अखिल भारतीय समन्वित खरपतवार प्रबंधन अनुसंधान परियोजना

All India Coordinated Research Project on Weed Management

वार्षिक प्रतिवेदन
ANNUAL REPORT
2015 - 2016

भाकृअनुप – खरपतवार अनुसंधान निदेशालय

ICAR - Directorate of Weed Research

जबलपुर, मध्यप्रदेश

Jabalpur, Madhya Pradesh

ISO 9001:2008 Certified

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All India Coordinated Research Project
on Weed Management

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Annual Report
2015-16

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Jabalpur, Madhya Pradesh
ISP 9001: 2008 Certified

Correct citation: Annual Report 2015-16. AICRP-Weed Management, ICAR-Directorate of Weed Research, Jabalpur, 116 p.

Published by

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Published in
June, 2016

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Cover page photographs

Left to right : 1. XXII Annual Review Meeting of AICRP-WM held at PJTSAU, Hyderabad during 17-18 October, 2015 2. Onion crop infested with *Cuscuta* spp. 3. Infestation of *Orobanche cernua* in tobacco 4. Activity of *Neochetina bruchi* weevils 5. Infestation of *Mikania* spp. in banana 6. Atrazine 0.5 kg/ha *fb* 2,4-D 0.5 kg/ha as post-3mergence in maize

Preface

All India Coordinated Research Project on Weed Control (AICRP-WC) was launched in 1978 to undertake systematic research on weed management in the country. Initially, there were 6 centres in different parts of the country, which grew to 23 centres in 2014, almost in all the Agricultural Universities of the country. Over the last 38 years, vast information relating to weeds in different cropped and non-cropped situations, management practices, herbicide residues and utilization aspects of weeds has been generated. Location-specific improved technologies on weed management have been developed and adopted in large areas throughout the country. We can claim that weed management technologies are now available for almost all crops and cropping systems as well as for non-cropped situations which have the potential to increase productivity and profitability, and ensure environmental sustainability and biodiversity.

Several initiatives were taken since 2012 to improve and strengthen the research programmes on weed management under this project. The recommendations made by the Quinquennial Review Team (2006-12) were also effectively implemented. Nodal Officers were identified for providing technical guidance, monitoring and evaluation of the work done at difference centres. Norms of the ICAR for posting of staff and release of funds were followed. Collaborations were initiated with other AICRPs at the same University. On-Farm Research was given greater emphasis and impact assessment of weed management technologies was updertaken.

The proposals for the XII Plan in terms of infrastructure development, contingencies, staff restructuring and new research programmes were approved with a nearly two-fold increase in the budget compared with the XI Plan. Five low-performing centres at VNMKV, Parbhani; CSAUAT, Kanpur; V.B., Sriniketan; RAU, Bikaner; and UAS, Dharwad were closed, while new centres were opened at MPUAT, Udaipur; UAS, Raichur; SKUAST, Jammu; CAU, Pasighat and PDKV, Akola. The name was also changed to AICRP on Weed Management considering the utilization aspect of weeds for beneficial purposes.

I express my sincere gratitude to Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR; Dr. S. Ayyappan Ex-Secretary, DARE and Ex. Director General, ICAR; and Dr. A.K. Sikka, Deputy Director General (NRM) for providing constant encouragement and guidance. I am also thankful to Dr. S. Bhaskar, Assistant Director General (Agronomy, Agroforestry and Climate Change) and Dr. B. Mohan Kumar, former Assistant Director General for their keen interest and support in running the project. I thank Dr. Shobha Sondhia, Incharge, AICRP-WM for help in running the project activities. Thanks are also due to the Nodal Officers i.e. Dr. P.K. Singh, Dr. Sushil Kumar, Dr. R.P. Dubey, Dr. Bhumesh Kumar; Dr. P.J. Khankhane and Senior Technical Officers, Mr. O.N. Tiwari, Mr. Pankaj Shukla, and Assistant Chief Technical Officer, Mr. Sandeep Dhagat.

This report contains consolidated information on the research achievements and other activities related to teaching, training and extension undertaken at all the regular and volunteer centres of the project during the period from January to December, 2015.

I hope this document will be useful to all our stake holders including the scientist and teachers at various ICAR institutes and SAUs, development officer of state agriculture departments, NGOs, herbicide industry, and other public and private sector organisations concerned with weed management in the country.

Comments and suggestions are welcome for our consideration and further strengthening of the activities.

Date: 30.06.2016
Place: Jabalpur

(A.R. Sharma)

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- tkjgkV dUn e] Xyk;QklV ifrjk/kh pk; [kjirokj *fM;kfUFk;e ,lhfey* dk idki mRrj&ioh {k= d cjkd oyh df"k tyok; {k= e ifgy l fpfUgr 30 fdeh- dh gokb njh e c< jgk gA *iuhde fjiUl* ij Xyk;QklV dk fNMdko bld tfVy xgj dn ij iHkkodkjh ugh ik;k x;kA frulfd;k fty d lfn;k mlHkkx e *bylkbu bfMdk* vkj *vejUFkl Likbukll* [kjirokjk dh ifrjk/kdrk eVhC;ftu d ifrnr dh xb gA
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- *Qyfjl ekbuj* vkj pkMh iRrh oky [kjirokjk d li.k fu;=.k gr iUMheFkfyu 100 xk-@g- ¼vdj.k io½ rnUrj DykfMukQku 60 xk-@g-] lYQklY¶;jku 25 xk-@g-] eh tklY¶;jku$vkbMklY¶;jku ¼jMhfeDl½ 14-4 xk-@g- ;k ihukDlkMu 50 xk-@gdk- cckb d 35 fnu ckn vudfed i;kx dju ij iHkkodkjh ik;k x;k gA Åij of.kr 'kkdukf'k;k d vudfed mi;kx d ifj.kkeLo:i xg d nkuk dh mit e vdj.k i.k i;kx fd; x; 'kkdukf'k;k dh ryuk e l/kkj ik;k x;kA ykHk ykxr vuikr Hkh 0-07&1-10 l 1-14&1-16 T;nk ik;k x;kA iUMheFkfyu 1000 xk-@g- dk vudfed l;ktu iUMheFkfyu 1500 xk-@g- d rY; ik;k x;kA

- *lkbil jkVUMl* d fu;=.k gr Xyk;QklV 1-5 fd-x-@g- vf/kd iHkkodkjh ik;k x;kA flQ Xyk;QklV ;k 2]4&Mh d lkFk l;ktu u dju ij [kjirokj e iutuu deh ikb xbA
- *lkbil jkVUMl* d fu;=.k gr 2]4&Mh ,ekbu lkYV 125 xk-@g- vkj XykbQklV 750 xk-@g- dk vudfed mi;kx dju ij lcl T;knk iHkkodkjh ik;k x;k gA
- xgj ikuh e lh/kh cckb /kku e] fcgkj e njHkxk vkj e/kcuh ftyk e txyh /kku dk xlu ik;k x;k gA [krk e txyh /kku dk iHkko *vkjkbtk :Qhikxku* 7 *vkjkbtk LikUVfu;k* d dde e ik;k x;kA
- *Vk;uFkek ikjVyDlVe* cgr gh de le; e yxHkx 45 fnu e x.kkRed nj l of) djrk g ,o ;g 7000 cht ifr ik/k mRiUu djrk gA *,cVhyku bUMhde* 100 fnuk e viuk thou pd ijk djrk gA

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- jkfir /kku e bFkkDlhlY¶;jku 18-8 xk-@g- DykjhE;jku $ eVlY¶;jku 4 xk-@g- ;k ,thelY¶;jku 20 xk-@g- Vd feDl fclik;jhcd lkfM;e 25 xk-@g- ;k iVhykDykj 750 xk-@g- d vudfed i;kx d lkFk pkMh iRrh oky [kjirokjk vkj ltl d lkFk xkldy d [kjirokjk ij jkfir /kku e iHkkodkjh fu;=.k d lkFk ohM Qh lykV dh ryuk e egRoi.k /kku dh mit ,oa ykHk ykxr vuikr nt fd;k x;kA
- jkfir /kku e vdj.k i'pkr fiukDlye$ lkbgykQki C;Vkby ¼135 xk-@g-½ d feJ.k vkj i.MheFkfyu 1000 xk-@g- d dfed mi;kx rnkijkr fclik;jhcd lkfM;e ¼25 xk-@g-½ vdj.k i'pkr mi;kx dju ij /kku dh mPpre mit ikIr dh xbA
- gnjkckn e] epkvk /kku e] ;k rk ik;jktklY¶;jku bFkkby 20 xk-@g- cckb d 8&10 fnu ckn rnkijkr euvy fujkb cckb d 40 fnu ckn ;k ik;jktklY¶;jku bFkkby rnkijkr vthelY¶;jku 35 xk-@g- cckb d 25&30 fnu i'pkr ;k cckb d 20 vkj 40 fnu ckn gkFk }kjk nk ckj fujkb dju ij vkfFkd :i l /kku dh vf/kd mit ikIr dh xbA
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- l[kh lh/kh cckb /kku e] ik;jktlY¶;jku bFkkby 20 xk-@g- cckb d 3 fnu ckn rnkijkr fclik;jh cd lkfM;e 25 xk-@g- cckb d 25 fnu ckn ;k gkFk }kjk fujkb ¼cckb d 45 fnuk ckn½ vkj iukDlye $ lkbgykQki ¼jMh feDl½ 135 xk-@g- cckb d 15 fnu ckn] nkuk dh mit rhu ckj gkFk }kjk fujkb 20] 40 vkj 60 fnuk cckb d i'pkr d rY; ik;k x;kA

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- gYnh e] eVhC;ftu 700 xk-@g-] i.MheFkfyu 1000 xk-@g- ;k ,Vkftu 750 xk-@g- rnkijkr ivky l efYpx $ cckb d 75 fnuk ckn gkFk }kjk fujkb dju ij lcl vPNk iHkkodkjh mipkj ik;k x;kA
- yllu e] pkMh iRrh oky [kjirokjk vkj ltl ij iyokj 5 Vu@g- fcuk ivky d efYpx dju ij egRoi.k iHkko ik;k x;kA yglu dh mPpre vkj vFki.k mit ¼29-5 fDo-@g-½ fcuk ivky d efYpx dju dh vi{kk eYp eVfj;y d lkFk ikIr dh xbA iUMheFkfyu ¼1-0 fd-xk-@g-½ ;k vkDlh¶ykjQu ¼0-223 fd-xk-@g-½ nkuk dk vdj.k io mi;kx dju ij ryukRed :i l yglu d cYc dh mit vf/kd ikIr dh xbA

- yglu e vkDlkMk;jfty 140 xk-@g- rnkijkr vkDlh¶ykjQu 0-223 fd-xk-@g- dk mi;kx dju ij yglu d cYc dh vFki.k mPprj mit d lkFk ykHk ¼ ykxr vuikr ikIr fd;k x;k tk fd euvy fujkb d led{k ik;k x;kA
- vnjd e vdj.k vku d ifgy XykbQkIV 0-80 fd-xk- $ vkDlh¶ykjQu 0-2 fd-xk-@g- dh nj l mi;kx dju ij [kjirokjk d fu;=.k gr vf/kd iHkkodkjh ik;k x;k rFkk vnjd d dn dh vf/kdre mit ¼29 V-@g-½ 'k) ykHk ¼:- 9]52]230½ vkj ykHk ¼ ykxr vuikr ¼4-59½ nt dh xbA

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- vdj.k io betFkkik;j $ betekDl ¼jMhfeDl½ dk mi;kx dju ij ex dh Qly e fo"kkDr iHkko ik;k x;k yfdu vkxkeh ljlk dh Qly e bldk dkb vof'k"V fo"kkDr iHkko ugh ik;k x;kA
- betFkkik;j vkj jMhfeDl betekDl dk l;ktu i;kx 60&80 xk-@g- dju ij *Vk;,uFkek ikjVyDlVe* [kjirokj dh pkj ifRr;k okyh voLFkk e iHkkokRikndrk n[kh xbA
- mMn e] vdj.k d io betFkkik;j $ i.MheFkfyu 100 xk-@g- dh nj l fNMdko dju ij [kjirokjk d 'k"d Hkkj e deh vkj mPpre [kjirokj fu;=.k n{krk ¼97-9 ifr'kr½ d lkFk mPpre mit ¼1407 fd-xk-@g-½ ik;k x;kA

MCY;-, l-3-5 dikl esa [kjirokjksa dk ,dhdr ikc/ku

- dikl e] vdj.k d io iUMheFkfyu 1-0 fd-xk-@g- dh nj l mi;kx dju ij *Vk;uFkek ikjVyDlVe* vkj *bdkbukDykvk dkykuk* ij iHkkodkjh fu;=.k ik;k x;k ,o bldk iHkko dikl e cckb d 90 fnuk rd ik;k x;kA
- Xyk;QkIV ¼0-5 ifr'kr½ dk lj{kRed fNMdko ,o bldk iUMheFkfyu vkj ijkDokV ¼0-3 ifr'kr½ rFkk ikfFk;kcd&lkfM;e rnkijkr fDotkykQki& ih&bFkkby d lkFk ,dhdr dju ij rhu ckj ;kf=d fof/k;k }kjk fujkb dju d rY; ik;k x;k vkj [kjirokjk dh l[;k vkj 'k"d Hkkj ¼cckb d 90 fnuk ckn½ ohMh pd dh ryuk e vFki.k iHkko ik;k x;kA

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MCY;-, l-3-7 fofHkUu Qlyh; pØksa esa ycch vof/k oky 'kkdukf'k;ksa dk iHkko

- Xkg e ohMh pd lykV e gjh [kkn vkj fcuk gjh [kkn dh ryuk e gjh [kkn e *Qyfjl ekbuj* dh l[;k vf/kd ikb xb ¼213@eh²½ tcfd fcuk gjh [kkn e ;g ek=k ¼130@eh²½ nt dh xb] tcfd gjh [kkn oky lykVk e pkMh iRrh oky dh l[;k ¼130@eh²½ ,o fcuk gjh [kkn e ¼163@eh²½ nt dh xbA fglkj e *Qyfjl ekbuj* d fu;=.k gr DykfMukQki 'kkduk'kh dk fujrj mi;kx dju l vHkh rd dkb ifrjk/kdrk ugh ikb xbA

