digitaria sanguinalis*, *Eragrostis pilosa*, *Phyllanthus niruri* and *Cyperus rotundus*.

Fertilization treatments did not have any significant influence on density of different weed species except vermicompost sole which had lower density of grass weeds than FYM sole or its mixture with vermicompost.Vermicompost sole had lowest grass weed biomass at 60 and 90 DAT while FYM sole had the lowest broad leaf weed biomass at 90 DAT. Sedge weed biomass did not vary among fertilization treatments. Among weed control, plastic mulch had significantly low density of all weed species than rest of treatments; PSM and intercropping had significantly low weed density than weedy check. Plastic mulch had lowest biomass of all type of weeds; it was closely followed by PSM in case of grass and sedge weeds and intercropping treatment in case of broadleaf weeds.

Among fertilization treatments, FYM sole provided the highest brinjal yield which was significantly higher than mixture of FYM plus vermicompost; vermicompost sole had lowest brinjal yield.

Among weed control, plastic mulch treatment gave the highest brinjal yield which was significantly higher than all other weed control treatments. It was followed by PSM which gave significantly higher yield than hand weeding. Intercropping treatment gave the lowest brinjal yield which was similar to weedy check.

IGKV, Raipur

Weed management in organically grown aromatic rice in transplanted rice-sweet corn cropping system.

Sweet Corn (Rabi 2021-22)

Weed flora: *Medicago denticulata, Alternanthera sessilis, Chenopodium album* and *Echinochloa colona* were the major weeds observed in the experimental field while the density of *Cyperus* spp, *Ammania baccifera,* and *Cynodon dactylon* observed lesser and grouped as other weeds.

At 60 DAS, the lowest count of *Medicago denticulata*, *Echinochloa colona* were observed under black polythene mulch, whereas, *Alternanthera sessilis*, *Chenopodium album* and other weeds was observed the lowest in stale seed bed +25% higher plant density + mulching with paddy straw + one hand weeding (T_4). On the other hand, the highest weed count of major weeds and total weed count was recorded in live mulching with green gram (incorporation 30 DAS) (T_6) **(Table 1.3.6)**.

Table 1.3.6 Weed dry weight, green cob yield and economics of organically grown sweet corn as affected by different weed management options in transplanted rice - sweet corn cropping system.

S.No.	Treatment	Weed dry Weight at harvest (g/m²)	Weed control efficiency (%)	Green cob yield (t/ha)	Net Returns (Rs./ha)	B:C
T_1	Hand weeding twice at 20 & 40 DAS	4.41 (15.30)	47.0	6.20	153507	3.52
T_2	Black polythene mulch (20 micron thickness)	3.30 (7.83)	72.90	7.42	189302	3.89
T_3	Paddy straw mulch 5 tonne/ ha	4.32 (14.63)	49.37	6.46	163080	3.70
T_4	Stale seed bed +25% higher plant density) + mulching with paddy straw + one hand weeding	4.23 (13.90)	51.90	6.80	170805	3.67
T_5	Hand hoe twice 20 & 40 DAS	4.97 (20.00)	30.79	5.21	124917	3.15
T_6	Live mulching with green gram (incorporation 30 DAS)	5.87 (28.90)	-	3.80	81213	2.44
T_7	Live mulching with green gram (incorporation 30 DAS) + one intra row hand weeding	5.42 (24.23)	16.15	5.01	121078	3.10
T_8	Weed mulching 20 DAS (in-situ mulching of weeds in between rows) + one hand weeding at 40 DAS	4.88 (19.20)	33.56	5.47	134882	3.27
	SEm ±	**0.07**		**0.28**		
	CD (P=0.05)	**0.23**		**0.85**		

Significantly the highest green cob yield (7.42 t ha^{-1}) of sweet corn was recorded in black polythene mulch (20 micron thickness) (T_2). It was found at par with the treatment having stale seed bed + 25% higher plant density + mulching with paddy straw + one hand weeding (6.80 t ha^{-1}) (T_4).

Among all the weed management practices, highest net income was obtained in black polythene mulch treatment (Rs. 189302/ha) followed by stale seed bed +25% higher plant density + mulching with paddy straw + one hand weeding (Rs. 170805 ha^{-1}) and paddy straw mulch 5 t/ha (T_3) (Rs. 163080/ha). While lowest net income and BC ratio was achieved in live mulching with green gram (incorporation 30 DAS) (Rs 81213/ha) (T6).

Among different establishment methods, the highest net return (Rs.1,35,360/ha) was recorded with stale seed bed-direct seeded rice + *Sesbania* (M1), while, similar benefit cost ratio (2.8) was recorded with all the treatments except transplanted rice (M4). However, within non-chemical weed management practices, mechanical weeding with two passes of cono weeder (S1) recorded the highest net return (Rs.1,32,860/ha); while all the treatment showed similar benefit cost ratio (2.8).

Aromatic rice (*Kharif* 2021)

Weed Flora: Weed flora of the experimental site dominated with *Echinochloa colona* among grasses, *Cyperus iria* in sedges and *and Alternanthera triandra, Spilanthes acmella and S. diander* in broadleaf. *Spilanthes diander* was appeared in the field after 40 days after transplanting and persist upto the harvest, while *Spilanthes acmella was* found during later or maturity stage of the crop in the field. Other weed flora present on the field was *Cynotis axillaris, Ischemum rugosum*, and *Fimbristilis miliaceae* etc.

At 30 DAT, effective control of *Echinochloa colona* (1.22/m^2) was observed in the treatment where mechanical weeding was done through either motorized weeder twice (single row type) + one intra row HW or using Ambika paddy weeder at 20 and 40 DAT as compared to the other treatments. Among sedges, lowest number of *Cyperus iria* was counted in the mechanical weeding through Ambika paddy weeder at 20 DAT. While, highest number (12.0/m^2) of *C. iria* was recorded under the treatment of dense planting of rice (closer spacing of 15 x 10 cm) followed by the treatment of 10 days delayed planting with incorporation of emerged weeds However, Ambika paddy weeder did not control the *Alternanthera triandra* and highest weed density (5.0/m^2) of *Alternanthera triandra* was recorded under this treatment. During later stages, at 60 DAT and at harvest, green leaf manuring (incorporation at puddling) + one HW at 20 DAT controlled *Alternanthera triandra* effectively and recorded lowest number (5.0 and 6.0/m^2) as compared to the others. Any noticeable difference among all the treatments was not observed for controlling *Cyperus iria* at 60 DAT. The treatment of dense planting of rice (closer spacing of 15 x 10 cm) recorded the highest number of total weeds in the field at all the stages.

Weed management options showed significant variation in weed dry weight at all the stages. At 30 and 60 DAT significantly lower dry weight of weeds (2.07 and 3.80 g/m^2) was observed under hand weeding (HW) twice at 20 and 40 DAT over all the other weed management options except motorized weeder twice (single row type) + one intra row HW (2.14 and 3.84 g/m^2) at 30 and 60 DAT and green leaf manuring (incorporation at puddling) + one HW at 20 DAT (2.11 g/m^2) treatments at 30 DAT and mechanical weeding through Ambika paddy weeder at 20 DAT+ one intra row HW at 60 DAT. Highest weed control efficiency (73.95%) was recorded under hand weeding (HW) twice at 20 and 40 DAT closely followed by motorized weeder twice (single row type) + one intra row HW (73.40%) and Ambika paddy weeder at 20 DAT+ one intra row HW (71.91%) at 60 DAT. Both the mechanical weed management treatments maintained their competence at later stage i.e. at harvest.

Maximum grain yield (2.97 t/ha) was achieved under application of hand weeding (HW) twice at 20 and 40 DAT which was significantly superior to rest of the treatments except motorized weeder twice (single row type) + one intra row HW (2.81 t/ha) which was at par with HW twice. Among mechanical weeding either through motorized weeder twice single row type (T2) or Ambika paddy where mechanical weeding done at 20 and 40 DAT alone (T4) and not combined with intra row hand weeding did not perform well and gave lower yields. Dense planting (closer spacing of 15 x 10 cm) produced the lowest grain yield (1.81 t/ha).

Legume intercropping for weed management organically grown Casava

Weed flora: The broad-leaved weeds present were *Alternanthera bettzickiana*, *Borreria hispida*, *Cleome* spp., *Euphorbia geniculata, Mitracarpus verticillatus, Emilia sonchifolia* and *Ludwigia parviflora. Grasses included Pennisetum* pedicellatum, *Eleusine indica*, *Digitaria ciliaris* and *Panicum maximum. Cyperus rotundus* was the only sedge present.

At 30 days after planting (DAP), the population in mehanically weeded plot (T_8) was 177 no/m^2, which was comparable to T_7 (earthing up). In all other treatments the population was considerably low and statistically comparable and average count was only 17 no/m^2. This clearly indicates the smothering effect of legumes in the interspaces. The same trend was observed at later stages of observations also. By harvest stage, weed population did not increase due to earthing up done at 60 and 90 DAP and due to canopy closure by the crop.

All treatment with legume incorporation registered superior and statistically comparable tuber yield per hectare in both years and same trend was found in pooled analysis also. The average tuber yield was 30.58 t/ha in these treatments whereas the average yield in the two treatments where legume incorporation was not done was 23.77 t/ha. Thus it could be inferred that legume incorporation can bring about 28 percent increases in yield.

Hence, in organic weed management in cassava, any ground legumes like cowpea, greengram or horse gram can be recommended with a seed rate of 20 kg/ha for cowpea, 10 kg/ha for greengram and horse gram. Thus, it can save cost of organic manure also by way of biomass addition to the tune of 3-4 t/ha depending on growth of legume.

The pooled analysis shows that weed growth was considerably low in legume cover cropped fields and all treatments were statistically at par with respect weed dry matter the treatments where no cover crops

Greengram as intercrop in cassava

Cowpea as intercrop in cassava

Mechanical weeding

Unweeded control

were grown had almost four times the weed dry weight compared to others at 30 DAP. Similar treatments could be observed at 90 DAP, 120 DAP as well as harvest.

The B:C ranged from 1.72 for treatment where three earthing-ups were practiced which was the lowest value among the various treatments . All the treatments involving legume crops registered higher benefit -cost ratios ranging from 2.30 in the case of horse gram + two earthing-up to 2.67 for cowpea+one earthing up, which was the highest value. Additional one earthing-up in legume cover cropped treatments resulted in slight reduction in net profit as well as B-C ratio. Hence, it can be inferred that in the case of cassava grown under organic system of cultivation, legume cover cropping can be practiced to manage weeds as well as to add organic matter to soil, there by realizing better yields and profit.

Weed management in organically grown chilli (*Kharif* 2021)

The soil had good weed seed bank and with stale seed bed technique depletion of weed seed could be achieved to a limited extent only. Stale seed bed technique followed by one hand weeding at 45 DAT was inferior to stale seed bed followed by two hand weedings due to more weed competition as evident from the data on weed dry matter production.

The weed spectrum in unweeded plot at 30 DAT showed 80% BLWs, 4% sedges as well as 16% grasses. A reduction in weed density compared to unweeded plots was observed in stale seed bed. However straw mulching registered still lower population of weeds. The trend was almost same at 60 DAT also. Polythene mulching continued to register lower weed population at all stages of observation, with population as low as 2 nos/m^2 at 60 DA whereas the population in UWC at this stage was 190nos/m^2. The next best treatments were straw mulching as well as straw mulching followed by hand weeding with an average weed density of 54 nos/m^2.

At 30 DAT, unweeded plots as well as mechanical weeding had the highest and statistically comparable weed dry matter production, as no weeding was done till 30th day. Mulching with straw resulted in low weed dry matter and this was the second best treatment, next to polythene mulching. However there was considerable reduction in weed dry weight to the tune of about 60-70%, over unweeded control. Polythene mulching resulted in almost cent per cent weed control at later stages also. Next best treatments were straw mulching and straw mulching + one hand weeding as well as mechanical weeding at both 60 & 90 DAT as per pooled data also, Polythene mulching resulted in more than 95% WCE at all stages **(Table 1.3.5)**. Through straw mulching 82% weed control efficiency could be achieved at 30 DAP as per pooled analysis and it reduced to 72% by 90 DAP.

The highest yield of 23.06 t/ha was recorded in polythene mulched plots which was statistically superior to all others. The next best treatment was (18.88 t/ha) straw mulching followed by hand weeding at 60 DAT which differed statistically from straw mulching alone (17.02 t/ha). Stale seed bed *fb* two hand weeding and mechanical weeding twice registered comparable fruit yield of 13.36 and 12.40 t/ha, respectively. Stale seed bed *fb* one hand weeding was inferior to the above treatments with yield of 9.52 t/ha.

A similar trend to that of first year was seen in second year of study also and pooled analysis of data also showed a similar trend. Superior yield of 22.44 t/ha was registered in polythene mulched field, which was 23 % higher than the next best treatment which was straw mulching together with a hand weeding at 60 DAT. Straw mulching alone was the next best treatment and here the fruit yield was 16.55 t/ha. Stale seed bed together with two hand weedings and mechanical weeding together with two hand weedings were inferior to the above two treatments and were at par. The yield in UWC was only 1.55 t/ha due to severe weed competition as evident from data on weed dry matter production at various stages of crop growth.

The highest net returns and B:C was in polythene mulch. The next best treatment was straw mulching+ one hand weeding fb straw mulch alone. Mechanical weeding and stale seed bed + two hand weedings were almost comparable in net profit nd B-C ratio, whereas stale seed bed with one hand weeding registered the least profit and B-C ratio among various weed management practices tried.

Table 1.3.5 Effect of treatments on weed control efficiency (%)

Treatments	30 DAS			60 DAS			90 DAS		
	1st Year	2nd Year	Pooled	1st Year	2nd Year	Pooled	1st Year	2nd Year	Pooled
T_1- SSB+ 2HW@ 30 & 60 DAT	58	56	56	75	55	65	85	75	80
T_2- SSB+1HW@ 45	53	54	77	85	74	80	84	53	68
T_3- Black polythene mulch	95	100	87	97	99	98	97	99	98
T_4- Straw mulch	85	78	82	85	71	78	85	60	72
T_5- Straw mulch+1HW@ 60 DAT	82	80	81	86	72	79	84	88	86
T_6- Mechanical weeding at 30 & 60 DAT	19	4	11	88	68	78	86	85	86

Polythene mulch

Straw mulch

UAS, Bengaluru

Weed management in organically grown Kodo millet-blackgram cropping system

Blackgram (*Rabi* 2020-21)

Weed Flora: Sedges - *Cyperus rotundus*; *Grasses- Digitaria marginata*, *Echinochloa crusgalli*, *Dactyloctenium aegyptium*, *Elucina indica, Cynodon dactylon*; Broad leaf weeds- *Borreria hispida*, *Emilia sonchifolia*, *Euphorbia hiritia*, *Spilanthus acmella*, *ageratum conyzoides*, *Acanthospermum hispidum*, *Alternanthera sessilis*, *Commelina benghalensis*, *Ionaidium supfruiticesum*, *Cleome viscosa*, *Amaranthus viridis*, *Portulaca oleracia*, *Sida acuta*.

Straw Mulching 5t/ha at 10-15 DAS, Blackgram + Fodder cowpea as intercrop + 1 Intercultivation at 20 DAS and mechanical (Cycle weeder) weeding at 35 DAS recorded higher weed density at later stages of crop growth compared to other weed control treatments, which was on par with Control. This is due to non-control of weeds at later stages. Among non-chemical method of weed control treatments, Stale seed bed technique + Intercultivation at 25 DAS & 45 DAS, Intercultivation at 25 DAS + 1 Hand weeding at 45 DAS, Two Mechanical (Cycle weeder) weeding at 20 and 40 DAS, Black gram + Fodder cowpea as intercrop with in-situ incorporation on 35 DAS + 1 Intercultivation at 40 DAS reduced the weed density and weed dry weight significantly over other treatments, which was comparable to hand weeding at 20 and 40 DAS.

In non-chemical methods of weed control, Hand weeding at 20 and 40 DAS, recorded higher weed control efficiency (83.60%) followed by Stale seed bed technique + intercultivation twice at 25 and 45 DAS (79.99 %), Inter cultivation at 25 DAS + One hand weeding at 45 DAS (78.04%), Mechanical (Cycle weeder) weeding at 20 and 40 DAS (75.50%) and Black gram + Fodder cowpea as intercrop with in-situ incorporation on 35 DAS + 1 Intercultivation at 40 DAS (54.58 %).Other weed control treatments, where second Intercultivation or hand weeding was not imposed, recorded less than 50 % weed control efficiency at 30 days after sowing.

The weed index was higher in Straw Mulching 5t/ha at 10-15 DAS, Kodo millet + Fodder cowpea as intercrop + 1 Intercultivation at 20 DAS and blackgram + Fodder cowpea as smothering crop in between rows of blackgram + 1 Intercultivation at 40 DAS, Mechanical (Cycle weeder) weeding at 35 DAS to the fact that it produced less yield indicating the per cent yield loss varied from 28.86 to 45.57 % over hand weeding.

Two hand weeding (20 & 40 DAS) recorded significantly higher seed yield (1.13 t/ha) which was on par with stale seed bed technique followed by Intercultivation twice at 25 at 45 DAS (1.09 t/ha), one Intercultivation 25 DAS and one hand weeding at 45 DAS (1.08 t/ha), mechanical cycle weeding at 20 and 40 DAS (1.03 t/ha) and Black gram+ Fodder cowpea as intercrop with in-situ incorporation on 35 DAS + 1 Intercultivation at 40 DAS (0.96t/ha) This higher yield might be due to better control of weeds at critical stage of the crop which is crucial for blackgram.

The benefit: cost ratio was higher in Mechanical (Cycle weeder) weeding at 20 and 40 DAS (2.50) which is almost comparable with treatments Hand weeding twice at 20 and 40 DAS, Stale seed bed technique + Intercultivation at 25 DAS & 45 DAS and Intercultivation at 25 DAS + 1 Hand weeding at 45 DAS. Hence, under non chemical method of weed control, and in a situation where availability of labour is crucial, managing weeds through combinations of various cultural operations like stale seed bed technique, Intercultivation practices, and hand weeding plays a greater role in controlling weeds at critical period of crop.

Stale seed bed technique+ Intercultivation at 25 & 45 DAS

Unweeded check

Kodo millet (*Kharif* 2021)

Weed Flora: *Cyperus rotundus*, *Cynodon dactylon, Digitaria marginata, Echinochloa colona, Dactyloctenium aegyptium, Elucine indica* among narrow leaf weeds. In broad-leaf weeds, *Borreria hispida, Commelina benghalensis, Phyllanthus niruri, Alternanthera sessilis, Spilanthus acmella, Oldenlandia corymbosa, Ageratum conyzoides, Amaranthus viridis, Cleome viscosa* and *Portulaca oleracea.*

All the treatments recorded significantly lower density of weeds over weedy check at 30 and 60 DAS. In the plots where treatments were imposed sequentially at 20-25 and 40-45 days after sowing recorded significantly lower weed density over the treatments compared to the treatments wherever sequential imposition of weed control method was not adopted. Stale seed bed technique + Intercultivation at 25 DAS & 45 DAS and Kodo millet + Fodder cowpea as smothering crop in between rows of Kodo millet recorded lower weed density 29.3 and 24.6 no /m2 at later stages of crop growth compared to other weed control treatments.

In non-chemical methods of weed control, hand weeding at 20 and 40 DAS recorded higher weed control efficiency (68.1%) followed by Two Mechanical (Cycle weeder) weeding at 20 and 40 DAS (52.5%), kodomillet + fodder cowpea as smothering crop in between rows of kodo millet (51.4%), Straw mulching (48.9%) and Stale seed bed technique + Intercultivation at 25 DAS & 45 DAS(48.8%) at 30DAS.

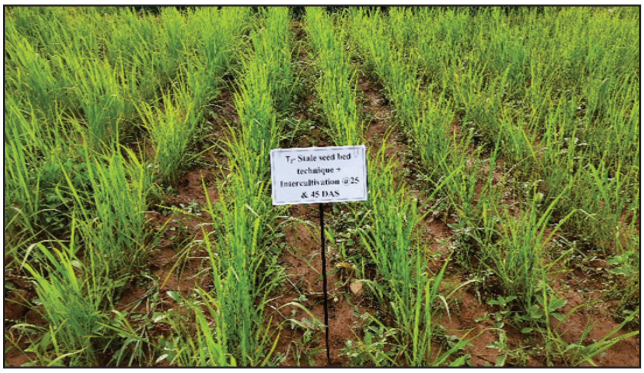
Hand weeding at 20 & 40 DAS recorded significantly higher seed yield (0.926 t/ha) compared to all other treatments. Stale seed bed technique + Intercultivation at 25 DAS & 45 DAS (0.763 t/ha) was on par with Intercultivation at 25 DAS + one hand weeding at 45 DAS (0.733 t/ha) followed by Two mechanical weeding (Cycle weeder) at 20 and 40 DAS (0.680 t/ha) and Kodo millet + Fodder cowpea as intercrop with in-situ incorporation on 35 DAS + 1 Intercultivation at 40 DAS (0.666 t/ha).

The benefit cost ratio was higher in Hand weeding twice at 20 and 40 DAS (2.3) and Stale seed bed technique + Intercultivation at 25 DAS & 45 DAS (2.3) which is almost comparable with treatments Kodo millet + Fodder cowpea as intercrop with in-situ incorporation on 35 DAS + 1 Intercultivation at 40 DAS

(2.2), Mechanical (Cycle weeder) weeding at 20 and 40 DAS (2.1) and Intercultivation at 25 DAS + 1 Hand weeding at 45 DAS (2.1).

Among non-chemical methods of weed control in Kodo millet, Hand weeding twice at 20 and 40 DAS, which is almost comparable with treatments, Stale seed bed technique + Intercultivation at 25 DAS & 45 DAS, and Intercultivation at 25 DAS + 1 Hand weeding at 45 DAS and Mechanical (Cycle weeder) weeding at 20 and 40 DAS was found to be effective in controlling weeds.

Kodo millet + fodder cowpea as intercrop with in-situ mulching on 35DAS + 1 intercultivation at 40DAS



Stale seed bed technique + Inter cultivation twice at 25 and 45 DAS

Fig 1.3.3: Organically grown *Kharif*- Kodo millet (*Paspalum scrobiculatum*)

Weed seed bank studies was conducted in plots where the experiment on Kodo millet-blackgram based cropping system under non-chemical methods of weed management was proposed to be imposed during *Kharif*-2021. At 14 days, weed density was more compared to 7 and 30 days. But at 30 days weeds were bigger compared to other stages and at 7 days weeds were smaller.

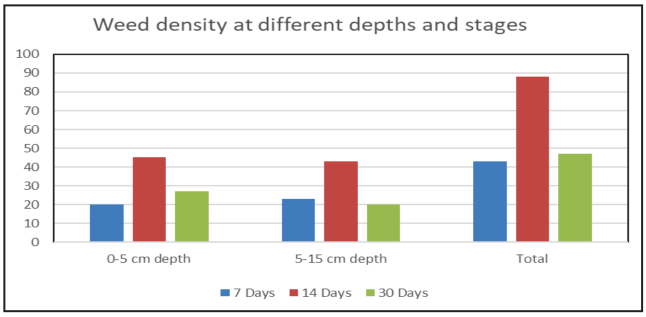


Fig. 1.3.2 Weed seed density at different depth of soil at different stages in Kodo millet–Blackgram based cropping system

PDKV, Akola

Weed management practices in organically grown cotton-chickpea sequence

Cotton (*Kharif* 2020)

Weed flora: *Cynodon dactylon, Cyperus rotundus, Commelina benghalensis, Ischaemum pilosum, Digitaria sanguinalis, Dinebra retroflexa, Poa annua, Cyanotis axillaris* among monocots and *Digera arvensis, Lagasca mollis, Euphorbia geniculata, Tridex procumbense, Parthenium hysterophorus, Alysicarpus monolifer, Alternanathera triandra, Portulaca oleracae, Amaranthus viridis, Acalypha indica, Cardiospermum helicacabum, Ipomoea reniformis, Corchorus acutangulus, Phyllanthus niruri, Abutilon indicum, Abelmoschus moschatus, Boerhavia diffusa, Ageratum conyzoides, Bidens pilosa, Xanthium strumarium, Datura stramonium* among dicots.

Plastic mulching at sowing on ridges recorded significantly lowest weed population and weed dry matter consistently throughout the growth stages over remaining treatments, however, which in turn was found at par with farmer's practice. Stale seed bed and soil solarization *fb* by twice hand weeding, respectively, recorded statistically comparable reduction in weed population and weed dry matter accumulation which was at par with hand weeding at 20 DAS + straw mulch, green manuring with Sesbania and cover crop with greengram.

The highest weed control efficiency was recorded with farmers practice (3 hoeing *fb* 2 HW at 20 & 40 DAS) at all the growth stages this may be due to better control of weeds with timely intercultivation. While lowest weed index was noticed in intercrop of greengram closely followed by green manuring with sesbania at 30 DAS **(Table 1.3.6)**.

Weed control practices caused significant variation on seed cotton yield. The highest seed cotton yield (2.04 t/ha) was registered with 3 HW at 20, 40 and 60 DAS fb 2 HW which was at par with plastic mulching a sowing on ridges.

Table 1.3.6 Weed control efficiency as influenced by different treatments

Treatment	Weed Control Efficiency (%)				Weed index (%)
	30 DAS	60 DAS	90 DAS	120 DAS	
Stale seedbed preparation + Hand weeding at 20 & 40 DAS	68.87	75.78	73.94	69.23	11.11
Soil solarization + Hand Weeding at 20 & 40 DAS	70.18	75.60	72.94	68.80	18.75
Plastic mulch at sowing on ridges	83.53	87.18	84.42	77.98	3.26
Intercrop/Cover crop (Blackgram 1:2)	61.29	68.54	61.10	59.40	22.58
Green manuring (Incorporation of *Dhaincha* 30 DAS) 2:1	63.87	70.97	67.18	64.95	34.75
Hand Weeding once at 20 DAS + Straw mulch (5 t /ha) at 20 DAS)	75.94	76.71	71.39	68.10	19.50
Farmers practice (3 Hoeings 20 Days interval *fb* 2 HW 20 & 40 DAS	78.26	83.00	82.55	81.70	0.00
Weedy check	0.00	0.00	0.00	0.00	115.91

WP 1.4 Management of herbicide resistance in weeds

Monitoring and management of herbicide resistance to different herbicides in *P. minor* biotypes from farmers' fields (Pot-culture)

CCSHAU, Hisar

All the populations showed variable phytotoxicity with graded doses of clodinafop. With the increase in the dose, there was an increase in the mortality rate. With the maximum dose under testing *i.e.* 2x dose of this herbicide, only three populations showed more than 70 % control. Only three populations out of the 12 populations under the testing show ≥ 70 % control to the recommended dose of sulfosulfuron (25 g/ha), five to mesosulfuron + iodosulfuron (RM) (14.4 g/ha) and three to pinoxaden (50 g/ha). It shows the development of resistance to the *P. minor* populations against these tested herbicides. Out of the total 12 populations under testing 3,7,8,6 populations show ≥ 70 % control with the 2X dose of clodinafop, sulfosulfuron, mesosulfuron + iodosulfuron (RM) and pinoxaden respectively. This study showed that a higher level of resistance has developed against these herbicides. At Karnal, all the populations show less than 70% control at even 2x dose of clodinafop, sulfosulfuron and mesosulfuron + iodosulfuron **(Fig. 1.4.1)**.

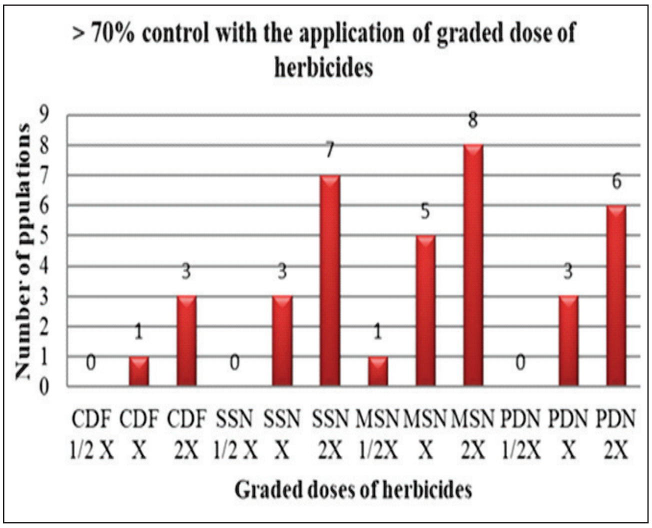


Fig. 1.4.1 Efficacy (≥70%) of different herbicides against *P. minor* biotypes in pot studies

PAU, Ludhiana

P. minor population from PAU showed cross-resistance to sulfosulfuron, clodinafop at double the recommended dose, partial resistance to pinoxaden and mesosulfuron + iodosulfuron at the recommended dose, and no resistance to pre-emergence herbicides pendimethalin and pyroxasulfone. Population from farmer's field was found to have a high level of resistance against all these herbicides except pre-emergence herbicides at recommended doses.

GR_{50} values for PAU population were more than 8 times the recommended dose in case of sulfosulfuron, more than 3 times in case of clodinafop and fairly higher for meso + iodosulfuron. However, the values were lower than the recommended dose in case of pinoxaden, pendimethalin and pyroxasulfone (Table 1.4.1). In case of farmer's field population, it was highly resistant to sulfosulfuron and clodinafop (resistance index >20), moderately resistant tomesosulfuron + iodosulfuron (RI 5.43) and fair resistance to pinoxaden (RI 2.96), pyroxasulfone (RI 1.88) and pendimethalin (RI 1.46) (Table1.4.2).

Table 1.4.1 GR_{50} (g ha^{-1}) values of *P. minor* populations for different herbicides based on percent control

Herbicides	GR 50 (g ha-1)		
	Populations		
	Sensitive	PAU	Resistant
Sulfosulfuron	13.30	206.37	298.56
Clodinafop	27.64	204.78	972.42
Pinoxaden	26.99	31.73	79.81
Atlantis	7.85	24.17	42.65
Pendimethalin	60.44	77.80	88.19
Pyroxasulfone	6.11	11.22	11.48

Table 1.4.2 Resistance index of *P. minor* populations for different herbicides

Herbicides	Resistance Index	
	Populations	
	PAU	Resistant
Sulfosulfuron	15.52	22.44
Clodinafop	7.41	35.18
Pinoxaden	1.18	2.96
Atlantis	3.08	5.43
Pendimethalin	1.29	1.46
Pyroxasulfone	1.84	1.88

SKUAST, Jammu

Pinoxaden, mesosulfuron+ iodosulfuron and Fenoxaprop caused satisfactory control of all *P. minor* populations at the recommended dose (x) as well as 2x. At the recommended dose of clodinafop and sulfosulfuron exhibited satisfactory control of all biotype except one biotype (P4) in case of clodinofop and two biotypes (P6 & P7) in case of sulfosulfuron. Isoproturon exhibited satisfactory control of only susceptible biotype. This indicated that isoproturon, clodinafop and sulfosulfuron showed resistance in all ten biotypes, one biotype and two biotypes, respectively.

Management of cross-resistance in *P. minor* against recommended herbicides in wheat through use of pre and post-emergence herbicides

CCSHAU, Hisar

Application of metribuzin through mixing with urea provided effective control of *P. minor* and broadleaf weeds. Metribuzin at 350 g/ha resulted in significantly lower weed density of *P. minor, Coronopus didymus, Medicago denticulata, Rumex dentatus* at harvest as compared to weedy check. Application of metribuzin (350 g/ha) through mixing with urea after first irrigation resulted in significantly lower weed dry matter accumulation by grassy weeds at harvest (30.1 g/m^2) and broadleaf weeds (53.1 g/m^2) was as compared to weedy check treatment. Aclonifen + diflufenican (TM)) *fb* mesosulfuron+ iodosulfuron (RM) (1000+ 200 *fb*14.4) resulted in 100 % weed control efficiency for both grassy as well as broadleaf weeds at harvest **(Table 1.4.3)**. Pyroxasulfone + pendimethalin (TM) *fb* mesosulfuron + iodosulfuron (RM) also resulted in higher WCE for both grassy (92.5%) as well as broadleaf weeds (89.0%). Application of metribuzin at 350 g/ha through mixing with urea after irrigation had no phytotoxicity on the crop at 20 days after treatment

(DAT), however metribuzin at 525 g/ha had phytotoxicity at 20 DAT (5%) which recovered later while application of metribuzin at 700 g/ha resulted in more phytotoxicity (20%) causing yield reduction. Weed-free treatment resulted in higher grain yield (5300 kg/ha) which was significantly higher than metribuzin 350 g/ha, 525 g/ha and 700 g/ha and weedy check treatments. Application of metribuzin 700 g/ha through mixing with urea after first irrigation resulted in lower grain yield (4233 kg/ha) as compared to other treatments due to phytotoxicity to the crop.

Table 1.4.3 Effect of different treatments on weed dry weight (g/m^2) and WCE (%) at harvest

Sr. No	Treatment	Dose (g/ha)	Dry wt. (grassy weeds) harvest (g/m^2)	Dry wt. of (BLW) harvest (g/m^2)	WCE (%) (grassy) at harvest	WCE (%) (BLW) at harvest
1.	Metribuzin*	350	5.54 (30.1)	7.33 (53.1)	37.0	33.2
2.	Metribuzin*	525	4.60 (20.2)	5.35 (27.8)	57.7	65.0
3.	Metribuzin *	700	2.93 (7.7)	4.60 (20.4)	83.9	74.4
4.	Metribuzin* *fb* pinoxaden	350/50	1.00 (0.0)	7.23 (51.5)	100.0	35.2
5.	Metribuzin* *fb* mesosulfuron + iodosulfuron (RM)	350/14	2.69 (6.4)	1.0 (0.00	86.0	100.0
6.	Aclonifen 500 SC + diflufenican 100 SC (TM)	1000 + 200	3.30 (10.0)	4.68 (21.0)	79.1	73.6
7.	Aclonifen 500 SC + diflufenican 100 SC (TM)	1250 + 250	1.00 (0.0)	4.13 (16.2)	100.0	79.7
8.	Farmers' practice – clodinafop + metribuzin (TM)	60 + 105	4.15 (16.4)	6.05 (36.2)	65.6	54.5
9.	Pyroxasulfone + pendimethalin (RM)	127.5 + 1500	2.96 (7.9)	4.67 (20.8)	83.5	73.9
10.	Pyroxasulfone + pendimethalin (TM) *fb* mesosulfuron+ iodosulfuron (RM)	127.5 + 1500/ 14.4	2.1 (5.2)	3.11 (8.7)	92.5	89.0
11.	Aclonifen 500 + diflufenican 100 SC (TM)) *fb* mesosulfuron+ iodosulfuron (RM)	1000 + 200/14.4	1.0 (0.0)	1.00 (0.0)	100.0	100.0
12.	Aclonifen + diflufenican (TM) *fb* pinoxaden	1000 + 200/50	2.12 (3.6)	4.02 (15.4)	92.5	80.7
13.	Farmers' practice – metribuzin	350	5.45 (28.8)	7.30 (52.4)	39.7	34.1
14.	Weedy check	-	6.96 (47.8)	8.96 (79.5)	0.0	0.0
15.	Weed Free	-	1.0 (0.0)	1.0 (0.0)	100.0	100.0
	SEm±		**0.20**	**0.22**		
	CD (p=0.05)		**0.59**	**0.64**		

*Metribuzin at specified dose by mixing in 25 kg urea after first irrigation

**Original data in parenthesis were subjected to square root transformation

Management of multiple herbicide-resistant populations of *P. minor* in wheat

CCSHAU, Hisar

Application of different herbicides, either may be pre-emergence (PRE) alone, post-emergence (PoE) or PRE followed by PoE resulted in significantly lower weed density of grassy weed *i.e. P. minor* at 90 DAS.. Application of PRE pyroxasulfone + pendimethalin (127.5 + 1000 g/ha) *fb* PoE *i.e.* clodinafop + metribuzin (RM), meso + iodosulfuron (RM), pinoxaden+ metribuzin (TM) resulted in no grassy weeds as well as broadleaf weeds at 90 DAS. As there were no grassy as well broadleaf weeds at 90 DAS, resulting in 100 % weed control efficiency at 90 DAS for both grassy as well as broadleaf weeds **(Table 1.4.4)**.