- C;VkDykj dk yxkrkj nk _rvk rd mi;kx dju ij f='kj dUn e 'kkduk'kh vo'k"k dk dkb iHkko enk vkj nkuk d ueuk e ugh ik;k x;kA
- Ykf/k;kuk e /kku&xg Qly pd e nh?kdkfyd i;kx 31 o"k rd dju e 2&8 o"kk e xg e [kjirokjk dh ixfr;k c< xbA *Qyfjl ekbuj* d fu;=.k gr 'kkduk'kh lYQklY¶;jku] DykfMukQki vkj iUMheFkfyu iHkkoh ik;k x;kA bu 'kkdukf'k;k dk 2]4&Mh d lkFk ,dhdr dju ij *Ih- MhMhel] ,Q-ikoh¶ykjk* vkj *Ih- ,Yce* ij fu;=.k dju dh {kerk c<h ikb xb tcfd eVlY¶;jku l ,dhdr dju ij *vkj- MUVkVl* ij Hkh fu;=.k ik;k x;kA /kku e [kjirokj itkfr;k dh l[;k 2 lo"kk e c<h ikb xbA Mh- ,thflV;e ,du;k [kjirokjn[kk x;kA

MCy ,l 4 leL;kdkjh [kjirokjkd dk fu;=.k

- betFkkik;j 30 xk-@g- dk jki.k d 40 fnuk d mi;kx l rEckd dh ifRr;k ij iHkko iMkA ik/k l[k x; vkj iRrh;k ugh vk;hA *vkjkcdh* d ru 60 vkj 90 fnuk e jki.k d ckn mRiUu g; vkj nlj ijh{k.kk dk rEckd ij dkb iHkko ugh ikIr gvkA
- rEckd dh vf/kd mit ½2-45 Vu@g-½ vkj vkjkcdh ruk d /kuRo e deh cckb d le; uhe dd 200 fd-xk-@g- vkj ik/k jki.k d 20 fnuk d ckn eVkyDly ,e-tM 0-2 ifr'kr l enk dk xhyk dju l ikIr gbA ik/k jki.k d 40 fnuk d ckn betFkkik;j 30 xk-@g- dk mi;kx dju l rEckd dh ifRr;k e fo"kkDrk ik;h xbA ik/k dh c<r xHkhj :i l :d xb] iRrh;k dk vkdkj ?kVu l mit e deh vkbA
- vdj.k d io iUMheFkyhu 0-5 fd-xk-@g- jr feDpj d rjg mi;kx dju l ylu d ik/k xHkhj :i l iHkkfor g;A chMh pd dh ryuk e vdj.k d i'pkr betFkkik;j 40 xk-@g- cckb d 20 fnuk d ckn *dldVk Vou* d fu;=.k e iHkkodkjh ik;k xk; fdr vU; ijh{k.kk l dldVk fu;=.k ugh gvkA
- betFkkik;j dk 75 xk-@g- LVycM d lkFk vkj cxj LVycM d fo"kkDr iHkko cjlhe e n[kk x;k rFkk bll cjlhe dk vdj.k ,o ck< e Hkh deh ik;h xbA *dldVk* dh xHkhj leL;k vDVcj vkj ekp&viy e n[kh xbA cjlhe dh mit e 5&10 ifr'kr deh n[kh xbA
- v[kjkV] vthj vkj uhc dk NkMdj etokj ijthoh e dikl dh iVVh e dkij lYQV $ 2]4&Mh lkfM;e lYQV l ijthoh [kjirokj dk lrk"k tud fu;=.k ik;k x;kA phd d cxhpk e dikl dh iVVh d lkFk 4 xk- dkij lYQV $ 0-5 xk- 2]4&Mh lkfM;e lkYV 30 vkj 60 fnuk e Mkyu ij *MUVk¶Fkh QydV* e deh ik;h xbA bl if'k{k.k l phd e fo"kkDrk ugh ik;h xb vkj ijthoh dk fu;=.k Hkh lrk"k tud FkkA

MCy ,l 5 'kkduk'kh vo'k"k vkj i;koj.k xl.koRrk

- f=lj e Qly dh dVkb d ckn vnjd e iMheFkyhu vkj vkDlh¶ykjQu d vo'k"k ugh ik;; x;A vdj.k d io d 'kkduk'kh dk ijkDokV d lkFk fcuk trkb dh eDdk dh enk e i;kx dju d 60 fnu d ckn ,Vkftu d vo'k"k enk e ik;; x;A /kku dh Qly dh dVkb d ckn enk e ik;; x;A /kku dh Qly dh dVkb d ckn enk dh mojdrk vkj mlh Hkkfrd jklk;fud x.k e dkb egRoi.k cnyko ugh vk;kA
- jch e 20 LFkkuk e l 9 ueuk e lYQklY¶;jku vkj ehlk $ vk;MklY¶;jku d vo'k"k 0-011 l 0-048 ekbdkxke@xke rd enk e ik;; x;A [kjhQ e 21 e l 9 ueuk e iVhykDykj d vo'k"k 0-004 l 0-024 fe-xk-@xk- enk e ik;; x;A /kku e ifVykDykj d vo'k"k 21 e l 3 ueuk e Hkl e ifVykDykj d vo'k"k 0-014 l 0-089 fe-xk-@xk- fglkj e ik;; x;A
- dVkb d le; vkDlh¶ykjQu d vo'k"k enk vkj l;kt e ugh ik;; x;A vifjiDo vkj ifjiDo eDdk] LVk vkj enk e VeckVjhvku eVkckykbV ¼,b 417268½ dVkb d le; ugh ik;; x;A
- /kku e i.MheFkyhu ¼0-066 ekbdk xk-@xk-½ d vo'k"k tM-$Mh-,l-vkj-$vkj-&tM-Vh-MCY;-$¼vkj-½ e ik;; x;A vU; nlj ijh{k.kk e /kku e vo'k"k ugh ik;; x;A LVk d ueuk e i.MheFkyhu Mh-,l-vkj- ijh{k.kk 0-007 l 0-059 ekbdkxk-@xk- ifjofrr gvkA
- lkruxj e *jch* vkj *[kjhQ* d ekle e fdlkuk d [krk e 2]4&Mh d vo'k"k tyh; fudk;k e ugh ik;; x;A

MCY;-,l-6 d"kd i{k= ij 'kk/k

- VDlkVhvku 'kkduk'kh d i;kx l 92 ifr'kr *lkbil jkVUMl] cfdvkfj;k jiVkUl] deyhuk cU/kkyfUl] fMftVfj;k lXokyfUl] lkjke gYiUl vkj bylkbu bfMdk* [kjirokjk dk fu;=.k ik;k x;k tk fd fdlkuk }kjk ,Vkftu d mi;kx dju ij Hkh ugh gkr FkA
- vklru 18 {k=k e lYQklY¶;jku $ DykfMukQki ¼Vh-,e-½ $ 25 $ 60 xk-@g- lYQklY¶;jku $ eVlYQk&lY¶;jku ¼vkj-,e-½ 32 xk-@g-] elk$ vk;MklY¶;jku ¼vkj-,e-½ 14-4 xk-@g- vkj

fiukD tkMu 50 xk-@g- l ftll 84&88 ifr'kr rd *Qyfjl ekbuj* ij fu;=.k fd;k x;k vkj dkb Hkh fo"kDr xg dh Qly e ugh n[kh xbA

- fllnojh xko e 6 d"kd i{ki in'kuk e lh/kh cokb dh /kku 60 fdxk-@g- dh cht nj d lkFk ik;jktklY¶;jku 20 xk-@g- l mit e 24-8 ifr'kr fdlkuk dh i)fr l vf/kd ikIr gb blh idkj ykHk ykxr vuikr 2-76 vkj 2-36 ikIr gvkA
- jfMfeDl d lkFk ifVykDykj $ ik;jktklY¶;jku l 92-6 ifr'kr tfVy [kjirokj ouLifr dk fu;=.k fd;k x;k ftll mit e 6-25 ifr'kr dh of) fdlkuk dh rduhdk dh ryuk e gbA
- vdj.k d i'pkr XykbQklV 25 xke@g- 30 fnu cckb d ckn ,o bldk mi;kx 50 xk-@g- 50&60 cckb d dju l ljlk e 65&98 ifr'kr vkjkcdh ij fu;=.k fHkokuh] fglkj vkj egUnx< ftyk e ikIr gvkA
- dkdj] cyjkeij vkj ljxtk ftyk d 9 xkeh.k bykdk e 110 ,dM d {k= e /kku e iFkeifr in'ku fd;k x;kA ftle 40 in'ku epÅvk /kku vkj 70 in'ku lh/kh ifDr /kku d fd; x;A vklru mit e 41 ifr'kr vf/kd ykHk ykxr vuikr fdlkuk dh i)fr ryuk e lh/kh cckb dh /kku ,o fNMdko epÅvk /kku l ikIr gvkA
- jxk jMMh fty d dEejk xko e /kku e fd; x; d"kd i{k= e ;g ik;k x;k fd [krh dh ykxr e vklr deh 10 ifr'kr d"kd i)fr dh ryuk e ikb xb vkj 'k) ykHk 15-8 ifr'kr ik;k x;kA [krh dh ykxr e deh Qly&[kjirokj Li/kk d dkj.k ikb xbA /kku Qly of) dh ikjfHkd voLFkk e vdj.k d io vkDlkMk;jfty 70 xk-@g- ;k culY¶;jku feFkkby$ ihVykDykj&,l 0-66 fd-xk-@g- vkj gkFk d }kjk /kku jki.k d 40 fnu ckn funkb dju l ikb xbA

tutkfr lg;ksxh

- xg d in'ku lykV ¼eVlY¶;jku eFky 4 xk-@g-½ dh vklr mit 4144 fdxk-@g- tcfd fdlkuk dh [krh dh mit 2837 fd-xk-@g- ikIr dh xbA inf'kr lykV dh mit fdlkuk d [krk dh mit dh ryuk e 46-25 ifr'kr vf/kd FkhA vklr ykHk ykxr vuikr inf'kr lykV e 2-94 Fkk tcfd fdlkuk dh i)fr d vulkj 2-10 ikIr gvkA
- pu d in'ku lykV ¼iMheFkfyu 0-75 fdxk-@g- vdj.k d io½ dh vklr mit 1147 fdxk-@g- tcfd fdlkuk [krh dh vklr mit 817 fd-xk- ik;h xb in'ku lykV dh mit fdlkuk d [krk dh mit l 40-59 ifr'kr vf/kd FkhA vklr ykHk ykxr vuikr inf'kr lykV e 1-85 Fkh tcfd fdlkuk dh if)fr d vulkj 1-39 ik;k x;kA
- lk;kchu d in'ku lykV ¼betFkkik;j 100 xk-@g-½ dh vklr mit 1235 fd-xk-@g- tcfd fdlkuk d [krk l ikIr vklr mit 997 fdxk-@g- ik;h xbA inf'kr lYkkV dh mit fdlkuk d [krk dh mit l 23-88 ifr'kr vf/kd FkhA inf'kr lykV dh vf/kdre mit 1350 fd-xk-@g- vkj U;ure mit 1150 fd-xk-@g- vklr ykHk ykxr vuikr inf'kr lykV e 2-27 Fkk tcfd fdlkuk dh i)fr }kjk 1-96 ik;k x;kA
- eDdk d in'ku lykV e ¼,Vkftu 0-5 fdxk-@g-½ vklr mit 2682 fdxk-@g- ikIr gb tcfd fdlkuk d [krk e vklr mit 2040 fd-xk-@g- in'ku {k= dh mit fdlkuk dh i)fr l ikIr mit l 31-55 ifr'kr vf/kd ikIr gbA inf'kr i{k= l vf/kdre 2875 fdxk-@g- tcfd U;ure 2550 fdxk-@g- vklr ykHk ykxr vuikr inf'kr {k= 2-06 ikIr gvk tcfd fdlkuk dh i)fr l 1-63 ikIr gvkA

EXECUTIVE SUMMARY

WS1 Weed surveillance and monitoring

- *Celosia argentea* was found a severe problem in middle Gujarat, North Gujarat and some part of Saurashtra region in *Kharif* crops like soybean, pigeonpea, greengram, blackgram on farmers field.
- A new invasive weed, *Nicandra physalodes* was identified which appeared in the winter season crops at Tinsukia district, Assam.
- Intensity of *Lolium* spp., in wheat and berseem crops is increasing in Sirsa district.
- Tomato and brinjal crops in Nuh, Punhana and Ferozepur Jhirka areas of Mewat and Dadri tehsil of Bhiwani district were severely infested with *Orobanche* spp causing 30-70% decrease in fruit yield of both crops. Taramira, radish, turnip, *gobhi sarson* and cabbage were also found infested with *Orobanche* but *Karan rye* had no infestation.
- Wild rice (*Oryza sativa f. rufipogon* and *Oryza sativa f. spontanea*) were observed in the lowlying rice growing areas in Varanasi and Jaunpur districts on Utter Pradesh.
- In wheat, 2 new broadleaf weeds, *Lamium amplexicaule* and *Galium aparine* were recorded by PAU, Ludhiana. *Cannabis sativa* and *Solanum nigrum* infestation in wheat and *Ipomoea* sp. was increasing in cotton.
- Pre-plant imazethypyr 75 g/ha was not safe for use in berseem at Ludhiana.
- A new weed *Solanum melongena var. insanum* (L.). sp. was found in Kodicherla village of Mahabubnagar district near Hyderabad.
- Escape incidences of *Commelina benghalensis* were observed on farmers' field after application of recommended herbicides in different crops at Anand. While escape incidences of *Digera arvensis* were observed in pendimethalin applied experimental field.
- At Jorhat, glyphosate resistant tea-weed, *Dichanthium assimile* advanced in the north-east direction, about 30 km aerial distance from the earlier spots in Barak Valley agroclimatic zone. *Panicum repens* was found escaped from the efficacy of glyphosate through its deep placing rhizome complex. *Eleusine indica* and *Amaranthus spinosus* were recorded as resistant to metribuzin at Sadiya sub-division of Tinsukia.
- Heavy infestation of *Cirsium arvense*, *Argemone mexicana* and *Solanum nigrum* were observed in farmers' fields at Pantnagar.
- In DSR-chickpea cropping system, aggressive appearance of *Celosia argentea* was noticed at Raipur.
- At Ludhiana, *Phalaris minor* showed cross resistance to pinoxaden, fenoxaprop and clodinafop.

WS 2 Weed biology and physiology

- Sequential application in lower dose of glyphosate 0.5 kg/ha was found effective in reducing population and rhizome biomass of *Panicum repens.*
- Sequential application of pendimethalin 1000 g/ha (PRE) *fb* clodinafop 60 g/ha, sulfosulfuron 25 g/ha, mesosulfuron + iodosulfuron (RM) 14.4 g/ha or pinoxaden 50 g/ha at 35 DAS provided complete control of *P. minor* along with broadleaf weeds and resulted in higher grain yield of wheat as compared to post-emergence herbicides alone. The B : C ratio also increased from 0.07-1.1 to 1.1-1.12.
- Glyposate at 1.5 kg/ha was most effective to control *Cyperus rotundus.* Glyphosate alone or in combination with 2,4-D reduced the regeneration of this weed.
- Infestation of weedy rice was found in direct-seeded deepwater rice in Darbhanga and Madhubani districts of Bihar. The species wise dominancy of weedy rice was in the order: *Oryza rufipogan > Oryza spontanea.*
- *Trianthema portulacastrum* was having quick multiplication rate in shorter period of 45 days and produced about 7000 seeds per plant. *Abutilon indicum* completed its life cycle within 100 days at Coimbatore.

WS 3 Weed management in crops and cropping systems

WS 3.1 Herbicide combinations for control of complex weed flora in transplanted rice

- Application of ethoxysulfuron 18.8 g/ha, chlorimuron+ metsulfuron 4 g/ha or azimsulfuron 20 g/ha as tank-mix, bispyribac-sodium 25 g/ha, or as sequential application with pretilachlor 750 g/ha provided effective control of broadleaf weeds and sedges along with grass weeds in transplanted rice.
- In transplanted rice, ready-mix application of penoxsulam+cyhalofop-p-butyl (135 g/ha) applied as post and sequential application of pendimethalin (1000 g/ha) as pre *fb* post-emergence application of bispyribac-Na (25 g/ha) recorded the highest grain yield.
- In puddled rice, either pre- emergence application of pyrazosulfuron-ethyl 20 g/ha at 8-10 DAS *fb* manual weeding at 40 DAS or pyrazosulfuron-ethyl *fb* azimsulfuron 35 g/ha at 25-30 DAS or hand weeding twice at 20 and 40 DAS were found economical at Hyderabad.
- In direct-seeded rice, weed density was lowest due to pendimethalin 1000 g/ha *fb* manual weeding (25DAS) and pendimethalin 1000 g/ha *fb* bispyribac-Na 25 g/ha + manual weeding (45 DAS) at 20 and 40 days after sowing, and was at par with weed-free.

WS 3.2 Herbicide combinations for control of complex weed flora in wheat

- Maximum grain yield of wheat (4.56 t/ha) was recorded with the sequential premix application of pinoxaden+metsulfuron-methyl (0.06+0.004 kg/ha) applied as post-emergence followed by sequential application of pendimethalin (pre) + sulfosulfuron (post) at 1.0+0.018 kg/ha). Among the herbicides alone, pre-emergence application of pendimethalin at 0.75 kg/ha recorded the highest grain and straw yield.

WS 3.3 Weed management in turmeric and other vegetables

- In turmeric, metribuzin 700 g/ha, pendimethalin 1000 g/ha or atrazine 750 g/ha *fb* straw mulching + hand weeding at 75 DAS were found most effective treatments.
- In garlic, significant effect was found on BLWs and sedges by the application of mulch at 5 t/ha over without application. Highest and significantly high yield (2.95 t/ha) was achieved with the application of mulch material. Application of pendimethalin (1.0 kg/ha) as well as oxyfluorfen (0.223 kg/ha) applied as pre-emergence were found comparable in achieving the bulb yield of garlic crop.
- Oxadiargyl 140 g/ha resulted in significantly higher garlic bulb yield and fetched higher B:C ratio followed by oxyfluorfen 0.223 kg/ha, which was on par with manual weeding. The interaction of straw mulch and weed management practices was non-significant.
- Application of glyphosate 0.80 kg/ha + oxyfluorfen 0.2 kg/ha applied just before emergence of sprouts of ginger was more effective in controlling weeds and resulted in maximum rhizome yield (29 t/ha), net returns (` 9,52,230/-) and B:C ratio (4.59).

WS 3.4 Weed mangement in pulses and oilseed crops

- Application of imazethapyr PoE and imazethapyr + imazamox (RM) PoE caused phytotoxicity on greengram. There was no any carry over/residual phytotoxic effects on succeeding mustard.
- Imazethapyr and ready-mix combination with imazamox at 60-80 g/ha showed poor efficacy against *Trianthema* at 4 leaf stage.
- In blackgram, pre-emergence application of imazethapyr + pendimethalin at 1000 g/ha was found effective in reducing dry matter accumulation of weeds and maximizing the weed control efficiency (97.9%) with highest grain yield (1.41 t/ha).

WS 3.5 Integrated weed management in cotton

- Pendimethalin 1.0 kg/ha as pre-emergence provided effective control of *Trianthema portulacastrum* and *Echinochloa colona* up to 90 DAS in cotton.
- Protected spray of glyphosate (0.5%) integrated with pendimethalin and paraquat (0.3%) with pyrithiobac-Na *fb* quizalofop-p-ethyl was at par with three mechanical weedings and reduced weed population and dry weight at 90 DAS significantly over weedy check.

WS 3.6 Weed management in conservation agriculture systems

- Application of oxadiargyl + 1 HW at 40 DAS was found best treatment exhibiting highest WCE in terms of growth of weeds and consequently grain and straw yield of rice. Weed growth of monocots and broadleaved weeds was least due to CT (Transplanted rice) over all other tillage practices and resulted in higher yield attributes and yield of rice at Dapoli.
- Highest grain yield of wheat was obtained under TPR (CT)-wheat (CT) in weed management under rice-wheat system in conservation agriculture. However, in rice, maximum grain and straw yields were recorded in CT-ZT-ZT treatments. Maximum microbial properties were observed under ZT+R, ZT+R and ZT treatments at Faizabad.
- Retention of residues in rice and/or in wheat increased organic C, available N and available P in comparision to conventional or zero tillage without residue.
- In greengram , lowest weed count and dry weight were recorded at 30 and 60 DAS under CT (Transplanted)-ZT-ZT under tillage and residue management. However, highest grain yield of moong (2.6 t/ha) was recorded under CT (Direct seeded) – CT-ZT at Pusa.

WS 3.7 Long term herbicide trial in different cropping system (rice-wheat)

- Infestation of *P. minor* in weedy check was more under green manured plots (213/m^2) than non-green manured plots (139/m^2), while broadleaf weeds were less under green manuring (130/m^2) than non-green manuring (163/m^2) in wheat. There were no signs of development of resistance in *P. minor* against continuously used herbicide clodinafop till now at Karnal.
- Continuous application of butachlor for 2 seasons did not result in buildup of residues in soil and grain samples at Thrissur.
- Weed species increased from 2 to 8 in 31 years in long-term experiment in wheat. Sulfosulfuron, clodinafop and pendimethalin recorded effective control of *P. minor*. Integration of these herbicides with 2,4-D enhanced control of *C. didymus*, *F. parviflora* and *C. album*. In rice, weed species increased from 2 to 7 in 31 years. *Dactyloctenium aegyptium* was new weed species observed at Ludhiana.

WS 4 Management of problematic weeds

- Tobacco leaves was severely affected by the application of imazethapyr 30 g/ha at 40 DATP. Plants were stunted and the affected leaves were not recovered. Number of *Orobanche* shoots emerged at 60, 90 DATP and harvest of tobacco were not influenced by the treatments at Anand.
- Neem cake 200 kg/ha at sowing *fb* soil drenching of metalaxyl MZ 0.2% at 20 DAP reduced *Orobanche* shoot density with better weed control and higher tobacco yield (2.45 t/ha). Imazethapyr 30 g/ha at 40 DAP caused severe phytotoxicity on tobacco leaves.
- Lucerne plants were severely affected by pre-emergence application of pendimethalin 0.5 kg/ha as sand-mix. Post-emergence application of imazethapyr 40 g/ha at 20 DAS was also found effective for the suppression of *Cuscuta* twine.
- Imazethapyr at 75 g/ha with or without stale bed was phytotoxic to berseem and significantly reduced the germination and growth. *Cuscuta* problem was more severe during first cut in October and March-April. Yield losses in berseem varied between 5 and 10%.
- Cotton padding of copper sulphate + 2,4-D sodium salt gave satisfactory control of parasitic weed *Dendrophthoe* spp. in all the host-parasite situations except walnut, fig and citrus.
- In sapota orchard, *Dendrophthoe falcata* was considerably reduced after 30 and 60 days of imposing cotton padding of 4 g copper sulphate + 0.5 g 2,4-D sodium salt. This treatment was found safe without any phytotoxicity symptoms and provided satisfactory control of the parasite.

WS 5 Herbicide residues and environmental quality

- 2,4-D residues were not detected in water bodies under farmers' field conditions at Pantnagar. At Thrissur, pendimethalin and oxyfluorfen residues in ginger rhizome were below the detectable level after the harvest of the crop.
- In no-till maize, atrazine residues in soil were detected up to 60 DAA when applied as pre-

emergence in combination with paraquat at Hyderabad.

- No significant changes in physico-chemical (pH, EC, OC) and fertility properties of the soil (Available N, P and K) were noticed due to different treatments after harvest of the rice.
- In *Rabi*, nine samples out of 20 locations were having sulfosulfuron and meso+iodosulfuron (RM) residues in soil which ranged between 0.011 and 0.048 µg/g (below MRL of 0.05 µg/g). In *Kharif*, 9 out of 21 samples were detected with pretilachlor residues ranging between 0.004 and 0.024 µg/g in soil. Three out of 21 samples were having pretilachlor residues in rice grain ranging from 0.005 to 0.089 µg/g and 9 out of 21 samples were having pretilachlor residue from 0.014 to 0.089 µg/g in straw at Hisar.
- Oxyfluorfen residues were below the detection limit (0.05 mg/kg) in soil and spring onion at the time of harvest. Immature and matured maize grains, straw and soil did not contain tembotrione metabolite (AE1417268) at harvest.
- Pendimethalin residues (0.066 µg/g) were detected in rice grains in ZTDSR+(R)-ZTW+(R). In all other treatments, residues were not detected in rice grains. In straw samples, residues of pendimethalin varied from 0.007 to 0.059 µg/g in DSR treatments. Pendimethalin residues (0.059 µg/g) in CTDSR-ZTW+(R) were above than MRL value of 0.05 µg/g.

WS 6 On-farm research and impact assessment

- Tembotrione provided effective (92%) control of *Cyperus rotundus, Brachiaria reptans, Commelina benghalensis, Digitaria sanguinalis, Sorghum helepense, Eleusine indica* which were not controlled by atrazine being used by farmers at Hisar.
- On an average of 18 locations, sulfosulfuron + clodinafop (TM) at 25+60 g/ha, sulfosulfuron+ metsulfuron (RM) at 32 g/ha, meso+iodosulfuron (RM) at 14.4 g/ha and pinoxaden at 50 g/ha provided 84-88% control of *P. minor* without any toxicity to wheat at Hisar.
- Six on-farms trials in village Sisdevari, on direct-seeded rice with a seed rate of 60 kg/ha with application of pyrazosulfuron 20 g/ha as pre-emergence followed by POE application of bispyribac 20 g/ha + metsulfuron 4 g/ha increased grain yield by 24.8% over farmers' practice along with a B:C ratio of 2.7 and 2.3, respectively.
- Post-emergence application of glyphosate 25 g/ha at 30 DAS followed by its use at 50 g/ha at 50-60 DAS provided 65-98% control of *Orobanche* in mustard in Bhiwani, Hisar and Mahender Garh districts.
- In an area of 110 acres, frontline demonstrations on weed management in rice were laid in 9 tribal villages in districts of Kanker, Balrampur and Sarguja of Chhattisgarh State. Of there, 40 demonstrations were taken on puddled rice and 70 on direct seeded rice. An average increase of 41% in benefit :cost ratio was obtained due to recommended practice over farmers' practice.
- Mean reduction of cost of cultivation of 10% over farmers' practice with increased net returns of 15.8% in rice was obtained due to PE application of oxadiargyl 70 g/ha or bensulfuron -methyl + pretilachlor 0.66 kg /ha along with hand weeding at 40 DAT in Kummera village in Ranga Reddy district of Telengana.

Tribal sub plan

- Average yield in the demonstration plots of wheat (metsulfuron-methyl 4 g/ha PoE) was 4.14 t/ha while in farmers field average yield was 2.84 t/ha. Yield of demonstration plot were higher by 46.2% as compared to the farmers field. Average B:C ratio generated in FLDs was 2.9 as against 2.1 in farmers' practices.
- Average yield in the demonstration plots of soybean (imazethapyr 100 g/ha) in tribal area was 1.24 t/ha while in farmers field it was 997 kg/ha. Yield of demonstration plot were higher by 23.8% as compared to farmers field. Average B:C ratio generated in FLDs was 2.2 as against 1.9 in farmers' practice.

1.ORGANIZATION AND FUNCTIONING

1.1 Introduction

Systematic research work on weed management in the country started with the launching of All India Coordinated Research Project on Weed Control by the ICAR in collaboration with the United States Department of Agriculture (USDA) at six locations, *viz.* Punjab Agricultural University, Ludhiana (Punjab); University of Agricultural Sciences, Bangalore (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, viz. Assam Agricultural University, Jorhat (Assam); Marathwada Agricultural University, Parbhani (Maharashtra); Gujarat Agricultural University, Anand (Gujarat); Narendra Dev University of Agriculture and Technology, Faizabad (U.P.); Indian Institute of Horticultural Research, Bangalore (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, *viz*. Birsa Agricultural University, Ranchi (Bihar); Haryana Agricultural University, Hisar (Haryana); Vishwa Bharati, Sriniketan (W.B.); Rajendra Agricultural University, Pusa (Bihar); Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.); Kerala Agricultural University, Thrissur (Kerala); Orissa University of Agriculture and Technology, Bhubaneshwar (Orissa); Acharya N.G. Ranga Agricultural University, Hyderabad (Andhra Pradesh) and ICAR Research Complex, Barapani (Meghalaya) were initiated at total outlay of 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, *viz.* Rajasthan Agricultural University, Bikaner; Indira Gandhi Krishi Vishva Vidyalaya, Raipur; Konkan Krishi Vidhya Peeth, Dapoli and University of Agricultural Sciences, Dharwad were initiated with total outlay of Rs 16.41 lakhs. Seventy five percent of the total budget required by each centre was provided by the ICAR and the remaining 25% was met from the state department of agriculture as a state share. There was however 100% funding by the ICAR to Visva Bharati, Sriniketan.