Application of pyroxasulfone (127.5 g/ha) and pinoxaden (50 g/ha) resulted in at par yield with the weedy check, however, other herbicides resulted in significantly higher yield as compared to the weedy check treatment. Application of PRE *fb* POE herbicides resulted in higher grain yield as compared to PRE alone or PoE alone herbicides. Weed-free treatment resulted in significantly higher grain yield (5566.7 kg/ha) as compared to pyroxasulfone (127.5 g/ha) (4716.7 kg/ha), pyroxasulfone + pendimethalin 127.5 + 1000 g/ha (4873.3 kg/ha), pinoxaden+ metribuzin (TM) (50+105 g/ha) (4936. 7 kg/ha) and pinoxaden 50 g/ha (4780 kg/ha) but at par with other herbicide treatments.

Table 1.4.4 Weed dry weight (g/m²) and WCE (%) as influenced by different herbicide treatments at 90 DAS

Sr. No.	Treatments	Dose (g/ha)	Grassy weed (g/m²)	BLW (g/m²)	WCE (%) (grassy)	WCE (%) (BLW)
1	Pyroxasulfone	127.5	2.84 (7.1)*	4.91 (23.2)	82.2	41.6
2	Pyroxasulfone + pendimethalin	127.5 + 1000	2.21 (3.9)	3.57 (11.8)	90.2	70.4
3	Pyroxasulfone + pendimethalin	127.5 + 1500	1.61 (1.8)	2.86 (7.2)	95.5	81.9
4	Pyroxasulfone + pendimethalin	160 + 1500	1.00 (0.0)	2.52 (5.4)	100.0	86.5
5	Pyroxasulfone + pendimethalin *fb* clodinafop + metribuzin (RM)	127.5 + 1000 *fb* 60+175 (RM)	1.00 (0.0)	1.82 (2.3)	100.0	94.2
6	Pyroxasulfone + pendimethalin *fb* clodinafop + metribuzin (RM)	127.5 + 1000 *fb* 60+210 (RM)	1.00 (0.0)	1.00 (0.0)	100.0	100.0
7	Pyroxasulfone + pendimethalin *fb* meso + iodosulfuron (RM)	127.5 + 1000 *fb* 14.4	1.00 (0.0)	1.00 (0.0)	100.0	100.0
8	Pyroxasulfone + pendimethalin *fb* pinoxaden + metribuzin (TM)	(127.5 +1000) *fb* (50+105)	1.00 (0.0)	1.00 (0.0)	100.0	100.0
9	Clodinafop + metribuzin (RM)	60+175	1.84 (2.4)	2.31 (4.3)	93.9	89.1
10	Clodinafop + metribuzin (RM)	60+210	1.00 (0.0)	1.00 (0.0)	100.0	100.0
11	Pinoxaden + metribuzin (TM)	50+105	1.00 (0.0)	3.44 (10.9)	100.0	72.5
12	Pinoxaden + metribuzin (TM)	50+132	1.00 (0.0)	2.58 (5.7)	100.0	85.5
13	Meso + iodosulfuron (RM)	14.4	1.00 (0.0)	3.94 (14.5)	100.0	63.4
14	Pinoxaden	50	1.00 (0.0)	5.95 (36.5)	100.0	8.1
15	Weedy		6.34 (39.6)	6.38 (39.7)	0.0	0.0
16	Weed free		1.00 (0.0)	1.00 (0.0)	100.0	100.0
	SEm±		**0.15**	**0.12**		
	CD (p=0.05)		**0.43**	**0.35**		

*Original data in parenthesis were subjected to square root transformation

PAU, Ludhiana

Pyroxasulfone alone at 127.5 g/ha provided effective control of *P. minor* and its fair control of broadleaf weeds. Tankmixture of pyroxasulfone with pendimethalin improved control of broadleaf weeds and significantly reduced broadleaf weed density and dry biomass than pyroxasulfone alone.

All weed control treatments provided significantly higher wheat grain yield than the weedy check which had 42% lower grain yield than weed-free check. Pyroxasulfone alone at 127.5 g/ha provided wheat grain yield and attributes at par to its tank-mixture with all doses of pendimethalin as well as sole application of ready mixtures of clodinafop + metribuzin. Wheat grain yield and attributes under sequential application of tank mixture of pyroxasulfone + pendimethalin as pre-and ready mixtures of clodinafop + metribuzin as post-emergence were similar to tank mixture of pyroxasulfone + pendimethalin alone as pre-emergence. However, the sequential application of pre-and post-emergence herbicides had significantly higher grain yield than the application of pyroxasulfone alone at 127.5 g/ha.

SKUAST, Jammu

Different treatments had a significant effect on weed density and weed biomass at 60 DAS. Among the herbicidal treatments, the lowest weed density, as well as biomass of *P. minor*, was observed in fenoxaprop-p-ethyl + metribuzin which was statistically at par with pinoxaden + metribuzin and clodinafop propargyl + metribuzin and significantly lower than other treatments. Clodinafop-propargyl 60 g/ha and sulfosulfuron 25 g/ha did not exhibit satisfactory control of *P. minor* **(Table 1.4.4)**.

Different treatments had a significant effect on the grain yield of wheat. Among the herbicidal treatments, the highest grain yield was observed in fenoxaprop-p-ethyl + metribuzin which was statistically at par with pinoxaden + metribuzin and clodinafop propargyl + metribuzin, pendimethalin + pyroxasulfone as PE, pendimethalin + metribuzin as PE, metribuzin as POE and significantly lower than other treatments. The lowest grain yield was recorded with a weedy check which was statistically at par with clodinafop-propargyl 60 g/ha and sulfosulfuron 25 g/ha as POE.

Table 1.4.4 Effect of weed management treatments on weed biomass in wheat (*Rabi* 2020-21)

S. No.	Treatment	Dose (g/ha) and time	Weed biomass at 60 DAS (g/m²)			WCE
			P. minor	BLWs	Total	
1.	Pendimethalin	1000 PE	7.10 (49.93)	3.96 (14.68)	8.07 (64.61)	79.05
2.	Pyroxasulfone	127.5PE	5.98 (34.76)	5.72 (31.87)	8.21 (66.63)	78.40
3.	Pendimethalin + pyroxasulfone	1000 + 127.5 PE	3.32 (10.01)	3.04 (8.29)	4.39 (18.30)	94.07
4.	Pendimethalin + metribuzin	1000 + 210 PE	3.84 (13.75)	2.96 (7.74)	4.74 (21.49)	93.03
5.	Metribuzin	210 2-4 Leaf stage	6.47 (40.81)	4.13 (16.11)	7.61 (56.92)	81.55
6.	Pinoxaden	40 2-4 Leaf stage	5.20 (26.08)	6.51 (41.39)	8.27 (67.47)	78.13
7.	Pinoxaden + metribuzin	40 +210 2-4 Leaf stage	1.84 (2.40)	2.81 (6.91)	3.21 (9.31)	96.98
8.	Clodinafop-propargyl	60 2-4 Leaf stage	15.73 (246.93)	6.84 (45.85)	17.13 (292.79)	5.08
9.	Clodinafop propargyl + metribuzin	54 + 120 2-4 Leaf stage	7.11 (49.60)	4.82 (22.25)	8.53 (71.85)	76.71
10.	Clodinafop propargyl + metribuzin	60 + 210 2-4 Leaf stage	2.18 (3.75)	2.76 (6.63)	3.37 (10.38)	96.64
11.	Sulfosulfuron	25 2-4 Leaf stage	15.45 (238.12)	4.42 (18.56)	16.04 (256.68)	16.79
12.	Sulfosulfuron + metribuzin	25 + 210 2-4 Leaf stage	8.97 (79.55)	3.70 (12.75)	9.65 (92.30)	70.08
13.	Fenoxaprop-p-ethyl	100 2-4 Leaf stage	5.52 (29.63)	6.89 (46.52)	8.78 (76.15)	75.31
14.	Fenoxaprop-p-ethyl + metribuzin	100 + 175 2-4 Leaf stage	1.78 (2.15)	2.90 (7.41)	3.25 (9.56)	96.90
15.	Weedy check	-	16.15 (260.67)	6.98 (47.80)	17.57 (308.47)	0.00
16.	Weed Free	-	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	100.00
	SEm ±	**-**	**0.29**	**0.15**	**0.28**	**-**
	LSD (p=0.05)	**-**	**0.85**	**0.43**	**0.80**	**-**

Data was subjected to square root transformation √ X+1. Original values are in parenthesis

WP 1.5 Management of parasitic weeds

Management of *Cuscuta* in Lucerne

In Anand (Gujarat), application of pendimethalin 38.7% EC 680 g/ha PE, pendimethalin 30% + imazethapyr 2% EC 640 g/ha PE and pendimethalin 30% + imazethapyr 2% EC 800 g/ha PE were found phytotoxic to lucernecrop , however, it was found effective and no germination of *Cuscuta* was noticed. All the herbicidal treatments recorded significantly lower fresh weight, length and seed yield of *Cuscuta* as compared to control plot. Significantly higher green fodder yield (22.8 t/ha) at 75 DAS was recorded in application of pendimethalin 38.7% CS 680 g/ha at 10 DAS but remained at par with imazethapyr 35% + imazamox 35% WG (PM) 70 g/ha PoE, imazethapyr 10% SL 50 g/ha PoE and propaquizafop 2.5% + imazethapyr 3.75% ME (PM) 125 g/ha PoE and weedy check. Further, fluazifop-p-butyl + fomesafen 250 g/ha PoE was also found phytotoxic to lucerne crop and showed burning effect on leaves of lucerne, however, which were recovered after 10 days of application **(Table 1.5.1)**.

Table1.5.1 Effect of treatments on fresh weight, length and seed yield of Cuscutain lucern at Anand (Gujarat)

Treatment	*Cuscuta* twines at 60 DAS		Seed yield of *Cuscuta* (g/m^2)	Green fodder yield at 75 DAS (t/ha)
	Weight (g/m^2)	Length (m/m^2)		
Pendimethalin 38.7% CS 680 g/ha PE	8.57 (72.7)	9.86 (96.3)	7.26 (51.8)	13.0
Pendimethalin 38.7% CS 680 g/ha at 10 DAS	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	22.8
Pendimethalin 30% + imazethapyr 2% EC (PM) 640 g/ha PE	1.00 (0.00)	1.00 (0.00)	1.00 ((0.00)	7.00
Pendimethalin 30% + imazethapyr 2% EC (PM) 800 g/ha PE	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	5.57
Imazethapyr10% SL 50 g/ha PoE	13.7 (189)	15.5 (245)	6.82 (45.6)	20.0
Imazethapyr 35% + imazamox 35% WG (PM) 70 g/haPoE	16.5 (275)	18.1 (333)	6.67 (43.5)	22.7
Fluazifop-p-butyl 11.1% + fomesafen 11.1% SL (PM) 250 g/ha PoE	14.5 (211)	15.7 (255)	6.81 (45.4)	12.7
Propaquizafop 2.5% + imazethapyr 3.75% ME (PM) 125 g/ha PoE	10.5 (108)	11.3 (129)	6.82 (45.8)	19.4
Weedy check	22.0 (486)	24.2 (588)	9.65 (92.4)	18.9
SEm ±	**0.782**	**1.20**	**0.199**	**2.17**
LSD (P=0.05)	**2.34**	**3.60**	**0.597**	**6.51**
CV %	**13.8**	**19.1**	**6.5**	**23.7**

Management of *Cuscuta* in berseem

In Gwalior conditions, all the tested herbicides significantly controlled the number of *Cuscuta* over weedy check in barseem. Density of Cuscuta emerged/m2 and fodder yield iu different cut/ plot are given in **Table 1.5.2**. The maximum *Cuscuta* density wasrecorded in weedy check. Among pre-emergence herbicides, the highest fodder yield was observed with the application of pendimethalin 500 g/ha at 10 DAS and it significantly suppressed the *Cuscuta* emergence up to 60 DAS *fb* the application of pendimethalin 500 g/ha as pre- emergence. The post-emergence application of imazethapyr 40g/ha after 1st cut *fb* imazethapyr 40 g/ha after last cut of green fodder effectively controlled the *Cuscuta campestris* and produced the maximum green fodder (67.22 t/ha) and seed yield (470.65 kg/ha) and it was at par with the post-emergence application of imazethapyr 40 g/ha after 1st cut (**Table 1.5.3**) .

Among the application of herbicides, the lowest green fodder yield (53.19 t/ha) and seed yield (237.68 kg/ha) was obtained where oxyflorfene 150g/ha was applied and maximum fodder yield (67.22 t/ha) and seed yield (470.65 kg/ha) was recorded where imazethapyr 40g/ha was applied after first cut *fb*imazethapyr 40g/ha after last cut of berseem and it proved significnalty superior over rest of the treatments and it was *at par with the application of* imazethapyr 40 g/ha after 1st cut of berseem. However the *Cuscuta* free treatment was given highest fodder and seed yield among all the treatments. The highest fodder yield (67.50 t/ha) and seed yield (492 kg/ha) with net monetory returns (Rs. 216581/ha) and BC ratio 5.28 was recorded in *Cuscuta* free treatment. However, among herbicide application, the maximum monetary returns (Rs. 212385/ha) and benefit cost ratio 5.27 was recorded with the application of imazethapyr 40g/ha after first cut *fb*imazethapyr 40g/ha after last cut which was best in terms of profitability. Terefore, it was concluded that among herbicides application, the imazethapyr 40g/ha after first cut *fb*imazethapyr 40g/ha after last cut provided the maximum fodder yield (67.22 t/ha) and seed yield (470.65 kg/ha) with BC ratio (5.27) *fb*imazethapyr 40 g/ha after 1st cut (66.39 t/ha) and (422 kg/ha) fodder and seed yield respectively (**Table 1.5.3**).

Table 1.5.2 Effect of different weed management practices on density of Cuscuta emerged/m² fodder yield (kg/plot) in berseem fodder crop during 2020-21

Treatment	Density of *Cuscuta* emerged/m²				Fodder yield (kg/plot)			
	30 DAS	60 DAS	90 DAS	120 DAS	I cut at 60 DAS	II cut at 90 DAS	III cut at 120 DAS	Total fodder yield in three cuts (kg/plot)
Pendimethalin 500g/ha (PE)	1.05 (0.67)	0.71 (0.00)	1.34 (1.33)	1.00 (0.67)	17.33	21.00	29.67	68.00
Pendimethalin 500 g/ha at 10 DAS	0.71 (0.00)	0.71 (0.00)	1.17 (1.00)	1.39 (1.67)	18.43	21.33	30.00	69.77
Oxyfluorfen 150g/ha (PE) (within 24 hours)	1.05 (0.67)	0.71 (0.00)	1.05 (0.67)	1.34 (1.33)	17.00	21.33	25.50	63.83
Imazethapyr 40g/ha after 1st cutting	1.86 (3.00)	1.68 (2.33)	0.71 (0.00)	1.68 (2.33)	24.00	23.00	32.67	79.67
Imazethapyr at 40 g/ha after last cut	1.77 (2.67)	1.77 (2.67)	2.04 (3.67)	1.76 (2.67)	23.67	21.83	31.67	77.17
Imazethapyr 40g/ha after 1st cutting *fb* imazethapyr 40g/ha after last cut	0.88 (0.33)	0.71 (0.00)	0.88 (0.33)	1.34 (1.33)	24.33	23.00	33.33	80.67
Pendi 500g/ha (PE) + imazethapyr 40g/ha PE	1.44 (1.67)	0.71 (0.00)	0.88 (0.33)	1.39 (1.67)	20.33	18.67	28.50	67.50
Imazethapyr + imazamox 50 g/ha POE	1.68 (2.33)	2.04 (3.67)	1.05 (0.67)	1.34 (1.33)	22.50	20.33	31.17	74.00
Cuscuta free	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	24.50	23.83	32.67	81.00
Cuscuta infested	2.34 (5.00)	2.48 (5.67)	2.04 (3.67)	2.04 (3.67)	16.50	21.33	22.83	60.67
SEm (±)	**0.143**	**0.048**	**0.151**	**0.206**	**1.065**	**0.753**	**1.425**	**2.147**
CD (5%)	**0.435**	**0.146**	**0.459**	**0.625**	**3.229**	**2.285**	**4.322**	**6.513**
Transfomation	$\sqrt{x+0.5}$	$\sqrt{x+0.5}$	$\sqrt{x+0.5}$	$\sqrt{x+0.5}$				

In Raipur, no infestation of *Cuscuta*was found under the treatments having pre-emergence application of herbicides *viz*. pendimethalin 1.0 kg/ha as PE, pendimethalin 1.0 kg/ha at 10 DAS as EPoE and oxyfluorfen 0.25 kg/ha as PE. Application of oxyfluorfen 0.25 kg/ha (PE) reduced the density of *Medicagodenticulata, Chenopodium album* and *Cichorium intybus*, other weeds and total weed density very effectively at 30, 60 DAS and at harvest. Using imazethapyr either at 0.04 kg/ha after first cut or at last cut and even imazethapyr at 0.04 kg/ha after 1[st]cutting *fb* imazethapyr at 0.04kg/ha after last cut had least effect on controlling weed density of *M.denticulata, C.album* and *C. intybus*. Whereas, pendimethalin 1.0 kg/ha as PE or at 10 DAS as EPoE have performed better to that of imazethapyr. However, imazethapyr at 0.04 kg/ha after 1[st] cutting *fb* imazethapyr at 0.04 kg/ha after last cut found better to control other weeds population as compared to pendimethalin 1.0 kg/ha as PE or at 10 DAS as EPoE.Treatment of oxyfluorfen 0.25 kg/ha (PE) registered lowest total weed dry weight at 30, 60 DAS and at harvest (106.78 g/m^2). Pendimethalin 1.0 kg/ha at 10 DAS as EPoE did also well and reduced the weed dry weight significantly as compared to imazethapyr at 0.04 kg/ha after last cutat all the stages **(Table 1.5.4)**. Significantly highest total green fodder yield (54.09 t/ha) and seed yield (0.23 t/ha) was registered with the application of oxyfluorfen 0.25kg/ha (PE) over rest of the treatments. The selective action of oxyfluorfen and effective early post-emergence control of weeds by pendimethalin 1.0 kg/ha at 10 DAS as EPoE might have better control of grassy as well as broad-leaves weeds resulted in poor crop-weed competition during critical crop growth period for moisture, nutrients and light which cause better growth of crop. The economics (net income and BC ratio) are presented in **(Table 1.5.5)**. Pre emergence application of oxyfluorfen 0.25kg/ha recorded maximum net return (Rs 74,708/ha) and B:C ratio (3.18) as compared to rest of the treatments. Next was Pendimethalin 1 kg/ha (EPoE) at (10 DAS) for net return (Rs 52,929/ha) and BC ratio (2.54). Imazethapyr at 0.04 kg/ha after last cut generated lowest net return of Rs 21695/ha with an ordinary BC ratio of 1.64 **(Table 1.5.5)**.

Table 1.5.4 Weed dry weight at 30, 60 DAP and harvest as influenced by weed management practices for problem weeds cuscuta in berseem, *Rabi* 2020-21

Treatment	Weed dry weight (g/ m²)			Green forage yield (t/ha)		
	30 DAP	60 DAP	At harvest	After 1[st] cut	After 2[nd] cut	After 3[rd] cut
Pendimethalin 1.0 kg/ha (PE)	2.39 (5.22)	4.96 (24.15)	11.08 (122.24)	13.58	18.83	17.80
Pendimethalin 1.0 kg/ha (EPoE) at (10 DAS)	2.57 (6.09)	5.19 (26.42)	11.47 (131.11)	13.58	18.50	17.62
Oxyfluorfen 0.25 kg/ha (PE)	1.99 (3.47)	4.55 (20.18)	10.36 (106.78)	15.83	19.83	18.42
Imazethapyr at 0.04 kg/ha after 1st cutting	3.29 (10.34)	6.32 (39.49)	12.68 (160.16)	11.58	16.83	18.04
Imazethapyr at 0.04 kg/ha after last cut	3.37 (10.89)	6.54 (42.30)	12.88 (165.29)	11.92	10.00	17.28
Imazethapyr at 0.04	3.33 (10.56)	6.38 (40.24)	10.50 (109.75)	11.75	17.58	15.76
SEm±	**0.05**	**0.03**	**0.01**	**0.35**	**0.57**	**0.25**
LSD (P= 0.05)	**0.17**	**0.08**	**0.05**	**1.13**	**1.82**	**0.80**

Table 1.5.5: Total green forage yield, seed yield and economics of berseem as influenced by weed management practices for problem weeds cuscuta in berseem, *Rabi* 2019-20

Treatment	Total green forage yield t/ha	Seed yield t/ha	Net income Rs/ha	BC Ratio
Pendimethalin 1.0 kg/ha (PE)	50.22	0.11	48170	2.40
Pendimethalin 1.0 kg/ha (EPoE) at (10 DAS)	49.70	0.14	52929	2.54
Oxyfluorfen 0.25 kg/ha (PE)	54.09	0.23	74708	3.18
Imazethapyr at 0.04 kg/ha after 1st cutting	46.46	0.09	40370	2.19
Imazethapyr at 0.04 kg/ha after last cut	39.20	0.04	21695	1.64
Imazethapyr at 0.04 kg/ha after 1st cutting fb Imazethapyr at 0.04 kg/ha after last cut	45.09	0.10	38166	2.07
SEm±	0.67	0.02	-	-
LSD (P= 0.05)	**2.13**	**0.06**	-	-

WP. 1.5.3. Management of *Cuscuta* in onion

In Coimbatore, early post-mergence application of fluazifop-p-butyl + fomesafen 250 g/ha (PM) followed by EPOE propaquizafop + imazethapyr 125 g/ha (PM) reduced the density of *Cuscuta chinenesis* as well its dry weight in onion.*Cuscuta chinenesis* control efficiency was higher with early post-emergence application of fluazifop-p-butyl + fomesafen 250 g/ha (PM) followed by EPOE propaquizafop + imazethapyr 125 g/ha (PM) at later stages of crop growth. Higher onion bulb yield with better control of *Cuscuta* was obtained with early post-emergence application of fluazifop-p-butyl + fomesafen 250 g/ha (PM) followed by EPOE propaquizafop + imazethapyr 125 g/ha (**Table 1.5.6**).

Table 1.5.6 Effect of treatments on *Cuscuta* density, dry weight, control efficiency (%) and onion yield (*Kharif* 2021)

Treatment	Density (No. / m^2)				Dry weight (g/m²)				*Cuscuta chinenesis* Control Efficiency (%)				Onion bulb yield t/ha
	Cuscuta chinenesis		Other weeds		*Cuscuta chinenesis*		Other weeds		Density basis		Dry weight basis		
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	
PE Pendimethalin 680 g/ha EPOE	10.8	14.3	3.4	15.8	6.81	10.38	4.10	18.78	49.8	39.4	54.0	52.1	12.54
Pendimethalin 680 g/ha at 10 DAS	13.0	23.8	17.6	20.8	8.22	15.39	20.85	24.69	24.3	8.5	30.3	47.9	12.78
PE Pendimethalin + imazethapyr 900 g/ha (PM)	26.4	15.8	3.6	12.9	9.24	13.99	15.08	16.52	63.1	60.8	66.4	69.7	17.01
EPOE Imazethapyr 50 g/ha	13.9	20.7	4.6	16.7	8.77	13.19	5.51	19.78	52.2	42.8	56.6	54.8	12.67
PE Imazethapyr + imazamox 70 g/ha (PM)	21.9	32.9	6.9	26.8	13.90	20.93	8.14	31.86	55.4	34.0	59.2	67.2	14.77
EPOE Fluazifop-p-butyl + fomesafen 250 g/ha (PM)	9.9	12.5	12.7	13.8	17.60	7.76	4.32	15.33	8.8	65.9	11.5	83.9	19.04
EPOE Propaquizafop + imazethapyr 125 g/ha (PM)	14.6	21.9	10.7	13.3	7.73	9.94	12.69	15.80	66.4	56.8	61.7	71.3	17.53
Weedy check	28.9	36.0	18.8	21.6	19.87	28.89	18.67	26.11	-	-	-	-	7.72
CD (P=0.05)	**2.3**	**3.1**	**1.8**	**2.1**	**3.43**	**5.66**	**2.93**	**4.85**	-	-	-	-	**9.75**

Management of *Orobanche* in tomato and brinjal

Tomato

In Udaipur, five demonstrations on management of *Orobanchae* in tomato through herbicide were conducted at Kantoda village of tehsil-Sarada. Sulfosulfuron and ethoxysulfuron applied as post-emergence at 30, 45, 60, 75 and 90 DAT were more selective to tomato and controlled the parasitic weed more effectively. No herbicide residues were observed in tomato fruits and soil at harvest. No residual carry over effect of these herbicides was observed on succeeding fodder sorghum crop planted one month after harvest of tomato crop. Data indicate that *Orobanchae* appeared only in untreated check. Excellent control of *Orobanchae* was obtained with sulfosulfuron 50 g/ha at 60 DAT *fb* 50 g/ha at 90 DAT and gave 105.06 % control of *Orobanchae* upto harvest (**Table1.5.7**)

Table 1.5.7 Performance of herbicides in terms of *Orobanche* control and yield of tomato

Treatment	*Orobanche* control (%)	Fruit yield (t/ha)	% Increase in yield over untreated check
Ethoxysulfuron 25 and 50 g/ha at 30 and 60 DAT	45 (40-50)	14.50	49.79
Ethoxysulfuron 25 and 50 g/ha at 45 and 75 DAT	53 (45-55)	18.56	91.74
Sulfosulfuron 25 g/ha at 45 DAT *fb* 50 g/ha at 70 DAT	50 (44-52)	18.05	86.47
Sulfosulfuron 50 g/ha at 60 DAT *fb* 50 g/ha at 90 DAT	59 (50-60)	19.85	105.06
Untreated check	0	09.68	-

Sale price (Rs./kg): Tomato- 10/kg

In Hisar, broomrape panicles were not appeared even up to 75 days after transplanting (DAT) in the treatments. Application of ethoxysulfuron 50 g/ha at 60 and 90 DAT, 45 and 90 DAT provided effective control of broom rape stalks (5.0-6.2 /m^2) as compared to untreatedcheck. 23.5 /m^2) at harvest. Application of sulfosulfuron at 50 g/ha at 60 and 90 DAT resulted in more phyto-toxicity to crop as compared to sulfosulfuron at 25 g/ha at 60 DAT *fb* 50 g/ha at 90 DAT. Similarly, the phyto-toxicity with ethoxysulfuron ranged between 10-12% at 20 DAT. Phyto-toxicity due to application of sulfosulfuron at 50 g/ha at 60 and 90 DAT also resulted in yield reduction. Maximum fruit yield (16.4 t/ha) was recorded from use of sulfosulfuron 25 g/ha at 60 DAT *fb* 50 g/ha at 90 DAT, which was at par with ethoxysulfuron 50 g/ha as 45 and 90 DAT and significantly higher than weedy check with 61.0 % increase over untreated check (**Table 1.5.8**).

Table 1.5.8 Effect of different weed control measures on broom rape (*Orobanche*) spikes, visual control, crop toxicity and fruit yield of tomato (2020-21)

Treatment	Number of broom rape spikes/m^2 Harvest	Visual phyto-toxicity (%) on crop 20 DAT	Visual broom rape control (%) Harvest	Fruit yield (t/ha)
Sulfosulfuron 25 g/ha as PRE and 60 DAT	3.0 (8.0)	8	60	11.3
Ethoxysulfuron 50 g/ha as 60 and 90DAT	2.7 (6.2)	10	75	15.9
Ethoxysulfuron 50 g/ha as 45 and90DAT	2.4 (5.0)	12.0	78	15.2
Sulfosulfuron 25 g/ha at 60 DAT *fb* 50 g/ha at 90DAT	2.3 (4.3)	15.0	80	16.4
Sulfosulfuron 50 g/ha at 60 and 90DAT	2.1 (3.3)	20.0	85	14.1
Handpulling	1.0 (0.0)	0.0	100	18.0
Untreatedcheck	5.0 (23.5)	0.0	0.0	7.0
SEm+	**0.21**			**0.38**
CD (p=0.05)	**0.63**			**1.20**

Brinjal

In Udiappur, five demonstrations on management of *Orobanchae* in brinjal through herbicide was conducted at Kantoda village of tehsil- Sarada. Farmers reported 40-70% loss in fruit yield due to its infestation in brinjal crop depending on intensity of infestation. A continuous increase in *Orobanchae* infestation in these areas has forced farmers to abandon brinjal cultivation and switch over to other profitable crops cultivation. Maximum fruit yield (21.40 t/ha) was obtained with post emergence use of sulfosulfuron twice 50 g a.i./ha at 60 DAT *fb* 50 g a.i./ha at 90 DAT and would be very helpful in reducing the *Orobanche* infestation and increasing brinjal yield by 104 % over untreated check (**Table 1.5.9**)

Table 1.5.9 Performance of herbicides in terms of *Orobanche* control and yield of brinjal

Treatment	*Orobanche* control (%)	Fruit yield (t/ha)	% Increase in yield untreated check
Ethoxysulfuron 15 g/ha at 30 and 60 DAT	49 (45-50)	13.70	37.00
Ethoxysulfuron 20 g/ha at 30 and 60 DAT	62 (55-65)	19.87	98.70
Sulfosulfuron15 g/ha at 30 and 60 DAT	57 (55-60)	18.54	85.40
Sulfosulfuron 20 g/ha at 30 and 60 DAT	67 (60-70)	21.40	104.00
Untreated check	0	10.00	-

Sale price (Rs./kg): Brinjal- 12/kg

Effect of arbuscular mycorrhizal fungi (AMF) in the management of *Orobanche*: a parasitic weed in tomato and tobacco

In Dharwad at 90 DAS, the highest numbers and dry matter of *Orobanche* was observed in un-inoculated control (UIC) plots (32.00/plot and 325.89 ng/plot), while lowest were recorded with the plots received STD AMF consortium (1.22/plot and 11.35 g/plot). Among the methods of application, the plot received precolonised seedlings with STD AMF and soil application of STD AMF recorded the lowest *Orobanche* emergence (**Table 1.5.10)** as well as weed dry matter compared to of the methods (1.44/plot and 17.83g/plot). (**Table 1.5.11**). The highest yield was recorded in the tomato plants received STD AMF consortium (9.25 kg/plot).Among the different methods of application, precolonised seedlings and soil application STDAMF recoded highest yield (9.04 kg/plot) (**Table 1.5.11**). The physiological (42.50-SPADvalue); mycorrhizal root colonization at 60 and 90 DAS (72.20% and 74.00%) and soil dehydrogenase activity at 60 and 90 DAS (41.59 and 44.93 µg TPF formed/g soil/ d) was influenceded with STD AMF compared to rest of mycorrhizal consortium. Among the methods of application, planting of precolonised seedling with STD AMF and soil application of STD AMF influenced the physiological (44.25); mycorrhizal root colonizationat 60 and 90 DAS (74.50 and 72.78 %) and dehydrogenase activity (41.63 and 46.65 µg TPF formed g^{-1} soil d^{-1}) (**Table 1.5.11, 1.5.12 and 1.5.13**).