During IX Plan (1997-2002), X Plan (2002-2007) and XI plan (2007-2012), the total expenditure incurred under AICRP-WC was Rs 823.79, 1696.57 and 3548.78 lakhs, respectively.

During XII Plan (2012-17), four AICRP on Weed Control centres *viz.* University of Agricultural Sciences, Dharwad; Chandra Shekhar Azad University of Agriculture & Technology, Kanpur; Swami Keshwanand Rajasthan Agricultural University, Bikaner, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani and Visva-Bharati, Sriniketan were closed and new centers at Maharana Pratap University of Agriculture and Technology, Udaipur; University of Agricultural Sciencies, Raichur; Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola; Bidhan Chandra Krishi Viswavidyalaya, Kalyani; Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu and Central Agricultural University, Pasighat by redeployment of existing manpower were opened.

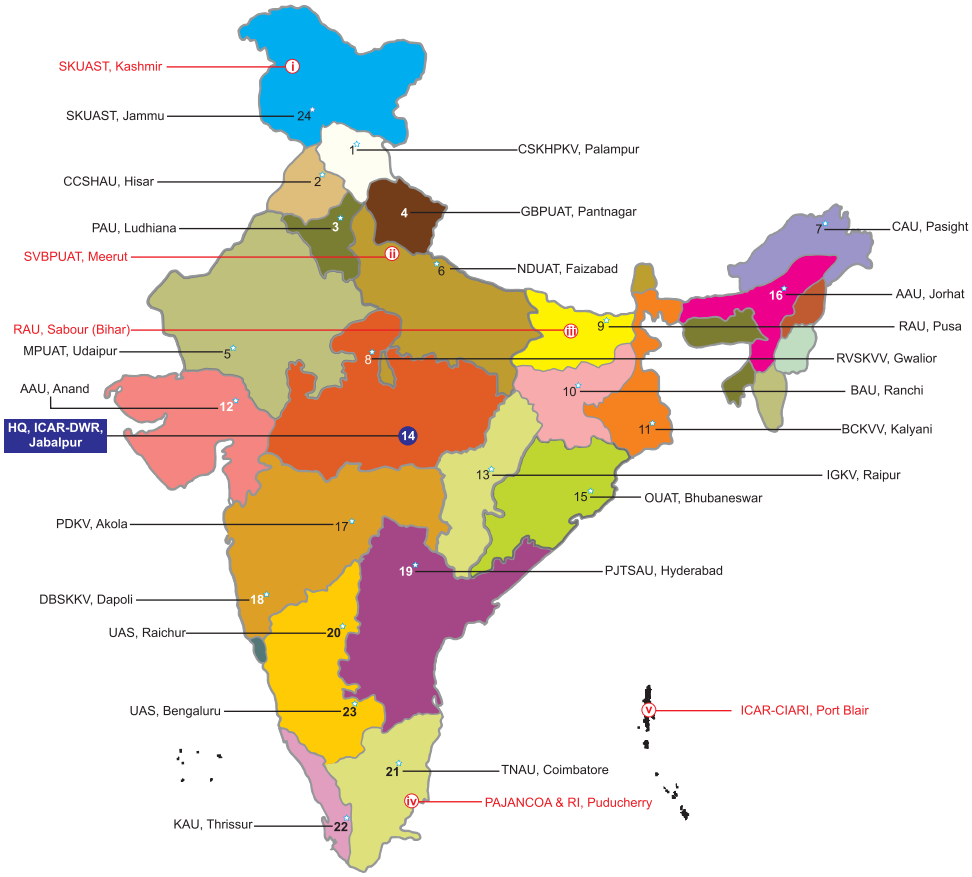
The coordinating unit of the project was located initially at Central Rice Research Institute, Cuttack, and shifted to National Research Centre for Weed Science in 1989. Later in 2009, NRC for Weed Science was upgraded to Directorate of Weed Science Research. During XII Plan (2012-17), it has renamed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

1.3 Objectives

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



AICRP-Weed Control

Regular Centres

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

Volunteer Centres

i SKUAST, Kashmir
ii SVBPUAT, Meerut
iii RAU, Sabour
iv PAJANCOA & RI, Puducherry
v ICAR-CIARI, Port Blair

2. STAFF POSITION AND EXPENDITURE

AICRP on Weed Management is presently under operation in 22 State Agricultural Universities in 20 different states of the country. These centres represent 18 agro-ecological regions. Altogether, 62 scientists of different disciplines (Agronomy, Plant Physiology, Taxonomy, Residue Chemistry and Microbiology) are working in inter-disciplinary mode. Besides 22 main centres, 5 volunteer centres are also in operation. The details of staff position and funds allocated in the financial year 2015-16 are given below:

Table - Staff position at different coordinating centres during 2015-16

Centre	Scientific		Technical		Administrative		Supporting	
	Sanctioned	Filled	Sanctioned	Filled	Sanctioned	Filled	Sanctioned	Filled
PAU, Ludhiana	4	4	3	2	1	-	2	2
UAS, Bengaluru	4	3	3	3	1	1	2	2
RVSKVV, Gwalior	3	2	2	2	1	-	2	2
GBPUAT, Pantnagar	4	4	1	1	1	1	2	2
CSKHPKV, Palampur	4	4	3	3	1	-	2	2
AAU, Jorhat	4	4	3	3	1	1	1	1
AAU, Anand	4	3	3	3	-	-	2	1
TNAU, Coimbatore	4	4	3	3	1	1	2	2
NDUAT, Faizabad	4	4	2	2	1	-	2	2
BAU, Ranchi	3	2	2	2	1	1	1	1
KAU, Thrissur	4	3	2	2	1	1	1	1
OUAT, Bhubaneshwar	3	3	3	3	1	1	1	1
PJTSAU, Hyderabad	3	3	1	1	1	1	1	1
CCSHAU, Hisar	4	3	2	1	1	-	2	1
RAU, Pusa	3	2	1	1	1	1	1	1
DBSKKV, Dapoli	2	2	1	1	1	1	1	1
IGKVV, Raipur	3	3	1	1	1	1	1	1
PDKV, Akola	2	2	1	1	1	-	1	1
CAU, Pasighat	2	1	1	-	1	-	1	-
UAS, Raichur	2	2	1	1	1	1	1	1
MPUAT, Udaipur	2	2	1	-	1	-	1	-
SKUAST, Jammu	2	2	1	-	1	-	1	-
Total	70	62	41	36	21	12	31	26

Table - Funds released to different coordinating centres during the financial year 2015-16

Sl. No.	Centre	Pay and allowances	TA	Recurring contingency	Total (` in lakhs)
1	PAU, Ludhiana	40.31	0.61	3.44	44.36
2	UAS, Bengaluru	40.81	0.46	2.97	44.24
3	RVSKVV, Gwalior	22.33	0.30	2.51	25.14
4	GBPUAT, Pantnagar	50.79	0.61	3.44	54.84
5	CSKHPKV, Palampur	50.49	0.61	3.44	54.54
6	AAU, Jorhat	77.24	0.61	3.44	81.29
7	AAU, Anand	25.19	0.46	2.97	28.62
8	TNAU, Coimbatore	41.79	0.61	3.44	45.84
9	NDUAT, Faizabad	53.63	0.46	2.97	57.06
10	BAU, Ranchi	19.33	0.30	2.51	22.14
11	KAU, Thrissur	44.58	0.46	2.98	48.02
12	OUAT, Bhubaneshwar	35.96	0.46	2.98	39.40
13	PJTSAU, Hyderabad	32.96	0.46	2.98	36.40
14	CCSHAU, Hisar	37.80	0.46	2.98	41.24
15	RAU, Pusa	22.10	0.46	2.98	25.54
16	Dr BSKKV, Dapoli	15.71	0.30	2.51	18.52
17	IGKV, Raipur	24.33	0.30	2.51	27.14
18	PDKV, Akola	16.13	0.30	2.51	18.94
19	CAU, Pasighat	4.64	0.22	1.50	6.36
20	UAS, Raichur	14.13	0.30	2.51	16.94
21	MPUAT, Udaipur	15.63	0.30	2.51	18.44
22	SKUAST, Jammu	14.12	0.22	2.50	16.84
	Total	700.00	9.27	62.58	771.85
	PC, Unit, Jabalpur	0.00	0.00	8.15	7.19
	Total (ICAR Share)	700.00	9.27	70.73	779.04

3. RESEARCH ACHIEVEMENTS

WS 1 Weed surveillance and monitoring

WS 1.1 Monitoring of appearance of new weed species

AAU, Anand

Celosia argentea was found a new weed in middle Gujarat, North Gujarat and some part of Saurastra region. In *Kharif* season, the weed was invading many crops like maize soybean, pigeonpea, greengram, blackgram in districts of Dahod and Panchmahals. Farmers were using this weed as fodder for cattles and not managing this weed. *Celosia* may create serious problem in future and need to manage as early as possible by creating awareness among the farming community through effective weed management technology.

CCSHAU, Hisar

No new weed was appeared in any crop at Hisar. Wild rice (*Oryza rufipogon*) was not observed in any of the rice growing districts. Infestation of hemi-parasitic weed *Striga* was not observed in any part of state. Intensity of new weed *Lolium* spp. was found in wheat and barseem crops in Karnal, Kaithal, Ambala, Yamuna Nagar, Kurukshetra, Rania (Sirsa) and Tohana (Fatehbad) districts. Tomato and brinjal crops in Nuh, Punhana and Ferozepur Jhirka areas of Mewat and Dadri tehsil of Bhiwani district were severely infested with *Orobanche* spp. caused 30-70 % decrease in fruit yield of both crops. Even taramira, radish, turnip, gobhi sarson and cabbage were found infested with *Orobanche* but Karan rye field had no infestation of *Orobanche*.

PAU, Ludhiana

Weed surveillance was carried out in *Rabi* 2014-15 and *Kharif* 2015 in Roopnagar, Hoshiarpur, Jalandhar, Kapurthala, Nawan Shahar, Ludhiana, Moga, Bathinda, Muktsar and Faridkot districts of Punjab. In wheat, 4 major broad leaf weeds (*Cannabis sativa, Chenopodium album, Malva neglecta* and *Rumex dentatus*) and 3 major grass weeds (*Phalaris minor, Avena ludoviciana, Poa annua*) were observed. Two new broadleaf weeds, *Lamium amplexicaule* in sub-montaneous area of Pathankot and *Galium aparine* in Ludhiana and Shaheed Bhagat Singh Nagar districts were observed in wheat. *Solanum nigrum* and *Canabis sativa* were also observed in wheat. In transplanted rice, *Echinochloa crus-galli* was dominated weed flora. In cotton, *Ipomoea* sp. was recorded. In berseem, *Cuscuta* sp emerging as problematic weed. *Verbesina encelioides* emerging as major road-side weed in Ludhiana, Moga, Bathinda, Faridkot and Muktsar districts of Punjab.

GBPUAT, Pantnagar

In the farmer's field, heavy infestation of *Cirsium arvensis*, *Argemone mexicana* and *Solanum nigrum* were observed. It was also observed that there were moderate to heavy infestation of *Parthenium hysterophorus* in cultivated area.

IGKV, Raipur

Alternanthra triandra in cropped fields' especially direct seeded rice which occupies around 70% area in Chhattisgarh, has emerged as a new havoc. Control of this weed after 4-5 leaf stage was difficult with chlorimurom+metsulfuron (Almix), however, 2,4-D was an effective solution for this weed. Other weeds invading the non-cropped area were *Malwa pusila*, *Cenchrus ciliaris* in Chhattisgarh plains and *Chromolaena odorata* entering from southern parts of Chhattisgarh and knocking the door steps of C.G.Plains. The intensity of these weed is multiplying at a rapid pace and replacing *Parthenium hysterophorus.*

KAU, Thrissur

Tithonia diversifolia, Ageratum houstonianum, Sphagneticola trilobata and *Brugmansia suaveolens* were found to be fast spreading in the Idukki district and replacing the natural weeds of the region. However the weed has not spread in Thrissur district.

PJTSAU, Hyderabad

Public distribution systems, procurement centres, FCI godowns, garbage area were selected to monitor appearance of new weed species with fixed points and GPS data. Survey of the fields at Kodicherla, Penjerla and Ranga puram villages revealed that *Rottboellia cochinchinensis* (locally called as *Saddha Gaddi)* population has increased tremendously during the past two years and farmers were unable to control this weed. During survey one new weed species was found and identified as *Solanum melongena var. insanum* (L.).

RVSKVV, Gwalior

No new weed species was seen in any crops at Bhind, Gwalior, Datia and Morena region and Vidisha, Guna and Rajgarh districts in *Rabi* and *Kharif*, respectively.

Weed survey, was done in *Rabi* 2014-15 in wheat and mustard crops of Bhind, Gwalior, Datia and Morena district of Madhya Pradesh. *Phalaris minor, Chenopodium album, Spergula arvensis, Anagallis arvensis, Cyperus rotundus* and *Asphodelus tenuifolius* were found as major weeds in respect to IVI value as well as relative density. In *Kharif*, weed survey work was done in paddy, soybean, blackgram, pigeonpea and jowar in Guna, Rajgarh and Vidisha districts of Madhya Pradesh. *Echinochloa crus-galli* was the common weed in all the surveyed crops and disctrict. The second important weed was *Dinebra Arabica* on the basis of IVI value, found in Jowar, soybean and blackgram crops. *Cynodon dactylon, Eclipta abla* and *Commelina* spp. were other major weeds.

MPUAT, Udaipur

Areas of FCI godown, Udaipur, Krishi Upaj Mandi, Udaipur, Krishi Upaj Mandi, Fatehnagar, Udaipur, PDS shop in outerskirt of Udaipur city, *viz.* Amberi, Vallabh Nagar, Sunderpura, Barapal, Valli, Girwa, Udaipur were surveyed. No new weed flora was observed in these areas.

A survey and surveillance work was undertaken at Salumber, Vallabhnagar and Girwa tehsils during rainy season of 2015. Rainfed maize was the major crop in these tehsils. *Echinochloa colona, Eleusine indica, Dactyloctenium aegyptium, Chloris barbata, Brachiaria reptans* and *Cynodon dactylon*. Among broad-leaved weeds *Commelina diffusa, Trianthema portulacastrum, Parthenium hysterophorus, Physalis minima, Celosia argentia* and *Corchorus olitorius* were major weed species. In non-cropped area, *Cynodon dactylon, Dactyloctenium aegyptium* were major grassy weeds. Among braod-leaved weed species, *Physalis minima, Euphorbia geniculata, Cassia tora, Ipomea* spp., *Cucumis* spp., *Tephrosia purpurea* and *Ziziphus rotundifolia* were major species.

AAU, Jorhat

Nicandra physalodes (L.) Gaertn, *Euphorbia serpens* Kunth and *Lamium amplexicaule* L. were recorded from Assam and Punjab, respectively. Grasses were the most dominant weeds of buckwheat couple with nutsedge, *Cyperus rotundus* in the entire buckwheat grown areas of Sadiya and constituted more than 60% dominance spectrum compared to the broadleaved weeds. *Cynodon dactylon* and *Eragrostis unioloides* were found most troublesome species of the crop, followed by *Eleusine indica* and *C. rotundus. Cyperus rotundus, Celosia argentia* and *Cynodon dactylon* were the most troublesome weeds of rapeseed in Tinsukia district. Broadleaved weeds dominated the crop in this region occupying 50% of the total dominance spectrum (SDR) led by *C. argentea.* Only sedge recorded during early crop growth stage was *C. rotundus* and possessed 21% SDR, rest 29% SDR was found to be shared by four species of grasses. Citrus (Assam lemon) was infested with *Oxalis debilis* var. *corymbosa* followed by rhizomatous fern, *Sphaerostephanos unitus* during winter season.

BAU, Ranchi

During *Kharif* 2015, Jharkhand experienced severe drought which resulted in crop damage particularly rice crop. However, where rice was grown as transplanted, it suffered badly owing to appearance of non aquatic weeds like *Dactyloctenium aegyptium*, *Digitaria sanguinalis*, *Ageratum conyzoides*, *Stellaria media* and even *Alternathera sessilis* also appeared. Swine cress (*Coronopus dydimus*) has been found to develop resistance against spray of pendimethalin 1.0 kg / ha pre-emergence.

Study on weed seed bank in conservation agriculture systems under different tillage system revealed that conventional method of tillage recorded reduced grassy, broad leaved as well as total weeds as compared to zero tillage (Fig 1.1).

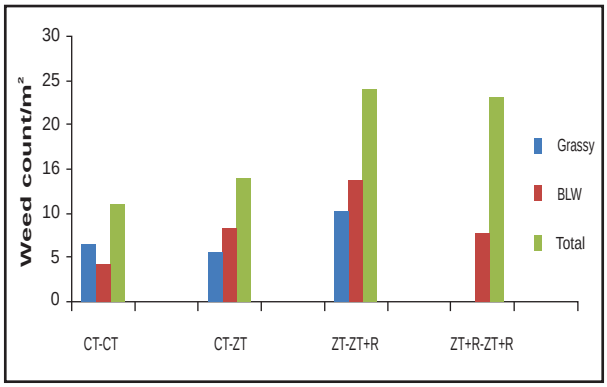


Figure 1.1 Emergence of weeds in conservation agriculture systems under different tillage system

Severe infestation of *Orobanche* was found in tomato and brinjal crops. *Orobanche* was not infesting other solanacious crops like, potato and chilli and also mustard which are also susceptible to *Orobanche*. *Cassia tora* was found to replace *Parthenium hysterophorus* on non-crop lands. Similarly, it was also observed that where dominance of *Hyptis suaveolence* or *Leonotis nepetifolia* exists, there *Parthenium hysterophorus* did not grow.

RAU, Pusa

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

A survey of weed flora in field crops of wheat, *Rabi* maize + potato inter cropping, mustard and lentil was conducted in East Champaran and West Champaran districts during *Rabi* 2015-16. In *Kharif* 2015 survey was made in Lakhisarai and Munger districts of Bihar covering direct seeded rice, transplanted rice, *Kharif* pigeonpea and sugarcane crops. In wheat, *Physalis minima, Launea pinnatifida, Chenopodium album, Solanum nigrum* and *Anagallis arvensis* were the dominant broad leaved weeds of wheat field and their IVI were 17.4, 17.2, 15.8, 15.3 and 11.9, respectively. Grassy weeds like, *Cynodon dactylon, Avena fatua* and *Phalaris minor* were also found as dominant weeds in wheat with IVI 16.9,13.2 and 11.4, respectively and only one sedge (*Cyperus rotundus*) was found with IVI, 11.2. In the mustard crop, higher IVI value was observed in *Digitaria sanguinalis* (15.7) and *Avena fatua (15.47)* among *grasses*. Only one sedge (*Cyperus rotundus)* was found with its IVI 23.5.

In rice, highly dominant weed species were *Echinocloa colona, Echinochloa glabrescens, Cynodon dactylon* and *Cyperus rotundus* followed by *Cyperus iria* with IVI values of 19.8, 16.9 and 15.8 and 15.7 and 13.2, respectively. Among the broad leaved weeds, prevalent weed species were *Caesulia axillaris (*13.2*), Amaranthus spinosus (*11.6*)* and *Cleome viscosa* (11.2). Sugarcane was infested with *Cynodon dactylon* (25.2). Among sedges, dominant weed species were *Cyperus rotundus* (24.3) followed by *Cyperus iria* (17.1). Among BLWs, dominant weed species were *Abutilon indicum* (24.9) followed by *Physalis minima* (22), *Launea pinnatifida* (19.3), *Euphorbia hirta* (18.9) and *Solanum nigrum* (18.2) (Table 1.1).

Table 1.1 Dominancy spectrum of the weed flora of sugarcane in *Kharif* 2015

Weed type	RD	RF	IVI	Density /m²
Grasses				
Cynodon dactylon	12.7	12.5	25.2	9.0
Sedges				
Cyperus iria	9.6	7.5	17.1	6.87
Cyperus rotundus	14.3	10.0	24.3	10.2
BLWs				
Solanum nigrum	8.2	10.0	18.2	5.8
Physalis minima	9.5	12.5	22.0	6.7
Abutilon indicum	12.4	12.5	24.9	8.8
Euphorbia hirta	8.9	10.0	18.9	6.3
Croton bonplandianum	7.0	7.5	14.5	5.0
Launea pinnatifida	9.2	10.0	19.2	6.6
Melilotus alba	7.7	7.5	15.2	5.5

RD = Relative density; RF = Relative frequency;
IVI = Importance value index

SKUAST, Jammu

Survey of Jammu district was done for monitoring of appearance of new weed species during 2015-16 and *Euphorbia hirta, Physalis minima, Ipomea* spp., *Solanum nigrum, Ageratum conyzoides, Phylanthus niruri* were found in Railway track (Table1.2).

Table 1.2 Weed species recorded in bench-mark survey in *khaif* - 2015 at places of high risks in Jammu district

Name of Location	GPS coordinates	Weed species
FCI godowns		
Nagrota	N 320 48' 25.4" and E 740 55' 23.1" Elevation*-344 m	*Portulaca oleracea, Commelina benghalensis, Achyranthes aspera, Calatropis gigantea, Casia tora, Ageratum conyzoides, Solanum nigrum, Malvestrum, Amaranthus viridis, Sida acuta*
Railway station	N 320 41' 48.8" and E 740 53' 05" Elevation-327.1 m	*Euphorbia hirta, Physalis minima, Ipomea* spp., *Solanum nigrum, Ageratum conyzoides,Phylanthus niruri*
Birpur	N 320 39' 32" and E 740 56' 46" Elevation-400 m	*Parthenium hysterophorus, Achyranthus aspera, Calatropis gigyantia, Physalis minima, Tridax* spp.
Chatha	N 320 40' 31.3" and E 740 49' 39.9" Elevation-278.1 m	*Amaranthus* spp., *Solanum nigrum, Euphorbia* spp., *Rumex* spp., *Xanthium strumarium, Coronopus didymus, Eleusine indica, Parthenium hysterophorus, Setaria glauca*
Public distribution system godowns of state govt.		
MAM college	N 320 43' 3.4" and E 740 51' 43.3" Elevation-307 m	*Eleusine indica Solanum nigrum, Parthenium hysterophorus, Ageratum* spp.
Warehouse	N 320 42' 53.6" and E 740 51' 30.5") Elevation-295 m	*Setaria glauca, Eleusine indica, Solanum nigrum, Parthenium hysterophorus, Ageratum* spp., *Datura* spp., *Tridax* spp., *Lantana camara, Malvastrum,Euphorbia hirta*
Chatha	N 320 40.2' 29.6" and E 740 49' 35.3" Elevation-282.3 m	*Amaranthus* spp., *Solanum nigrum, Calotropis* spp., *Euphorbia* spp., *Malvestrum* spp., *Rumex* spp., *Xanthium strumarium, Coronopus didymus, Eleusine indica, Parthenium hysterophorus, Setaria glauca*
Garbage area		
Bhagwati Nagar	N 320 43' 17.2" and E 740 49' 37.6"	*Amaranthus* spp., *Solanum nigrum, Calotropis* spp., *Euphorbia* spp., *Malvastrum* spp., *Rumex* spp.
State govt. small ruminants butchery		
Shakuntala	N 320 44 ' 11" and E 740 52' 45" Elevation-350 m	*Rumex* spp., *Xanthium strumarium, Solanum nigrum, Coronopus didymus*
Gujarnagar	N 320 43' 35" and E 740 52' 14.1" Elevation-392 m	Not found

TNAU, Coimbatore

Survey was carried out throughout the year in Coimbatore, Tirupur and Erode districts covering potential weed threat areas in 12 locations at cropped area, non-cropped area and garbage areas.

i) Cropped area

Parthenium hysterophorus (20.2) was with relatively higher SDR than all other broad leaved weeds. *Cyperus rotundus* (19.2) was the only sedge found in the survey area. *Dactyloctenium aegyptium* (10.7) had relatively higher SDR than all other grassy weeds in cropped area.

ii) Non-cropped area

Parthenium hysterophorus registered higher (19.2) SDR. In grasses, *Cynodon dactylon* recorded higher (16.2) SDR than other grasses. *Cyperus rotundus* (7.1) was the only sedge weed found in non-cropped area.

iii) Garbage area

Parthenium hysterophorus recorded higher SDR (19.4) followed by *Alternanthera pungens* (17.2). In grasses, *Cynodon dactylon* (14.6) and among sedge, *Cyperus rotundus* (9.4) was found in garbage area.

There was no new weed species noticed in all the three districts of study areas.

UAS, Raichur

No new weed appearance was noticed at places of high risks like, FCI godowns, nearby area of public distribution systems and garbage area at Raichur.

NDUAT, Fiazabad

At Barabanki, Amethi, Jaunpur and varanasi districts of eastern Uttar Pradesh, *Eichnochloa colona, Echinochloa crus-galli*, *Eclipta alba*, *Commelina benghalensis* and *Cyperus* species were found to be

highly dominating over other weed species present in rice. *Echinochloa* species were the most dominant weed in all the districts with a weed density of 19-46 plants / m^2, relative density 4-10% with IVI values ranged from 12-26.9%. Broad leaf weeds viz. *Commelina benghalensis* and *Eclipta alba* and in sedges *Cyperus* spp. occurred at all the sites surveyed. In all the districts, *Caesulia axillaris*, *Ludwigia parviflora* and *Alternenthra* spp. were also observed though their density and IVI values varied. Among the sedges, *Cyperus rotundus* and *Fimbristylis* spp. were also found in all the districts. Weedy rice has also been noticed in low lying areas of eastern UP districts district. Among the broad leaf weeds, *Chenopodium album, Anagallis arvensis*, *Phyllanthus niruri* and *Fumaria parviflora* were found in the dominating proportion in almost all the districts. Density of *Phyllanthus niruri* was 33 to 35 plant / m^2 in Barabanki and Amethi districts.

Weed surveillance studies revealed that due to continuous use of isoproturon in wheat from the last 22 years, poor efficacy against *P. minor* at some locations was reported but other herbicides such as, sulfosulfuron at 25 g / ha as well as clodinafop at 60g / ha found very effective to control this weed. Due to continuous use of rice herbicides, *viz*. butachlor and oxydiarzyl, infestaiton of sedges and broad leaved weeds like *Eclipta alba, Ammania baccifera, Cucumus mello* and *Scirpus tuberosus* are increasing every year. Amine formulation of 2,4-D was the most preferred herbicides by farmers to control sedges particularly *Cyperus* and *Scirpus* and broadleaf weeds in rice crop. Infestation of dicotyledonous weeds eg. *Solanum nigrum, Malwa perviflora* and *Lathyrus aphaca* (Jangli matar) was more in wheat fields planted by zero till method and only carfentrazone was found effective against these weeds.

BAU, Sabour

Survey was undertaken in the fields of farmers in Bhagalpur and Banka districts during *Rabi* 2014-15. Major crops and cropping systems was rice - wheat, rice- lentil, rice – chickpea, *Rabi* maize, paira linseed and mustard. No new weed species was observed during survey in both the districts. However, major presence of *Parthenium hysterophorus* was noticed in fallow land near road side field

In crop field, dominant weed flora in wheat were *Chenopodium album, Rumex dentatus, Medicago denticulata, Anagallis arvensis, Coronopus didymus* and *Fumaria parviflora*. In Chickpea and lentil, *Chenopodium album, Rumex dentatus, Vicia sativa, Vicia hirsuta, Medicago denticulata, Anagallis arvensis, Coronopus didymus* and *Polypogon monspeliensis* were dominant weeds. Zero till wheat was severely infested with *Polypogon monspeliensis* and *Rumex dentatus.* On the basis of IVI values and relative density, dominants weeds were *Echinochloa colona, Cyperus rotundus, Cyperus difformis, Corchorus olitorius, Caesulia axillaris* and *Dactyloctenium aegyptium* in direct seeded rice. Floristic composition of grasses, sedges and BLW were 37.4, 26.6 and 36%, respectively.