Table 1.5.10 Effect of AMF fungal cultures on *Orobanche* emergence in tomato

Treatment	No. of *Orobanche* emergence (90 DAP)			
	Methods of application			
AM Funal consortium	**S1**	**S2**	**S3**	**Mean**
M1	2.00	5.33	0.67	2.67
M2	5.00	15.33	3.67	8.00
M3	0.00	3.67	0.00	1.22
Mean	2.33	8.11	1.44	
UIC				32.00
	S.Em±		**C D at 5 %**	
M	**1.86**		**7.29**	
S	**1.19**		**3.66**	
M at S	**2.50**		**8.88**	
UIC	**5.38**		**15.99**	

Table 1.5.11 Effect of AMF fungal cultures on dry biomass and yield tomato of *Orobanche* at 90 DAP

Treatment	Biomass (g/plot)				Yield (kg/plot)			
	Method of application				Method of application			
AM Fungi	**S_1**	**S_2**	**S_3**	**Mean**	**S_1**	**S_2**	**S_3**	**Mean**
M_1	24.32	53.50	9.73	29.18	6.48	4.99	7.38	6.28
M_2	43.78	150.78	43.78	79.45	4.23	4.26	7.18	5.22
M_3	0.00	34.05	0.00	11.35	7.99	7.19	12.56	9.25
Mean	22.70	79.45	17.83		6.23	5.48	9.04	
UIC				325.89				3.89
	S.Em±		**C D at 5 %**		**S.Em±**		**C D at 5 %**	
M	**0.59**		**2.31**		**0.10**		**0.41**	
S	**0.38**		**1.18**		**0.13**		**0.40**	
M at S	**0.80**		**2.83**		**0.21**		**0.70**	
UIC	**1.67**		**4.97**		**0.22**		**0.66**	

AM Fungi
M_1: UASDAMFT (tobacco native)
M_2: UASDAMFS (sugarcane native)
M_3: STD AMF
UIC: Un-inoculated control

Method of application
S_1: pre-colonized
S_2: soil application
S_3: pre-colonized + soil application

Table 1.5.12 Relative chlorophyll contentand AMF root colonization in tomato as influenced by AM fungi in tomato

Treatment	SPAD Reading							
	60 DAP				90 DAP			
	Method of application				Method of application			
AM Fungi	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
M_1	41.78	39.21	42.89	41.29	40.93	38.90	49.04	42.96
M_2	39.83	38.85	42.87	41.53	38.90	34.09	41.92	38.30
M_3	42.87	40.67	46.99	42.50	44.95	40.85	48.98	44.93
Mean	41.50	39.57	44.25		41.59	37.95	46.65	
UIC				36.82				31.79
	S.Em±		**C D at 5 %**		**S.Em±**		**C D at 5 %**	
M	**0.011**		**0.042**		**0.06**		**0.22**	
S	**0.027**		**0.084**		**0.04**		**0.13**	
M at S	**0.040**		**0.126**		**0.08**		**0.29**	
UIC	**0.048**		**0.141**		**0.09**		**0.28**	

Table 1.5.13 Dehydrogenase activity in tomato rhizosphere as influenced by AM fungi

Treatment	µg TPF formed g^{-1} soil d^{-1}							
	60 DAP				90 DAP			
	Method of application				Method of application			
AM Fungi	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
M_1	42.89	39.21	41.91	41.34	40.93	38.90	49.04	42.96
M_2	37.89	36.81	37.99	37.56	38.90	34.09	41.92	38.30
M_3	42.96	36.82	44.98	41.59	44.95	40.85	48.98	44.93
Mean	41.25	37.61	41.63		41.59	37.95	46.65	
UIC				32.82				31.79
	S.Em±		**C D at 5 %**		**S.Em±**		**C D at 5 %**	
M	**0.04**		**0.15**		**0.06**		**0.22**	
S	**0.03**		**0.08**		**0.04**		**0.13**	
M at S	**0.05**		**0.19**		**0.08**		**0.29**	
UIC	**0.06**		**0.18**		**0.09**		**0.28**	

WP 2 Management of weeds in non-cropped and aquatic areas

WP 2.1 Surveillance and management of new/ invasive/ quarantine weed

Monitoring of appearance of new weed species

PAU, Ludhiana observed that *Phalaris minor* continued to be the most problematic weed in wheat. In case of transplanted rice, *Fimbristylis* sp. and *Leptochloa chinensis* were recorded in select areas. In DSR, *Dactlyolctenum aegyptium, Leptochloa chinensis, Cyperus rotundus, Echinochloa colona* and *E. Crusgalli* continued to be problematic weeds. In *Egyptian* clover, *Cuscuta* sp. is on the increase. In summer vegetables, *Cyperus rotundus* is among major weeds and in early winter vegetable also this weed is becoming problematic.

RVSKVV, Gwalior did not record new weed species. In *Palampur Bromus sp*, *Galium aparine* and *Brija minor* were reported towards reproductive/ maturity stage of wheat after the satisfactory control of weeds with pre-emergence application of pendimethalin *fb* clodinafop + metsulfuron methyl was achieved during early stages of wheat growth. In Assam, *Arundo donax* L., the common environmental weed of non-cropped was found established in the deepwater paddy fields of Golaghat district, which is probably the first report of the weed in the cropland. *Mimosa diplotricha*, which was confined earlier only in Kaziranga National Park has been found throughout the state. *Tillandsia uaneoides* (L.) L. (Family: Bromaliaceae; common name: Spanish moss), an epiphytic weed mostly on citrus plantations was recorded in Tinsukia district. *Orobanche aegyptica* Pers. (family Orobanchaceae) was recorded from a new location of Dima Hasao other than Nagaon district. *dentatis* a new weed in wheat crop in Tarapur village of. TNAU did not report any new weed species, however increasing invasion of *Parthenium hysteroporus* was found in Coimbatore, Tirupur and Erode districts. followed by *Trianthema Portulacastrum* and *Euphorbia geniculata*.

PJTSAU, Hyderabad reported different weeds with GPS data, however no new weed species was observed in any of these fixed spots. CCSHAU, Hisar also did not observe any new species new weed species was found infesting the field crops in Haryana. PDKV, Akola reported heavy infestation of *Hyptis suoveolenc* (Ran Tulas) 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 on soybean and pigeonpea crop particularly in western Vidarbh districts which needs effective weed management technology.

MPUAT, Udaipur observed *Ipomoea trifida* as new weed during the survey particularly at later stage of crop growth that quickly covered the whole crop of maize and soybean and other crops. This became emerging problem of salumber and sarada tehsils of Udaipur. This weed infested at later stage therefore even Imazethapyr applied fields also observed this problem. *Commelina diffusa* in soybean became problematic and was not controlled by imazethapyr alone and even mixture of imazamox + imazethapyr. SKUAST, Jammu and BAU, Sabour did not record any new weed.



Biology and management of important weeds

KAU, Thrissur

Studied the biology and management of *Leptochloa chinensis.* Germination percent at different soil depths (at field capacity) showed maximum germination from surface soi, while 75 to 85 % was germinated from 2 cm depths**.** This weed was found to be resistant to bispyribac sodium and hence the continuous use of this herbicide in the rice fields of Kerala resulted in dominance of this weed among the graminacoeus weeds. Hence a study was conducted to study the effectiveness of various herbicides - both pre emergence and post emergence on *Leptochloa*.

Fenoxaprop-p-ethyl was the most effective herbicide against *Leptochloa chinensis* and resulted in 100% control of the weed at 30 and 60 DAS **(Table 2.1.1)**. This was followed by cyhalofop butyl and pretilachlor. The pre emergence herbicides pretilachlor, butachlor and oxyfluorfen were effective in controlling the germination and establishment of *Leptochloa chinensis* in the early stages of crop, as indicated by the data at 30 DAS. There was subsequent germination resulting in higher count of *Leptochloa* at 60 DAS and harvest stages of crop. Metamifop and azimsulfuron were not very effective against this weed.



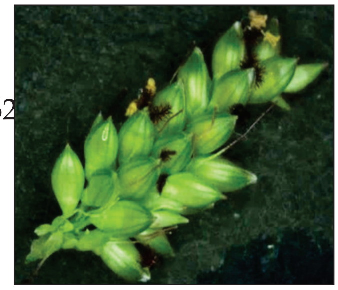
62



Table 2.1.1 Count of *Leptochloa chinensis* at 30 DAS, 60 DAS and harvest stage of rice (No./m²)

Treatment	30 DAS	60 DAS	Harvest
Butachlor	*0.71[g] (0)	5.06[g] (25.7)	4.16[f] (17.3)
Oxyfluorfen	0.71[g] (0)	5.77[f] (33.3)	4.0[f] (16.0)
Pretilachlor	0.71[g] (0)	4.65[h] (21.7)	2.89[g] (8.3)
Pyrazosulfuron ethyl	0.71[g] (0)	6.11[e] (37.3)	5.06[e] (25.7)
Azimsulfuron	3.65[c] (13.3)	7.98[d] (63.7)	6.11[d] (37.3)
Bispyribac sodium	4.69[a] (22.0)	10.33[a] (106)	7.53[a] (56.7)
Cyhalofop butyl	2.36[e] (5.7)	2.82[i] (8.0)	2.16[h] (4.7)
Fenoxaprop-p-ethyl	0.71[g] (0)	0.71[j] (0)	1.38[i] (2)
Metamifop	2.99[d] (9.0)	8.48[c] (72.0)	6.73[b] (45.3)
Penoxsulam	3.69[c] (13.7)	7.98[d] (63.7)	6.43[c] (45.3)
Handweeded control	1.22[f] (1)	0.71[j] (0)	0.71[i] (0)
Unweeded control	4.20[b] (17.7)	9.75[b] (95.0)	6.81[b] (46.3)
SEm±	**0.87**	**0.98**	**1.14**
CD (P - 0.05)	**1.69**	**1.79**	**2.06**

*$\sqrt{x+0.5}$ transformed values, Original values in parentheses.
In a column, figures followed by same alphabet do not differ significantly at 5% level in DMRT.
DAS – Days after sowing

The dry weight of *Leptochloa* (**Table 2.1.2**) was registered from 30 days after sowing (DAS) rice to harvest stage. At 30 DAS, the highest dry weight of Chinese sprangletop was registered in unweeded control (58 kg/ha). The treatments pyrazosulfuron ethyl, fenoxaprop-p-ethyl, oxyfluorfen, pretilachlor and butachlor were free of leptochloa, also the handweeded control. At 60 DAS, 574.2 kg/ha was the highest dry weight recorded in unweeded control followed by bispyribac sodium, with 417.6 kg/ha. *Leptochloa chinensis* was absent in fenoxaprop-p-ethyl and in hand weeded treatments. The dry weight of *Leptochloa chinensis* increased to 614 kg/ha in unweeded control at harvest stage of rice, followed by bispyribac sodium sprayed plot (527.7 kg/ha). Among the herbicides used, lowest dry weight was in fenoxaprop-p-ethyl with 10.2 kg/ha followed by cyhalofop butyl (48 kg/ha).

Table 2.1.2 Effect of herbicidal treatments on dry matter production (kg/ha) of *Leptochloa chinensis* at 30 DAS, 60 DAS and at harvest

Treatment	30 DAS	60 DAS	At harvest
Butachlor-50 EC	0	139.20[h]	186.40[h]
Oxyfluorfen-23.5 EC	0	185.60[f]	192.22[g]
Pretilachlor-50 EC	0	116.10[i]	96.00[i]
Pyrazosulfuron-ethyl-10 WP	0	173.03[g]	288.00[f]
Azimsulfuron-50 DF	23.30[c]	368.20[d]	336.0[e]
Bispyribac sodium-10 SC	34.80[b]	417.60[b]	427.70[b]
Cyhalofop-butyl-10 EC	11.60[d]	23.30[j]	48.00[j]
Fenoxaprop-p-ethyl-6.9 EC	0	0	10.20[k]
Metamifop-10 EC	23.40[c]	200.80[e]	432.50[d]
Penoxsulam-24 SC	23.80[c]	371.40[c]	477.40[c]
Handweeded control	0	0	0
Unweeded control	58.00[a]	574.23[a]	614.00[a]
SEm+	**1.51**	**1.50**	**1.64**
CD (P=0.05	**3.36**	**3.17**	**3.44**

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

At 30, 60 DAS and harvest (**Table 2.1.3**) the fenoxaprop-p-ethyl application was on par with handweeded control with 98 to 100% control of Chinese sprangletop. At 30 DAS, cyhalofop butyl showed 80% WCE followed by metamifop (60.1%) and azimsulfuron with 59.81%. The least WCE was with bispyribac sodium with 40.2%. At 60 DAS again handweeded control and fenoxaprop-p-ethyl showed 100% control of leptochloa followed by cyhalofop butyl (96%), but the least efficiency was with bispyribac sodium (27.3%) followed by penoxsulam (35.4%). At harvest, the highest WCE was handweeding (100%) followed by fenoxaprop-p-ethyl (98.33%) and cyhalofop butyl with 92.20%. The lowest WCE was recorded with bispyribac sodium with 24.1%.

Biology of weeds *Setaria barbata* was also studied in non-cropped area. Maximum germination was observed from surface area followed by 2 to 5 cm depth, however, no germination was found below 10 cm depth. General description on morphological characters of *Setaria barbata* were taken.

Biology of *Alternanthera bettzickiana* weeds of cropped area was studied. Germination was observed till one month and maximum germination (58.6) was found from surface followed by up to 5 cm depth (24%). Morphological characters of the weed was worked out

Management of *Sphagneticola trilobata* in non-cropped areas

Experiment conducted by KAU, indicated that many herbicides are effective against this weed and hence can be chosen depending on availability and cost of the herbicide. Tank mix spray of 2,4-D, 1.25 kg/ha + glyphosate 2 kg/ha resulted in 100% control of *Sphagneticola trilobata* and this treatment gave quick results and drying up of weed was observed within two weeks of spraying . Spraying glyphosate at 2 or 2.5 kg/ha, was also effective . However as action was slow and it took 25-30 days for drying up. Spraying combination product containing metsulfuron-methyl + chlorimuron-ethyl at the rate of 10.0 or 12.5 g/ha also resulted in 100 % control. Herbicide formulation containing metsulfuron- methyl alone, 10 g/ha also resulted in 100 % control of the weed. Compared to the above treatments, 2,4-D alone at 1.25 kg/ha was not very effective and resulted in only 80 % control. Same was the case with metsulfuron-methyl + chlorimuron-ethyl at 4.0 and 6.0 g/ha and Metsulfuron-methyl at 7.5 g/ha where 80% control was registered.

Table 2.1.3 Weed control efficiency of treatments with regard to *Leptochloa chinensis* 30 DAS, 60 DAS and at harvest

Treatment	WCE(%)		
	30 DAS	60 DAS	At harvest
Butachlor-50 EC	100	76.00[c]	69.64[d]
Oxyfluorfen-23.5 EC	100	67.70[e]	68.70[de]
Pretilachlor-50 EC	100	79.80[b]	84.40[c]
Pyrazosulfuron-ethyl-10 WP	100	69.90[d]	53.10[e]
Azimsulfuron-50 DF	59.81[b]	36.00[g]	45.30[f]
Bispyribac sodium-10 SC	40.20[d]	27.30[i]	24.05[i]
Cyhalofop-butyl-10 EC	80.00[a]	96.00[a]	92.20[b]
Fenoxaprop-p-ethyl-6.9 EC	100.00	100.00	98.33[a]
Metamifop-10 EC	60.10[b]	65.03[f]	29.60[g]
Penoxsulam-24 SC	59.00[c]	35.32[h]	32.25[h]
Handweeded control	100	100	100
Unweeded control	-	-	-

In a column, means followed by common letters do not differ significantly at 5% level by DMR

CSKHPKV, Palampur

Studied the biology and management of *Alternanthera philoxeroids* (Alligator weed). Stem and leaves: The stem of the weed often grow as runners along the ground surface. The sucker are present in the weed. This species has become a weed in the warmer temperate, subtropical and tropical region. The weed is better managed using metsulfuron methyl 4 g/ha. Marphological character of *Synedrella* were also studied

IGKV, Raipur

Conducted experiment on the management of *Alternanthera* spp particularly *Alternanthera triandra* which has made its serious presence in the field through out the season. All the weed management practices have their significant effect on the biomass of *Alternanthera triandra* and total weed biomass . Penoxsulam alone or mix with cyhalofop PoE significantly reduced the weed dry weight of *Alternanthera triandra* over weedy check, cyhalofop butyl 0.080 kg/ha PoE, fenoxaprop-p-ethyl 0.056 kg/ha PoE and pretilachlor 0.750 kg/ha PoE at 30 and 60 DAS. Penoxsulam alone or mix with cyhalofop PoE maintained its effect on weed dry weight upto at harvest and registered the significantly lowest value than the rest of the treatments except weed free treatment. Lowest dry weight of *Alternanthera triandra* (6.40 g/m^2) and total weed dry weight (12.39 g/m^2) was recorded under weed free treatment. Although, weed free treatment produced the highest grain yield (5.14 t/ha), and highest weed control efficiency (97.4%), penoxsulam + cyhalofop 0.135 kg/ha PoE produced significantly higher grain yield (4.78 t/ha) over rest of the weed management practices. Similarly, highest net return (Rs.71420/ha) accompanied by maximum B:C ratio (4.42) were also generated under the penoxsulam + cyhalofop 0.135 kg/ha PoE. Interestingly, despite of generating Rs 7358/- less to that of penoxsulam + cyhalofop 0.135 kg/ha PoE, the application of bispyribac sodium 0.025 kg/ha PoE (Rs 64362/ha) had just 0.20 less BC ratio (4.22) owing to the lesser cost of chemical **(Table 2.1.4)**.

Table 2.1.4 Test weight, seed yield and economics of rice as influenced by weed management practices in direct seeded rice, *Kharif* 2020

Treatment	Test weight (g)	Grain Yield (t/ha)	Net income Rs/ha	BC Ratio	WCE (%)
Pretilachlor 0.750 kg/ha PE	26.67	3.07	39656	2.99	48.7
Bispyribac sodium 0.025 kg/ha PoE	27.13	4.35	64362	4.22	61.6
Fenoxaprop-p-ethyl 0.056 kg/ha PoE	26.67	2.40	26715	2.34	44.8
Cyhalofop butyl 0.080 kg/ha PoE	26.00	2.15	21808	2.10	34.1
Penoxsulam + cyhalofop 0.135 kg/ha PoE	28.00	4.78	71720	4.42	71.0
Penoxsulam 0.022 kg/ha PoE	27.33	4.26	62221	4.04	66.8
Metsulfuron methyl 0.004 kg/ha PoE	27.00	3.77	53887	3.81	51.8
2,4-D ethyl ester 0.750 kg/ha PoE	27.00	4.14	60803	4.13	58.4
Weed free	27.17	5.14	71236	3.51	97.4
Weed check	25.70	1.15	4000	1.22	-
SEm±	**0.51**	**0.06**	-	-	-
LSD (P= 0.05)	**1.50**	**0.19**	-	-	-

Price of rice in Chhattisgarh: Rs. 19400/ per tonne

Management of problematic weeds like *Sorghum halepense*, *Alternanthera sessilis*, *Ipomea* spp. and *Cyperus rotundus* in sugarcane ratoon crop

GBPUAT, Pantnagar

Among the grasses, *Sorghum halepense* was completely controlled with the application of atrazine *fb* trash mulch (2000g, 8t/ha), whereas, *Eleusine indica* and *Bracharia* spp. with atrazine *fb* topramezone (2000&25 g/ha) and among the BLWs, *Ipomea* spp.with Atrazine 50WP + halosulfuron (PM) (2000+67.5 g/ha) and Sulfentrazone followed by either by 2,4-D EE 38 EC or MSM (720 *fb* 1000 or 4 g/ha). Lowest weed density of *Alternenthera sessilis* and *Trienthema monogyna* was observed with sulfentrazone *fb* 2,4-D EE 38 EC (720 *fb* 1000 g/ha) at par with Atrazine *fb* topramezone (2000 & 25 g/ha), whereas among the sedges, *Cyperus rotundus* with metribuzine+ halosulfuron (PM) (1000 + 675 g/ha).

The lowest total grassy weed density and dry weight was recorded under atrazine *fb* topramezone (2000&25 g/ha) which was at par with hoeing (3) and Sulfentrazone *fb* 2,4-D EE 38 EC (720 *fb* 1000 g/ha) with respect to total weed density and dry weight, respectively, whereas, lowest weed density and dry weight of BLWs and sedges was observed under sulfentrazone *fb* 2,4-D EE 38 EC (720 *fb* 1000 g/ha) and metribuzine+ halosulfuron(PM) (1000 + 675 g/ha), respectively. Sulfentrazone *fb* 2,4-D EE 38 EC (720 *fb* 1000 g/ha) was at par with sulfentrazone *fb* MSM (720 *fb* 4 g/ha) and atrazine *fb* topramezone (2000&25 g/ha) in terms of weed dry weight of BLWs.

Application of atrazine *fb* topramezone (2000 & 25 g/ha) recorded the highest cane yield (79.6 t/ha) which was at par with three hoeing (**Table 2.1.5**). Application of Atrazine *fb* topramezone resulted in highest gross returns (Rs./ha 298500) net returns (Rs./ha 186400) and benefit cost ratio (2.7) followed by three hoeing.

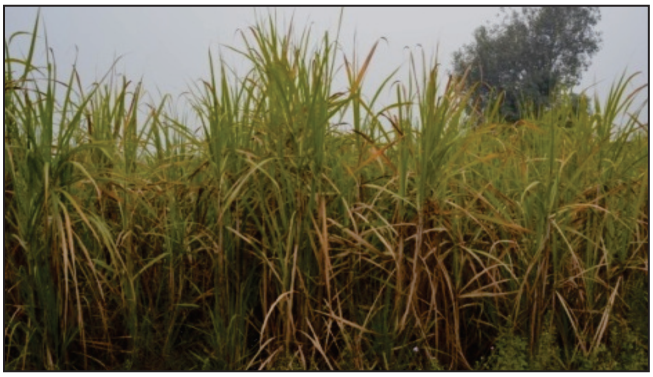


Table 2.1.5 Effect of treatments on yield attributes and yield of sugarcane

Treatment	Dose (g/ha)	cane length (cm)	cane weight (kg)	Millable cane (000/ha)	Cane girth (cm)	Cane yield (t/ha)
Trash mulch(8 t/ha)	-	227.7	0.633	68.9	6.7	44.6
Atrazine 50 WP *fb* Trash mulch(8t/ha)	2000	233.7	0.675	75.4	6.9	51.0
Atrazine *fb* topramezone	2000 & 25	266.5	0.875	89.8	7.1	79.6
sulfentrazone *fb* 2,4-D EE 38 EC	720 & 1000	258.7	0.858	77.3	6.9	69.2
Sulfentrazone *fb* MSM	720 & 4	242.7	0.842	80.2	6.7	65.8
Atrazine 50WP + Halosulfuron(PM)	200+67.5	233.7	0.717	74.9	7.1	56.5
Metribuzine+ Halosulfuron(PM)	1000+67.5	236.3	0.775	69.2	6.9	54.9
3 Hoeing	30,60 & 90 DAR	252.0	0.874	77.6	7.1	73.3
Unweeded control	-	228.2	0.662	56.2	6.5	38.3
SEm ±		**3.9**	**0.0**	**3.9**	**0.1**	**2.7**
C.D. (P=0.05)		**11.8**	**0.1**	**11.8**	**0.2**	**8.3**

Taxonomic and phyto-geographic assessment of invasive and other problem weeds

AAU, Jorhat

AAU, Jorhat started the study to develop taxonomic criteria for field identification of problem weed flora and to monitor phyto-geographic distribution of invasive and resident problem weed species. Targeted weeds were (I) Ironweed (*Vernonia* spp.) and its relatives of NE India (ii)Hitch hikers (*Desmodium* spp.) of Assam

Vernonia (*sensu lato*): Mostly because of covid related restrictions, survey activity around NE Region was highly limited; despite of that three common weedy species belonging to earstwhile *Vernonia* genus were identified and studied during 2020 and 2021. Collected specimens when critically identified, found to belong to three species, under two genera, namely *Cyanthillium* and *Vernonia* (*sensu stricto*).

1.1 Cyanthillium cinereum (L.) H. Rob. **Synonyms:** ConyzacinereaL.**;** Vernonia abbreviata DC.**;** Vernonia arguta Baker**;** Vernonia betonicaefolia Baker**;** _Vernoniacinerea (L.) Less. Annual erect herb, with conspicuously ribbed grayish pubescent branches. Leaves alternate, lanceolate or ovate to broadly ovate, puberulous to villous; apex acute to acuminate or obtuse, base attenuate. Inflorescences are corymbose panicles of 5-6mm long capitula. Florets 18-20 per capitula, purple or white. Cypsela 1.5-1.8mm long; pappus persistent, biseriate, white or fulvous bristles. A highly frequesnt facultative weed of upland crops, also common in road sides, gardens, and other disturbed land of upland and marshland situations. Collection locality were Disangmukh, Sivasarar district; Kulhati, Kamrup district; Jilangso, Karbi Anglong district.

1.2 Vernonia saligna DC. Synonyms: Acilepissaligna (DC) H.Rob.; Cacaliasaligna Kuntze; Conyzalaetahort. calc. ex C.B. Clarke; Conyzasaligna Wall. Collection locality: Garbhanga and Basistha, Kamrup district; Amsoi, Nagaon district.

1.3 *Vernonia silhetensis* (DC.) Handel-Mazzetti. Synonyms: *Acilepis silhetensis* (DC.) H.Rob.; DecaneurumsilhetenseDC.; Gymnanthemumglabrum(DC.) Sch. Bip. ex Waip.; Gymnanthemumsilhetense (DC.) Sch. Bip. ex Walp.

Collection locality: Garbhanga and Rani, Kamrup district.

***Desmodium* of Assam:** Altogether 14 numbers of species have been identified in the state. The study revealed that the species belonged to the genus *Desmodium* (*sensu lato*) so far collected from different parts of Assam, represented altogether four genera, namely i. *Codorocalyx,* ii. *Desmodium* (*sensu stricto*), iii. *Ohwia* and iv. *Tadehagi.* Because of presence of sticky lomentum (fruit) caused by dense hooked hairs in most of the species, these weeds are commonly named as "*Biyoni haputa*" in Assamese. The check list is presented in the Table 2.1.7 showing their presnt day accepted scientific names and phyto-geographical distribution in India **(Table-2.1.6)**.

Dinsinguishing characters of *Desmodium* (*sensu lato*): Leguminous herbs or shrubs with tri- or uni-foliate leaves. Flowers small, papilionaceous, usually in simple or branched racemes.Legumes are flat and of several 1-seeded joints (Lomentum), usually indehiscent, or in some dehishing along the lower suture. Seeds are reniform and without strophiole.

Taxonomic Key for identification:

1a. Petioles winged ………………….2

1b. Petioles never winged ………..4

2a. Petiole wings rather large and foliacious …..…….. 3 (***Tadehagi***)

2b. Petiole wings narrow ……….…… ***Ohwia caudata*** (Thunb.) H. Ohashi

3a. Stem ascending. Leaflets 3–10 × 1.5–5.0 cm, usually less than three times longer than breadth, lateral nerves 7-11 on either side, not reaching margins but arching and joining together. Legume densely white pubescent on both sutures, entirely glabrous and reticulate veined on lateral surfaces ………………………………… ***Tadehagi pseudotriquetrum*** (DC.) H. Ohashi

3b. Stem erect. Leaflets 6–13 × 1.1–3.5 cm, usually more than three times longer than breadth, lateral nerves 8-19 on either side, usually much arched. Legume densely yellowish or whitish strigose, not reticulate veined ………………… ***Tadehagi triquetrum*** *(L.) H. Ohashi*

4a. Legume not jointed, many seeded, dehiscent along lower suture ……..… 5 (***Codoriocalyx***)

4b. Legume jointed; lomentum 1-seeded, usually indehiscent, sometimes dehiscing along lower suture ………. ………………. 6 (***Desmodium*** *senu stricto*)

5a. Terminal leaflet narrowly elliptic or lanceolate. Pods glabrescent ……......……….. ***Codoriocalyx motorius*** (Houttuyn) H. Ohashi

5b. Terminal leaflet obovate or elliptic. Pod densely hairy …………………..***Codoriocalyx gyroides*** (Roxb. ex Link) Hassk.

6a. Leaf unifoliate by reduction of lateral leaflets……… 7

6b. Leaf trifoliate or both uni-and trifoliate …… 9

7a. Leaves ovate-lanceolate to oblong-elliptic, abaxial surface glabrous or glabrate, base acute, apex acute to acuminate, never mucronate …………… ***Desmodium gangaticum*** (L.) DC.

Table 2.1.6 List of earstwhile *Desmodium* species recorded in Assam, and their phyto-geographic distribution in India

S.N.	*Desmodium* species	Present Accepted name	Distribution in India	Remarks
1	*D. gyroides* Roxb. ex Link	Codoriocalyx gyroides (Roxb. ex Link) Hassk.	Throughout E & NE India	Common in riverine grasslands and fringe areas of forests as facultative weeds of croplands.
2	*D. gyrans* (L f.) DC	*Codoriocalyx motorius* (Hout.) H. Ohashi	NER, Eastern & North India, Tamilnadu	
3	*D. dioicum* (D Don) DC.	*Desmodium confertum* DC.	Arunachal, Sikkim, Assam, WB, Meghalaya, Uttarakhand	Weedy in regenerating forests and croplands of forest margins
4	*D. cavaleriei* H. Lév,	*Desmodium gangeticum* (L.) DC.	Throughout the country, except Rajasthan & Kashmir	A common facultative weed in shaded uplands and marshyland crops fields
5	*D. griffithianum* var. *leiocarpum* Gao & Chen	*Desmodium griffithianum* Benth.	Assam, Tripura Meghalaya	Grassy slopes, roadsides, forests floor, upland crop fields.
6	*D. triflorum* (L.) DC. var. *major* Wight *et* Arn.	*Desmodium heterophyllum* (Willd.) DC.	NE and South Inidia	A facultative weed of upland crops, adapted to high rainfall regions.
7	*Desmodium parvifolium* DC.	*Desmodium microphyllum* (Thunb.) DC.	Almost throughout the country	Common amidst the grasses up to an elevation of 1000 m
8	*D. floribundum* (D. Don) Sweet ex G. Don	*Desmodium multiflorum* DC.	NER to Kashmir, Himachal, Punjab, UP, MP, E. India, Tamilnadu	A common weed in plantation crops; usually occurs in jungles along the sides of upland crops, roadsides and foothills.
9	*D. retroflexum* (L.) DC.	*Desmodium styracifolium* (Osb.) Merr.	Assam, Meghalaya, *Kerela, Tamil Nadu*	*A facultative weed in plantations and other upland crops and in roadsides*
10	*D. triflorum* (L.) DC.	*Desmodium triflorum* (L.) DC.	Almost throughout the country	Most common in dry, disturbed sites, wastelands, grasslands, roadsides, riversides, sandy soils
11	*Desmodium latifolium* (Roxb. ex Ker.) DC		Tamilnadu, Andhra Pradesh, Orissa, NER	Facultative weeds in shifting cultivation, several upland crops and plantation crops. Also occurs in grasslands and roadsides
12	*D. caudatum* (Thunb.) DC.	*Ohwia caudata* (Thunb.) H. Ohashi	Himalaya, W. ghat, NER	
13	*D. pseudotriquetrum* DC.	*Tadehagi pseudotriquetrum* (DC.) H. Ohashi	Almost throughout the country	
14	*D. triquetrum* (L.) DC.			

7b. Leaves broadly ovate or orbicular or broadly obovate, abaxial surface sericeous or villous, base rounded or truncate, apex acute or obtuse and often mucronate ………… 8

8a. Leaves orbicular to broadly abovate, apex rounded or emerginate. Standard petal mucronate at apex …………… ***Desmodium styracifolium*** (Osb.) Merr.

8b. Leaves (broadly-)ovate, apex acute or obtuse and mucronate, never emerginate. Standard petal rounded at apex ……….… ***Desmodium velutinum*** (Willd.) DC.

9a. Creeping or ascending herbs. Stems stoloniferous. Most of the leaves less than 2.5 cm long …………………...…………………..… 10

9b. Erect herbs, undershrubs or shrubs. Stems never stoloniferous. Leaves more than 2.5 cm long ……………………. 13

10a. Inflorescence 6-10 flowered racemes. Terminal leaflet mucronate at apex ……….……. 11

10b. Inflorescence 1-3 flowered racemes or flowers solitary. Terminal leaflet more or less emerginate …………………………… 12

11a. Stamens monadelphous. Both the sutures of legume shallowly indented…………………. ***Desmodium microphyllum*** (Thunb.) DC.

11b. Stamens diadelphous. Abaxial suture of legume deeply indented, upper suture straight ……. …………….…… ***Desmodium griffithianum*** Benth.

12a. Terminate leaflet broadly ellipict or broadly obovate, 10-18(-30) mm long. Pedicel 6-25 mm long. Lomentum broadly oblong or quadrate ………… ***Desmodium heterophyllum*** (Willd.) DC.

12b. Terminal leaflet obcordate or obtriangular or obovate, 2.5 to 10 mm long. Pedicel 5-8 mm long. Lomentum orbicular ……………………… ***Desmodium triflorum*** (L.) DC.

13a. Legumes 2-4 jointed. Lomentum 2-3 times longer than broad: ***Desmodium confertum*** DC.

13b. Legumes 4-10 jointed, Lomentum up to twice as long as broad ..………….. ***Desmodium mutiflorum*** DC.

Integrated management of problematic weed *Parthenium hysterophorus* in university campus to achieve status of Parthenium free campus.

In view of the seriousness and magnitude of the threat posed by Parthenium weed, all the 17 AICRP-Weed Management centers located in different states organized different activities during 16th *Parthenium* Awareness Week (PAW)" from 16-22 August, 20122 on the appeal of ICAR-Directorate of Weed Research**.** All the scientists of AICRP-WM centers also attended 'National training programme organised by ICAR-DWR on 19 August, 2021 during Parthenium Awareness Week, 2021.

All the AICRPWM centers organized many activities like online lectures, webinars, photo exhibitions, farmers' meetings, students' rallies, uprooting of Parthenium, releasing and distribution of Parthenium eating beetle, demonstrations on management *etc*.. Such awareness activities attracted print and electronic media to publish news and telecast on different news channels. Awareness was also made using social media platforms like Youtube, facebook, WhatsApp etc.

In Northern region of the country, universities like SKUAST, Jammu; GBPUAT, Pantnagar; CSKHPKV, Palampur; CCSHAU, Haryana; and PAU, Ludhiana organized various awareness programmes in collaboration with Krishi Vigyan Kendras, colleges and schools**.** Village Mansuran (Ludhiana) continued to be maintained as *Parthenium* free village with support of villagers and AICRP personnel. In central India, IGKVV, Raipur and RVSKVV, Gwalior observed the week in collaboration with schools and colleges and KVks. In Southern India, all the AICRPWM centers like PJTSAU, Telangana, Hyderabad; TNAU, Coimbatore; KAU, Kerala; and University of Agricultural Sciences, Bengaluru, From the western part of India, awareness programmes were organized by AICRPWM of AAU, Anand; MPUAT, Udaipur; Dr. PDKV, Akola. In North-Eastern region of the country, programmes were organized by Assam Agricultural University, Jorhat; Bidhan Chandra Krishi Vishwavidhyalya, Mohanpur; Orissa University of Agricultural and Technology, Bhubaneswar, in collaboration with KVKs, schools and colleges in the region.

Mass rearing and distribution of *Zygogramma bicolorata* to stakeholders

Mass rearing of the Mexican beetle has been started at IGKVV, Raipur, MPUAT, Udaipur, OUAT, Bhubaneshwar.

WP 2.2 Weed flora shift under changing climatic scenario

PAU, Ludhiana

A long-term field experiment to study the effect of tillage and residue management practices on shifts in weed flora and productivity of rice-wheat system was started in *Kharif* 2018. As compared to previous year 2019-20, shift in weed flora was recorded. MB plough treatment had the highest density of *P. minor;* in 2019-20, this treatment had the lowest *P. minor* density at 30; in 2019-20 it was recorded at 60 days stage; it was highest under continuous ZT. In rice, as compared to previous year there was shift toward *Echinochloa colona, Cyperus rotundus, C. Compressus* and *Ammania baccifera* **(Table 2.2.1)**.