WS 1.2 Monitoring of weed shift due to weed management practices, changes in cropping systems and climatic parameters prevailing ecosystems

AAU, Anand

In some parts of state, farmers growing wheat crop and using continuous 2,4-D and metsulfuron-methyl to control dicot weeds were facing problem of monocot weeds in their fields.

AAU, Jorhat

Broad-leaved weed population as well as total weed population was decreased gradually in autumn rice after 2007 and in *Kharif* rice after 2005 in all the treatments that received butachlor, pretilachlor and 2,4-D. There was heavy reduction of grasses indicated that double cropping as well as continuous use of herbicides in rice cropping were effective in controlling grassy weeds.

Application of butachlor in both the rice seasons successfully eliminated several problematic weeds from the field exhausting their soil seed bank. As a result, perennial grasses like *Axonopus compressus, Panicum repens* and *Paspalum conjugatum* disappeared from the field within 4-5 years of experimentation, *Isachne himalaica* and *Hymanachne acutigluma* within 5-6 years and *Echinochloa crus-galli, Rottboelia exaltata, Isachne globosa* and probably *Oryza rufipogon* complex, within 8-9 years. Reappearance of *O. rufipogon* complex was occasionally noticed in recent years, and that might be from the external sources viz. seed and seedling contamination. Continuous use of butachlor + 2,4-D also eliminated *Cyperus difformis* and *C. platystylis* at 4 and 8 years after the date of start of the experiment. *Ceratophyllum-*

Utriculria complex, submerged juvenile plants of *Monochoria vaginalis* and *Sagittaria guayanensis* and *Scirpus* spp. escaped from the toxicity of these herbicides. Rotation of butachlor + 2,4-D by pretilachlor reduced the population of *Cuphea balsamona, Monochoria vaginalis* and *Sagittaria guayanensis* and to some extent the aquatic fern, *Marsilia minuta.*

PJTSAU, Hyderabad

In maize crop, based on IVI values, *Cyperus rotundus* was found to be ecologically more dominant till end of the crop growing season followed by *Dactylactenium aegyptium* at 30 DAT, *Parthenium hysterophorus* and *Cynodon dactylon* upto 60 DAT and *Echinochloa colona* at 90 DAS. Increased relative density of *Cynodon dactylon* was observed with application of FYM + vermicompost + neemcake (Each equivalent to 1/3rd N)+ agronomic practices for weed and pest control and application of 50% N as FYM + biofertilizer for N (Azospirillum) + rockphosphate for P + PSB at end of the crop growing season. During entire crop season relatively less density of broad leaved weeds were observed except during early stages.

BAU, Ranchi

In upland rice field of Ranchi-Gumla route, *Mollugo* (IVI 35.7%), *Ammannia baccifera* (IVI 19 %), *Fimbristylis miliacea* (IVI 15.4%) were dominant, while in transplanted rice, *Cynodon dactylon* (IVI 44.1%), *Ludwigia parviflora* (IVI 21.7%), *Digitaria sanguinalis* (IVI 17.6%) were dominant. In mustard crop, average IVI value of dominated weeds were: *Mollugo* (IVI 35.8%), *Cynodon dactylon* (IVI 17.4%), in ginger crop, *Ageratum conyzoides* (IVI 22.4%), in maize *Ageratum conyzoides* (IVI 13.3%), *Cynodon dactylon* (IVI 22.9%), *Spilanthes acmella* (IVI 10.8%). In transplanted rice of Ranchi - Rukka - Ramgarh Route *Ludwigia parviflora* (IVI 40.5%), *Spilanthes acmella* (IVI 28.2%), *Cyperus* sp. (IVI 29%), *Ammannia baccifera* (IVI 18.5%), in mustard, *Stellaria media* (IVI 30.3%), *Poa annua* (IVI 35.8%), *Alternenthera* (IVI% 18.9), in onion *Coronopus didymus* (IVI 25%) *Amaranthus viridis* (IVI 22.8%) and *Chenopodium album* (IVI 17.8%) were dominant.

RAU, Pusa

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

CCSHAU, Hisar

In Kalka, Panchkula, Raipur Rani and Chhachrouli areas of Panchkula districts, weed flora has been shifted towards *Eleusine indica, Brachiaria reptans, Cleome viscose* and *Commelina benghalensis* due to continuous use of atrazine in maize crop. Pea crop in north-eastern districts of state was severely infested with grassy as well as broadleaf weeds, viz. *P. minor, Poa annua, Polypogon monspliensis, Coronopus didymus, Malwa parviflora, Medicago denticulata,* etc. due to addition of FYM and its succession after rice. Wheat and mustard crops in Gurgaon, Mewat, Rewari and Narnaul areas were severely infested with thorny weed, *Carthamus oxycantha* and deep rooted perennial weed *Pluchea lanceolata. In* berseem fodder, *C. didymus* was replacing *C. intybus* as a major weed. *Cuscuta* sp. is emerging as a new weed. Pearlmillet and sorghum crops in Mewat area was severely infested with *Eleusine indica, Digera arvensis, Commelina diffusa* and *Phyllanthus niruri.* In north-eastern Haryana, *Ageratum conyzoides* has invaded sugarcane fields also.

IGKV, Raipur

In sixth year of long-term herbicide trial in DSR-chickpea cropping system, aggressive appearance of *Celosia argntea* was noticed in *Kharif* direct seeded rice in 2015, which caused suppression of *Alternanthera* sp. in the early growth stage of crop.

RVSKVV, Gwalior

In some places, mustard is being replaced by gwar-wheat, pigeon pea- mustard and blackgram-mustard cropping system due to availability of irrigation facilities. Therefore, *Orobanche* become as a minor weed of mustard in this area. In mono-cropping system also *Orobanche* was not the major weed.

TNAU, Coimbatore

Monitoring of weed flora was done in the ongoing permanent herbicide trial with rice-rice cropping system. *Echinochloa colona* and *Leptochloa chinensis* under grasses and *Cyperus iria* under sedges found in the first crop were completely lacking in the 30th (*Rabi* 2014-15) crop. *Echinochloa crus-galli* in grasses, *Cyperus difformis* in sedges and *Ammania baccifera, Marselia quadrifolia* in broad leaved weeds continued to persist in the field throughout the period of study.

KAU, Thrissur

Infestation of broadleaved weeds was more than grasses and sedges in Palakkad, Thrissur, Wayanad and Idukki districts. In the high range areas of Kerala, based on SDR values, *Spilanthes radicans* and *Ageratum conyzoides* emerged as the most dominant broad leaved weed species of ginger in Wayanad area (SDR: 27.1 and 23.9, respectively). Other important weed species observed in these districts were *Crassocephalum crepidioides*, *Scoparia dulcis*, *Erigeron canadensis*, *Mimosa pudica*, *Blumea* sp., *Ludwigia parviflora, Spermacoce ocymoides* and *Digitaria ciliaris.* These weeds were typical of high range areas because of the favorable climatic conditions. *Ageratum conyzoides*, *Scoparia dulcis*, *Ludwigia parviflora, Cyperus iria, Mimosa pudica* and *Eragrostis japonica* were seen both in plains and high ranges. These weeds were usually seen in annual crops like vegetables, tubers, spices etc. Distribution of these weeds was not affected by variation in climate or soil type, they mainly grow in association with the crops.

PAU, Ludhiana

In 2004, *Phalaris minor* and *Rumex dentatus* were major weeds in wheat. In 2015, *Poa annua, Avena ludoviciana, Medicago denticulata, Anagallis arvensis, Chenopodium album, Coronopus didymus, Malva parviflora, Oenothera laciniata* and *Fumaria parviflora* were recorded. In 2004, *Echinochloa crus-galli, Cyperus iria, Ischaemum rugosum* and *Caesulia axillaris* were major weeds in rice fields. In 2015, *Ammania baccifera, Alternanthera* sp. and *Cyperus compressus* also recorded. *L. chinensis, Trianthema portulacastrum* and *I. rugosum* recorded in weed seed bank.

WS 1.3 Monitoring herbicide resistance/ escape in weeds of the dominant cropping system

AAU, Anand

Escape incidences of monocot weed *Commelina benghalensis* after application of recommended herbicides in different crops were observed at farmers and experimental fields. Escape of dicot weed *Digera arvensis* was observed in the experimental field as a result of pre-emergence application of pendimethalin.

AAU, Jorhat

Glyphosate resistant weed *Dichanthium assimile* was found to spread to Katlichera and vicinity of Hailakandi districts. *Panicum repens* was found escaped from the efficacy of glyphosate through its deep placing rhizome complex. Sedge species belonging to *Scirpus* and suspended weed complex belonging to *Ceratophyllum, Utricularia,* etc. were recorded as escape of resistant to the combine effect of butachlor, pretilachlor and 2,4-D long-term herbicidal trial in rice-rice cropping sequence.

BAU, Ranchi

Cynadon dectylon, Commelina benghalensis and *Conyza bonariensis* were found to resistant to herbicides due to application of glyphosate in non-cropped area. Major weeds during *Kharif* were *Echinocloa crus-gali, Ageratum conyzoides, Spilanthes acmella, Cyperus rotundus, Cyperus iria, Fimbristylis miliacea, Marselia quadrifolia,* etc.

RAU, Pusa

No herbicides resistance was observed under dominant cropping system.

PJTSAU, Hyderabad

No weed species showed resistance to commonly used herbicide under farmer field conditions.

IGKV Raipur

In Chhattisgarh, no incidences of herbicide resistance were found at on and off-farm.

CCSHAU, Hisar

Phalaris minor has developed resistance against clodinafop-propargyl in Kaithal, Kurukshetra, Karnal, Jind, Panipat and parts of Sonipat, Fatehbad, Ambala and Sirsa districts of state. To control resistance problem against clodinafop at farmers fields, use of mesosulfuron +iodosulfuron (RM) 14.4 g/ha, sulfosulfuron+metsulfuron (RM) at 40 g/ha and pinoxaden at 70 g/ha was effective and exhibited 85% control and good yields. In some areas of rice-wheat cropping, farmers have started using double the recommended dose of clodinafop or sequential application/tank mix of clodinafop and sulfosulfuron and metribuzin for control of *P. minor*; even these mixtures were not working well. The problem was worse in areas under continuous use of a particular herbicide. In wheat crop, infestation of dicotyledonous weed *Solanum nigrum* was increasing due to continuous use of metsulfuron or 2, 4-D by the farmers and only carfentrazone was found effective to control these weeds in north-eastern Haryana.

Tomato crop infested with *Orobanche* in Mewat

Solanum nigrum new wheat weed

Ageratum infestation in ratoon sugarcane

RVSKVV, Gwalior

No resistance against used herbicides was recorded at farmer's field.

TNAU, Coimbatore

Herbicide resistant / escape of weeds have not been found weeds of the dominant cropping systems of Coimbatore districts.

UAS, Bengaluru

Herbicide resistance or escapes in weeds in rice-rice, rice-sugarcane cropping systems in Bhadra command area of Kathalagere, Davangere district and Cauvery command area in Mandya district were not obserbed.

UAS, Raichur

No particular weed was found to be in the form of poor control for the herbicides applied, which was earlier controlled with the same herbicide.

WS 1.3 Monitoring of herbicide resistance in different weeds

NDUAT, Faizabad

Seeds of *P. minor* were collected from the farmers fields during the winter season of 2014-15 from different localities in the districts of Faizabad, and Amethi and evaluated against isoproturon at 0.5, 1.0 and 1.5 kg/ha. Emergence of *P. minor* plants took place in the range of 5.0 to 8.5 per pot in case of lowest dose of isoproturon (0.5 kg /ha) while in case of higher doses (1.5 kg /ha), very effective control of *P. minor* was recorded and none of the *P. minor* plant was observed at all the six locations from where soil samples were collected. However, at recommended dose of IPU (1 kg /ha), few *P. minor* plants were recorded ranging from 2.0-4.5%. Resistance against the isoproturon was not supposed to be there N (Table 1.3.1).

Table 1.3.1 Survival of *P. minor* plants after isoproturon application at different doses

Site	No. of plants survived (out of 20 seeds)			
	I_0	I_1	I_2	I_3
Faizabad				
S_1	19	6	0	0
S_2	18	5	0.4 (2%)	0
S_3	19	7	0.8 (4%)	0
Amethi				
S_4	16	8	0	0
S_5	18	8	0.8 (4%)	0
S_6	19	8.5	0.9 (4.5%)	0

I_0 : Control; I_1 : 0.5 kg /ha Isoproturon, I_2 : 1.0 kg /ha Isoproturon, I_3 : 1.5 kg/ha of the Isoproturon, S_1 : Campus, S_2 : Milkipur, S_3 : Amaniganj, S_4 : Jagdishpur, S_5 : Masodha, S_6 : Gosaiganj

PAU, Ludhiana

Seven herbicides viz. isoproturon, clodinafop, sulfosulfuron, fenoxaprop-p-ethyl, pinoxaden, mesosulfuron+ iodosulfuron and metribuzin+ fenoxaprop were sprayed at recommended doses, across the rows at 30 days after sowing of *P. minor*. Dry matter accumulation was

Table 1.3.2 Percent mortality and biomass of *P. minor* under different herbicides

Treatment (g/ha)	Percent mortality (20 DAS)	Biomass (mg/plant) (30 DAS)
Unsprayed control	0	1309
Isoproturon (980)	22.8	643
Clodinafop (60)	33.2	651
Fenoxaprop –p-ethyl (100)	41.3	690
Pinoxaden (50)	71.2	285
Sulfosulfuron (25)	67.5	446
Mesosulfuron+ iodosulfuron (14.4)	69.5	498
Metribuzin+fenoxaprop-p-ethyl(275)	95.3	119
SEm±	1.5	14
LSD (p=0.05)	4.3	38
P. minor populations		
P_1	78.3	441
P_2	37.7	615
P_3	54.6	532
P_4	49.6	548
P_5	57.7	561
P_6	50.0	568
P_7	49.6	577
P_8	30.0	725
P_9	46.0	630
P_{10}	47.5	606
SEm±	1.7	15
LSD (P=0.05)	4.8	43

minimum in metribuzin+fenoxaprop and caused >90 % mortality to all *P. minor* populations. Isoproturon, fenoxaprop and clodinafop recorded <40% control indicated development of cross resistance. Pinoxaden, sulfosulfuron and mesosulfuron+ iodosulfuron recorded 70% mortality (Table 1.3.2). weed populations differed significantly in their response to herbicides with respect to mortality and dry matter accumulation. Isoproturon and clodinafop exhibited satisfactory control of only one biotype (P_1) and fenoxaprop of 3 (P_1, P_3 and P_5). Pinoxaden caused >70% mortality of all populations except P_8. Sulfosulfuron and mesosulfuron + iodosulfuron provided satisfactory control of all biotypes except P_2 and P_8. This indicated that pinoxaden, sulfosulfuron and mesosulfuron+iodosulfuron may meet same future as that of isoproturon, clodinafop and fenoxaprop.