Table 2.2.1 Weed flora shift in wheat under different tillage and residue management practices.

Weed species	
2018-19	**2020-21**
Phalaris minor	*Phalaris minor*
Rumex dentatus	*Rumex dentatus*
Anagallis arvensis	*Anagallis arvensis*
Coronopusdidymus	*Coronopusdidymus*
Medicago denticulata	*Medicago denticulata*
-	*Avena ludoviciana*

RVSKVV, Gwalior

The second phase of long-term field experiment on "Weed management in pearlmillet-mustard-cowpea cropping system under conservation agriculture" was started during *Kharif* 2018 with 5 different tillage practices and 3 weed management practices. In pearlmillet, in 2019 the *Cynodon dactylon* was not seen in the experimental trial up to 30 DAS but in 2020 it was observed from the initiation of the crop. In 2021, the *Cynodon dactylon* was emerged, but density was very less. Similarly the *Brachiaria reptance* was not germinated up to 30 DAS in the experimental trial excecuted in 2020 but after 30 DAS it was emerged in different treatments. Whereas, the *Acrachne racemosa* was not seen at 60 DAS during both the years in the experimental trial. In Mustard, the main weeds observed at the experimental site were *Phalaris minor, Spergula arvensis* and *Cynodon dactylon* as grasses and *Chenopodium album, Anagallis arvensis, Convolvulus arvensis* and *Medicago hispida* as major broad leaved weeds. C*yperus rotundus* was most dominating sedge among all weeds

AAU, Anand

Argemone Mexicana was reorted during survey work and farmers field visit, high weed intensity of *Argemone mexicana* infestation was observed in different parts of Gujarat. *Argemone mexicana* flourished after harvesting of *Rabi* crops and entering in new cultivated field as new emerging weed in Gujarat. In many areas of different districts of Gujarat weed flora shifted towards monocot weed like *Phalaris minor* in wheat fields due to continuous use of 2, 4-D or MSM to manage dicot weeds. Escape incidence of monocot weed *Commelina benghalensis* after application of pendimethalin 750-1000 g/ha in cotton, greengram, soybean were observed at farmers and research farms. Escape of dicot weed *Digera arvensis* and *Phyllanthus niruri* was also observed in the research farm as a result of pre-emergence application of pendimethalin 750-1000 g/ha in cotton, greengram and soybean crops.

TNAU, Coimbatore

Weed shift was monitored in the ongoing permanent herbicide trial with rice- rice cropping system. *Echinocloa crusgalli* and *Leptochloa chinensis* were the dominant species in grasses, *Ludwigia parviflora* was the dominant in broad leaved weeds, where as *Cyperus iria and Cyperus nudans* under sedges present in the field in both *rabi* and *kharif* 2021 of 10^{th} crop in the long-term herbicidal trial rice-rice system.Hence, it is concluded that, after 10^{th} rice in the rice – rice cropping system, there is no shift in weeds.

PJTSAU, Hyderabad

A survey was conducted in villages in NSP left canal command area during *Kharif* 2021. Following weed species were identified as predominant weed species in farmers rice fields.*Leptochola chinensis* is a new emerging weed of economic importance in rice fields, especially in DSR fields. Predominant weed flora observed in groundnut crop were **BLWs:** *Ageratum conyzoides, Cleome viscosa, Tridax procumbens, Physalis minima, Amaranthus* spp: **Grasses:** *Dactyloctenium aegyptium, Cynodon dactylon,* **Sedges:** *Cyperus rotundus*

CCSHAU, Hisar

Weed surveillance was carried out in Hisar, Rohtak, Sonipat, Kaithal, Karnal, Jind, Bhiwani districts during *Rabi* 2020-21. The infestation of *Polypogon monspeliensis* (Loomar ghas) was on rise in the area particularly low lying fields. Based on the observations recorded from farmers' interviews and experiments being conducted at farmers' fields, greenhouse bioassay studies, it seems that *P. minor* has developed cross resistance against clodinafop-propargyl, sulfosulfuron and pinoxaden. The control of *P. minor* was good in Hisar district, while the control was poor in Rohtak, Sonipat, Kaithal and Karnal area. Mustard crop was severely infested with parasitic weed. In different parts of Haryana, *Coronopus didymus* is emerging as a major weed in fodder berseem affecting the fodder quality as well as the yield of the crop. *Dactyloctenium aegyptium*, Echinochloa sp., *Leptochloa chinensis* were major weed in both direct seeded rice and transplanted rice. Infestation of *Leptochloa chinensis* in both direct-seeded rice and transplanted rice is increasing.Wild rice (*Oryza rufipogon*) was not observed in any of the rice growing districts.Infestation of *Ipomoea* sp. is also increasing in cotton. In rainfed area, *Rhynchosia* sp. infested the crops like mungbean, clusterbean and other pulse crops causing yield losses to a greater extent. In groundnut, *Digera arvensis* was also a major MPUAT, Udaipur monitored the weed shift in maize- wheat cropping system, the data presented in **(Table 2.2.2)**.

Table 2.2.2 Weed shift in maize- wheat cropping system

Season	Weed status at 2016-17 in maize wheat cropping system	Weed status at 2021-22 in maize wheat cropping system
Kharif	*Monocots* *Echinochloa colona (33.7%), Dinebra retroflexa (30.2%), Commehina bengalensis (11.6%),* *Dicots* *Digera arvenris (9.6%), Trianthema partulacafram (8.8%) and Corchorus olitorious* (6.1%) at 30 DAS	*Monocots* *Echinochloa colona (31.9%), Dinebra retroflexa (16.4%), Commelina benghalensis (09.3%),* *Dicots* *Digera arvenris (20.3%), Trianthema partulacastrum (18.0%) and Corchorus olitorious* (4.1%).
Rabi	*Monocots* *P. minor* (39.6%) and *A. ludoviciana* (12.9%), Dicots *C. album* (21.6%), *C. murale* (4.1%), *Convolvulus arvensis* (4.6%), *Fumaria parviflora* (7.0%) and *Melilotus indica* (10.2%)	*Monocots* *Phalaris minor(8.4%) and Cynodon dactylon* (3.5%). Dicot *Chenopodium album(6.3%), Chenopodium murale(14.3%), Melilotus indica(4.2%), Malwa parviflora(43.6%)., Sonchus oleraceus (7.2%), Coronopus didymus* (5.6%)

SKUAST, Jammu observed increased density of *Medicago* spp. in ZTDSR-ZTW with or without residue in wheat as compared to CTTPR-CTW.

WP 2.3 Management of aquatic weeds

Biological control of water hyacinth by *Neochetina* spp.

At MUAT, Udaipur, there was no significant built up in the population of the weevil on water hyacinth and scars developed on 10-20% portion of the leaf sheath. Complete defoliation and plant mortality was not observed; however, it suppressed the growth of water hyacinth. After successful biological control of water hycienth in one big water body, RVSKVV, Gwalior released the weevils in another pond in 2019. Before release of the weevils, five random samples were taken to measure the density of water hyacinth by the quadrate (1x1m) and subsequent population build-up. The population of bio-agent was very less in the month of March, 2021. The feeding scars and dieback symptoms were also very less in each leaf and found 0-10 on an average. However, the population of bio-agents increasing as compare to last six months. Dieback symptoms on leaves had also been increased. PAU, Ludhiana observed low level beetle build up and no damage to leaf tissues. AAU, Anand released the bioagent in one perennial pond at village Sadanapur, Taluka Anand. In 2019. There were gradually built up of the population of the weevil on the water hyacinth during and feeding scars were observed on the water hyacinth leaves/plant in December 2021. Some dieback symptoms were also recorded on the water hyacinth plants (0 scale) by the weevil. IGKV, Raipur released the bioagent in pond at at Kachna, Raipur on 12 January 2022.

SKUAST, Jammu observed only average 17-24 feeding scars/leaf were observed and only few die back symptoms were also observed. *Neochetina* spp caused 5-10% die back symptoms in water hyacinth infested pond at Tanda village. PJTSAU observed low population (1.0 to 1.8 weevils/10 plants). Hence to augment the existing populations, we have initiated rearing of weevils in water tanks constructed at AICRP on Weed Management. The weevils are being reared, and they were released into the tanks.

Multiplication of Neochetina

WP 2.4 Utilization of weeds

Utilization of weeds for composting using microorganism (collaboration with Agril. Microbiology department)

AAU, Anand started an experiment with 8 different types of weeds at flowering stage. Anubhav Microbial Bio decomposer Consortium I (AMBC-I) 1.0 lit/ton was used along with the fresh cow dung in each pit 20 kg/100 kg of biomass. Common turning at every 15 days after filling the pit was carried out and 50-60 % moisture in the pit was maintained. After completion of each cycle, surface soil from pits was removed. Weed seed bank study was carried out in trays (1.5 kg compost/tray). The results presented in **Table 2.4.1** revealed that application of AMBC-I along with 20% fresh cow dung reduced decomposing days from 90 to 75 in *Digera arvensis* and *Amaranthus spinosus,* 90 to 60days in *Parthenium hysterophorus* and 75 to 60 days in *Trianthema monogyna* as compared to only cow dung. Among the treatments, all the weed species recorded minimum number of seed germinated in treatments receiving cow dung (20%) along with AMBC-I (1 l/t) as compared to only cow dung except *Trianthema monogyna.* Cow dung (20%) along with AMBC-I (1 l/t) applied to *Trianthema monogyna* recorded maximum number of seeds germinated (1720) as compared to all other treatments with or without AMBC-I whereas, no seed germination in *Parthenium hysterophorus* with cow dung (20%) along with AMBC-I (1 l/t) was noticed under weed seed bank study. In general treatment receiving cow dung (20%) along with AMBC-I (1 l/t) of *Parthenium hysterophorus* weed biomass shown outstanding performance on decomposition rate as well as chemical properties of composted material **(Table 2.4.2)**.

Table 2.4.1 Effect of treatments on days to degradation of weed biomass, C: N, recovery% and weed seed bank

Sr. No.	Treatment Details	Days to degradation after filling the pit	C: N		Recovery %*	Viable weed seed (No./tray)
			Initial	Harvest		
T_1	*Digera arvensis*	90	55.8	23.8	30.3	85.0
T_2	*Parthenium hysterophorus*	90	53.6	24.0	34.0	227
T_3	*Amaranthus spinosus*	90	52.4	24.0	33.7	143
T_4	*Trianthema monogyna*	75	53.7	25.6	30.3	1002
T_5	T_1 + Microbial consortium	75	55.6	18.1	37.0	66.0
T_6	T_2 + Microbial consortium	60	50.8	16.0	43.7	0.00
T_7	T_3 + Microbial consortium	75	52.5	16.8	38.7	135
T_8	T_4 + Microbial consortium	60	53.1	18.0	35.0	1720
S.Em. ±		**-**	**2.97**	**1.94**	**1.03**	**-**
CD at 5 %		**-**	**NS**	**5.83**	**3.10**	**-**
CV %		**-**	**9.61**	**16.20**	**5.07**	**-**

* At harvest after removing undegraded biomass debris.

Table 2.4.2 Effect on chemical properties of degraded material

Sr.No.	Treatment Details	OC (%)	N (%)	P (%)	K (%)	pH (1:10)	EC (dS/m) (1:10)
T_1	*Digera arvensis*	23.4	0.99	0.113	0.89	6.16	0.043
T_2	*Parthenium hysterophorus*	24.8	1.05	0.102	0.89	6.18	0.035
T_3	*Amaranthus spinosus*	23.7	1.01	0.113	0.93	6.10	0.046
T_4	*Trianthema monogyna*	25.5	1.02	0.108	1.08	5.93	0.045
T_5	T_1 + Microbial consortium	21.4	1.20	0.139	1.62	6.67	0.060
T_6	T_2 + Microbial consortium	19.4	1.22	0.140	1.88	6.69	0.052
T_7	T_3 + Microbial consortium	19.3	1.16	0.131	1.16	6.61	0.063
T_8	T_4 + Microbial consortium	20.5	1.14	0.120	1.27	6.44	0.062
S.Em.±		**0.94**	**0.09**	**0.01**	**0.08**	**0.27**	**0.00**
CD at 5%		**2.82**	**NS**	**0.02**	**0.25**	**NS**	**0.01**
C.V. %		**7.3**	**13.6**	**9.9**	**12.1**	**7.5**	**9.6**

WP 3 Fate of herbicide residues in different ecosystems

WP 3.1 Assessment of herbicide residues in the long-term experiments and farmer's fields

PJTSAU, Hyderabad

Herbicide residues in cotton- maize-green manure conservation agriculture were studied.

A field study was initiated at College farm, Rajendranagar, Hyderabad on conservation agriculture in cotton (*Kharif, 2021*) – maize (*Rabi 2020-21*) – *Sesbania* green manure (summer) cropping system to study the influence of herbicides on soil properties and also to assess the carryover of the herbicide residues, Diuron, pyrithiobac-sodium, atrazin, quizalofop-p-ethyl herbicides were applied to the cotton crop, the impact of herbicides on soil enzyme activity and the microbial population was assessed after herbicide application, flowering stage and harvest of the crop. along with the herbicide persistence, the impact of tillage and weed management practices on soils properties was also initiated, no significant changes in soil physico-chemical properties were recorded as impacted by different tillage and weed management options after the cotton crop's harvest. The interaction of tillage and weed management practices was also non-significant.

Atrazine residues were determined on GC-FTD. Diuron residue in soil was determined by using HPLC-UV. LOD and LOQ reported for diuron was 0.0165 µg/g and 0.05 µg/g respectively. Pendimethalin residues in soil was quantified by GC-ECD. At 4 hours after herbicide application, initial residues of atrazine varied from 0.403 to 0.412 µg/g in the soil samples. In the final soil sample, and maize grain/ plant samples collected at the time of harvest, the atrazine residues were below the detection limit of 0.05 µg/g in all the soil samples **(Table 3.1.1).**

Soil enzymatic activity

Soil dehydrogenase activity (DHA) was assessed at 5, 15 days after pre-emergence herbicide application, 30 days after pre-emergence herbicide application, flowering and harvest stages. The DHA increased gradually from sowing up to the crop's flowering stage, which later on decreased at harvest of the crop. Tillage treatments did not significantly influence DHA at any crop growth stage. However, DHA was significantly influenced by the different weed management adopted. At 5 and 15 DAA (PE) the DHA decreased significantly in all the treatments where atrazine was applied as a pre-emergence herbicide. The negative effect of post-emergence herbicide was evident from the significantly lower DHA in chemical weed management treatments, which were significantly lower than the IWM and control treatments. Soil UA and soil DHA was assessed at 5, 15 DAS, 30 days after pre-emergence herbicide application, flowering and harvest stages. At the crop's flowering stage, the soil DHA was statistically on par in IWM and control treatments significantly superior to chemical weed management treatments. At the harvest stage of the crop, significantly lower soil DHA was recorded in all the treatments, and the impact of the weed management treatments was non-significant. The interaction effect of weed management practices and tillage options on soil DHA and UA was non-significant.

In *Kharif* 2021 no significant changes in soil physico-chemical properties were recorded as impacted by different tillage and weed management options were noticed after the cotton crop's harvest. Therefore, the interaction was also non-significant. Initial residues of diuron at 4 hours after herbicide application varied from 0.306 to 0.312 µg/g in the soil samples. In the final soil sample at the time of harvest, the diuron residues were below the detection limit of 0.05 µg/g in all the soil samples.

Soil enzymatic activity

Soil dehydrogenase, soil urease activity, soil phosphatases activities were assessed at 5, 15 DAS, on the day of PoE herbicide application, 30 days after preemergence herbicide application, flowering and harvest stages of the crop. Tillage treatments significantly influenced the soil urease activity at all sampling stages of the crop till flowering. Tillage treatments did not significantly influence DHA at any crop growth stage except at the flowering stage of the crop. The negative effect of postemergence herbicide was evident from the significantly lower DHA in chemical weed management treatments (W_1 and W_2),which were significantly lower than the IWM and control treatments. At the crop's flowering stage, the soil DHA was statistically on par in all the treatments. At the flowering stage, significantly higher DHA was recorded in T_3 (ZT+R- ZT+R) compared to CT-CT and CT-ZT treatments. However, UA was significantly influenced by the different weed management adopted. The highest urease activity in soil was recorded in unweeded treatments at 05, 15 DDA(PE). At 5, 15 DAA decreased significantly in all the treatments where diuron was applied as a preemergence herbicide. The negative effect of postemergence herbicide was not significant at 30 days after PE herbicide application. The impact of herbicide on alkaline phosphatase activity was visible only upto 15 days after application. Whereas in the case of acid phosphatase, the impact was apparent up to 21 days after preemergence application. The interaction effect of weed management practices and tillage options on soil dehydrogenase , soil urease , soil phosphatases activity was non-significant.

Soil microbial populations

Soil microbial counts in the soil were estimated at 5 DAS, 30 DAS and 60 DAS in the cotton crop. Total bacteria, fungi and actinomycetes populations were not significantly influenced by the tillage treatments at the sampling stages. However, the impact of weed management options was evident. At 5 DAS highest bacterial, fungal and actinomycetes colonies were observed in unweeded control treatment compared to other treatments wherein diuron was applied as a preemergence herbicide. AT 30 DAS, the lowest bacterial and actinomycetes population were recorded in chemical weed management treatment, significantly lower than IWM and unweeded control. In the case of fungi, the number of colonies recorded at 30 DAS was on a par in all the treatments. The impact of herbicides was not witnessed at flowering stages in any of the groups of organisms studied.

Table 3.1.1 Residues (µg/g) of metribuzin in different treatments

	Recommended herbicide treatment			Integrated weed management treatment		
Treatments	0 DAT	Soil harvest	Wheat harvest	0 DAT	Soil harvest	Wheat harvest
PTR-CT	0.101	<0.01	<0.01	0.092	<0.01	<0.01
PTR-CT (MB)	0.086	<0.01	<0.01	0.081	<0.01	<0.01
PTR-ZT (HS)	0.051	<0.01	<0.01	0.048	<0.01	<0.01
ZT-ZT (HS)	0.035	<0.01	<0.01	0.031	<0.01	<0.01
PTR-CT (Rotavator)	0.079	<0.01	<0.01	0.072	<0.01	<0.01

PAU, Ludhiana

Metribuzin and clodinafop-propargyl from soil/wheat grain samples was extracted by MSPD. The residues were quantified using HPLC equipped with 2489 UV-visible detector. The LOD and LOQ of metribuzin and clodinafop-propargyl were 0.02 and 0.05 µg/g, respectively. Initial residues of metribuzin in soil ranged from 0.031 to 0.101 µg/g in different treatments (Table 3.3) and the residues were below the detectable limit (<0.01 µg/g) in soil and wheat grain at the harvest of crop .

In *Kharif* 2021,Pendimethalin from soil/rice grain samples was extracted by ultrasound assisted extraction (UAE) method and residues were analysed by HPLC -UV/Vis detector. The separation of pendimethalin was performed using princeton (5.0 µm ODS2 4.6 mm × 250 mm) column at 240 nm. The LOD and LOQ were 0.003 and 0.01 µg/g, respectively. Initial residues of pendimethalin in DSR-ZT-HS treatment soil ranged from 0.015 to 0.068 µg/g in different weed management treatments and the residues were below the detectable limit (<0.01 µg/g) in soil and rice grain at the harvest of crop . Penoxsulam and cyhalofop butyl from soil was extracted by MSPD. The residues were quantified using HPLC equipped with UV-visible detector. The LOD and LOQ of penoxsulam were 0.003 and 0.01 µg/g, respectively. The LOD and LOQ of cyhalofop butyl were 0.02 and 0.05 µg/g, respectively.

Initial residues of penoxsulam in soil ranged from 0.023 to 0.095 µg/g in different treatments **(Table 3.1.2)**. Penoxsulam and cyhalofop butyl residues were below the detectable limit (<0.01 µg/g) in soil and rice grain at the harvest of crop.

Table 3.1.2 Residues (µg/g) of penoxsulam in different treatments

Treatments	Recommended herbicide treatment (W2)			Integrated weed management treatment (W3)		
	0 DAT	Soil harvest	Rice harvest	0 DAT	Soil harvest	Rice harvest
DSR-ZT-HS	0.095	<0.01	<0.01	0.081	<0.01	<0.01
PTR-CT MB	0.072	<0.01	<0.01	0.062	<0.01	<0.01
PTR-CT-Rotavator	0.053	<0.01	<0.01	0.041	<0.01	<0.01
PTR-ZT HS	0.042	<0.01	<0.01	0.035	<0.01	<0.01
CT-PTR-CT	0.039	<0.01	<0.01	0.023	<0.01	<0.01

TNAU, Coimbatore

Herbicide residues were determined in the long-term tillage and residue management practices. During *Rabi* 2020-21baby corn was grown as test crop which received atrazine as pre emergence herbicide, tembotrione and topramezone and 2,4-D as early post emergence herbicide as per the treatment to control weeds. Soil samples were collected from the PE herbicide applied plots on 0,3,7,15, 30, 45 and at harvest;and that were subjected to residue analysis to find out the persistence and residue in soil as influenced by the tillage and residue management practices. The residues of 2,4-D, atrazine and tembotrione in soil, maize stover and grain were analysed by HPLC determination **(Table 3.1.3)**.

Table 3.1.3 Influence of conservation tillage and weed management practices on herbicide (mg/kg) residues in soil with baby corn (Late *Rabi* 21) in Cotton- baby corn cropping system

Treatments	Days after herbicide application						
	0	3	7	15	30	45	Harvest
	PE Atrazine 0.5 kg/ha						
(CT)	0.386	0.314	0.274	0.194	0.112	0.052	0.014
(ZT)	0.392	0.326	0.283	0.206	0.132	0.072	0.021
(ZT+R)	0.374	0.318	0.279	0.192	0.116	0.061	0.017
Treatments	**PE Atrazine 1.0 kg/ha +BC on 45 DAS**						
	0 day	3 day	7 day	15 day	30 day	45 day	Harvest
(CT)	0.726	0.672	0.608	0.485	0.295	0.174	0.048
(ZT)	0.731	0.680	0.619	0.490	0.302	0.182	0.061
(ZT+R)	0.714	0.654	0.594	0.472	0.286	0.164	0.052
Treatments	**EPOE Tembotrione 120 g/ha**						
	0 day	3 day	7 day	15 day	30 day	45 day	Harvest
(CT)	0.089	0.078	0.0425	0.021	0.012	BDL	BDL
(ZT)	0.098	0.083	0.061	0.039	0.016	BDL	BDL
(ZT+R)	0.096	0.081	0.06	0.036	0.014	BDL	BDL
Treatments	**EPOE Topramezone 12.5 g/ha**						
	0 day	3 day	7 day	15 day	30 day	45 day	Harvest
(CT)	0.035	0.029	0.012	0.01	BDL	BDL	BDL
(ZT)	0.037	0.025	0.02	0.012	BDL	BDL	BDL
(ZT+R)	0.033	0.023	0.013	0.011	BDL	BDL	BDL
Treatments	**2,4 D 500 g/ha**						
	0 day	3 day	7 day	15 day	30 day	45 day	Harvest
(CT)	0.328	0.278	0.212	0.045	BDL	BDL	BDL
(ZT)	0.369	0.285	0.198	0.062	BDL	BDL	BDL
(ZT+R)	0.335	0.298	0.189	0.051	BDL	BDL	BDL

The conventional tillage plots recorded lower residues when compared to zero tillage with and without residue. The dissipation of all the herbicide molecule was found to follow first order reaction kinetics (R2 > 0.90) with the half life of 12.8-17.6 days for atrazine, 10.0 to 11.4 days for tembotrione, 7.9 to 9.7 days for topramezone and 5.9 to 6.7 days for 2,4- D irrespective of tillage practices and weed management methods **(Table 3.1.4)**.

Table 3.1.4 Correlation coefficient and half lives of different herbicides in soil

Treatments	Atrazine 0.5 kg/ha	
	r^2	$t^{1/2}$ (days)
Conventional tillage	0.963	12.79
Zero tillage	0.974	14.90
Zero tillage + Residue	0.969	14.30
Treatments	**Atrazine 1.0 kg/ha +BC on 45 DAS**	
Conventional tillage	0.955	16.86
Zero tillage	0.960	17.59
Zero tillage + Residue	0.952	16.27
Treatments	**Tembotrione 120 g/ha**	
Conventional tillage	0.935	10.06
Zero tillage	0.999	11.40
Zero tillage + Residue	0.999	10.82
Treatments	**Topramezone 12.5 g/ha**	
Conventional tillage	0.837	7.94
Zero tillage	0.932	9.70
Zero tillage + Residue	0.897	9.55
Treatments	**2,4 D 500g/ha**	
Conventional tillage	0.974	5.89
Zero tillage	0.945	6.74
Zero tillage + Residue	0.983	6.49

Residues of 2,4-D, tembotrione and topramezone in soil, baby corn cob and straw from different plots were below 0.01 mg/kg irrespective of the tillage management practices followed for weed control. Whereas, application of atrazine at 0.5 kg/ha recorded residues of 0.014 to 0.021 mg/kg and at 1.0 kg/ha with residues of 0.048 to 0.061 mg/kg at harvest in soil.

Soil biological parameters

Microbial population

Soil samples were analyzed at initial stage and at initial, 7, 15, 30, 60 DAS and harvest in baby corn crop for enumeration of microorganisms *viz*., total bacteria, fungi and actinomycetes. Among the tillage method, zero tillage in ZT+R system recorded maximum number of total bacteria, fungi and actinomycetes irrespective of the stages observed (Table 28 and 29). Among the weed management practices, PE Atrazine 0.5 kg/ha fb EPOE tembotrione 120 g / ha recorded maximum number of microbial population while the lowest was observed in the treatment which received the application of atrazine 1.0 kg/ha + BC on 45 DAS.

Enzymes activities

The enzymes activities such as alkaline phosphatase, dehydrogenase and urease were assessed at 30,60 DAHA and at harvest. Soil enzyme activity*viz*., alkaline phosphatase and dehydrogenase urease and microbial biomass carbon and nitrogen were significantly higher in zero tillage in ZT+Rsystem and among the weed management practicesatrazine 0.5 kg/ha fb EPOE Tembotrione 120g/ha recorded the maximum activity, whereas urease activity was less influenced by the weed management practices. The activities were maximum at 60 DAS and got reduced at the time of harvest.

Soil biological parameters (*Kharif* 2021)

Soil samples were analyzed at initial stage, 15, 30, 45 DAHA for enumeration of microorganisms *viz*., total bacteria, fungi and actinomycetes. Among the tillage method, zero tillage in ZT+R system recorded maximum number of total bacteria, fungi and actinomycetes irrespective of the stages observed. Application of diuron fb pyrithiobac sodium significantly reduced the microbial population at 15 DAHA.

Enzymes activities

The enzymes activities such as alkaline phosphatase, dehydrogenase and urease were assessed at initial 15, 30 and 60 DAHA. Soil enzyme activities and microbial biomass carbon and nitrogen were significantly higher in zero tillage in ZT+R system and among the weed management practices Pendimethalin applied plots has recorded the maximum activities, whereas urease activity was less influenced by the weed management practices. Application of diuron fb pyrithiobac sodium significantly reduced the soil enzyme activities. The activities were maximum at 60DAS.

Butachlor residue in rice grain were analyzed by HPLC technique.. Initial residues of butachlor, i.e. in soil samples collected at 2.0 hours after application of the herbicide was in range of 0.524 - 0.628 µg/g (Table 3.1.5). The quantity of residue present in the soil and rice grain under different tillage and residue management techniques were below detectable limits at the time of harvest. No residues of butachlor could be detected in the rice grain samples collected at harvesting.

Table 3.1.5 Residues (µg/g) of butachlor in rice cropped soil under different planting pattern

Treatment		W1 (Butachlor 1.00 kg/ha)	
Maize	Wheat	Immediately after spray	Harvest Soil
CT	CT	0.524	<0.05
CT	ZT	0.546	<0.05
ZT	ZT	0.628	<0.05
ZT	ZT+R	0.617	<0.05
ZT+R	ZT+R	0.534	<0.05

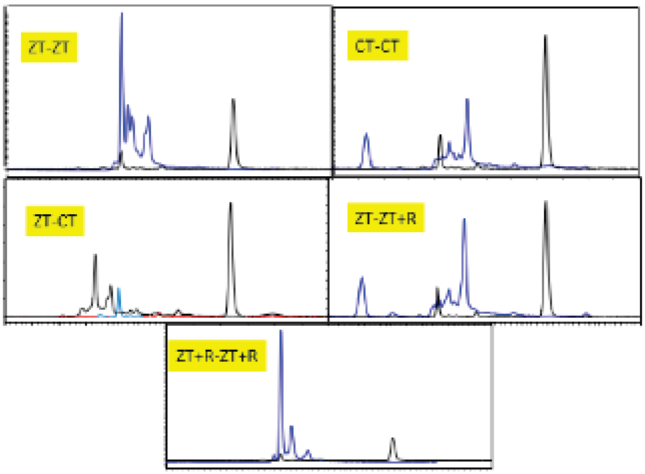


Fig 3.1.1 Overlayed Chromatograms showing butachlor residues in soil immediately after application and at harvest

Soil samples at zero day & harvest and crop produce i.e. rice grain after the harvest was used for analysis of bispyribac sodium . The initial deposits of bispyribac sodium applied plots were 0.340, 0.389, 0.364, 0.386 and 0.392 µg/g under conventional tillage practice and zero tillage practice **(Table 3.1.6)**.

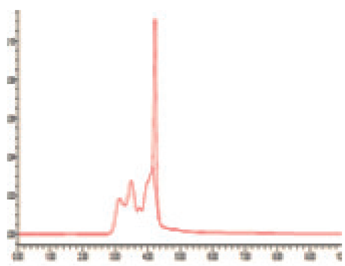
Retention time of Bispyribac sodium	Instrument used	LOD & LOQ (ppm)
	HPLC	0.001 & 0.005 ppm

Table 3.1.6 Resdues (µg) of bispyribac in soil under different planting pattern

Treatment		W1----- Bispyribac sodium (25 g/ha)	
Rice	Wheat	Immediately after herbicide spray	Harvest Soil
CT	CT	0.340	<0.05
CT	ZT	0.389	<0.05
ZT	ZT	0.364	<0.05
ZT	ZT+R	0.386	<0.05
ZT+R	ZT+R	0.392	<0.05

WP 3.2 Assessment of herbicide residues in high value crops

TNAU, Coimbatore

Field experiment is conducted in farmers field to estimate the harvest time residues of oxyfluorfen in/on onion and soil. A single pre emergence application of the test chemical (oxyfluorfen) was done at different doses (T_1 - 200 g ha^{-1}, T_2 - 400 g ha^{-1}and T_3 – un weeded control). Soil samples were collected at 0 days after application. The soil samples were processed and residue was analysed by HPLC-DAD. After the application of oxyfluorfen, the residues of 0.162 and 0.225 mg/kg were found with the applied concentration of 200 and 400 g/ha of Oxyfluorfen respectively. At 200 g/ha application rate, the residues of oxyfluorfen were not detected in soil as well as onion plant top at harvest whereas the residue of 0.014 and 0.023 mg/ kg was recorded in soil and onion bulb at harvest when oxyfluorfen was applied at double the recommended dose, (MRL of 0.05 mg/kg).

PJTSAU, Hyderabad

Herbicide residues in baby corn and maize plants in babycorn-cabbage cropping system. The persistence of atrazine in soil, stover and grain of sweet corn crop and impact of the atrazine residues on the cabbage crop establishment and performance was studied. Atrazine 50%WP was applied 1000 g/ha as preemergence spray 24 hours after sowing using a spray volume of 500 litres/ha The residues of atrazine in soil sample / baby corn were determined by GC-FTD. After 2 hours of herbicide application, the soil sample showed 0.452 μg/g in surface soil samples in pre emergence treatments. No detectable residues (0.05 μg/g) of atrazine were present in the baby corn and stover samples collected from the field experiment at harvest. LOQ of oxyfluorfen in soil was 0.05 mg/kg, and in onion bulb, LOQ was 0.05 mg/kg. Residues of oxyfluorfen in soil and cabbage samples and soil at the time of harvest were below the detection limit of 0.05 mg/kg.

CSKHPKV, Palampur

Samples were collected at crop produce after the harvest of pea crop in *Rabi* 2020-21. Pendimethalin residues were analysed by Waters HPLC – PAD. During ***Kharif***, soil samples (immediately after spray and at the harvest and maize grain were collected at harvest from atrazine (1.5 kg/ ha) treated plots and analysed by HPLC and The deposits of atrazine in soil immediately after application of atrazine were 0.724μg/g. Atrazine residues in soil and grain samples were below detectable levels (BDL >0.01μg/g).

Estimation of ethalfluralin residues in soybean

A field experiment was conducted during Rabi season in a randomized block design with three replications. Ethalfluralin was applied at 520 g ha^{-1}, 720 g ha^{-1}& 1440 g ha^{-1} in direct-seeded soybean crop as pre-emergence herbicide. The soil samples (0-20cm depth) and soybean at harvest of crop were collected from all treatments**.** The residue of ethalfluralin in extracts were quantified on HPLD-PDA. The residues were below detectable levels (< 0.001 μg g^{-1}) in the soil and soybean grain at harvest.

WP 3.3 Assessment of herbicide residues in farmers fields

PAU, Ludhiana

Soil, water and crop samples were collected at harvest from farmer's fields from Ludhiana, Moga, Kapurthala, Fazilka and Sangrur districts of Punjab in rice-wheat cropping system. The soil, water and crop samples were extracted by standard methodologies and residue of pretilachlor, butachlor, anilofos, bispyribac sodium, penoxsulam, cyhalofop butyl, fenoxaprop, pyrazosulfuron, triafamone and ethoxysulfuron, pendimethalin, sulfosulfuron, metsulfuron-methyl, pinoxaden, metribuzin, pyroxasulfone, mesosulfuron methyl + iodosulfuron methyl sodium, and clodinafop + metribuzinin the samples was estimated using HPLC**.** The residue of these herbicides in soil, water and crop produce were below detectable limit (<0.01 μg/g). Soil and crop produce samples were collected at harvest from OFR and FLD trials sprayed with pyroxasulfone and clodinafop + metribuzinin wheat and residues in soil, water and crop produce were below detectable limit (<0.01 μg/g).

TNAU, Coimbatore

Soil and plant samples were collected at the time of harvest from the maize, tomato, brinjal, rice and black gram grown fields of different farmers from Devarayapuram, thondamuthur village of coimbatore district which received atrazine, quizalofop ethyl, pendimethalin and pyrazosulfuron ethyl. The collected soils are clay loam sandy loam, sandy clay loam in texture and the organic carbon content ranged from 0.53 to 0.67 per cent, pH and EC ranged from 7.50 to 8.41 and 0.20 to 0.32 dS/m respectively. NPK were supplied as per the state recommendation to the particular crop. They were analyzed in HPLC-DAD for their residue content at the time of harvest in soil and plant produce. None of the applied herbicides were detected in the different plant matrices and soil. This showed that they have been degraded from the soil before the harvest of the crop.

On farm trial have been conducted in 5 locations with groundnut consisting of 4 treatments. Soil and plant samples were taken at the time of harvest and analysed for the residues. Results showed that all the herbicides used for the study were present in below detectable level in soil and plant parts in all the locations.

PJTSAU, Hyderabad

Four soil/onion bulbs were collected from different farmers. Soil and onion bulb stage of the crop samples were collected from the farmer's fields. In all soil samples, Oxyfluorfen residues in soil and onion bulb samples were below the 0.025 mg/kg detection limit. Fruit samples (4 samples) and soil samples (4 samples) were collected from farmers' fields during *rabi* season for determination of metribuzin residue. Farmers' fields were chosen where metribuzin was used as a postemergence herbicide. Information in terms of date of application, dose adopted, and application method was also recorded. Metribuzin residues in the soil samples were determined by GC-ECD. The limit of detection in the study was 0.05 ppm. Among the six soil samples collected at harvest of the tomato fruits, residues of metribuzin were below the detection limit (0.05 mg/kg) in four samples. In two soil samples, metribuzin residues in soil were 0.174 mg/kg and 0.058 mg/kg In all six tomato samples collected from the farmers' fields, metribuzin residues were BDL (0.05 mg/kg).

CSKHPKV, Palampur

During ***Rabi*** 2020-21, samples both soil and grain from wheat crop treated with recommended herbicides clodinafop and MSM were collected at the time of harvest form farmers fields. Herbicide residues were analyzed by HPLC-DAD for their residue content in collected soil and crop produce were below detectable limits.

During *Kharif* 2021, samples of okra, beans, cauliflower, cabbage and radish from vegetable growers of Kullu district were collected. Commonly used herbicides by farmers in these crops were oxyflourfen, pendimethalin, and metribuzin and alachlor. Samples were analysed by using GC equipped with ECD. Residues of different herbicides i.e., alachlor (0.01-0.04 ppm), pendimethalin (0.012- 0.10 ppm) and metribuzin (0.007- 0.014 ppm) were detected in less than 10% of samples & were below MRL values.

WP 3.4 Degradation of herbicide in plants, soil and aquatic bodies

PAU, Ludhiana

The pyroxasulfone residues were quantified using HPLC -UV-visible detector. The initial residues of pyroxasulfone at 0 day (3 hours after herbicide application) ranged from 0.028 ± 0.004 µg/g at 76.5 g/hawhereas at higher application rates the residues varied from 0.045 ± 0.003, 0.052 ± 0.0064, 0.089 ± 0.005 and 0.099 ± 0.003 µg/gat 102, 127.5, 204 and 255 g/ha. The residues of pyroxasulfone decreased significantly over time and were below the detectable limit at 30 DAA of pyroxasulfone at an application rate of 76.5 g/ha. However, 0.013 ± 0.004, 0.018 ± 0.0033, 0.028 ± 0.005 and 0.03 ± 0.002 µg/g residues were detected at 102, 127.5, 204 and 255 g/ha at 45 DAA **(Figure- 3.4.1)**. The degradation of pyroxasulfone fitted well to first-order kinetics with correlation coefficient >0.99 and half-lives (DT_{50}) obtained are presented in Table 3.4.1. The representative chromatograms of different treatments are presented in **Figure 3.4.2**.

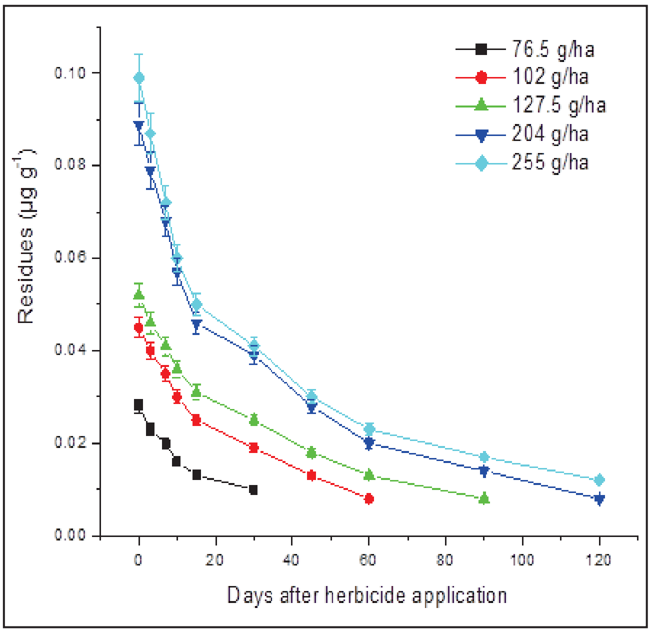


Figure 3.4.1 Residues of pyroxasulfone in different treatments

Table 3.4.1 Statistical parameters for dissipation of pyroxasulfone in different treatments

Application rate (g/ha)	R^2	K	DT_{50}*
76.5	0.97	0.0339	20.43
102	0.98	0.0273	25.37
127.5	0.94	0.0204	33.97
204	0.92	0.0192	36.02
255	0.96	0.0169	40.83

Carryover effect of pyroxasulfone applied to maize crop, was studied on succeeding crops potato, peas, cabbage, spinach, metha, methi and toria under field conditions. Pyroxasulfone showed significant reduction in plant count, root length, shoot length, fresh and dry biomass of all succeeding crops compared to weedy check. Plant count, root length, shoot length, fresh and dry biomass of succeeding crops decreased with every increase in dose of pyroxasulfone from 76.5 g to 255 g/ha; at highest dose, presence of higher amounts of residue of pyroxasulfone in soil affected emergence and growth of succeeding crops.

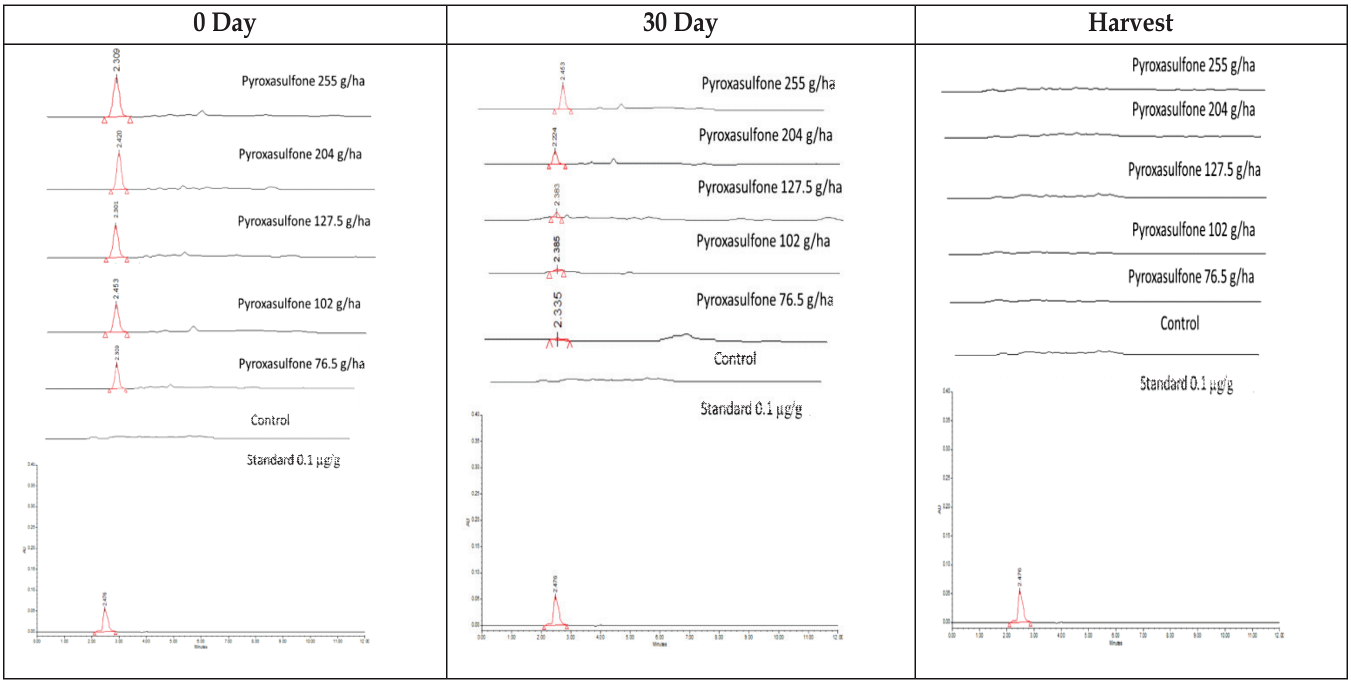


Figure 3.4.2 Chromatograms of pyroxasulfone at different days after treatment

TNAU, Coimbatore

Farmers growing rice crop in different locations at Narasipuram, Ikkarai Booluvampatti and Vellerukkampalayam have been selected for collecting soil and plant samples to study herbicide residues. Soil samples were collected from farmers field at 0, 15, 30, 45, 60 days after herbicide application and analysed for its residues. Plant samples will be collected at the time of harvest. The collected soils are clay loam in texture and the organic carbon content ranged from 0.52 to 0.74 %, pH and EC ranged from 7.82 to 8.31 and 0.22 to 0.35 dS/m respectively. NPK were supplied as per the state recommendation to the particular crop. They were analyzed in HPLC-DAD for their residue content. Water samples were collected from the down stream of noyal river basin at Mathampatty, Irrutupallam and perur and bore well water from nallurvayal at different intervals and analysed for its residues using HPLC. Pretilachlor residues were persisted in the soil up to 45 DAHA in all the locations **(Table 3.4.2)**.

Table 3.4.2 Herbicides persistence in rice soil from farmer's field

Farmer Name and Location	Herbicide	Residue(mg/kg)				
		0 DAHA	15 DAHA	30 DAHA	45 DAHA	60 DAHA
Mr. N.S. Nanjappan Pattiar kovil pathi Thottam Narasipuram	Pretilachlor 0.6 kg ai/ha	0.533	0.218	0.098	0.021	<0.01
Mr. Moorthi Paramesampalayam Ikkarai Booluvampatti	Pretilachlor 0.6 kg ai/ha	0.449	0.154	0.071	0.018	<0.01
Mr. Kunjan Vellerukkam palayam	Pretilachlor 0.6 kg ai/ha	0.483	0.182	0.082	0.011	<0.01

Water sample collected from mathamaptti and perur were analysed for pretilachlor residues, while irrutupallam and nallurvayal samples were analysed for butachlor residues and found that both the herbicides were not detected in the water samples collected at different intervals.

Atrazine residues in water bodies

In order to study the atrazine residues in water bodies, water samples have been collected from the udamalpet location where farmers are cultivating maize during *Kharif* and *Rabi* season applied with PE herbicide atrazine 0.5 kg/ha on 3-10 days after sowing of maize. In this region maize are being cultivated for more than 10 years with atrazine for weed management for both the seasons. Water samples have been collected from pappankulam pond at madathukulam and three bore well from mukkonam during November 2021 and analysed for its residues in HPLC using PDA detector. The atrazine residue was not detected in any of the locations of water sample.

PJTSAU, Hyderabad

Water samples were collected from the aquatic bodies surrounded by rice-growing areas under the Nagarjuna Sagar Project Left canal command area to study the persistence and contamination of the aquatic bodies by rice herbicides (pertilachlor and bispyribac sodium). Samples were collected two times, i.e. at the time of transplanting (01-09-2020) and at 20-25 DAT (20-09-2020).

First sampling

Pretilachlor residues (above the 0.05 mg/l) were detected in two samples (samples no 5 and 8). In addition, pretilachlor residues were detected in both water samples collected from drain channels (0.063 and 0.071 mg/l).

Second sampling

None of the samples drawn contained residues pretilachlor irrespective of the source. Samples collected from none of the sources were saline, and the pH of the water samples was neither acidic nor alkaline. pH and EC of the water samples did not change significantly compared with the first sampling.

Water sample collection from surface and sub-surface aquifers in NSP command area

CSKHPKV, Palampur

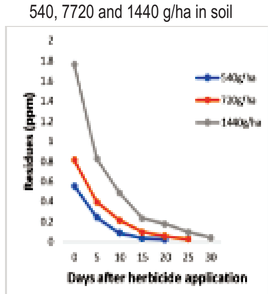
A field experiment consisting of four treatments *viz*. ethalfluralin @ 540 g/ha, 720 g/ha and 1440 g/ha andcontrol replicated five times in a randomized block design (RBD) at kangra during *2021* is being conducted to determine dissipation behaviour of ethalfluralin in soil. Samples of soil (0-15 cm) at five days interval were collected replication wise from three imposed treatments of ethalfluralin along with control.

Initial residues of ethalfluralin in soil immediately after application of herbicide applied at 540 g/ha, 720 g/ha and 1440 g/ha were 0.554 µg/g, 0.812 µg/gand 1.762 µg/g revealed that within fifteen days after herbicide application, approximately 93.1, 87.9 and 86.4 per cent of applied ethalfluralin dissipated. Whereas residue levels were below detectable level (<0.001 µg/g) for ethalfluralin 540g/ha at 25 days after herbicide application indicated the complete dissipation of applied ethalfluralin. Residue concentration for ethalfluralin 720 g/ha and ethalfluralin 1440 g/ha was 0.026 µg/gand 0.058 µg/grespectively. At 30 days residues were below detectable limit at lower doses i.e. ethalfluralin 540 and 720 g/ha whereas, at higher dose i.e. 1440 g/ha residues were found to be 0.042 µg/g. This clearly indicates that ethalfluralin at higher dose persisted in the soil for longer periods than at lower doses (**Table 3.4.3)**. The results of residues of ethalfluralin in soil when applied @ 520g/ha persisted upto 20 days. Ethalfluralin 740 g/ha persisted upto 25 days after herbicide application whereas at higher dose i.e. ethalfluralin 1440 g/ha, it persisted up to 30 days after herbicide application. The dissipation of ethalfluralin at all application rates viz. 540 g/ha, 720 g/ha and1440 g/ha followed first order kinetics decay. The correlation coefficient (r^2) for all the three applied doses *i.e.* ethalfluralin 540 g/ha, 720 g/ha and 1440 g/ha were 0.981, 0.994 and 0.989 indicating perfect fit.

Table 3.4.3 Residues of ethalfluralin in soil applied at different doses

Days after herbicide application	Residues (µg/g) Rates of ethalfluralin (g/ha)		
	540	720	1440
0	0.554±0.02	0.812±0.06	1.762±0.07
5	0.248±0.04	0.394±0.03	0.842±0.05
10	0.090±0.007	0.216±0.02	0.486±0.02
15	0.038±0.0002	0.098±0.008	0.234±0.02
20	0.024±0.0003	0.058±0.0004	0.178±0.017
25		0.028±0.0002	0.098±0.009
30			0.042±0.0006

Presistence curve of ethalflurain at 540, 7720 and 1440 g/ha in soil



WP 4 Demonstration and impact assessment of weed management technologies

WP 4.1 On Farm Trials

TNAU, Coimbatore

OFTs were conducted to demonstrate the integrated weed management in groundnut at Nallur, Pollachi South Block, Coimbatore district and Chinnapudur, Kangayam Block, Tiruppur district during *Kharif* 2021. The major weeds present in groundnut fields were *Acanthospermum hispidum, Boerhaavia hispida, Amaranthus viridis, Digeria arvensis, Cyperus rotundus, Echinochloa spp.,* and *Panicum repens etc.* Total weed density and weed dry weight were considerably lower with the application of EPOE imazethapyr + quizalafob-ethyl (50+50 g/ha) *fb* hand weeding 30 - 35 DAP in all five locations next to POE propazuizafop + imazethapyr 125 g/ha and and PE oxyfluorfen 0.20 kg/ha *fb* hand weeding 30-35 DAP. It was higher in farmers practice (PE pendimethalin 1 kg/ha *fb* hand weeding 30-35 DAP). Two hand weeding induced the emergence of new weeds and regrowth of present weed seeds which ultimately resulted in higher weed density and weed dry weight in farmers' practice. EPOE imazethapyr + quizalafob-ethyl (50+50 g/ha) *fb* hand weeding 30 - 35 DAP recorded seed yield (820 to 1070 kg/ ha). Net returns were higher in the same treatment (Rs. 0.34 –0.57 lakh /ha). Effective control of early and late emerged weeds was the reason for the higher yield of seed and economic returns in the above treatment.

PAU, Ludhiana

Four OFTs on weed management in wheat were conducted in *Rabi* 2020-21 with tank mix of pyroxasulfone 127.5g + pendimethalin 750g/ha, pyroxasulfone 127.5 g/ha, and unsprayed control. Tank mix was found to be effective against resistant *Phalaris minor* at all locations and farmers were satisfied with the performance of the herbicide. *Phalaris minor* has developed cross resistance to recommended herbicides like clodinafop, fenoxaprop, and pinoxaden in wheat fields. In such fields, tank mixture of pyroxasulfone 127.5g/ha + pendimethalin 750g/ha recorded effective control of *P. minor* and increased wheat grain yield than unsprayed control and was at par with pyroxasulfone 127.5g/ha. Seven OFTs on weed management in maize were conducted during *Kharif* 2021 with tembotrione as post-emergence herbicide and, its band spray followed by (*fb*) inter-culture in inter-rows. The band application followed by inter-culture provided effective control of weeds.

CCSHAU, Hisar

Five on-farm trials on weed management in green gram were conducted. The farmers' fields were infested with both grassy and broad leaf weeds including *Trianthema* spp., *Digera* spp. and *Echinochloa, Dactyloctenium aegyptium*. The pre-emergence application of pendimethalin followed by one hoeing at 30 DAS resulted in higher weed control efficiency with a seed yield of 1006 kg/ha, while the application of pendimethalin alone resulted in 54 per cent WCE with a seed yield of 660 kg/ha. The pre-emergence application of pendimethalin + imazethapyr (RM) 1000 g/ha (RM) provided 78 per cent control of weeds with seed yield of 834 kg/ha which was 26.3 percent higher than the pre-emergence application of pendimethalin. Post-emergence application of aclonifen + clodinafop provided 60 per cent control of weeds with seed yield of 772 kg/ha which was 7 per cent less than pendimethalin + imazethapyr (RM) 1000 g/ha (PRE). The pre-emergence uses of pyroxasulfone + pendimethalin (TM) at (127.5 + 1500 g/ha) followed by PoE application of meso + iodosulfuron 14.4 g/ha and pinoxaden 50 g/ha demonstrated at eight sites in rice –wheat growing areas of Haryana provided 91.3 and 90% control of multiple herbicide resistant *P. minor* whereas application of metribuzin (urea mix) after first irrigation followed by mesosulfuron + iodosulfuron 14.4 g/ha resulted in 75.3% control of *P. minor*. Application of pyroxasulfone + pendimethalin (TM) at (127.5 + 1500 g/ha) followed by PoE application of pinoxaden 50 g/ha resulted in higher grain yield (5710 kg/ha) followed by pyroxasulfone + pendimethalin (TM) at (127.5 + 1500 g/ha) *fb* meso + iodosulfuron 14.4 g/ha (5668 kg/ha). Application of metribuzin 350 g/ha causes some phytotoxicity to crop where the patches have higher moisture but recovered with time and did not affect the crop yield. Similarly, the application of clodinafop+ metribuzin (RM) 60+210 g/ha also causes toxicity to the crop but recovered with time.

KAU, Thrissur

On-farm research on early post-emergence weed control was conducted at four locations, two in *Kole* lands and two in other wetland fields. It was found that ready mix herbicide combination of cyhalofop butyl + penoxsulam was not very effective against *Ludwigia*. However, all graminaceous weeds, as well as sedges, were effectively controlled. Bispyribac followed by fenoxaprop spray resulted in effective weed control and was the best treatment. Bispyribac alone application could not effectively control *Sacciolepis*. The results indicated that the farmers' practice of the use of bispyribac sodium and the other herbicides tried were comparable in performance with respect to weed control and grain yield. Hence these herbicides can be included in herbicide rotations to prevent the chances of development of herbicide resistance in weeds.

SKUAST, Jammu

On-farm research experiments were conducted at four farmer's fields in the Jammu region in *Kharif* 2021. The highest grain yield and B: C ratio was recorded for pendimethalin 1000 g/ha (PE) *fb* bispyribac-sodium 25 g/ha+ ethoxysulfuron- ethyl 18 g/ha as post-emergence at all the locations.

UAS, Dharwad

On-farm research experiments on bio-efficacy and phytotoxicity evaluation of haloxyfop-r-methyl 10.5% against some weeds in comparison to standard check treatments in soybean were conducted. The lowest weed density was recorded with haloxyfop-R-methyl 10.5% EC @1500 ml ha^{-1} at 30 and 45 DAA (18 and 15 gm^{-2} respectively). The yield attributing parameters *viz.*, number of pods $plant^{-1}$; seed yield g $plant^{-1}$; 100 seed weight was significantly influenced in the treatment received haloxyfop-R-methyl 10.5% EC @1500 ml ha^{-1} (43.81; 14.23 and 12.51 respectively). The highest seed yield was recorded with the spraying of haloxyfop-R-methyl 10.5% EC @1500 ml ha^{-1} (2248 q ha^{-1}). Further, The increased dosage caused the slightest phytotoxicity on soybean crop at 03, 07 and 14 DAP with haloxyfop-R-methyl 10.5% EC @1250 and 2500 ml ha^{-1}. However, the phytotoxicity symptoms were not observed 28 at 21and DAP.

IGKV, Raipur

Eight OFTs were conducted on weed management in direct-seeded rice of the cultivar *Rajeshwari*. Treatment application of pre emergence pyrazosulfuron 20 g/ha at 0-7 DAS *fb* bispyibac- Na 20 g/ha at 20 DAS (T1) and other treatment application of pre emergence pyrazosulfuron20g/ha *fb* cyhalofop-butyl + penoxsulam 135 g/ha (T2) was laid down. The average yield of farmers' practice was 4.5 t/ha whereas the average grain yield obtained under treatments was 5.33 and 5.47 t/ha for T1 and T2, respectively. However, the percentage increase under recommended practice over farmers' practice was 18.45 and the percentage increase in grain yield by improved practice (T2) was 21.55 over farmers' practice. Also, the average benefit-cost ratio of treatments was higher (3.41 to 3.56) as compared to the farmers' practice (2.91).

AAU, Anand

OFRs were conducted in summer groundnut with treatments viz. fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% (premix) *fb* IC+HW at 40 DAS (T1), imazethapyr 35% + imazamox 35% WG 70 g/ha *fb* IC+HW at 40 DAS (T2) and Farmers' practice (IC *fb* HW at 20 and 40 DAS) (T3). The result indicated that T1 was more effective in controlling the weeds and it has a benefit-cost ratio of 2.87. Further, two OFRs were conducted in *Rabi* maize with respective treatments; atrazine 50% WP + topramezone 336 g/l w/v SC (tank mix) (T1), atrazine 50% WP + tembotrione 34.4% SC (tank mix) (T2) and farmers practice (IC *fb* HW at 20-25 DAS) (T3). The results showed that the T1 performed better in terms of weed density, and weed dry weight and it had the highest benefit-cost ratio (2.79) over the other treatments.

RVSKVV, Gwalior

Four on-farm trials were conducted in wheat crop at farmers' fields under the OFR programme during *Rabi* 2020-21. Combinations of post-emergence herbicides sulfosulfuron + metsulfuron (30+2) g/ha, and clodinafop + metsulfuron (60+4) g/ha were tested for chemical weed control and compared with farmer's practices at three locations of Gwalior district. The dominant weeds on farmers' fields consisted of *Cyperus rotundus, Anagallis arvensis, Phalaris minor, Convolvulus arvensis, Chenopodium album,* and *Spergula arvensis,* etc. It was observed that both the combinations of weed management practices gave lower weed population and higher seed yield over farmer's practices. The maximum yield of 4.71 t/ha was obtained with the application of sulfosulfuron + metsulfuron (30+2) g/ha PoE followed by clodinafop + metsulfuron (60+4) g/ha PoE with 4.69 t/ha which was 40% and 39% higher over farmers' practice (3.38 t/ha) respectively. The B:C ratio was found to be 2.74 in these weed management practices compared to 2.30 in the farmer's field. Two OFRs were conducted on pearlmillet at farmer's fields in two villages of Gwalior district. Herbicides atrazine

0.5 kg/ha *fb* 2,4-D 0.5 kg/ha and pendimethalin 1.0 kg/ha (PE) were tested on pearlmillet and compared with farmer's practices where farmer has not applied any herbicide. The dominant weeds on farmer's field were *Cyperus rotundus, Phyllanthus niruri, Echinocloa crus-galli, Commelina benghalensis, Digera arvensis* and *Sateria glauca*. It was observed that both the chemical weed management practices gave higher grain yields than farmers' practice. The maximum yield of pearlmillet 2.95 t/ha was obtained with the application of atrazine 0.5 kg/ha + 2, 4-D 0.5 kg/ha (PoE) *fb* pendimethalin 1.0 kg/ha PE which was 51.0%, and 45.0% higher over farmer's practices respectively. The B C ratio (2.11) was also recorded higher with the application of atrazine 0.5 kg/ha + 2, 4-D 0.5 kg/ha (PoE). It is concluded that at farmers' fields the application of atrazine 0.5 kg/ha + 2, 4-D 0.5 kg/ha (PoE) gave a 51.0% increase in pearl millet yield over farmer's practice with B C ratio of 2.11. Two on-farm trials were conducted in the berseem crop during *Rabi* 2020-21. Pendimethalin 0.5 kg/ha (EPOE) was applied after 10 days of sowing and imazethapyr 40 g/ha was applied after 1st cut of berseem and tested to control the problematic weed *Cuscuta.* It was compared with farmers' practices in two locations in the Gwalior district. It was observed that both herbicides controlled the *Cuscuta* and gave higher fodder yield over farmers' practices. The maximum fodder yield of 101.25 t/ha was obtained with the application of pendimethalin 0.5 kg/ha as early PoE followed by imazethapyr 40 g/ha after 1st cut of berseem (98.75 t/ha) which was around 23% and 20% higher over farmer's practice respectively. The B C ratio was also found 7.35 and 7.17 respectively from both weed management practices as compared to 6.19 in farmers' fields.

CSKHPKV, Palampur

During 2018-19, four OFTs on rice, four on maize, five on wheat, three on peas, and four in grasslands were undertaken. The results were encouraging and the results showed that the treatment pretilachlor 0.75 kg/ha provided the highest grain yield (3.8 t/ha) in rice, treatment tembotrione 120 g/ha gave the highest yield (5.3 t/ha) in maize, treatment Clodinafop 60 g/ha + metsulfuron-methyl 4 g/ha gave the highest yield (38.4 t/ha)??? in wheat, treatment imazethapyr 100 g/ha + HW gave highest (8.09 t/ha) in peas, and metsulfuron methyl 0.5 g/ha used for the control of obnoxious weeds in grasslands gave highest grass yield (34.2 t/ha). Further, OFTs on the control of *Lantana camara* and *Parthenium* were also undertaken.

GBPUAT, Pantnagar

Two on-farm research trials were conducted in the U.S. Nagar district on the wheat crop at farmers' fields during *Rabi* season of 2020-21. The area of each treatment was 500 m^2. Treatments were comprised of pinoxaden 40 g/ha (25-30 DAS) *fb* metsulfuron methyl 4 g/ha (35-40 DAS), carfentrazone + sulfosulfuron 20+25 g/ha (post-em.), clodinafop propargyl + metribuzin 175 g/ha (54+120 g/ha) (Post-em.) were taken as improved technology. Clodinafop propargyl 60 g/ha was taken as farmers practice. These four treatments were compared with weedy check for yield loss estimation. The major weeds that infested the weedy check plots were *Polygonum plebejum, Medicago denticulata, Visia sativa, P. minor, Rumex acetose, Solanum nigrum, Melilotus indica, Avena fatua, Lathyrus aphaca, Anagallis arvensis, Coronopus didymus* and *Chenopodium album.* An average increase in grain yield due to adoption of improved technology was 15.2% higher than farmer's practice. Among the weed management treatments, higher weed control efficiency was recorded with improved technology (80.0, 66.7 % and 73.3 %) over farmer's practice (66.7%). Application of pinoxaden 40 g/ha (25-30 DAS) *fb* metsulfuron-methyl 4 g/ha (35-40 DAS) recorded highest grain yield 5.5 t/ha, gross return Rs. 105875.0/ha, net return Rs. 58898/ha and B:C ratio 2.3 followed by carfentrazone + sulfosulfuron 20 + 25 g/ha which attained grain yield 5.3 t/ha, gross return Rs. 102025/ha, net return Rs. 56060/ha and B:C ratio 2.2 followed by clodinafop–propargyl+metribuzin 175 g/ha (54 + 120 g/ha), grain yield 5 t/ha, gross return Rs. 96250/ha, net return Rs. 49735/ha and B.C ratio 2.1 which were higher as compared to farmer's practice (4.6 t/ha). The lowest values of these parameters were recorded with weedy check. In Nainital District, three on-farm research trials were conducted on wheat crop at three different locations of farmer's field during *Rabi* season of 2020-2021 to evaluate the bio-efficacy of different herbicidal treatments. The major weeds infested the weedy plots were *Polygonum plebejum, Madicago denticulata, Visia sativa, P. minor, Rumex acetosela, Solanum nigrum, Melilotus indica, Avena fatua, Lathyrus aphaca, Anagallis arvensis, Coronopus didymus* and *Chenopodium album.* The loss in grain yield due to weeds in weedy check plot was 17.8% in comparison to improved technology, whereas an increase in grain yield due to adoption of improved technology viz. pinoxaden 40 g/ha (25-30 DAS) *fb* metsulfuron methyl 4 g/ha (35-40 DAS), carfentrazone + sulfosulfuron 20 +25 g/ha, clodinafop–propargyl + metribuzin 175 g/ha (54+120 g/ha) was 21.6 % higher as compared to weedy check. An average increase in grain yield due to improved technology was 11.75 % higher than farmer's practice. Among weed management treatments, adoption of improved technology viz., pinoxaden 40 g/ha (25-30 DAS) *fb* metsulfuron-methyl 4 g/ha (35-40 DAS), recorded the higher grain yield 4.7 t/ha, gross return Rs. 90475/ha, net return Rs.43516/ha and B:C ratio 1.9 followed by carfentrazone + sulfosulfuron 20 + 25 g/ha which recorded grain yield 4.5 t/ha, gross return Rs. 86625/ha, net return 40629/ha and B.C. ratio 1.8. Five OFR trials were conducted in rice at different locations of farmer's field in the Udham Singh Nagar district during *Kharif* season 2021 to evaluate the performance of different herbicidal treatments. The treatments were consisted of Pretilachlor 750 g/ha (PE) *fb* penoxsulam + cyhalofop-butyl 135 g/ha (PoE), pretilachlor 750 g/ha (PE) *fb* penoxsulam 22.5 g/ha (PoE) and pyrazosulfuron 20 g/ha (PE) *fb* bispyribac-sodium 20 g/ha (PoE) were applied as improved technology, whereas pretilachlor 50% EC 750 g/ha (PE) was applied as farmer's practice and the weedy check was taken to estimate the yield loss caused by weeds. The plot size of each treatment was 500 m^2. The major weeds that infested the weedy plots were *Ammania baccifera, Cyperus difformis, Eclipta alba, Paspalum distichum, Cyperus iria, Fimbristylis mileacea, Echinochloa colona*, *Echinochloa crus-galli,* and *Leptochloa chinensis.* The reduction in grain yield due to uncontrolled weed was 21.6% in weedy check while an increase in grain yield with pretilachlor 750 h/ha (PE) *fb* penoxsulam + cyhalofop-butyl 135 g/ha (PoE) was achieved 29.8%, pretilachlor 750 g/ha (PE) *fb* penoxsulam 22.5 g/ha (PoE) 27.7%, pyrazosulfuron 20 g/ha (PE) *fb b*ispyribac-sodium 20 g/ha (PoE) 25.5% and in farmer's practice 8.5% over weedy check. Among different weed management treatments, highest grain yield 6.1 t/ha, gross return Rs.118340/ha, net return Rs.74210/ha and B:C ratio 2.7 were achieved with Pretilachlor 750 g/ha (PE) *fb* penoxsulam + cyhalofop-butyl 135 g/ha (PoE).

MPUAT, Udaipur

Two OFR trials on different herbicide combinations in black gram were conducted at the village Madar. The farmers' field was infested with *Ecinochloa colona, Commelina bengalensis* and *Cyperus rotundus* among the monocots *Trianthema pertulacastrum* and *Digera arvensis* were observed among dicots. *Parthenium hysterophorus* is a perennial weed and the most problematic weed in the cropped and non-cropped fields. All the herbicide treatments reduced the number of weeds/m^2. Application of ready-mix herbicide imazamox + imazethapyr 75 g/ha as PoE (15-20 DAS) *fb* IC was recorded minimum weed density and weed dry matter as compared to imazethapyr 75 g/ha as PoE (15-20 DAS) *fb* IC with increased the blackgram seed yield by 26.66 per cent. However, in monetary terms these herbicide combinations gave a higher net return.

WP 4.2 Front-line Demonstrations

TNAU, Coimbatore

Front-line demonstrations (FLDs) were conducted in turmeric (*var* Erode Local) at five farmer's fields of Channaur and Thaneerpandal villages, Thondamuthur block of Coimbatore District. Due to the adoption of improved weed management technology, PE Oxyfluorfen 0.25 kg/ha *fb* hand weeding at 30-35 DAP, the weed density and dry weight recorded lesser than farmer's practice (Two hand weeding). The crop is at the rhizome maturity stage and harvest will be completed second fortnight of January 2022.