Fv/Fm values of P_8 population which was resistant to all herbicides except metribuzin+ fenoxaprop were recorded at 24 hrs after spray, 5 days after spray (DAS) and 15 DAS. Only metribuzin+ fenoxaprop caused significant reduction in Fv/Fm ratio as compared to unsprayed control at 24 hrs and 5 DAS. Isoproturon failed to cause any decrease in Fv/Fm ratio indicated resistance in *P. minor*. At 15 DAS, fenoxaprop, clodinafop and pinoxaden caused <10% decrease in Fv/Fm ratio indicated these herbicides did not show much phytotoxic effect. At 15 DAS, sulfosulfuron, mesosulfuron+iodosulfuron and metribuzin+fenoxaprop caused 17, 15 and 79% reduction in Fv/Fm ratio compared to unsprayed control indicated damage to PSII and photo-inhibition that consequently resulted in mortality of *P.minor* plants (Table 1.3.3).

Table 1.3.3 Chlorophyll a fluorescence (Fv/Fm ratio) of *P. minor* population (P_8) under different herbicide treatments

Herbicides dose (g/ha)	24 hrs after spray	5 DAS	15 DAS
Control	0.739	0.705	0.711
Isoproturon (980)	0.741	0.708	0.694
Clodinafop (60)	0.735	0.710	0.663
Fenoxaprop–p-ethyl (100)	0.731	0.706	0.673
Pinoxaden (50)	0.735	0.706	0.646
Sulfosulfuron (25)	0.737	0.699	0.593
Mesosulfuron+ iodosulfuron (14.4)	0.736	0.701	0.604
Metribuzin+ fenoxaprop(275)	0.437	0.262	0.147
SEm±	0.01	0.04	0.01
LSD (P=0.05)	0.02	0.09	0.03

WS 2 Weed Biology and physiology

WS 2.1a Biology of important weeds

AAU, Anand

Biology of *Digera arvensis*, *Trianthema monogyna*, *Cyperus rotundus* and *Parthenium hysterophorus* was studied in pots at 0, 2, 5, 10 cm depths. Seed germination of *Digera*, *Trianthema monogyna* and *Parthenium* was observed in 0 - 5 cm depth. No germination of *Trianthema monogyna* was recorded below 5 cm depth. Days to germination, days to first flowering, shoot and root fresh and dry

biomass and total fresh and dry biomass were not influenced by depth of sowing. *Parthenium* produced flowers and seed at any time of the year under favourable conditions.

PJTSAU, Hyderabad

Biology of *Cyperus rotundus* and *Celosia argentia* in cropped area and *Parthenium hysterophorus, Alternanthera* spp. under non-cropped were studied. *Alternanhera* sp. and *Celotia argentea* did not germinate from 10 cm depth where as percent germination of *Parthenium hysterophorus* and *Cyperus rotundus* was 35 and 40, respectively. *Celotia argentea* germinated from 5 cm depth but *Alternanhera* sp. was able to germinate only from zero cm depth, *Cyperus rotundus* and *Parthenium hysterophorus* germinated from all the depths but more germination of *Parthenium* was observed from the top layers.

GBPAUT, Pantnagar

In winter 2014-15, biology of *Phalaris minor*, *Medicago denticulata* and *Anagallis arvensis* were studied.

Phalaris minor

Duration of vegetative stage of *P. minor* was 85 days while the reproductive stage was 35 days. Total duration was 180 days. Plant height increased from 80 cm at 5 DAS to 117.5 cm at 120 DAS. Tiller number was around 45 per plant at 85 DAS. At 85 DAS, biomass of *P. minor* plants was 47.8 g/plant which increased to 158.5 g/plant at 120 DAS. Average number of panicles per plant was 125. Number of seeds per panicle ranged between 398-480 depending upon the size of panicles. Relative growth rate and crop growth rate were 0.10 g/g/week during 60-67 DAE which decreased in next week (68-75 DAE) to 0.08 g/g/week. The crop growth rate was 9.73 g/m^2/week during 60-67 DAE which increased in the next week to 14.36 g/m^2/week.

Medicago denticulata

Duration of vegetative growth stage was 90 days while the reproductive stage was 30 days. Total duration up to maturity was 145 days. Average number of flowers per plant were 46 while the total number of fruits/plant was 1021. Each fruit possessed 3-5 seeds. There were 3063-5105 seeds in a single plant. RGR was 0.05 g/g/week during 60-67 DAE which decreased in the next week to 0.04 g/g/week (68-75 DAE). Average fruit number per plant was around 400. The fruits contained 3-5 seeds each. On an average around 1200-2000 seeds were present in a plant.

Anagallis arvensis

Duration of different growth stages of *A. arvens*is of vegetative stage was 25 days while the reproductive stage was 70 days. Total duration was 127 days. Plant height of *A. arvensis* was 7.1cm at 25 DAS which increased to 29.4 cm at maturity. Average number of flowers per plant was 23. Total number of fruits per plant was 449. Capsule shaped fruits had 20-30 seeds. The total number of seeds per plant was around 8,980-13,470.

Echnichloa colona

Plant height of *Echnichloa colona* was 43 cm at 30 days after sowing and increased upto 108 cm at 75 DAS. Maximum numbers of tillers 49 per plant were recorded at 60 DAS which were reduced to 43 at maturity stage. Maximum number of leaves/plant (277) and leaf area (943.6 cm^2/plant) was recorded at 60 DAS. At maturity, number of ears/plant was 58.2. Ear length was around 10.8 cm. Number of seeds/panicle was 308.4 and the 1000- seed weight was 0.88 g.

Echnichloa crus-galli

Plant height of *Echnichloa crus-galli* at 30 DAS was 61.4 cm which increased to 115.5 cm at harvest. Number of tillers/plant was 16.6 at 60 DAS which reduced to 14 at 75 DAS. Maximum numbers of leaves (105/plant) as well as leaf area (3971 cm2) were recorded at 75 DAS. At maturity, numbers of ears/plant were 23.6 and the number of spiklets/spike was 18.8. Ear length was 17.4 cm. Numbers of seeds/panicle were 590.3 and the 1000- seed weight was 1.34 g.

BAU, Ranchi

A. Cropped area

Cyperus iria and *Ludvigia parviflora* were two most harmful weed of rice crop particularly in transplanted rice. Mean root shoot ratio of *Cyperus iria* was 8.2 and 5.0 with mean of 6.5:1. *Cyperus iria* flowered in the range of as early as 45 days after sowing to as late as 56 DAS during 2014 and 49.2 during 2015 while it matured in the range of 70 to 90 DAS during 2014 and 80 to 92 during 2015 with mean maturity duration of 79 and 84.75 DAS, respectively (Table 2.1a.1).

Non-cropped area

Detail biology of *Cassia tora* was carried out.

Table 2.1a.1 Biological study of *Cassiatora*

Name of Weed	Days to flower		Days to maturity		Number of branches		Number of pods / plant		No. of seed per plant		Plant height (cm)	
Cassia tora	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
1	45	54	85	95	5	6	21	22	21	20	40	45
2	50	45	95	90	5	4	11	25	23	15	53	60
3	54	50	90	110	5	4	15	20	22	15	46	65
4	55	50	85	95	6	5	15	15	20	20	45	45
Average	51	50	89	98	5	4.7	16	21	22	18	46	54

TNAU, Coimbatore

Cropped Situation

Trianthema portulacastrum

Trianthema portulacastrum emerged from 0 to 7.5 cm depth of soil and the emergence was higher in the top 2.5 cm of the soil. Flowering started 25-30 days after emergence. Seeds matured 15-22 days after flowering. Seed production was around 7000 - 7500 seeds / plant. Root weighs was about 0.16 g / seedling. Stem was cylindrical, dichotomously branched, prostrate or trailing. Somewhat glabrous, at places reddish tinted, nodes swollen, fresh stem succulent in nature . The length varied from 10-25 cm. Shoot dry weight was about 2.27 g / plant. Flower were small, solitary, sessile, pinkish, nearly concealed by the pouch of the petiole, calyx tube scarious, thin, stamens 10-15 in number, ovary superior, sessile, style single papillose, shorter than the stamens. Fruit capsule was 3-5 mm long, almost concealed in the petiolar pouch, slightly concave, upper beak-like part at the time of dehiscence, carrying 2-3 seeds per capsule, lower cup-like part enclosing 2-5 or more seeds, fracture fibrous. Seeds are reniform in size, dull black, rough, muriculate seeds were present.

Amaranthus viridis

Amaranthus viridis emerged mostly from the top 2.5 cm of the soil profile, with few emerging seeds located deeper than one 2.5 cm. The seeds required adequate moisture and good seed soil contact to absorb moisture and germinate. More deeply buried seeds remain dormant. Root were slender, tapering, the length ranges from 10-12.5 cm at 30 DAS. Distinct reddish coloration on roots was observed. Newly emerging seedlings open a pair of long, narrow cotyledons followed by the first true leaves. Leaves were simple, petiolate (stalked) leaves arranged alternately (singly) on stems. Flowering started five to six weeks after emergence. Flowering to formation of seeds ranged from 7–12 days. Flowers were arranged in terminal or axillary. Panicle was elongate in nature. Seed were smooth shiny and lens shapped.

Non-cropped area

Abutilon indicum

Emergence of *A. indicum* was maximum at a depth of 1-4 cm. Tap root system, fairly long with a number of lateral branches, 1.5-2 cm in diameter, light brown, outer surface smooth with dot like lenticels were present. *Abutilon indicum is* medium sized, branched perennial shrub and grows upto 2 meter. Plant covered with minute hairs. Leaves were alternate, cordate and acute. Stem was round, softly tomentose and often tinged with purple. Inflorescence was solitary axillary. Flowers were yellowish with 5 petals, corolla yellow, about 3 cm in diameter. Fruits have 15-20 chambers, arranged spirally. Reniform, blackish-brown, minutely pitted and stellate-hairy. Seed was blackish brown in color.

AAU, Jorhat

In 2015, response of *Panicum repens* Linn. was studied against different doses of glyphosate. Total dry matter of *Panicum repens* varied from 828 to 952 g / m^2 and total underground rhizomes varied from 392 to 462 g / m^2 quadrate in the untreated (control) plots. Glyphosate 1 kg, with or without 2% juggery, reduced the aerial parts of *P. repens* significantly at 30 days. However, in the later stages, glyphosate 0.75 kg followed by glyphodate 0.75 kg applied 15 days after first application mixing with 2% juggery gave much better reduction of aerial biomass and result was at par with single application of higher dose of glyphosate (1.5 kg). Regeneration was observed in all the plots nearly after 50 days of herbiciden application. Sequential application of glyphosate was found more effective than single application (Table 2.1a.2).

Table 2.1a.2 Dry matter and growth rate of aerial parts of *Panicum repens* under different treatments (2015)

Treatment	Dry matter of aerial parts (g/m²)				Growth rate (g/m²/day)		
	30 DAHA	60 DAHA	75 DAHA		60 DAHA	75 DAHA	60 DASA
No herbicide	436.0	449.3	460.0	469.9	0.44	0.35	0.32
G 1.5 kg / ha	27.8	64.9	63.6	46.5	1.23	-0.04	-0.57
G 1.0 kg / ha	64.4	163.4	160.1	38.7	3.29	-0.10	-4.04
G 0.5 + 0.5 kg / ha	290.1	130.1	118.4	36.5	-5.33	-0.39	-2.73
G 0.75 + 0.75 kg / ha	194.5	209.0	190.1	61.6	0.48	-0.62	-4.28
G 1.5 kg / ha+2%J	154.7	165.8	150.8	56.3	0.36	-0.49	-3.15
G 1.0 kg / ha+2%J	83.0	172.5	156.9	49.5	2.98	-0.51	-3.58
G 0.5 + 0.5 kg / ha+2%J	115.8	164.9	150.0	41.6	1.63	-0.49	-3.61
G 0.75 + 0.75 kg / ha+2%J	102.4	38.1	34.6	38.2	-2.14	-0.11	0.11
LSD (P=0.5)	22.6	54.3	49.2	8.16			
GM	163.2	173.1	165.0	93.3			
CV %	8.0	18.1	17.2	5.0			

DAHA= Days after 1st application of herbicide; G = Glyphosate; DASA= Days after 2nd application of herbicide.

IGKV, Raipur

Biology of *Echinochloa colona, Ischaemum rugosum* (cropped) and *Parthenium hysterophorus* and *Cassia tora* (Non-cropped) during *Kharif* 2015 were studied.

Table 2.1a.3 Biology of *Echinochloa colona, Ischaemum rugosum, Parthenium hysterophorus* and *Cassia tora*

Character	*Echinochloa colona*	*Ischaemum rugosum*	*Parthenium hysterophorus*	*Cassia tora*
Plant height (cm)	64.3	73.7	52.6	61.2
Tiller / branch	9.0	8.0	11.0	9.0
Total biomass (g)	15.2	44.7	21.2	17.8
Root biomass (g)	4.6	6.3	4.0	3.8
Shoot biomass (g)	10.6	38.4	17.20	14.0
Days to flower	33.0	74.0	37.0	32.0
Days to maturity	53.0	102	61.0	69.0
seeds per plant (g)	4.8	9.0	7.6.0	18.22
Weight of 100 seeds (mg)	80	430	41	1530

In cropped area, *Ischaemum rugosum* produced 9 g seed / plant against 4.8 g / plant by *Echinochloa colona.* Amongst non-cropped weeds, *Cassia tora* produced 18.2 g seed / plant as against 7.6 g / plant by *Parthenium hysterophorus* (Table 2.1a.3).