RVSKVV, Gwalior

Two demonstration trials were conducted at farmer's fields under FLD programme during *Rabi* 2020-21 in wheat crop. Post emergence herbicides sulfosulfuron + metsulfuron (30+2) g/ha, and clodinafop + metsulfuron (60+4) g/ha were applied to control the weeds in wheat and compared with farmer's practices at two locations of the Gwalior district where the farmer did not apply any herbicide. The dominant weeds on farmer's fields consisted of *Cyperus rotundus, Anagallis arvensis, Phalaris minor, Convolvulus arvensis, Chenopodium album,* and *Spergula arvensis,* etc. It was observed that both herbicide combinations gave lower weed population and higher seed yield over farmer's practices (Table-43). The maximum yield of 4.8 t/ha was obtained with the application of sulfosulfuron + metsulfuron (30+2) g/ha PoE followed by clodinafop + metsulfuron (60+4) g/ha PoE (4.72 t/ha) which was 43 and 40% higher over farmers practice (3.36 t/ha). Two FLDs were conducted in pearlmillet at farmer's fields in two different villages of Gwalior district to demonstrate the benefit of the application of atrazine 500 g/ha + 2, 4-D 500 g/ha. The dominant weeds on farmer's field were *Cyperus rotundus, Cynodon dactylon, Phyllanthus niruri, Commelina benghalensis, Digera arvensis* and *Echinocloa crus-galli.* It was observed that the application of atrazine 500 g/ha + 2, 4-D 500 g/ha gave higher grain yield over farmer's practice. The yield in demonstrated plots was recorded as 2.91 and 2.87 t/ha, which was 52.74 and 50.55% higher than farmer's practice. Similarly, higher B C ratio 2.08 and 2.05 was also recorded in the field where atrazine 500 g/ha PE + 2, 4-D 500 g/ha was applied.

CSKHPKV, Palampur

Sixty-eight demonstrations were conducted during 2021. in wheat clodinafop propargyl 60 g/ha + metsulfuron-methyl v/s farmer's practice and in peas imazethapyr 100 g/ha v/s farmers practice were evaluated. In rice, pretilachlor 0.6 kg/ha / bispyribac sodium 20 g/ha; in soybean, quazalofop-ethyl 6 g/ha + chlorimuron ethyl 4 g/ha; in maize tembotrione 120 g/ha; and in turmeric, metribuzin 0.75 kg/ha *fb* mulch *fb* HW were evaluated against the farmer's practice. Results showed 40% yield increase in wheat, 38% increase in peas, 64% increase in rice, 25% increase in maize, 53% increase in soybean, 32% increase in turmeric as compared to the yields of farmer's practice in the respective crops.

PAU, Ludhiana

Eight FLDs were conducted during Rabi, 2019-20 in wheat on control of *Phalaris minor* with pre-mix of clodinafop 9% + metribuzin 20% at 174 g/ha- a new post-emergence herbicide. *P. minor* has developed cross resistance to one or more of the currently recommended herbicides like clodinafop, sulfosulfuron and pinoxaden. Demonstrations of field efficacy were conducted in such wheat fields. Tank mix herbicide combination recorded effective control of *P. minor* than clodinafop, sulfosulfuron and pinoxaden alone and enhanced wheat grain yield by 18%. New herbicide will provide relief to farmers facing multiple herbicide resistance problems. Farmers were satisfied with results of new herbicide. Effective weed control is the key to the success of direct-seeded rice (DSR). A new DSR technique called 'Tar-wattar DSR' saves more than 20% irrigation water compared to puddle transplanted rice and has lesser weed incidence, due to dust mulching. Four demonstrations on Tar-wattar technique were conducted in district Amritsar. In Tar-wattar field was first laser leveled, then pre-sowing (rauni) irrigation applied and field prepared at tar-wattar (good soil moisture) condition and primed rice sown immediately using 'Lucky seed drill' along with application of pendimethalin 750 g/ha. First irrigation was applied at three weeks. Post-emergence herbicide bispyribac-sodium/ fenoxaprop-p-ethyl/ chlorimuron + ethoxysulfuron applied as per weed flora in the field and hand pulling of escaped weeds. In the case of transplanted rice, pretilachlor/butachlor was applied as pre-emergence and bispyribac-sodium / fenoxaprop-p-ethyl / chlorimuron + ethoxysulfuron as post-emergence depending on weed flora in the field and hand pulling of escaped weeds. Averaged over locations, Tar-wattar DSR recorded 87.5% control of weeds which was comparable to puddle transplanted rice (92%). Rice grain yield under DSR was 4% higher than transplanted rice. All farmers were fully satisfied with the new technology.

CCSHAU, Hisar

Demonstrations on the use of glyphosate for Orobanche control in mustard were carried out in 24 ha and 16 ha in Bhiwani and Mahendergarh 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 60-85% (average 70%) control of Orobanche in mustard with yield gain of 25% over untreated control. To show the efficacy of weed management technology in DSR during kharif 2021, twenty-two DSR demonstrations were conducted at farmers' fields in Kaithal, Karnal, Fatehabad, and Sirsa districts of the state. The sowing of the DSR was carried out from the last week of May to the first fortnight of June 2021. The grain yield under DSR varied from 42.5 q/ha to 80 q/ha depending the varieties. The yield under DSR was almost similar to transplanted rice. Under DSR, the infestation of Bakane disease was very less or absent as compared to transplanted rice. Frequent rainfall during flowering and pre-maturity led to yield loss in both transplanted rice and DSR, but more in transplanted rice.

PJTSAU, Hisar

Five front line demonstrations were conducted in rice during *Kharif* 2021 to popularize the integrated weed management technology at Seriguda Bhadraipally village, Kothur Mandal in Rangareddy district, respectively, concerning the technology generated at AICRP on Weed Management. The results showed that IWM involving post-emergence application of Pyrazosulfuron-ethyl pretilachlor 0.615 kg /ha *fb* one hand weeding at 35-40 DAT resulted in efficient weed control in early crop growth stages compared to the farmers' method. Further, the manual labour requirement was less when the farmer adopted the improved practice than the traditional method. This resulted in higher B:C in the range of 2.32 to 2.53 compared to the farmer's method, where B:C of 2.16 to 2.34 was recorded. Five FLDs were conducted in maize during *Kharif* 2021 and the results showed that post-emergence application of tembotrione 120 g/ha + atrazine 500 g/ha as POE resulted in efficient weed control in early crop growth stages compared to the farmers' method. Further, the manual labour requirement was less when the farmer adopted the improved practice than the traditional method. This resulted in higher B:C in the range of 2.0 to 2.13 compared to the farmer's method, where B:C of 1.79 to 1.98 was recorded. Five FLDs were conducted in cotton during *Kharif* 2020?? and the results showed that IWM involving post-emergence application of pyrithiobac-sodium 62.5 g/ha + quizalofop- butyl 50 g/ha POE *fb* inter cultivation at 35 - 40 DAS resulted in equally efficient weed control in early crop growth stages compared to the farmers' method of pendimethalin PE followed by inter cultivation at 15, 30, 45, 60 DAS. This resulted in higher B:C in the range of 1.88 to 2.04 compared to the farmers' method wherein B:C of 1.57 to 1.91 was recorded.

KAU, Thrissur

Four FLDs were conducted at four different locations in farmers' fields on management of broad spectrum weed flora in transplanted rice with the application of a ready mix combination of pretilachlor + bensulfuron methyl, 0.6 + 0.06 kg/ha at 0-6 DAT against bispyribac sodium, 25 g/ha, 15-20 DAS as farmers' practice. The results of the demonstrations showed that the application of premix herbicide pretilachlor + bensulfuron mixture has resulted in more economic benefits to farmers. This is because of the low cost of application of the granular herbicide compared to spraying of bispyribac sodium. Also, the herbicide is applied at right time along with the basal application of fertilizers

SKUAST, Jammu

Two front line demonstrations were conducted in *Rabi* 2020-21 at 8 farmer's fields of different blocks of Jammu region under irrigated conditions. In first front line demonstration, clodinafop-propargyl + metsulfuron (60+4 g/ha) at 30-35 DAS was taken as test treatment and compared farmer's practice (mesosulfuron + iodosulfuron (14.4 g/ha**)** at 30-35 DAS) under zero-tillage conditions. In second front line demonstration, sulfosulfuron + carfentrazone (25+20 g/ha) at 30-35 DAS was taken as test treatment and compared farmer's practice (metribuzin 200 g/ha at 30-35 DAS) under zero-tillage conditions. All the herbicides were applied at 30-35 DAS using 500 L water/ha. In both the FLDs, the lower weed density, higher grain yield and B: C ratio were recorded in test treatments (clodinafop-propargyl + metsulfuron 60 +4 g/ha or sulfosulfuron + carfentrazone 25+20 g/ha at 30-35 DAS) as compared to farmer's practice at all the locations. The new herbicidal interventions i.e. clodinafop-propargyl + metsulfuron 60+4 g/ha at 30-35 DAS or sulfosulfuron + carfentrazone 25 + 20 g/ha at 30-35 DAS recorded 8.97% and 6.36% higher mean yield as compared to farmer's practice (mesosulfuron + idosulfuron 14.4 g/ha or metribuzin 200 g/ha at 30-35 DAS).

MPUAT, Udaipur

Five FLDs on broad-spectrum weed control in wheat with premix application of sulfosulfuron + metsulfuron (30 + 2 g/ha) at 35 DAS were conducted at Vallabhnagar (Udaipur). The farmer's field was infested with *Phalaris minor* among the monocots *Chenopodium album, Chenopodium murale, Convolvulus arvensis* and *Melilotus indica* were observed among dicots. Application of sulfosulfuron + metsulfuron 30+ 2 g/ha at 35 DAS was recorded minimum weed density and weed dry matter as compared to farmers practice with increased the wheat grain yield by 17.6 per cent over farmers practice wheat yield (3380 kg/ha). Also, five FLDs on broad-spectrum weed control in wheat with premix application of mesosulfuron + iodosulfuron-methyl sodium 14.4 g/ha at 35 DAS were conducted at village madar (Udaipur). The farmer's field was infested with *Phalaris minor* among the monocots *Chenopodium album, Malwa parviflora, Melilotus indica, Chenopodium murale* and *Convolvulus arvensis* were observed among dicots. Application of ready-mix herbicide mesosulfuron + iodosulfuron-methyl sodium 14.4 g/ha at 35 DAS was recorded minimum weed density and weed dry matter as compared to farmers practice with increased the wheat grain yield by 7.58 per cent over farmers practice wheat yield (3495 kg/ha). However, in monetary terms, this herbicide combination gave higher net returns. Further, five demonstrations on different herbicide combinations in soybean were conducted at village Jhadole (Udaipur). The farmer's field was infested with *Ecinochloa colona, Commelina bengalensis* and *Cyperus rotundus* among the monocots *Trianthema pertulacastrum* and *Digera arvensis* were observed among dicots. *Parthenium hysterophorus* is a perennial weed and the most problematic weed in the cropped and non-cropped fields. The superior control of weeds was reflected in the growth and yield of soybean. The maximum seed yield (755 kg/ha) and haulm yield (1030 kg/ha) of soybean over farmers' practice was observed with tank-mix application of imazethapyar + propaquizafop 75+75 g/ha at 21 DAS. The maximum net returns (Rs. 15724/ha) were realized with imazethapyr + propaquizafop. No toxicity of herbicide was observed with these combinations. Hand weeding had higher values of an economic threshold than the herbicidal treatments due to higher wages. Herbicidal treatments had lower application costs and thus had lower values of economic threshold. Seven FLDs on weed management in maize through post-emergence herbicide tembotrione was conducted at village Vallabhnagar. Timely and effective weed control will go a long way in gaining crop yields. Traditional hand weeding is the most efficient and widely adopted practice of weed control at farmers' fields. However, it is labour intensive and time-consuming and costly due to high wage rates which narrowed down the profits of the cultivation. The data revealed that the minimum weed density and weed biomass was recorded with the application of atrazine *fb* tembotrione 500 g/ha as PE + 120 g/ha at 3-4 leaf stage (15 DAS) in maize. The highest weed biomass of 8.9 no./m^2 was recorded with farmers practice. The fields were infested with *Trianthema pertulacastrum, Digera arvensis, Ecinochloa colona, Commelina bengalensis, Cyperus rotundus* and *Parthenium hysterophorus* in the cropped and non-cropped fields. Maximum grain and stover yield were recorded with the application of atrazine *fb* tembotrione 500 g/ha as PE + 120 g/ha at 3-4 leaf stage (15 DAS) over farmers' practices and also by increasing 12.23 percent over farmers' practice in respect of grain yield of maize. It also showed mild phytotoxicity symptoms on crop but crop recovered after some days. The combined effect of both herbicides especially in the early and later stages of the crop might have contributed to effective weed control that was reflected by recording lesser weed counts and weed biomass in maize.

IGKV, Raipur

Five FLDs were conducted on direct-seeded rice cultivar IGKV R-1 (Rajeshwari). The weed management technology given to the beneficiary farmers was the application of cyhalofop-butyl + penoxsulam 135 g/ha at 20 DAS. The average yield under the application of demonstrated herbicide was 5.23 t/ha over local check/farmers' practice (4.50 t/ha). There was an overall 16.3 per cent increase in grain yield due to recommended practice over farmers practice with 3.38 B C ratio as compared to 2.73 from farmers' practice.

AAU, Anand

Five FLDs were conducted in soybean during *Kharif* 2021 with treatments viz. propaquizafop 2.5% + imazethapyr 3.75% w/w ME (premix) and farmers practice (imazethapyr 35% + imazamox 35% WG (premix). The results indicated that application of propaquizafop 2.5% + imazethapyr 3.75 w/w ME (premix) 125 g/ha PoE recorded higher WCE and gave higher yield, net return, and B: C (2.39) as compared to farmers' practice. Further, five FLDs were conducted in wheat during *Rabi* 2020-21 with treatments viz. sulfosulfuron 75% + metsulfuron 5% WG (premix) and farmers practice (metsulfuron 20% WP). The results showed that the application of sulfosulfuron 75% + metsulfuron 5% WG (premix) 32 g/ha PoE recorded higher WCE and gave higher yield, net return, and B: C (2.68) as compared to farmers' practice.

GBPUAT, Pantnagar

Fifteen front line demonstrations were conducted in various villages during the *Rabi* 2020-21 in the U.S. Nagar district, Uttarakhand. The treatments were comprised of clodinafop-propargyl 15.3% + metsulfuron-methyl 1% 60+4g/ha applied at 30-35 DAS was taken under improved technology, whereas clodinafop –propargy 15% WP 60 g/ha applied at 25-30 DAS was taken under farmer's practice. The herbicides were applied by using 500 liters volume of water/ha with flat fan nozzle. The area of each FLD was one acre. The major weeds that infested the weedy plots were *Polygonum plebejum, Madicago denticulata, Vicia sativa, Phalaris minor, Rumex acetosella, Solanum nigrum, Melilotus indica, Avena fatua, Lathyrus aphaca, Anagallis arvensis, Coronopus didymus* and *Chenopodium album*. The result showed a 12 per cent increase in grain yield with improved technology over farmer's practice. The higher grain yield 5.6 t/ha, gross return Rs. 107800/ha, net return Rs. 61560/ha, B: C ratio 2.3, and weed control efficiency of 57.5% were recorded with improved technology which was higher than farmer's practice. Also, three FLDs were conducted in transplanted rice during *Kharif* 2021 at farmer's fields in the U.S. Nagar district. The trials comprised cyhalofop-butyl + penoxsulam 135 g/ha (PoE) applied under improved technology, whereas pretilachlor 50 % EC 750 g/ha was applied by the farmer's technology within 3 days of transplanting. The area of each demonstration was one acre. The major weeds that infested the weedy check plots were *Cyperus iria, Echinochloa colona, Paspalum distichum, Eclipta alba, Cyperus difformis, Fimbristylis mileacea, Leptochloa chinensis, Echinochloa crus-galli, Ischaemum rugosum* and *Caesulia auxilaris*. The results indicated an increase of 6.7% higher grain yield with improved technology over farmer's practice. The highest grain yield of 4.8 t/ha, gross return Rs. 93120/ha, net return of Rs. 50491/ha and B: C ratio of 2.18 and weed control efficiency of 50% was recorded with improved technology over the farmer's technology.

Table 4.1 Extension activities undertaken by coordinating centres

Sl no.	Centre Name	Training imparted	Radio talks	TV Programmes	Kishan Mela/ Kishan Day	Handout/ folders /pamphlets	Bulletins /booklet	Training participated	On farms trials	Frontline demonstrations	Parthenium awareness
1	PAU, Ludhiana	7	0	1	2	0	7	4	0	8	1
2	UAS, Bengaluru	13	0	0	1	0	0	1	1	1	7
3	RVSKVV, Gwalior	2	0	0	0	0	0	0	3	2	7
4	GBPUAT, Pantnagar	8	1	0	2	0	0	0	9	2	6
5	CSKHPKV, Palampur	0	2	0	0	0	0	9	19	68	7
6	AAU, Jorhat	12	0	0	0	0	2	0	0	0	0
7	AAU, Anand	17	1	1	0	0	2	3	2	5	3
8	TNAU, Coimbatore	5	2	0	0	0	0	9	5	5	7
9	KAU, Thrissur	4	0	0	0	0	4	9	4	4	0
10	OUAT, Bhubaneshwar	6	0	0	0	0	0	0	4	30	6
11	PJTSAU, Hyderabad	25	4	1	0	0	13	0	0	5	5
12	CCSHAU, Hisar	5	3	0	0	0	3	19	5	0	5
13	IGKV, Raipur	2	0	1	0	0	2	0	8	5	1
14	PDKV, Akola	6	0	0	0	0	0	1	0	0	0
15	BCKV, Kalyani	7	0	0	0	0	0	3	4	0	8
16	MPUAT, Udaipur	9	0	0	0	0	0	1	10	15	3
17	SKUAST, Jammu	3	0	0	1	0	3	0	4	4	1
	Total	**131**	**13**	**4**	**6**	**0**	**36**	**59**	**78**	**154**	**67**

4. RECOMMENDATIONS FOR PACKAGE OF PRACTICES

PAU, Ludhiana

Tar-wattar Direct seeded rice-A novel technique to reduce water footprints in rice cultivation:

- In this technique, field is first laser levelled followed by pre-sowing irrigation and field prepared at tar-wattar condition and primed seed sown immediately preferably using 'Lucky seed drill'. A major departure from earlier practice, dry-DSR, is delayed first irrigation which is applied at 21 days after sowing which results in, 1) more saving in irrigation water, 2) lesser weed problem, 3) reduced incidence of nutrient deficiency, particularly iron, owing to deeper root development, 4) wider adaptability and, 5) comparable rice yield to that of puddled transplanted rice.

Collaboration: Deptt of FMPE; PBG; SWE; CCAM; KVKs Moga, Sangrur, Amritsar, Pathankot, Patiala; PAURRS, Gurdaspur, Bathinda; Tarntaran, FASC Barnala, Kapurthala ,Jalandhar, Fazilka

Weed management in maize using paddy straw mulch:

- Uniform spreading of 3.0 t paddy straw mulch/at sowing provides effective control of annual weeds in maize.

Collaboration: PAU Regional Research Station Gurdaspur

Weed management in marigold (*Tegetes erecta*) through straw mulch and polythene mulches:

- Uniform spreading of 10 ton paddy straw mulch/ha or Silver-black polythene mulch (25 micron) in summer and in rainy season marigold crops provide effective control of weeds.

Collaboration: Deptt of Floriculture and Land Scaping

Modified Lucky Seed Drill with press wheel attachment for enhancing the herbicide efficacy, enhancing profile moisture retention and tackling hard crust (*krand* formation) in DSR.

Collaboration: Deptt of Farm Machinery and Power Engg

Happy seeder with narrow (20cm) tyne spacing for better management of paddy residue and better weed management in wheat

- Happy seeder with narrow tyne spacing (20 cm) provides similar or higher wheat grain yield and higher suppression of weeds as compared to conventional 22.5 cm spaced happy seeder

Weed management in Happy Seeder sown wheat using pre-plant herbicides

- Pre-emergence herbicide (pendimethalin/ pyroxasulfone or pendimethalin plus metribuzin) is mixed with basal dose of Urea and broadcasted uniformly before sowing wheat with Happy Seeder

Collaboration: Deptt of Farm Machinery and Power Engg

Pantnagar

- In maize, application of pre-emergence atrazine 50%WP 0.5- 1.0 kg /ha or diuron 80%WP 0.8kg/ha and application of post-emergence 2,4 –D dimethyl Amine Salt 58% SL 0.5 kg /ha or 2,4-D ethyl ester 38% EC 0.9 kg/ha or 2,4-D sodium salt 80%WP 1.0 kg/ha for control of braod leaf weeds and halosulfuron methyl 70WG 67.5 g/ha for control of sedges weeds. Application of tembotrione 34.4% SC 120 g/ha (PoE) or topramezone 33.6% SC 25.2-33.6 g/ha+ adjuvant 2 ml/l of Water (PoE) for control of grasses, broad leaf weeds and sedges .
- In rice nursery, application of pre-emergence pretilachlor 1.0 kg/ha and application of post emergence penoxsulam 24 SC 22.5 g/ha or bispyribac-sodium 20 g/ha when first leaf of rice has turned green, and in transplanted rice, application of pre-emergence pretilachlor 1.0 kg/ha or anilofos 0.4 kg/ha and application of post emergence Bispyribac-sodium 20 g/ha or penoxsulam 24 SC 20-22.5 g/ha *fb* Almix 4 g/ha as

(post-emergence) to control grassy, sedges and broad leaf weeds. penoxsulam 1% w/w+ cyhalofop-butyl 5% w/w OD 120-135 g/ha (early post emergence) and in directed seeded rice pre-emergence pendimethalin 30 EC 1.0 -1.5 kg/ha, and application of post emergence for control of grassy weeds - cyhalofop-butyl 10% EC at 75-80 g/ha, and for control of broad leaf weeds and sedges metsulfuron methyl 4.0 g/ha at 25-30 DAS and for control of grasses, broad leaf weeds & sedges penosulam 24% SC 22.5-25.0 g/ha (early post emergence) or bispyribac-sodium 20 g/ha or penoxsulam 24 SC 20.0-22.5 g/ha penoxsulam 1% w/w+ cyhalofop-butyl 5% w/w OD 120-135 g/ha as (early post emergence).

- In soybean, application of pre-emergence diclosulam 84%WDG 22-26 g/ha or pendimethalin 30EC 0.75-1.0 kg/ha or pendimethalin 30% + imazethapyr 2% 750+50 g/ha or metolachlor 1.0 kg/ha or metribuzin 0.35 kg/ha and application of post-emergence for control of grassy weeds quizalafop 5%EC 37.5-50 g/ha or haloxyfop R methyl10.5%EC 108-135 g/h, and for control of grasses, broad leaf weeds & sedges Imazethapyr 100 g/ha or Imazethapyr 35% + Imazamox 35% 70 g/ha.
- In groundnut, application of pre-emergence oxyfluorfen23.5% EC 0.1-0.2 kg/ha, and application of post-emergence for control of grassy weeds - quizalafop 5% EC 37.5-50 g/ha or haloxyfop R methyl 10.5% EC 108-135 g/h and for control of grasses broad leaf weeds & sedges Imazethapyr 10% SL 0.1-0.15 kg/ha or imazamox 35%+ imazethapyr 35% WG 0.07 kg/ha or fluzifop-p- butyl 11.1 + fomesafen 11.1 SC 0.25 kg/ha.
- In sugarcane, application of pre-emergence metribuzine 1.0 kg/ha or atrazine 50% WP 2.0 kg/ha or pendimethalin 1.0 kg/ha and application of post-emergence for control broadleaf weeds and sedges, apply 2,4-D diethyl ester 38% EC 1.2-1.8 kg/ha or 2,4-D DMA salt 58% SL 3.5 kg/ha and for control of sedges of *Cyperus rotundus* apply halosulfuron methyl 75% WG 60-67.5 g/ha, and for control of grasses, broad leaf weeds & sedges spray hexazinone 13.2%+ diuron 46.8% WP 1.2 kg/ha (pre emergence or early post emergence).
- In wheat, for control of grasses & broad leaf weeds clodinafop propargyl 15%+ MSM 1% WP 60+4 g/ha or sulfosulfuron 75%+ metsulfuron methyl 5% WG 30.0+2.0 g/ha or mesosulfuron methyl 3% + iodosulfuron methyl sodium 0.6% WG 12+2.4 g/ha or clodinafop propargyl 9% + metribuzin 20%WP 54+120 g/ha or carfentrazon 20%+sulfosulfuron 25% WG 20+25 g/ha at 30-35 days stage of crop.
- In potato, application of pre-emergence pendimethalin 1.0 kg/ha or metribuzin 350 g/ha or oxyfluorfen 23.5 EC 100-200 g/ha and integrated weed management pendimethalin 1.0 kg/ha or metribuzin 350 g/ha or oxyfluorfen 23.5 EC 100-200 g/ha as pre-emergence fb one hand weeding and earthing up at appropriate stage.
- In urdbean moongbean, cowpea & pigeonpea application of pre-emergence pendimethalin 30% EC 1.0 kg/ha or metribuzin 0.35 kg/ha or pendimethalin 30% + imazethapyr 2% 750+50 g/ha as pre-emergence, and in application of post emergence quizalofop 5% EC 37.5-50g/ha or propaquizafop 10%EC 75 g/ha as post emergence. Application of quizalafop-p-butyl at 50 g/ha or haloxyfop 10.8% EC at 108 g /ha at 15-20 DAS followed by one hand weeding at 40-45 DAS.
- In conservation agriculture in rice-wheat system, conventional TPR- ZTW- along with *Sesbania* incorporate as green manure; and integrated weed management viz, post-emergence application of bispyribac-Na 20 g/ha at 20 DAT +1HW at 45 DAD/DAT in rice, and application of ready mix clodinafop+metsulfuron methyl 60+4 g/ha (PoE) with 1 HW at 45 DAS in wheat.

AAU, Anand

- In rice mechanical weeding at 20 and 40 DAS, pretilachlor 30% + pyrazosulfuron-ethyl 0.75% WG (600+15 g/ha) PE (PM) *fb* HW at 30 DAS, penoxsulam 1.02% + cyhalofop-butyl 5.1% OD 120 g/ha EPoE (PM) *fb* HW at 30 DAS and triafamone 20% + ethoxysulfuron 10% WG (44.0+22.5 g/ha) EPoE (PM) *fb* mechanical weeding at 30 DAS.

- Zero tillage with residue followed by zero tillage with residue in cotton.
- Application of pendimethalin 900 g/ha PE *fb* quizalofop ethyl 50 g/ha + pyrithiobac sodium 62.5 g/ha PoE (tank mix) *fb* HW at 60 DAS in cotton.
- Application of pendimethalin 38.7% CS 680 g/ha at 10 DAS in lucerne effectively control the *Cuscuta*, higher green fodder yield of lucerne without any phytotoxicity.
- Fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% (premix) 125 g/ha *fb* IC+HW at 40 DAS and Imazethapyr 35% + imazamox 35% WG 70 g/ha PoE *fb* IC+HW at 40 DAS once equally effective for weed control as IC *fb* HW at 20 & 40 DAS (farmers practice) with higher B:C (2.87, 2.74, respectively) compared to FP (2.66) in summer groundnut OFT.
- Atrazine 50% WP + topramezone 336 g/l SC 500+25.2 PoE (tank mix) and atrazine 50% WP + tembotrione 34.4% SC 500+120 PoE (tank mix) in *Rabi* maize.
- Application of propaquizafop 2.5% + imazethapyr 3.75 w/w ME (premix) 125 g/ha PoE in soybean.
- Sulfosulfuron 75% + metsulfuron 5% WG (PM) 32 g/ha PoE recorded higher weed control efficiency with higher B:C (2.68) as compared to metsulfuron methyl 20% WP 4 g/ha PoE (farmers practice) in wheat FLD.
- IC + HW *fb* PSM 5 t/ha (30 DAP) *fb* HW 75 DAP, IC + HW at 30 DAP *fb* WSM 5 t/ha (30 DAP) *fb* HW at 75 DAP, paddy straw mulch 5 t/ha (0-3 DAP) *fb* HW at 30 and 75 DAP and wheat straw mulch 5 t/ha (0-3 DAP) *fb* HW at 30 and 75 DAP, atrazine 50% WP 500 g a.i./ha + pendimethalin 30% EC 500 g a.i./ha (tank mix) PE *fb* paddy straw mulch 5 t/ha (0-3 DAP) *fb* HW at 75 DAP found effective with higher rhizome yield and B:C of turmeric.
- Oxyfluorfen 23.5% EC 80 g/ha EPoE and propaquizafop 5% + oxyfluorfen 12% w/w EC (PM) 43.75+105 g/ha EPoE for weed management in onion nursery.
- Application of pendimethalin 38.7% CS 580.5 g/ha PPI *fb* oxyfluorfen 23.5% EC 120 g/ha PoE, propaquizafop 5% + oxyfluorfen 12% w/w EC (PM) 43.75 +105 g/ha PoE, pendimethalin 38.7% CS 580.5 g/ha PPI and oxyfluorfen 23.5% EC 120 g/ha PE *fb* propaquizafop 5% + oxyfluorfen 12% w/w EC (PM) 43.75 +105 g/ha PoE found effective with higher bulb yield of onion.

TNAU, Coimbatore

Transplanted rice-rice cropping system

- PE pyrazosulfuron ethyl 10 % WP @ 150 g ha^{-1} on 3 DAT + hand weeding (HW) on 45 DAT.
- Early post-emergence application of bispyripac sodium 40 g ha^{-1} (2-3 leaf stage of weeds) + Hand weeding on 45 DAT

Maize

- In line sown crop, apply PE atrazine @ 0.25 kg/ha on 3-5 DAS followed by Twin Wheel hoe weeder weeding on 30-35 DAS.

Maize - Sunflower

- Conventional tillage (disc ploughing + two harrowing) with PE application of atrazine 0.5 kg /ha for maize and pendimethalin 1.0 kg/ha for sunflower + hand weeding on 45 DAS.

Cotton

- Integrated weed management in cotton: Post emergence application of pyrithiobac sodium @ 62.5g a.i./ha + quizalofop ethyl @ 50 g a.i./ha at 2 to 4 leaf stage or 45 DAS.

Blackgram and greengram

- Pre-emergence application of pendimethalin 0.75 kg on 3 DAS followed by early post-emergence application of Imazethapyr @ 60 g ai/ha on 15 DAE of weeds (2 - 3 leaves stage of weeds) and quizalofop ethyl @ 50 g ai/ha on 20 DAE of weeds (2 -3 leaves of weeds) are recommended for controlling broad leaved and grassy weeds, respectively.

***Solanum elagaenifolium* management in crop fallow fields**

- Post-emergence application of glyphosate 1.5 kg/ha + 2,4-D Na salt 1.25 kg/ha + wetting agent 2 ml litre of water was found to be effective in reducing density and dry weight of *Solanum elagaenifolium* and with no regeneration even after 60 days after herbicide application.

Management of Parthenium

- Application of glyphosate 15 g and ammonium sulphate 20 g and 2ml soap solution or glyphosate 10 g and 2,4 D sodium salt 8 g per litre of water on rosette stage of parthenium

PJTSAU, Hyderabad

Chemical weed management in rice- zero-till maize

- Bensulfuron methyl (0.6%) + pretilachlor (6%) 6.6% GR (ready mix) at 10.0 kg/ha as pre-emergence at 3-5 days after transplanting *fb* bispyribac sodium at 250 ml/ha *as* post-emergence at 20 -25 DAS (2-4 leaf stage of the weed) in *kharif* rice and atrazine 50% WP 2.5 kg/ha + paraquat 24 % SL (tank mix) 2500 ml/ha pre-emergence *fb* tembotrione 33.6% SC @ 287.5 ml /ha at 20-25 DAS (2-4 leaf stage of the weed) as post-emergence in *Rabi* maize (zero tilled or conventional).

Integrated weed management in rice- zero-till maize

- Bispyribac sodium 10% SC 250 ml/ha as early post-emergence at 15 days after transplanting (2-3 leaf stage of weed) followed by hand weeding at 40-45 days after transplanting in *kharif* transplanted rice and application of atrazine 2.5 kg/ha + paraquat (tank mix) 2.5 litres/ha as pre-emergence *fb* hand weeding at 40 DAS for *rabi* zero-till maize.

Non-Chemical weed management in okra-carrot organic cropping system.

Okra (*Kharif*)

- Poly-film (25 micro-metres thickness) followed by intra-row hand weeding at 30 DAS ***or*** inter-row rice straw mulch (5 tons/ha) *fb* Intra row weeding at 30 DAS ***or*** mechanical weeding in inter rows at 20 & 40 DAS *fb* intra-row manual weeding in okra.

Carrot (*Rabi*)

- Rice straw mulch 5 tons/ha (inter-row) *fb* intra-row weeding at 30 DAS or rice husk mulch (3 t/ha) followed by intra-row weeding at 30 DAS carrot.

CCSHAU, Hisar

- Apply triafamone (20%) + ethoxysulfuron (10%) 30%WG (Council Activ 30%WG @ 90 g/acre) as spray at 15 DAT in a water volume of 120 liter/area under saturated moist field conditions to control complex weed flora in transplanted rice. Drain the water from field one day before and apply irrigation in the field one day after spray.

Bhubaneshwar

- In maize, early post emergence application of (tembotrione+atrazine)at (120 + 500) g/ha or topramezone+ atrazine(25+500) g/ha.
- In onion, application of oxyfluorfen(6%)+ quizalofop-p-ethyl(4%) RM 35 g /ha is found to be the best combination in controlling the complex weed flora of onion.

MPUAT, Udaipur

- Application of atrazine 0.5 kg/ha as PE with tembotrione 120 g a.i./ha PoE at either 20 to 25 DAS for weed management in maize.
- Stale Seed Bed technique + plastic mulch (25 micron) at sowing for effective organic weed management in fennel.
- In sweet corn, crop sown with treatment of soil solarization with plastic mulch was found more effective in reduction of weed population and gave maximum green cob yield.

5. SCHEDULED CASTE SUB-PLAN PROGRAMME

Bengaluru

Under Scheduled Caste Sub-Plan, various weed management tools / equipments were distributed to beneficiaries from Hunsepalya, Arepalya, Bailuru, Hosapalya, P.G. Palya villages of Hanuru taluk under Chamarajanagar district. Total of 73 beneficiaries including 17 women farmers were covered during the period. They were provided with 20- cycle weeders, local hand weeding tools of 73-sickles (big), 73-sickles (small), 73-guddali 73-spade and 73-basin to the needy farmers. They were also made aware about the integrated weed management strategies in various crops cultivated by them through use of various pre- and post-emergence herbicides recommended for different crops in integration with use of weed management tools and implements.

Gwalior

Under SCSP scheme, agricultural inputs such as seed (wheat and mustard), fertilizers (urea, SSP) and herbicides (oxyfluorfen and sulfosulfuron + metsulfuron) for one acre area were distributed among 39 farmers and 9 sprayers with battery were distributed among BPL farmers of different villages. One *Krishak Sangoshthi* was also organized in the village Ganpatpura to introduce the SCSP programme in the village with the aim to enhance the socio-economic condition of the farmers.

Pantnagar

Two days training programme on "Weed management in *Kharif* and *Rabi* crops, spraying technology and precautions adopted during spraying" was organized under SCSP scheme. First training was organized on 11.09.2021 in village Chakarpur (Block-Bajpur) and the second training was organized on 15.09.2021 in village Jagdishpur (Block- Gadarpur) in District Udham Singh Nagar in which 50 farmers were participated in each training.

Palampur

Centre organized a training programme on "Weed Management in Integrated Horticulture" in collaboration with RKVY-RAFTAAR at Lajyan (Khaira) and Mashairna under SCSP. They also distributed 50000 grasses root slips of Setaria/Napier to 84 farmers of Burli Kothian Nagrota Bangwan and Mashairna villages. Demonstrations were also conducted in Lajyan Khaira, Mashairna and Burli Kothian Nagrota Bangwan villages where 950 fruit plants of apple, pear, plum, pomegranate, peach, and nectarine were provided to 102 farmers of the villages.

Coimbatore

Under Scheduled Caste Sub Plan, two training programmes on "Integrated Weed Management" were conducted at Chithalamputhur of Virudhunagar district and Therkupetthampatti of Madurai district on 27.08.2021 and 08.10.2021, respectively. Total of 68 farmers attended the training programmes. They were also provided with agricultural inputs such as herbicide, seeds, micro nutrient mixtures and training kit consisting of stationeries, leaf lets and pamphlets about the weed management technologies. At each location, herbicide application techniques were also demonstrated on non-cropped areas. They were explained about the herbicides recommended for different crops and their safe usage, especially for maize and cotton. They were also informed about the ill-effects of Parthenium and its management through herbicides.

KAU, Thrissur

Under SCSP scheme, inputs such as sprayers, turmeric seed, and herbicides were distributed to the 4, 6, 61 farmers, respectively, in villages of Thrissur, Palakkad and Alathur districts of Kerala. Training programmes on "Weed management in rice", "Weedy rice management" and "Herbicide use in rice" were also imparted to 100 farmers of these villages. 25 demonstrations on KAU Weed wiper usage, 10 on cultivation practices of high yielding turmeric variety and 13 on Methods of weed control in rice were conducted in Okkal, kattussery and Vengannur villages of Ernakulam and Palakkad districts.

Bhubaneshwar

Under the scheme, Knapsack sprayer, spade, hand hoe, tarpaulin shit (9' X 6'), Mask (protective gadgets), sickle, Pendimethalin 500 ml (Herbicide) were provided to 50 farm families of Alipingala, Nimapada, and Chenuan Sahi, Denuan of Puri district. Besides, one awareness training programme was also conducted in each village.

Kalyani

Various activities under SCSP Programme were conducted in Sridharpur and Paschim Simulia villages of Ranaghat-II Block during 2021-22 in farmers' field demonstration mode. Considering the fact that replacement of old variety with suitable new one is a better option for getting higher yield, JRO 204 (*Suren*), attaining traits of high yield (36-38 q/ha), green stem, good plant height (4.0 m - 4.3 m), non-branching was taken as component of demonstration with JRO 524 as check. Same practice was applied in both the villages along with use of implements like seed drill, nail weeder. Fifteen farmers covering 2.0 ha of jute area in each of the two villages were benefited under the demonstration.

Farmers' field demonstration on improved crop production technology on jute was conducted in both the villages during the jute season of the year. Improved production practice includes line sowing, chemical weed control with quizalofop ethyl 5% 1.5 ml/L at 20 DAS + one hand weeding after 20 days of herbicide application. In order to improve the socio-economic status of farmers in the ongoing SCSP villages in system based approach, demonstrations on adoption of advanced production technology in succeeding crops of jute were conducted in both the villages during *Rabi*, 2019-20. Economic benefits were showed to the farmers through these demonstrations.

Hisar

Training on "Herbicide spray techniques" was organized in Dher and Kana Khera villages of Fatehabad district and sprayers were distributed to the SC farmers. Another training on herbicide spray techniques was organized at village Mahamadki of Fatehabad District where sprayers were also distributed to the SC farmers.

Udaipur

Scheduled Caste Sub Plan (SCSP) activities were undertaken during *Rabi*, 2021-22 at Sayara, Visma, Madar, Daroli, Vallabhnagar villages of Udaipur and Rajsamand district in which demonstrations, trainings, human resources development programmes were done. Improved crop production technologies have been introduced to the farmers as per package of practices and for these five training camps were organized during *rabi* crop period. To promote small scale mechanization, implements and tools like hood, sprayer and drum for herbicide solution preparation and spray was provided to the SC farmers.

During the *Rabi* season of 2021, demonstration on weed management technologies in wheat, mustard, fenugreek and chickpea were conducted for SC beneficiaries and 293 demonstrations with support of inputs like improved variety seed, herbicides and knapsack sprayers, sprayer nozels, bio-fertilizers etc. were conducted in selected villages of this community. Details of demonstrations are given below.

Table: 5.1 Details of demonstration on weed management technologies

S.No.	Crop	Village	Number of SC beneficiary	Inputs given
1.	Wheat	Vallabhnagar (Udaipur) & Rajsamand	65	Improved variety seed, Total herbicide and knapsack sprayer and flat fan nozzel
2.	Mustard	Visma, Syara, Semar, Daroli, Bhawrasiya (Udaipur) & Rajsamand	148	Seed of improved variety and Sulphur fertilizer
3.	Fenugreek	Rajsamand	40	Bio-fertilizers & Seed of improved variety
4.	Chickpea	Rajsamand	40	Bio-fertilizers & Seed of improved variety
		Total	**293**	

SKUAST, Jammu

Under SCSP scheme, training on weed management in blackgram was conducted and agricultural inputs such as blackgram seed, fertilizer (DAP) and herbicides were distributed to 75 SC farmers of Pandorin village of Jammu district on 17 March, 2021. Besides, knapsack sprayers were also distributed to 100 SC Farmers of this village. Training on weed management in wheat was organized and herbicide viz. clodinafop+metsulfuron was distributed to 100 SC farmers at Upper Chakroi village of Jammu region on 29 Dec, 2021.

6. LINKAGES AND COLLABORATION

Name of the centre	Linkages and collaboration Name of the Institute	Nature of linkage and collaboration
PAU, Ludhiana	NABARD Bayer Crop Science GSP Crop Sci. Pvt. Ltd Syngenta India Ltd	Collaborative projects releted to weed management.
UAS, Bengaluru	Project Co coordinating Unit, AICRP on small Millets Research Institute of Organic farming, UAS, GKVK, Banglaore AICRP on IFS AICRP for dry land agriculture of UAS, Bengaluru Department of Plant and Environment Sciences, UAS, GKVK, Bengaluru KVK Hadonalli, UAS, Bengaluru KVK Hadonalli, UAS, Bengaluru Department of Agriculture, GOK, Chikkaballapur	Conduct large scale demonstrations of weed management technologies on farmers field.
AAU, Jorhat	Rain Forest Research Institute, Jorhat	External Expert in the Ph.D. Research Advisory Committee
	Researchers and students of Different Universities, Colleges and Institutions of NE India	Weed identification
	AICRP on Cropping Systemm AAU Jorhat Center	Weed flora monitoring
	Department of Pharmacology & Toxicology, College of Veterinary Science, AAU, Guwahati	Taxonomic guidance & Utilization of weeds for medicinal uses and drug making
	SHGs, Govt organizations, Tea Industries etc.	Weed biomass utilization for vermicomposting
	Regionsl cum Facilitation Centre- NER (National Medicinal Plants Board)	Weed management in medicinal plant cultivation
	North East Institute of Science & Technology, Jorhat	Weed Utilisation & Management
	World Bank aided Assam Agribusiness and Rural Transformation Project (APART)	To raise productivity, profitability & resource-use efficiencies of rice-based cropping systems in Assam
AAU, Anand	Airport Authority of India (Ahmedabad)	Weed management in airports areas
OUAT, Bhubaneshwar	Department of Agriculture, Govt. of Orissa Department of Horticulture, Govt. of Orissa ICAR Institutes operating in the state (CIFA, CRRI, Tuber Research) Other State Agricultural Universities Herbicide manufacturers NGOs and farmers of different district of our state	Transfer of technology in weed management
CCSHAU, Hisar	IRRI CIMMYT Rice-Wheat Consortium CSISA Australian Council of Agricultural Research	Weed managment technologies line are tested at farmers' fields by extension officers of KVK's and Department of Agriculture
IGKV, Raipur	AICRP- IFS and NPOF 20 Krishi Vigyan kendra's Department of Agriculture, Government of Chhattisgarh	Transfer of technology in weed management

7. Publications

PAU, Ludhiana

Mohammad Shafiq, Simerjeet Kaur, Tarundeep Kaur, M.S. Bhullar and N Chawla (2020) Chemical control of weeds in autumn potato using post emergence herbicides. *Agrilcultural Research Journal* 57 (1):111-114(NAAS rating: 4.71)

Sachin Dhanda, Ankur Chaudhary, Simerjeet Kaur and M S Bhullar (2020) Herbicide resistance in *Rumex dentatus* against metsulfuron herbicide in Punjab and Haryana, India. *Indian Journal of Weed Science* 52 (3): 259-64 (NAAS rating 5.17)

Kaur H and Kaur Pervinder (2021) Comparison of extraction procedures for the determination of mesosulfuron methyl and iodosulfuron methyl sodium from soil and wheat using Response surface methodology. *Microchemical Journal* 168: 106456(NAAS= 9.59).

Hasam, H, Kaur S., Kaur H, Kaur N, Kaur T, Aulakh C S and Bhullar M S (2021). Weed management using tillage, seed rate and bed planting in durum wheat (*Triticum durum* Desf.) under an organic agriculture system. *Archives of Agronomy and Soil Sci*DOI: 10.1080/03650340.2021.1946041. (NAAS = 8.14).

Saini A, Kaur Pervinder, Singh K and Bhullar M S (2021). Influence of soil properties, temperature and pH on adsorption desorption of imazamox in Indian aridisols. *Archives of Agronomy and Soil Sci.*10.1080/03650340.2021. 1925652. (NAAS= 8.14).

Kaur L and Kaur Pervinder (2021) Degradation of imazethapyr in soil: Impact of application rate, soil physicochemical properties and temperature. *International Journal of Environmental Science & Technology* https://doi.org/10.1007/s13762-021-03137-0. (NAAS= 8.54).

Sharma N, Devi S, Kaur P and Sondhia S (2021) Behaviour of bispyribac sodium in soil and its impact on biochemical constituents of rice. *International Journal of Environmental Analytical Chemistry* https://doi.org/10.1080/03067319.2021.1931852(NAAS=7.43).

Kaur T and Bhullar MS (2021). Field evaluation of fluorochloridone for broad-spectrum weed control in carrot (*Dacuscarota* L.) in north-west India. *International Journal of Pest Management* DOI: 10.1080/09670874.2021.1875151 (NAAS = 7.09).

Kaur Pervinder, Gupta S, Kaur K, Kaur Navjyot, Kumar R and Bhullar MS (2021) Nanoemulsion of *Foeniculum vulgare* essential oil: A propitious striver against weeds of *Triticum aestivum*. *Industrial Crops and Products* 168. DOI: 10.1016/j.indcrop.2021.113601. (NAAS = 10.24).

Kaur Pervinder, Shilpa, Kaur H and Bhullar MS (2021) Equilibrium, Kinetic and Thermodynamic Studies on Adsorption of Penoxsulam in Punjab Soils. *Soil Contamination*. DOI: 10.1080/15320383.2021.1992608. (NAAS=7.25).

Kaur H, Kaur N and Bhullar M S. 2021. Germination ecology and management of *Portulaca oleracea* L.- A weed of summer vegetable crops in Punjab. *Agricultural Research Journal* 58 (1): 51-59(NAAS: 5.44).

Kaur Pervinder, Kaur H, Kalsi N and Bhullar MS (2021). Evaluation of leaching potential of penoxsulam and bispyribac sodium in Punjab soils under laboratory conditions. *Internatoinal Journal of Environmental Analytical Chemistry*. DOI:10.1080/03067319.2021.1970148. (NAAS=7.43).

Bains S, Kaur R, Sethi M, Gupta M and Kaur T. 2021. Rice straw mulch mats – biodegradable alternative to herbicides in papaya. *Indian Journal of Weed Science* 53 (3): 275-280 (NAAS= 5.84).

Barua M, Kaur T, Bhullar M S and Gill J S. 2021. Productivity of zero-till wheat (*Triticum aestivum*) under different establishment methods, seed rate and weed control. *Indian Journal of Agricultural*

Science 91 (7): 1001–4. (NAAS= 6.21).

Barua M, Kaur T, Bhullar M S and Gill J S. 2021. Paddy straw mulch effect on microclimate, growth and yield of wheat under zero till sowing in North-West India. *Journal of Agrometeorology* 23 (4):461-464 (NAAS= 6.47).

Gupta M, Rattanpal H S, Singh G and Kaur T. 2021. Chemical weed control in mandarin (*Citrus reticulata* Blanco) CV. kinnow under subtropical conditions. *Agricultural Research Journal* 58 (4):678-684 (NAAS= 6).

HasamH, Kaur S, Sharma N, Kaur T, Aulakh C S and Bhullar M S. 2021. Weed dynamics, grain yield and quality of basmati rice (*Oryza sativa*) under organic agriculture system. *Indian Journal of Agricultural Science* 91 (10): 1505–9. (NAAS=6.21).

Dhaliwal S S, Sharma S, Shukla A K, Sharma V, Bhullar M S, Kaur T, Alorabi M, Alotaibi S S, Gaber A and Hossain A 2021. Removal of biomass and nutrients by weeds and direct-seeded rice under conservation agriculture in light-textured soils of North-Western India. *Plants 10* (11), 2431 https://doi.org/10.3390/plants10112431 (NAAS= 9.39).

Liu C, Bhullar M S, Kaur T, Kumar J, Reddy S R S, Singh M, Kaundun S S. 2021. Modelling the effect and variability of integrated weed management of *Phalaris minor* in rice-wheat cropping systems in northern India. *Agronomy* 11, 2331. https://doi.org/10.3390/ *agronomy* 11112331 (NAAS= 8.60).

Kaur Simarpreet, Kaur Navjyot and Bhullar M S. 2021. Quantification of multiple herbicide resistance in *Phalaris minor* populations of then orth-western Indo-Gangeticplains of India. *Agricultural Research* DOI10.1007/s40003-021-00545-z. (NAAS score:5.95).

Kaur Navjyot, Sethi Renu and Bhullar M S.2020. Weed management in non-cropped areas withpre-mix of indaziflam and glyphosate in Punjab. *Indian Journal of Weed Science* 52 (4): 358-361. (NAAS score: 5.18)

UAS, Bengaluru

S. Kamala Bai, K.K Sindhu, G. Avinash, G. N. Dhanpal and B. V. Krishnamurthy, 2021, Allelopathic Effects of *Alternanthera Philoxeroides* and Tilapia fish on growth of Water Hyacinth (*Eichhornia crassipes)*- pilot study. *The Mysore Journal of Agricultural Sciences*, 55 (2): 51-54. (NAAS: 4.64)

S. Kamala Bai, K.N. Geetha, Sindhu, K.K and Dhanapal, G.N., 2021, Screening of Herbicides for Weed Control in Little Millet (*Panicum sumatrense*) under South Karnataka, *The Mysore Journal of Agricultural Sciences.* 53(4): 150-155. (NAAS: 4.64)

RVSKVV, Gwalior

Gupta V, Sasode DS, Joshi E and Singh Y.K. (2020).Response of non-chemical approaches of weed management in potato (*Solanum tuberosum)* crop under organic cultivation mode. *Indian Journal of Agricultural Sciences.* 90(11), 2076-82.

Gupta V, Sasode DS, Joshi E Tiwari S and Singh YK (2020). Weed flora dynamics and yield of mustard as influenced by tillage and weed management in pearlmillet-mustard-cowpea cropping system. *Indian Journal of Weed Science* 52(3): 254–258, ISSN 0974-8164

Bhadu K, Gupta V, Rawat GS and Sharma J (2020). Comparative performance of pigeonpea (*Cajanus cajan* (L). Millsp.) based intercropping systems with short duration pulses and oilseed crops in gird region of Madhya Pradesh. *International Journal of Chemical Studies* 8(5): 192–194.

Mohaniya LS, Sasode DS and Gupta V (2020). Integrated Weed Management Studies in Potato (Solanum tuberosum L.) Crop. *International Journal of Current Microbiology and Applied Sciences* 9(10): 3475-3486

Gupta V, Joshi Ekta, Sasode D.S. and Kasana B.S. (2020). Nodulation, weed flora and yield of greengram *(Vigna radiata* L.) influenced by use of herbicides. *Indian Journal of Agricultural Sciences,* 90 (7): 1241–44.

Sasode DS, Joshi E, Jinger D, Sasode RS, Gupta V and Singh YK. (2020). Conservation tillage and weed management practices effect on weeds, yield and profitability of cowpea (Vigna unguiculata). *Indian Journal of Agricultural Sciences*, 90 (1), 86-90.

Sasode DS, Joshi E, Gupta V, Singh YK. (2020). Weed Flora Dynamics and Growth Response of Green Gram (*Vigna radiata* L.) to Weed Management Practices. *International Journal of Current Microbiology and Applied Sciences*. 9(4): 365-370

Gupta V, Joshi E, Sasode D S, Singh L, Kasana B S and Singh Y K (2019). The Effect of chemical and non-chemical control methods on weeds and yield in potato (*Solanum tuberosum* L.) cultivation under potato based organic cropping system. *International Journal of Current Microbiology and Applied Sciences.* 8(7): 2737-2747ISSN: 2319-7706

Gupta V, Sharma S, Sasode D S, Joshi E, Kasana B S and Joshi N (2019). Efficacy of herbicides on weeds and yield of greengram. *Indian Journal of Weed Science* 51(3): 262–265.ISSN 0253-8040

CSKHPKV, Palampur

Parita,D. Badiyala and S.S. Rana. 2021. Effect of herbicides on weed dynamics in wheat under mid hill conditions of Himachal Pradesh. Journal of Crop and weed. *Journal* of Crop and Weed, 17(2): 37-41.

Ankit, AD Bindra, S.S. Rana, and Sandeep Manuja. 2021. Effect of integrated weed management on turmeric under mid hill conditions of Himachal Pradesh. *Environment Conservation Journal* 22(3): 96-102.

Sharma R., G. D. Sharma, S. S. Rana, N. Kumar and s. Kumar. 2021. Weed floristic diversity in maize-garlic organic crop production system under mid-hill conditions of Himachal Pradesh. *Journal of Crop and Weed*, 17(2): 211-218.

Gurdeep Singh Malhi , M. C. Rana , Suresh Kumar, Muhammad Ishaq Asif Rehmani , Abeer Hashem and Elsayed Fathi Abd_Allah. 2021. Efficacy, Energy Budgeting, and Carbon Footprints of Weed Management in Blackgram (Vigna mungo L.). Sustainability 2021, 13, 13239. https://doi.org/10.3390/su132313239.

Sharma Neelam, Singh Siddhartha and Sondhia Shobha. 2020. Recent advances in mitigation methods for herbicide residues in the soil, India. *Indian Journal of Weed Science* 52(4): 300-308

Kumar Suresh,Sharma Neelam, Rana SS and Manuja Sandeep 2020. Bio-Efficacy of GOD H007 Formulation in Semi-temperate Undulating Pasture Lands of Himachal Pradesh 2020 *Himachal Journal of Agricultural Research* 46(2) 205-209*NAAS rating*- 3.44

Kumar Suresh, Sharma Neelam, Manuja Sandeep and Bhalla Tamanna. 2021. Bio-efficacy and phytotoxicity of GPH 315 (glufosinate + oxyflourfen) on weeds and tea. *Journal of Crop and Weed*. 17(2): 255-260

Pooja, Kumar Suresh, Sharma Neelam, Manuja Sandeep and Bhalla Tamanna. Efficacy of GOD H007 Formulation on Weeds in Grasslands of Himachal Pradesh 2021 *Himachal Journal of Agricultural Research* 47(1) 95-99

Pooja, Kumar Suresh, Sharma Neelam, Manuja Sandeep and Bhalla Tamanna. 2021. Efficacy of GOD H007 formulation in wastelands of Himachal Pradesh. *The Pharma Innovation Journal*. 10(8): 1426-1429

Kumar Suresh, Sharma Neelam, Manuja Sandeep and Bhalla Tamanna. 2021. Bio-efficacy and phytotoxicity of glyphosate 41% SL on weed flora and its effect on soil microbial activities in non-cropped area. *Journal of Natural Resource Conservation and Management*. 2(1): 81-83.

AAU, Jorhat

Neog, P. P. and Barua, I. C. (2021). Root-knot nematode Meloidogyne incognita reported from upland weeds of Assam. *Annals of Plant Protection Sciences.* 29(1): 76-78

Talukdar,L., Bora, P.C., Kalita, S. and Kurmi, K. (2021). Fodder yield, nutrient uptake and economics of baby corn fodder (*Zea mays* L.) as influenced by date of sowing and row spacing. *International Journal of Agricultural and Environmental Research,* 7(1):225-234. www.ijaer.in ISSN: 2455-6939

TNAU, Coimbatore

Gaesejwe Bagwasi, CR Chinnamuthu, P Murali

Arthanari, C Bharathi, P Malarvizhi and CN Chandrasekhar, 2021.Dissipation dynamics of atrazine in soil under irrigated maize-cowpea cropping system, *The Pharma Innovation Journal* 2021; 10(8): 922-927

Bhanuprakash,C. Sankari, A., Ushanandhini Devi, H.and MuraliArthanari, 2021.Performance Analysis of Bitter Gourd (*Momordica charantia* L.) under Different Training Systems, *Madras Agric.J.,* 2021; doi: 10.29321/MAJ.10.000291 (online first)

Blessy Thambi, KR Latha, P Murali Arthanari and M Djanaguiraman, 2021. Integrated weed management practices in barnyard millet-(*Echinochloa frumentacea*) under irrigated condition, *The Pharma Innovation Journal* 2021; 10(10): 1404-1408

Dhivya S, Kalpana R, Murali Arthanari P and Senthil A, 2021. Effect of non-chemical weed management practices on weed dynamics and yield in organic Okra (*Abelmoschus esculentus* L.), *The Pharma Innovation Journal* 2021; 10(10): 1417-1421

P. Arunjith and P. Murali Arthanari, 2021. Post Emergent NonChemical Formulations for Weed Management in Maize, *Indian Journal of Ecology* (2021) 48(1): 13-17.

Y Lavanya, K Srinivasan, CR Chinnamuthu, P Murali Arthanari, S Shanmugasundaram and CN Chandrasekhar, 2021. Study on effect of weed management practices on weed dynamics and productivity of *Kharif* maize, *The Pharma Innovation Journal* 2021; 10(1): 662-665.

Y Lavanya, K Srinivasan, CR Chinnamuthu, P Murali Arthanari, S Shanmugasundaram and CN Chandrasekhar, 2020. Effect of weed control methods on growth and yield of maize in western zone of Tamil Nadu, *International Journal of Chemical Studies* 2020; SP-9(1): 122-125

Y. Lavanya, K. Srinivasan, C. R. Chinnamuthu and P. Murali Arthanari, 2021. Impact of Weed Management Practices on Yield Attributes, Economics and Phytotoxicity of *Kharif* Maize, *International Journal of Plant & Soil Science 33(9): 42-49, 2021*

M Nandhini, H Usha Nandhini Devi, L Pugalendhi and P Murali Arthanari, 2021. Performance evaluation of sweet potato (*Ipomoea batatus* L.) as weed smothering under coconut ecosystem, *The Pharma Innovation Journal* 2021; 10(10): 1480-1483.

Vinothini, G and P Murali Arthanari, 2021.Nutrients removal by weeds as influenced by the Integrated Weed Management practices in irrigated kodo millet (*Paspalum scrobiculatum* L.), *The Pharma Innovation Journal* 2021; 10(5): 408-411.

C. Supriya, P. MuraliArthanari, R. Kumaraperumal and A. P. Sivamurugan, 2021.Optimization of Spray Fluid for Herbicide Application for Drones in Irrigated Maize (*Zea mays* L.), *International Journal of Plant & Soil Science 33(21): 137-145, 2021.*

P. Janaki and P. Murali Arthanari, 2020. Effect of Conservation Agricultural Practices on Candidate Herbicides Persistence under Maize-Sunflower System in Tropical Indian Conditions, *International Journal of Current Microbiological and Applied Sciences* (2020) *9*(7): 1375-1388.

Bharathi C., P. Murali Arthanari and C. Chinnusamy. 2020. Mitigation of Pendimethalin residues as influenced by the organic sources and bioagents in sandy clay loam soil grown with greengram. *International Journal of Current Microbiological Applied Sciences*.9(12) :1604-1612

Chinnusamy C., C. Bharathi, D. ravishankar, C. Nithya and K. Sivakamy 2020. Agronomic Efficiency of Herbicide Tolerant crops in Peninsular India- A Review. *Journal of Agricultural Science and Technology*. 10(6):317-326. ISSN 2161- 6264

Vikram Kannamreddy, C.R. Chinnamuthu, S. Marimuthu and C. Bharathi. 2020. Effect of Nanoencapsulated Pre-emergence Sulfentrazone Herbicide on soil Microbiome and Nodulation of Irrigated Blackgram (*Vigna mungo* L.) *International Journal of Current Microbiology and Applied Sciences* ISSN: 2319-7706 9(7): 1348-1354

Vikram Kannamreddy, C.R.Chinnamuthu, S. Marimuthu and C. Bharathi. 2021. Synthesizing Nanoencapsulated Sulfentrazone Herbicide and Optimizing Time and Dose for Season long Weed Management in Irrigated Blackgram (*Vigna* *mungo* L.) *Legume Research-An International Journal*. 10.18805/LR-4447(1-8).

Pavithran P., S. Marimuthu, C.R. Chinnamuthu, A. Lakshmanan, C. Bharathi and S. Kadhiravan. 2021. Synthesis and Characterization of Pectin beads for the smart delivery of Agrochemicals. *International Journal of Plant & Soil Science*. 33(22): 136-155.

Tamil Amutham.G, R.Karthikeyan, N.Thavaprakaash and C.Bharathi.2021. Agronomic biofortification with zinc on yield, nutritional quality, nutrient uptake and economics of babycorn. *Journal of Applied and Natural Science*. 13(SI), 80-85.

Sivamurugan A.P., R. Ravikesavan and C. Bharathi. 2021. Evaluation of late maturity maize (*Zea mays*) hybrids under varying plant density and nutrient levels. *Research on Crops* 22 (4):770-777(2021)

IGKV, Raipur

Tiwari, M., Chitale, S. and Tiwari, N. 2020. Energy analysis of berseem (*Trifolium alexandrinum* L.) crop under different weed management practices in Chhattisgarh. *International Journal of Current Microbiology and Applied Sciences* 9(12): 3563-3568 ISSN: 2319-7706 NAAS Rating 5.38(2020)

KAU, Thrsisur

Pai, V.G., Prameela P., and Menon, S.S. 2021. Crop establishment and weed incidence in cowpea under conservation tillage and magnesium nutrition. *Research Journalof Agricultural Science* 12(1): 143-148.

Rashidha, C. K., Mini Sankar, Sreelatha, U., Anupama, T. V. and Prameela. P., 2021 Standardization of soilless growth media for raising potted ornamental foliage plants for export purpose. *Journal of Tropical Agriculture* 59(1): 118-123.

Arya, P. Anitha, S., Menon, M. V., Bindhu, P. S. and Antony, S. 2021. Foliar application of micronutrients on growth and yield of okra under different irrigated conditions. *Journal of Tropical Agriculture* 59(1): 76-82.

OUAT, Bhubaneshwar

R Dash and Mishra M.M. 2021. Effect of weed management practices on growth and yield of potato. *Journal of Research*, OUAT. 16(1). 23-25

Mishra M.M. and R. Dash. 2021. Integrated weed management in black gram. *Journal of Research*, OUAT. 16(2). 37-39.

PJTSAU, Hyderabad

Sanketh GD, KB Rekha, TRamprakash, KS Sudhakar 2021 Bio-efficacy of ready and tank-mixed herbicides in chickpea. *Indian Journal of Weed Science* 53 (3), 307-309

CharithaN., M. Madhavi, G. Pratibha and T. Ramprakash 2021 A Study on Influence of Different Weed Management Practices on Yield and Economics of Rabi Groundnut in Telangana State *International Journal of Environment and Climate Change* 11(9): 9-13

CharithaN., M. Madhavi, T. Ramprakash and G. Pratibha (2021). Effect of Integrated Weed Management Practices in rabi Groundnut on Nutrient uptake by Crop and Nutrient Removal by Weeds. *Chemical Engineering*. v02i04, 70-74. http:// dx.doi.org/10.53709/CHE.2020.v01i01.011

Raviteja B, KP Vani, M Yakadri, T Ramprakash 2021 Effectiveness of Integrated Weed Management Practices on Dry Matter Production and Crop Nutrient Uptake in Machine Transplanted Rice *International Research Journal of Pure and Applied Chemistry*, 78-83.

Bhavitha K, K Suresh, M Madhavi, T Ramprakash 2021 Growth parameters of Maize (*Zea mays* L.) and weed control efficiency of post-emergence herbicides as influenced by quality of spray fluid. *The Pharma Innovation Journal* 2021; 10(9): 387-390

Venkatesh B, YS Parameswari, M Madhavi, T Ramprakash 2021 Performance of herbicides and herbicide mixtures on weed control in transplanted rice. *Indian Journal of Weed Science* 53 (2), 179-181

Yernaidu Y, YS Parameswari, M Madhavi, T Ramprakash 2021 Effect of weed management practices on weed parameters and nutrient removal by weeds in mustard (*Brassica Juncea* (L.) Czerj and Cosson) *The Pharma Innovation Journal*

2021; 10(8): 184-187

Sanketh GD, KB Rekha, KS Sudhanshu, T Ramprakash 2021 Effect of integrated weed management with new herbicide mixtures on growth, yield and weed dynamics in chickpea. The Pharma Innovation Journal 2021; 10(7): 1074-1077

Chaitanya, Y., Padmaja, B., Mallareddy, M and Srijaya, T. 2021. Bioefficacy of new generation herbicides on weed dynamics, crop growth and yield in *rabi* greengram (*Vigna radiata L.*). *The Pharma Innovation Journal*. 10(6): 17-19. (NAAS rating: 5.23).

BCKV, Kalyani

Mondal,A., Mandal,B. Mondal,R., Banerjee, S. and Sengupta, K. 2020. Weed management in spring planted sugarcane growing underWest Bengal situation**.** *Indian Journal of Weed Science* **52**(4): 353–357.

Bhattacharya,U.,Sarkar, S.and Bandopadhyay, P. 2020. Optimum use of Nonmonetary Inputs for Sustainability in Agriculture. *International Journal of Current Microbiology and Applied Sciences*. 9(4):1185-1195. NAAS Score:5.38.

Mukherjee, D. and Mandal, B. 2021. Effect of tillage and herbicide application on broad-leaf weeds andwheat yield under alluvial zone. *Journal of Crop and Weed, 17(1): 165-173*

S. Sarkar, U. K. Sarkar, S. Ali, S. Kumari and M. Puthiyotti (2021). Status, ecological services and management of aquatic weeds of floodplain wetlands in India: An overview. *Lakes & Reserv*. 26 (1):1–16. DOI: 10.1111/lre.12353,

MPUAT, Udaipur

Roshan Choudhary, Arvind Verma, S. K. Sharma, S. K. Yadav, R. K. Jain, Gajanand Jat, R. S. Choudhary and Devendra Jain. 2021. Productivity enhancement of sweet corn (*Zea mays*) through organic weed management practices. *Indian Journal of Agricultural Sciences*. 91(07): 1052–57. NAAS rating: 6.27

B.D. Malunjkar, A. Verma, Roshan Choudhary, R.S. Choudhary, M.K. Kaushik, G.R. Mali (2020). Production of fenugreek (*Trigonella foenum-graecum*) as influenced by weed management practices and vermicompost application *Legume Research – An International Journal*, 45(1): 68-72.NAAS rating: 6.30

S. K Yadav, S K Sharma, Roshan Choudhary, R K Jain and Gajanand Jat Yield performance and economics of wheat varieties under organic farming. *Indian Journal of Agricultural Sciences*. 90 (11): 2225–32. NAAS rating: 6.27

Arvind Verma and Roshan Choudhary 2020. Effect of Weed Management Practices on Weed Growth and Yield of Greengram (*Vigna radiata* (L.) Wilczek) in Southern Rajasthan. *International Research Journal of Pure & Applied Chemistry* 21(20): 12-19.

Shubha, M. R., Choudhary, Roshan., Verma, Arvind, Sharma, S.K. Choudhary, R.S., Jat, Gajanand,Dudi, D.P.S., Yadav, S. K., Jain, R. K. and Mahala, Subhash Chandra 2021 Effect of organic weed management practices on growth parameter, nutrient content and nutrient uptake by baby corn (*Zea mays* L.). *The Pharma Innovation Journal*; 10(9): 1417-1420.

SKUAST, Jammu

Sharma, A., Kachroo, D., Puniya, R., Thakur, N. P., Kumar, A., Mahajan, A., Stanzen, L., Sharma, R., Bhagat, S. 2021. Weed Dynamics and Productivity of Potato as Influenced by Organic Sources of Nutrients and Weed Management. *Agricultural Mechanization in Asia, Africa and Latin America* 52 (1): 2703-2713.

Stanzen, L., Kumar, A., Puniya, R., Sharma, A., Mahajan, A., Kumar, R., Upadhyay, L., Kumar, A., Ali, M. 2021. Influence of Tillage and Weed Management on Growth, Nutrient Uptake and Microbial population in Maize-Wheat Cropping System. *Agricultural Mechanization in Asia, Africa and Latin America* 52 (2): 3385-3392.

Mahajan, A., Kumar, A., Puniya, R., Singh, A. P., Sharma, A., Stanzen, L., Kumar, R., Khajuria, S. 2021. Bioefficacy and phytotoxicity of herbicides in urdbean and their residual effect on succeeding transplanted basmati rice. *Agricultural Mechanization in Asia, Africa and Latin America* 52 (2): 3393-3399.

Different publications by the coordinating centres during 2021-22

Sl. No.	Centre Name	Research Paper	Popular articles	Paper presented/ seminars/symposia/ conferences	Books	Books Chapter	Lecture delivered during training	M.Sc.	Ph.D
1	PAU, Ludhiana	21	0	1	0	2	7	3	4
2	UAS, Bengaluru	2	0	34	0	0	13	0	0
3	RVSKVV, Gwalior	13	14	0	0	0	2	5	8
4	GBPUAT, Pantnagar	0	1	0	0	1	5	5	3
5	CSKHPKV, Palampur	18	0	2	0	0	27	0	0
6	AAU, Jorhat	0	1	6	0	0	36	4	5
7	AAU, Anand	1	2	3	4	4	17	0	0
8	TNAU, Coimbatore	19	4	2	0	1	13	8	10
9	KAU, Thrissur	3	2	10	0	0	9	1	1
10	OUAT, Bhubaneshwar	0	0	0	0	1	0	2	0
11	PJTSAU, Hyderabad	9	3	8	4	4	8	0	0
12	CCSHAU, Hisar	8	5	2	2	2	18	0	0
13	IGKV, Raipur	1	0	0	0	0	0	3	2
14	PDKV, Akola	0	0	0	0	0	0	0	0
15	BCKV, Kalyani	1	1	1	0	0	1	6	4
16	MPUAT, Udaipur	6	6	0	0	0	5	4	4
17	SKUAST, Jammu	0	0	0	0	0	3	0	0
	Total	**102**	**39**	**69**	**10**	**15**	**164**	**41**	**41**

8. AWARDS AND RECOGNITIONS

Centre Name	Award and Recognitions	Venue and Date	Name of the Scientist
GBPUAT, Pantnagar	"Van Mahotsav Divas in Covid-19 Situation" organized by under community development programme in NCC,	R.S.M. (PG) College Dhampur, Bijnor (UP) July 1st to 7th, 2020.	Dr. S.P. Singh
CSKHPKV, Palampur	Member	Editorial Board, Himjyoti, COA, Palampur	Dr. S.S. Rana
	Member	Editorial Board, Parvtiya Khetibari, Directorate of Extension Education, CSKHPKV, Palampur	Dr. S.S. Rana
	Certificate of Excellence in Reviewing 2020 (No. SDI/HQ/PR/Cert/60137/SUR)	Current Journal of Applied Science and Technology	Dr. S.S. Rana
	Certificate of Excellence in Reviewing 2020 (SDI/HQ/PR/Cert/59543/Ind) -	Journal of Experimental Agriculture International	Dr. S.S. Rana
	Awarded Adarsh Vidya Sarswati Rashtriya Puraskar (National Award of Excellence) September 2020-	Glacier Journal Research Foundation, Global Management Council, Ahmadabad	Dr. S.S. Rana
	Associate Editor	Agriculture Letters	Dr. S.S. Rana
	Distinguished Scientist Award 26-27 Feb 2021, at Hyderabad India (www.vdgood.org)	VDGOOD Professional Association [No. 127/1 A1, VDGOOD Professional Association, East Kandasamypuram, Villupuram TN 606107,India]	Dr. S.S. Rana
	Certificate of Excellence in Reviewing 2021 (No. SDI/HQ/PR/Cert/65474/SUR)	Asian Journal of Biology	Dr. S.S. Rana
	Appreciation/Award for outstanding efforts in community service	Rotary International	Dr. S.S. Rana
	Editor, Pahari Section, College Magazine 'Him Jyoti'	COA, CSK HPKV, Palampur	Dr. S.S. Rana
AAU, Anand	Best Centre Award-2020 of AICRP-Weed Management for the year 2020 as "Outstanding All India Coordinated Research Project on Weed Management Award-2020"	18th June, 2021 by the Directorate of Weed Research, Jabalpur in the 28th Annual Review Meeting held online during 18-19 June, 2021.	Dr. B.D. Patel, Agronomist and PI
	Best research award as a Main Researcher for outstanding Research work in Agricultural Science amongst all scientists/faculty of Anand Agricultural University, Anand for the year 2020	Honorable Governorshri of Gujarat and Honorable Chancellor of Anand Agricultural University Acharya Devvratji in the 17th Annual Convocation held on February 4, 2021.	Dr. B.D. Patel, Agronomist
	Best research award as a Co-investigator for outstanding Research work in Agricultural Science amongst all scientists/ faculty of Anand Agricultural University, Anand for the year 2020	Honorable Governorshri of Gujarat and Honorable Chancellor of Anand Agricultural University Acharya Devvratji in the 17th Annual Convocation held on February 4, 2021.	Shri D.D. Chaudhari, Jr. Agronomist

	Best research award as a Co-investigator for outstanding Research work in Agricultural Science amongst all scientists/ faculty of Anand Agricultural University, Anand for the year 2020	Honorable Governorshri of Gujarat and Honorable Chancellor of Anand Agricultural University Acharya Devvratji in the 17th Annual Convocation held on February 4, 2021.	Shri D.D. Chaudhari, Jr. Agronomist, AICRP-Weed Management
	Best popular article Second Rank (Crop Production) published in Krushigovidya,	Directorate of Extension, AAU, Anand for 2020-21.	-
TNAU, Coimbatore	Tamil Nadu Young Scientist Award 2018	Science City, Ministry of Higher Education, Government of Tamil Nadu	Dr.P.Murali Arthanari
	Best Poster Award	At 5th International Agronomy, Congress organized by Indian Society of Agronomy, New Delhi from 23.11.2021	Dr.P.Murali Arthanari


E-Quiz on Van Mahotsav Divas
July 1st-July 7th, 2020
R.S.M. (PG) COLLEGE,
DHAMPUR, BIJNOR (U.P)
Affiliated to :Mahatama Jyotiba Phule Rohilkhand University, Bareilly
वन महोत्सव सप्ताह
CVW9QW-CE000757
E-Certificate of Participation
Date: 7/3/2020
This is to certify that
Dr Shailendra Pratap Singh
Associate Professor
Agronomy, College of Agriculture, GBPUAT, Pantnagar
has successfully participated and qualified with honour grade in awareness online quiz on "Van Mahotsav Divas in Covid-19 situation" organized by under community development programme in NCC, R.S.M. (PG) College Dhampur, Bijnor (U.P) held from July 1st, to July 7th, 2020.
We appreciate the participation and qualifying performance of the participant.
(Col. (Dr.) A. D. Sharma) Commanding Officer 32 UP, NCC BN, Dhampur
(Dr. Ranjan Agarwal) Principal
(Major (Dr.) R. S. Chauhan) Organizing Secretary Department of Agronomy
(Dr. Ravi Dhanker) Quiz Convener Deptt.of Soil Science & Agricultural Chemistry

9. RECOMMENDATION OF AICRP-WM ANNUAL REVIEW MEETING

- Concerted efforts need to be made to find out matching strategies and technologies to combat weed problems under altered agronomic practices like mulching in zero tillage technology, conservation agriculture, organic agriculture and direct-seeded rice
- Studies on weed management in direct-seeded rice should be undertaken by the coordinating centres in a network mode.
- Weedy rice, parasitic weeds, aquatic weeds, alien invasive weeds especially Lanata camara, Parthenium and other obnoxious weeds are also posing threat because of their fast spreading nature in several ecosystems. Therefore, emphasis should be given to find out the technologies to manage these weeds not only in agro-ecosystems but also in other ecosystems. 20
- Multiplication of bio-control agents of Parthenium, Eichhornia and Salvinia may be taken up at relevant centres.
- While reporting weed shift, new appearance of weeds the relative density, IVI and summed dominance ratio should be reported along with the geo-coordinates.
- Weed seed bank and weed biology needs to be studied in long-term experiments.
- Analyze the atrazin content in water bodies like ponds, tube wells, water channels etc.
- While conducting the allotted experiments, all the observations must be recorded as per the approved technical program.
- Weed species name and their spelling needs to be checked and corrected.
- The economic analysis of the experiments should bring out the contribution of the weed management component separately against the overall economics which includes other management practices also.
- The centres should make concerted efforts to publish the research results generated under AICRPWM in high impact journals.
- All the centres must follow the guidelines provided from the head quarter while submitting the information, data, annual report etc.
- The standard guidelines while conducting OFR and FLD should be followed.
- All the centres should work in tune with the recommendations of the QRT (2012-17) and timely prepare the ATR of the general as well centre-specific recommendations.
- The centres shall submit six monthly progress report containing salient findings with one or two data tables and one or two good quality photographs and recommendation emerged out of the study. It has been decided that report of the experiments conducted during Rabi season needs to be submitted within 31st July and report of the experiments conducted during Kharif season needs to be submitted within 31st December. Some other experiments, which are not season bound, can also be clubbed accordingly. As soon as these experiments are completed, the report can be submitted within shortest possible time. As Council has fixed the cut-off date 31st December, therefore, reporting period will be up to 31st December. The AICRP centres can submit their complete Annual Report within 15th January as the date has been fixed earlier.
- While recommending herbicides for weed management to the state government care must be taken to recommend only those herbicides which have label claim in that crop.
- Training and awareness on safe use of herbicide and adoption of advanced techniques for application of herbicide like drone-based application technique need to be strengthened at each centre.
- All the centres shall submit success stories of the promising weed management technologies developed at their place.
- Mobile apps should be developed by each centre in their local language. Copy of all the videos, literature, bulletins generated by the centers should be sent to the PC Unit for uploading in the ICAR-DWR website.
- The centres should submit the AUC in correct format, which was considered while developing the MoU. The next release of funds will be made after getting the AUC in that correct format.

10. STATUS OF EXPERIMENTS CONDUCTED

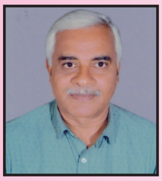
Sl. No.	Centres	WP 1 Development of location specific sustainable weed management practices	WP 2 Management of weeds in non-cropped and aquatic areas	WP 3 Fate of herbicide residues in different agroecosystem	WP 4 Demonstration and impact assessment of weed management technologies	ST Station trials on weed management	Total no. of experiment
1	PAU, Ludhiana	WP1.1.2.4 WP1.2.1.1.7 WP1.3.10 WP1.4.2(i) WP1.4.2(ii)	WP2.1 WP2.1.2 WP2.2 WP2.3.1	WP3.1.1 WP3.2 WP3.3 WP3.4	WP4.1.7(i) WP4.1.7(ii) WP4.2.13(i) WP4.2.13(ii)	-	17
2	UAS, Bengaluru	WP1.1.14 WP1.2.2.2.1 WP1.3.15 WP1.5.3	WP2.1 WP2.1.2 WP2.2	-	WP4.1.2* WP4.2.4*	ST4(i)* ST4(ii)* ST4(iii)	12
3	RVSKVV, Gwalior	WP1.2.2.3.1 WP1.3.9 WP1.5.2	WP2.1, WP2.1.2 WP2.1.3 WP2.2, WP2.3.1	-	WP4.1.3(i), WP4.1.3(ii), WP4.1.3(iii), WP4.2.11	-	12
4	GBPUAT, Pantnagar	WP1.1.9 WP1.1.12* WP1.2.1.1.6 WP1.3.4	WP2.1.1.2 WP2.1.2 WP2.2	-	WP4.1.10* WP4.2.8	ST8*	11
5	CSKHPKV, Palampur	WP1.2.1.1 WP1.3.7	WP2.1.1 WP2.1.2 WP2.2	WP3.1.1 WP3.2* WP3.3* WP3.4*	WP4.1.9* WP4.2.7*	-	11
6	AAU, Jorhat	WP1.1.1.2 WP1.1.1.3 WP1.1.2.1 WP1.2.1.1.3	WP2.1.1.4, WP2.1.1.5, WP2.1.2, WP2.2	-	WP4.1.14(i)* WP 4.1.14(ii)* WP4.2.14*	ST6	12
7	AAU, Anand	WP1.1.1.4* WP1.2.1.5.3 WP1.3.1 WP1.5.1	WP2.1, WP2.1, WP2.1.2 WP2.2 WP2.3.1 WP2.4.1	-	WP4.1.1(i) WP4.1.1(ii) WP4.2.1(i) WP4.2.1(ii)	ST2(i) ST2(ii) ST2(iii) ST2 (iv)	18
8	TNAU, Coimbatore	WP1.1.1.1 WP1.2.1.5.1 WP1.5.3	WP2.1 WP2.1.2 WP2.2 WP2.3.1	WP3.1.1 WP3.2 WP3.3 WP3.4	WP4.1.12 WP4.2.16	-	13
9	KAU, Thrissur	WP1.1.3.7 WP1.3.12(i) WP1.3.13(ii)* WP1.3.14(iii)*	WP2.1.1, WP2.1.1.1* WP2.2	-	WP4.1.11, WP4.2.10	ST5	10
10	OUAT, Bhubaneshwar	WP1.1.2.3 WP1.1.4.1 WP1.2.1.1.1 WP1.3.5 WP1.5.6*	WP2.1, WP2.1.2, WP2.1.3* WP2.2, WP2.3.1*	-	WP4.1.15* WP4.2.15*	ST7	13
11	PJTSAU, Hyderabad	WP1.1.5.1 WP1.1.6.1 WP1.2.1.5.2 WP1.3.2	WP2.1.1, WP2.1.2, WP2.2, WP2.1.3* WP2.3.1*	WP3.1.1, WP3.2, WP3.3, WP3.4	WP4.1.5* WP4.2.5	-	15

12	CCSHAU, Hisar	WP1.1.3.8, WP1.2.1.1.5 WP1.4.1(i), WP1.4.1(ii), WP1.4.4, WP1.5.6	WP2.1, WP2.1.2, WP2.2	-	WP4.1.4(i), WP4.1.4(ii), WP4.2.3(i), WP4.2.3(ii)	-	13
13	IGKV, Raipur	WP1.1.1.10 WP1.1.1.11 WP1.2.1.1.4 WP1.3.11 WP1.5.2	WP2.1.1, WP2.1.1.3, WP2.1.2, WP2.1.3, WP2.2, WP2.3.1	-	WP4.1.6* WP4.2.12	-	13
14	PDKV, Akola	WP1.1.1.12 WP1.1.2.7 WP1.2.1.4.1 WP1.3.16 WP1.5.2	WP2.1 WP2.1.2 WP2.1.3* WP2.2	-	WP4.1.13* WP4.2.9*	ST1	12
15	BCKV, Kalyani	WP1.1.1.9 WP1.1.7 WP1.1.13* WP1.2.1.1.8 WP1.3.6(i)* WP1.3.6(ii)*	WP2.1, WP2.1.2, WP2.2	-	WP4.1.17(i)* WP4.1.17(ii)*	-	11
16	MPUAT,Udaipur	WP1.1.3.1 WP1.1.4.2 WP1.2.2.2.2 WP1.3.8 WP1.5.5	WP2.1.1, WP2.1.2, WP2.1.3, WP2.2, WP2.3.1*	WP3.1.1	WP4.1.8, WP 4.2.6*	ST3(i), ST3(ii)	15
17	SKUAST, Jammu	WP1.1.1.7 (i) WP1.1.1.7 (ii) WP1.1.2.2 WP1.1.11 WP1.2.1.1.2 WP1.3.3 WP1.4.3(i) WP1.4.3(ii)	WP2.1, WP2.1.2, WP2.2, WP2.3.1	-	WP4.1.16, WP 4.2.2	-	14

* Not reported.

11. SCIENTIFIC STAFF

ICAR-DWR, Jabalpur



Dr. J.S. Mishra
Director & Coordinator
AICRP-Weed Management
E-mail: jsmishra31@gmail.com
Director.Weed@icar.gov.in
JS.mishra@icar.gov.in
Mob.: 9494240904, 8409899897

Dr. R.P. Dubey
Principal Scientist (Agronomy)
& Incharge, AICRP-Weed Management
E-mail: Rudra.Dubey@icar.gov.in,
dubeyrp@gmail.com
Mob.: 9425412041

REGULAR CENTRES

PAU, Ludhiana

Dr. M.S. Bhullar
Agronomist & Principal Investigator
E-mail: aicrpwc_pau@rediffmail.com
E-mail: bhullarms@pau.edu
Mob.: 9872811350

Dr. (Mrs.) Parvinder Kaur
Asstt. Residue Chemist
E-mail: pervi_7@yahoo.co.in
Mob.: 9646105418

RVSKVV, Gwalior

Dr. D.S. Sasode
Senior Scientist & Principal Investigator
E-mail: aicrp_wcgwl@yahoo.in;
dsingh.jnkvv@rediffmail.com
Mob.: 09617378979

Dr. Varsha Gupta, Scientist (Agronomy)
E-mail: drvarshagupta11@gmail.com
Mob.: 08368231803

GBPUAT, Pantnagar

Dr. V. Pratap Singh
Professor (Agronomy) &
Principal Investigator
E-mail: vpratapsingh@rediffmail.com;
Mob.: 09411159669

Dr. T.P. Singh, SRO (Agronomy)
E-mail : drtpsingh2010@gmail.com; Mob.: 09411184948
Dr. S.P. Singh, SRO (Agronomy)
E-mail: spdrsingh@gmail.com; Mob.: 09410657005

UAS, Bengaluru

Dr. K.N. Geetha
Agronomist & Principal Investigator
E-mail: aicrpweeds@uasbangalore.edu.in
E-mail: geethagowda@hotmail.com
Mob.: 9945204726
(w.e.f. 6.12.2019)

Dr. Mrs. S. Kamala Bai
Jr. Agronomist (Agronomy)
E-mail: skamalabai@yahoo.co.in
Mob.: 9449804296

AAU, Anand

Dr. B.D. Patel
Agronomist & Principal Investigator
(Up to 31.08.2021)
E-mail: anandweedcontrol@yahoo.co.in,
bdpatel62@yahoo.com;
Mob.: 9978102123

Mr. D.D. Chaudhari
Junior Agronomist
E-mail: ddcsms@gmail.com
Mob.: 9427639492

TNAU, Coimbatore

Dr. P. Murali Arthanari
Associate Professor (Agronomy) &
Principal Investigator
E-mail: dwsrc.cbe@gmail.com,
Mob.: 9443119053

Dr. C. Bharathi, Junior Scientist (Residue Chemistry)
E-mail: cbharathi75@yahoo.co.in;
Mob.: 9994926197

CSKHPKV, Palampur

Dr. (Mrs.) Neelam Sharma
Principal Scientist (Residue Chemistry) &
Principal Investigator (Up to 01.02.2022)
E-mail: sharma_neelam29@rediffmail.com;
Mob.: 9318847457

Dr. S.S. Rana
Asstt. Agronomist
E-mail: ranass_dee@rediffmail.com
Mob.: 9418063225

KAU, Thrissur

Dr. P. Prameela
Professor & Principal Investigator
E-mail: prameela.p@kau.in;
weedsvka@kau.in;
Mob.: 9495739065
(w.e.f. 03.07.2020)

Dr. Sreelakshmi K,
Assistant Professor (Agronomy)
(up to 06.07.2020)

OUAT, Bhubaneswar

Dr. M.M. Mishra
Agronomist & Principal Investigator
E-mail: mishramm2012@gmail.com;
mmmishra2004@yahoo.co.in;
Mob.: 09861066131

Dr. Rabiratna Dash, Jr. Agronomist
E-mail:rabiratnadashouat@gmail.com;
Mob.: 09777535224

PJTSAU, Hyderabad

Dr. T. Ram Prakash
Principal Scientist (Residue Chemist) &
Principal Investigator
E-mail: weedhydap@yahoo.co.in
trp.soil@gmail.com;
Mob.: 9440121398; 7396657949
(w.e.f. 19.12.2020)

Dr. M. Madavi
Principal Scientist & Principal Investigator
(up to 19.12.2020)
Dr. B. Padmaja, Principal Scientist (Agronomy)
E-mail: bhimireddymaduri@gmail.com;
Mob.: 9440040605 (w.e.f. 19.12.2020)

AAU, Jorhat

Dr. Khagen Kurmi
Principal Scientist & Principal Investigator
E-mail: khagen.kurmi@aau.ac.in;
Mob.: 9435350675
(w.e.f. 27.10.2020)

Dr. Iswar Chandra Barua, Principal Scientist (Ecology)
E-mail: iswar_barua@yahoo.co.in;
Mob.: 9435094326
Mr. M.J. Konwar, Jr. Scientist (Agronomy)
E-mail: milonjyotikonwar202@gmail.com;
Mob.: 6901374867
(up to 21.10.2020)

IGKV, Raipur

Dr. Shrikant Chitale
Associate Professor &
Principal Investigator
E-mail: shrikantmadhukarchitale@gmail.com
Mob.: 9425507453

Dr. Nitish Tiwari, Jr. Agronomist
E-mail: tiwarinitish@yahoo.co.in;
Mob.: 09425511028

SKUAT, Jammu

Dr. B.R. Bazaya,
Sr. Scientist (Agronomy)
& Principal Investigator
E-mail: aicrpwmjc@gmail.com;
Mob.: 9419213497

Dr. Ramphool Puniya, Asstt. Professor (Agronomy)
E-mail: ramagron@gmail.com;
Mob.: 9419256071

PDKV, Akola

Dr. V.V. Gaud
Agronomist & Principal Investigator
E-mail: vikasgoud08@yahoo.com;
Mob.: 8637707645
(w.e.f. 1.1.2021)

Dr. J.P. Deshmukh
Associate Professor & Principal Investigator
(up to 1.1.2021)

Dr. S.U. Kakade, Asstt. Professor (Agronomy)
E-mail: snjykakade@gmail.com;
Mob.: 9822225750

CCSHAU, Hisar

Dr. Todar Mal Poonia
Assistant Scientist &
Principal Investigator
E-mail: todarmal.poonia6@gmail.com;
Mob.: 8054121546
(w.e.f. 26.5. 2020)

Dr. S.S. Punia, Sr. Agronomist & Principal Investigator
(up to 28.2.2021)

Dr. Ankur Chaudhary, Jr. Agronomist
E-mail: ankurchaudhary292@gmail.com;
Mob.: (w.e.f 16.9.2020)

BCKV, Kalyani

Dr. Bikash Mandal,
Principal Investigator
E-mail: mbikas12@gmail.com;
Mob.: 09474320873

Dr. Smritikana Sarkar, Jr. Agronomist
E-mail: smritikanasarkar12@gmail.com;
Mob.: 08759377402

MPUAT, Udaipur

Dr. Arvind Verma
Agronomist & Principal Investigator
Email: arnd_verma@rediffmail.com;
Mob.: 09414386206

Dr. Roshan Choudhary
Asstt. Professor (Agronomy)
E-mail:roshan6109@yahoo.co.in;
Mob.: 09887740364

VOLUNTEER CENTRES

SKUAST, Kashmir

Dr. M. Anwar Bhat
Professor & Head (Agronomy)
E-mail : anwaragri@gmail.com;
Mob.: 09419451095, 07006590632

PAJANCOA & RI, Puducherry

Dr. P. Saravanane
Asstt. Professor (Agronomy)
E-mail: psaravanane@rediffmail.com;
Mob.: 09443049653

BUAT, Banda

Dr. Dinesh Sah
Associate Professor (Agronomy)
E-mail: dr.d.sah@gmail.com;
Mob.: 9862567430

SKNAU, Jobner

Dr. Shweta Gupta
Asstt. Professor (Agronomy)
E-mail: shweta.agro@sknau.ac.in;
Mob.: 9983606777

BAU, Sabour

Dr. Birendra Kumar
Assistant Professor (Agronomy)
E-mail: agrobacbr76@rediffmail.com;
Mob.: 09431925801

UAS, Dharwad

Dr. P. Jones Nirmalnath
Professor
E-mail: jones.nirmalnath@gmail.com
Mob.: 09341610193

ANGRAU, Guntur

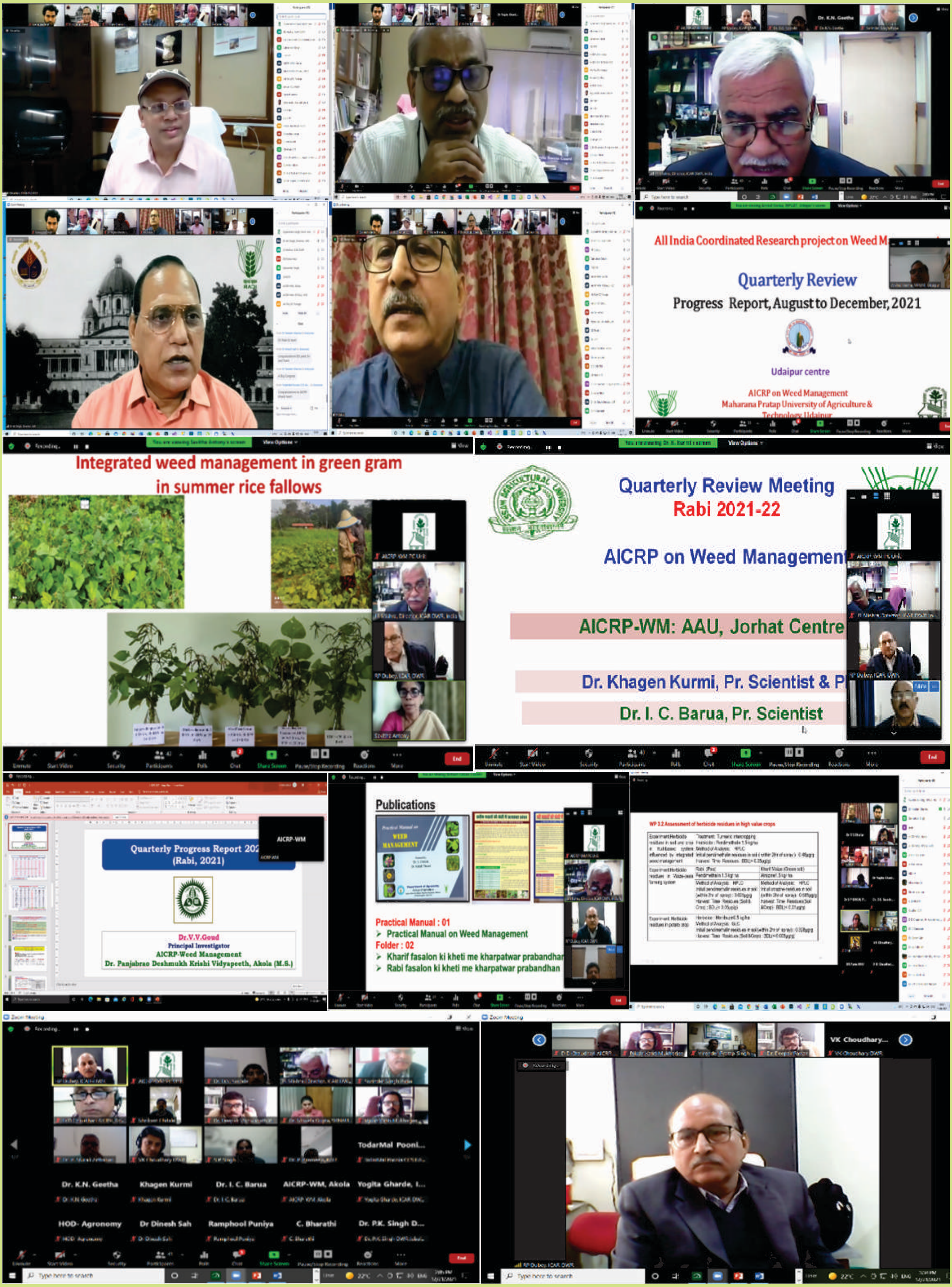
Dr. B. Prameela Rani
Principal Scientist (Weed)
Email: pramilarani_b@yahoo.co.in
Mob.: 8008404875

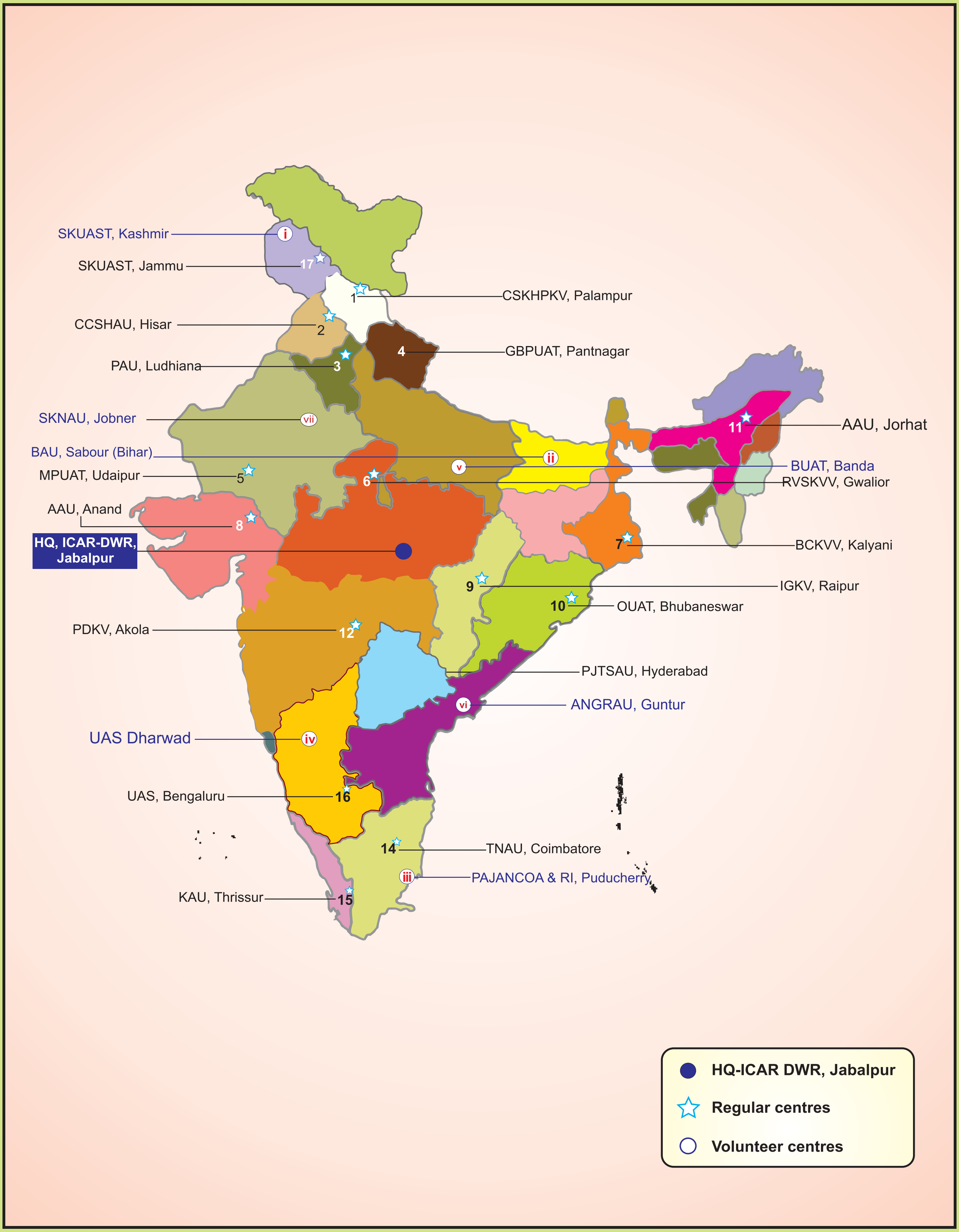
12. STATUS OF SUBMISSION OF ANNUAL REPORT 2021

Sl. No.	Centre's Name	Received	
		Before due date (15.01.2022)	After due date
Regular Centres			
1	PAU, Ludhiana	-	16.01.2022
2	UAS, Bengaluru	-	29.01.2022
3	RVSKVV, Gwalior	10.01.2022	-
4	GBPUAT, Pantnagar	-	31.01.2022
5	CSKHPKV, Palampur	-	31.01.2022
6	AAU, Jorhat	-	01.02.2022
7	AAU, Anand	-	31.01.2022
8	TNAU, Coimbatore	07.01.2022	-
9	KAU, Thrissur	04.01.2022	-
10	OUAT, Bhubaneshwar	-	31.01.2022
11	PJTSAU, Hyderabad	-	31.01.2022
12	CCSHAU, Hisar	-	24.03.2022
13	IGKV, Raipur	-	31.01.2022
14	PDKV, Akola	-	-
15	BCKV, Kalyani	-	24.03.2022
16	MPUAT, Udaipur	-	07.02.2022
17	SKUAST, Jammu	-	04.02.2022
Volunteer Centre			
1	ANGRAU, Guntur	28.12.2021	Not received
2	PAJANCOA & RI Pondicherry	-	20.01.2022
3	BUAT, Banda	-	17.01.2022
4	SKUAST, Kashmir	-	-
5	UAS, Dharwad	-	10.02.2022
6	SKNAU, Jobner	-	-
7	BAU, Sabour		29.01.2022

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 rice
TPR	Transplanted residue
TPR	Transplanted puddled rice
VSD	Variable speed drive
ZT	Zero tillage
ZT+R	Zero tillage + Residue


All India Coordinated Research project on Weed M
Quarterly Review
Progress Report, August to December, 2021
Udaipur centre
AICRP on Weed Management
Maharana Pratap University of Agriculture & Technology Udaipur
Integrated weed management in green gram
in summer rice fallows
Quarterly Review Meeting
Rabi 2021-22
AICRP on Weed Managemen
AICRP-WM: AAU, Jorhat Centre
Dr. Khagen Kurmi, Pr. Scientist & P
Dr. I. C. Barua, Pr. Scientist
Quarterly Progress Report 202
(Rabi, 2021)
AICRP-WM
Dr.V.V.Goud
Principal Investigator
AICRP-Weed Management
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.)
Publications
Practical Manual : 01
Practical Manual on Weed Management
Folder : 02
Kharif fasalon ki kheti me kharpatwar prabandhar
Rabi fasalon ki kheti me kharpatwar prabandhan
WP 3.2 Assessment of herbicide residues in high value crops
Dr. K.N. Geetha
Khagen Kurmi
Dr. I. C. Barua
AICRP-WM, Akola
Yogita Gharde, I...
HOD- Agronomy
Dr Dinesh Sah
Ramphool Puniya
C. Bharathi
Dr. P.K. Singh D...
TodarMal Pooni...
VK Choudhary...


SKUAST, Kashmir
SKUAST, Jammu
CSKHPKV, Palampur
CCSHAU, Hisar
GBPUAT, Pantnagar
PAU, Ludhiana
SKNAU, Jobner
AAU, Jorhat
BAU, Sabour (Bihar)
BUAT, Banda
MPUAT, Udaipur
RVSKVV, Gwalior
AAU, Anand
HQ, ICAR-DWR, Jabalpur
BCKVV, Kalyani
IGKV, Raipur
OUAT, Bhubaneswar
PDKV, Akola
PJTSAU, Hyderabad
ANGRAU, Guntur
UAS Dharwad
UAS, Bengaluru
TNAU, Coimbatore
PAJANCOA & RI, Puducherry
KAU, Thrissur
HQ-ICAR DWR, Jabalpur
Regular centres
Volunteer centres