UAS, Raichur

Biology of *Alternanthra sessilis, Cynotis cuculata* (cropped), *Parthenium hysterophorus* and *Cassia tora* (Non-cropped) during late *Kharif* season of 2015 was studied. Seed germination of all the four weeds was influenced by depth of sowing. Germination was observed in 0 to 5 cm depth, while in 10 cm depth germination was almost zero. *Parthenium hysterophorus* took 42-43 days for flowering and matured in 92 t0 100 days while *Cassia tora* started flowering starts after 50 days and matured in 95 days.

KAU, Trissur

Pennisetum is a major wasteland weed of Kerala. It is also a fodder species with high nutritive value growing wild in the wastelands of the state. In Kerala, *Pennisetum pedicellatum* Trin and *Pennisetum polystachyon* (L) Schult. were two species widely seen. *Pennisetum pedicellatum* and *polystachyon* seem to be fast spreading in the waste lands, mainly on the sides of the national highways of Kerala. Weed dispersal was mainly by wind, road traffic and by soil transportation for construction and road construction. This weed has become a major cause for summer fires (Table 2.1a.4 and 2.1a.5).

Table 2.1a.4 Total plant weight (g) at different stages

Pennisetum spp.	30 DAS		60DAS		90 DAS		120 DAS		150 DAS	
	Fresh wt.	Dry wt.	Fresh wt.	Dry wt.	Fresh wt.	Dry wt.	Fresh wt.	Dry wt.	Fresh wt.	Dry wt.
P. polystachyon	0.2	0.1	18.5	3.7	45.8	8.3	42.5	10.4	40.8	18.5
P. pedicellatum	0.5	0.2	40.9	6.5	53.4	11.3	38.2	10.4	40.1	18.8
Em±	0.05	0.02	3.2	0.6	5.0	0.7	1.2	1.5	2.1	1.3
LSD (P=0.05)	0.15	0.06	9.0	1.7	NS	2.1	3.5	NS	NS	NS

Highest germination was observed between 25 to 28°C and declined when the temperature was 40°C. Weed germinates only after the peak summer season and flowers during short day condition in September and October in the state.

Table 2.1a.5 Effect of temperature on seed germination of *Pennisetum pedicellattum*

Temperature	No of seeds germinated in petridish	Germination percentage (%)
40°C	3.6	7.3
30°C	6.0	12
20°C	8.3	16.6
15°C	9.6	19.3
Control (25 -28°C)	11	22
LSD (P=0.05)	NS	NS

Tithonia diversifolia

Tithonia diversifolia forms dense stands and prevents growth of the native flora. Flower heads were solitary on a peduncle 6-13 cm long, and yellow in colour. Plants were seen in dense stands with a number of branches and each mature stem bear several flowers at the top of branches. Seeds were achenes, 4-8 mm long and topped with a ring of scales and two awns. Seeds were blackish in colour and are somewhat four-angled. In Kerala the main flowering period is from October to March – April.

Allelopathic response of *Tithonia diversifolia* was tested on greengram seeds. Highest response was observed with the 10% solution. Cold water extract of weed was capable of slightly inhibiting germination and growth of greengram which was not significant. However, the total seedling length and vigour index showed significant reduction indicated that *Tithonia* was capable of suppressing other species and can be a threat to the biodiversity of the state (Table 2.1a.6).

Table 2.1a.6 Allelopathic effect of *Tithonia* on green gram

Treatment	Germination percentage	Shoot length (cm)	Root length (cm)	Total seedling length (cm)	Vigour index
2% solution	9.7	13.6	9.6	23.3 ^{ab}	225.4 ^{ab}
4% ''	9.7	13.4	11.1	24.6 ^{a}	239.8 ^{a}
6% ''	9.7	10.6	10.3	20.9 ^{ab}	205.6 ^{ab}
8% ''	9.7	10.5	5.9	16.4 ^{bc}	159.5 ^{bc}
10% ''	8.7	5.8	4.1	10.0 ^{c}	86.7 ^{c}
Control	10.0	12.4	7.8	20.3 ^{ab}	203.0 ^{ab}
LSD (P=0.05)	NS	NS	NS	7.0	78.4

Isachne miliacea

Soil type had an influence on the phenology of *I. miliacea.* Due to high acidity and salinity, seeds sown in Pokkali soils did not germinate. In Kuttanad soil seeds germinated within 5 to 8 days, while in Onattukara soil and Kole land soil, germination started on the 8th day. Seed sown in Palakkad soil started germination by the 12th day. Days to tillering also varied with the soil type and found in the range of 13-17 days. Seedlings from Onattukara soil started tillering by 15-28th day and continued up to 60 days. Seed formation and maturation varied with soil type. Plants dried after seed maturation. Seed production was comparatively higher in plants from Kuttanad soil at 45 DAS to maturity stage (41 -76.8).

Propagation of *I. miliacea* using both seeds and stem cuttings was influenced by depth of burial, moisture level, temperature and light. When the seeds were on the soil surface all the seeds germinated (100%) while only 42 % of the seeds germinated when

placed at a depth of 2 cm. None of the seeds placed at 10 cm depth germinated. Light has a significant influence on the germination of *I. miliacea*. Pots placed in open condition had the highest germination (100%) than under 50 % shade. Highest germination was observed at 25°C (72 %) followed by 20°C (56%) and 30°C (54%). Lowest germination of 20% and 22% were observed at 40°C and 15°C, respectively (Table 2.1a.7 and 2.1a.8).

Table 2.1a.7 Effect of light on propagation of *I. miliacea*

Treatment	Seed		Vegetative part (stem cutting)	
	Germination (%)	Dry weight at 60 DAS (g)	Establishment frequency	Dry weight at 60 DAS (g)
Open	100.0	18.5	100.0	9.8
50 % shade	32.0	8.1	20.0	4.5
75% shade	14.0	4.1	7.5	2.4
LSD (P=0.05)	9.4	0.8	1.1	0.1

Monochoria vaginalis

This weed was found to germinate only in submerged / saturated soil and was not seen in dry condition. Water was a prerequisite for germination of the weed. Under submerged conditions, seedlings emerged within 15 days, Seedling emergence was higher when the seeds were exposed to light than when buried inside the soil. The weed is rarely seen in dry sown condition.

Flower fruit and seedling of *Monochoria vaginalis*

Table 2.1a.8 Nutrient content of rice and *Monochoria* grown under different soil types of Kerala

Soil type	Rice			*Monochoria vaginalis*		
	N%	P%	K%	N%	P%	K%
Kole	0.71±0.01	0.34±0.20	0.91±0.07	2.41±0.02	0.40±0.01	1.46±0.31
Onattukara	0.35±0.02	0.34±0.10	1.6±0.02	1.76±0.02	0.47±0.01	2.28±0.57
Moncombu	0.36±0.01	0.50±0.04	1.82±0.23	2.48±0.02	0.19±0.02	1.02±0.09
Palakkad	1.08 ±0.02	0.67±0.19	1.42±0.12	2.2±0.08	0.39±0.02	2.96±0.36

NPK content of the weed was higher as compared to the rice plant except the P content in *M. vaginalis* grown in Moncompu soil. This might be because the P content in Moncompu soil was comparatively lower. Absorption of nutrients by the weed was associated with the availability of nutrients and the pH of the soil, which accounts for the variation in morphological attributes of the weed seen in different rice growing areas of Kerala (Table 2.1a.9).

Table 2.1a.9 Nutrient content of soil before and after growth of the crop and weed

Soil type	Before			After		
	N (kg/ha)	P (kg/ha)	K (kg/ha)	N (kg/ha)	P (kg/ha)	K (kg/ha)
Kole	235.04±2.76	12.33±0.25	255.36±1.82	174.23±2.85	7.12±0.69	117.97±3.21
Onattukara	186.65±1.17	23.09±0.91	91.54±1.76	135.39±2.17	20.24±0.50	8.96±1.58
Moncombu	175.88±0.35	15.04±0.20	89.22±1.90	125.06±2.49	11.50±0.75	77.28±1.58
Palakkad	201.61±1.34	26.48±0.68	210.56±3.29	163.56±0.43	17.89±0.06	139.6±0.52

WS 2.1b Biology of weedy rice

BAU, Ranchi

Weedy rice from various farmers fields were collected during 2014 and grown in pots for detailed morphological growth parameters (Table 2.1b.1)

Table WS 2.1b. 1 Observations on weedy rice

Farmes field	Phenophases (days taken after sowing)						Plant height (cm)	Total tiller/plant	Effective tiller/plant	Panicle length (cm)	Grains/ panicle
	Tiller	Panicle emergence	Flower	Milk	Dough	Mat					
1	21	40	53	63	N R	74	55	4	2	14	15
2	30	55	61	70	N R	75	65	5	3	12	28
3	33	41	55	63	N R	78	48	3	1	16	27
4	36	46	55	61	N R	78	65	5	3	17	45

NR= Not recorded

RAU, Pusa

Infestation of weedy rice was found in direct seeded deep water rice in Darbhanga and Madhubani districts of Bihar and they are locally known as Jharang or Lalsar. Weedy rice has the plant height 85-95 cm, No. of tillers / plant 11-22, effective tillers / plant 5-14, number of grains / panicle 27-70, length of panicle 9-22 cm and reduction in grain yield of rice varied from 27-48 %. All the weedy rice found were awned. Species wise dominancy of weedy rice in the rice field were in the order of *Oryza rufipogan* > *Oryza spontanea.*

UAS, Bengaluru

No problem of weedy rice in paddy cultivation in an alrming scale. However, monitoring was done in the rice fields for incidence of weedy rice.

NDUAT, Faizabad

Three species of weedy rice viz. *Oryza nivara*, *O. sativa* F. *spontanea* and *O. rufipogon* were found in the phyto-sociological survey of weedy rice in rice fields in Amethi, Jaunpur and Varanasi districts of eastern Uttar Pradesh. Among the three weed species, *Oryza sativa* f. *spontanea* was the most dominant species in Amethi and Varanasi districts with a weed density of 19.5-28.2 plants / m^2, relative density of 42.9-43% and IVI values ranged from 59.9- 98.2%. But in case of Jaunpur district, *O. spontanea* was found most dominant species followed by *O. rufipogon*. *Oryza nivara* and *O. rufipogon*. Farmers also explained the severity of these weed species and told that *O. rufipogon* and *O. spontanea* are being observed in the crop fields only from last 3-4 years.

PAU, Ludhaina

During *Kharif* 2015, two different accessions of weedy rice were sown. Data pertaining to these studies is given in Table 2.1b.2 as below:

Table 2.1b.2 Growth and phenology of two weedy rice accessions

Character	WRPAU/15-1	WRPAU/15-2
Plant height (cm)	56.8	62.2
Tiller no. / plant	10.3	13.6
Panicle no. / plant	7.1	5.9
Days to maturity	151	149

WS 2.1c Studies on herbicide resistance in weeds

WS 2.1.c(i) Inheritance of resistance against alternate herbicides in various biotypes of *P. minor*

CCSHAU, Hisar

Seeds of uncontrolled *P. minor* were collected from farmers' fields in different districts of Haryana during *Rabi* 2014-15. These biotypes along with biotype from RRS, Uchani, Karnal as susceptible check were sown in pots during *Rabi* 2014-15. Spray of graded doses (½X, X and 2X) of herbicides (clodinafop, sulfosulfuron, mesosulfuron+ iodosulfuron and pinoxaden) was done at 30 DAS (2-4 leaf stage).

Clodinafop and sulfosulfuron at X dose were effective (≥80% control) against 9 biotypes, and mesosulfuron + iodosulfuron and pinoxaden against

17 biotypes. Efficacy of mesosulfuron + iodosulfuron and pinoxaden against majority of the biotypes from farmers' fields indicated their suitability in management of herbicide resistance in *P. minor*. Clodinafop and sulfosulfuron were not effective (≤20% control) against five and one biotypes, respectively. All the biotypes were effective against the Uchani biotype (susceptible check).

WS 2.1.c (ii) Management of herbicide resistant *P. minor* in wheat at farmer's fields

CCSHAU, Hisar

Sequential application of pendimethalin 1.5 kg/ha PRE followed by tank mix pinoxaden+ metsulfuron 64 g/ha or mesosulfuron+iodosulfuron 14.4 g/ha POE provided excellent control of *P. minor* as well as broadleaf weeds. Although, in the absence of pendimethalin PRE, pinoxaden+metsulfuron 64 g/ha POE, mesosulfuron+iodosulfuron 14.4 g/ha POE and sequential application of sulfosulfuron 25 g/ha followed by pinoxaden 60 g/ha were effective against *P. minor* but some yield reductions were noted. Alone PRE application of pendimethalin + metribuzin was effective against *P. minor* at higher dose but due to the toxicity of metribuzin on wheat significant reductions in yield was recorded. PRE pendimethalin 1.5 kg/ha followed by pinoxaden + metsulfuron 64 g/ha significantly reduced *P. minor* density as compared to PRE pendimethalin + metribuzin at both doses. Similar trend was observed in grain yield of wheat.

Sequential application of pendimethalin 1000

Table 2.1c.1 Effect of pendimethalin alone and in sequential combination with post-emergence herbicides on dry weight of weeds, yield attributes and grain yield of wheat (*Rabi* 2014-15)

Treatment	Dose (g/ha)	Dry weight of weeds (g/m^2)		No. of effective tillers/ mrl	Plant height (cm)	Earhead length (cm)	Grain yield (kg/ha)	Cost of cultivation (`/ha)	Net returns (`/ha)	B:C ratio
		Grassy	BLW							
Pendimethalin	1000	34.0	3.2	73.8	93.3	10.9	4.48	85,311	53,037	0.9
Pendimethalin	1500	26.4	1.8	76.7	94.5	10.9	4.72	86,260	56,440	1.0
Clodinafop	60	17.2	6.3	79.7	95.6	10.9	4.90	84,421	60,508	1.0
Sulfosulfuron	25	18.9	0.7	79.0	95.3	10.9	4.88	84,478	60,809	1.0
Pinoxaden	50	10.2	6.6	83.0	94.3	10.9	5.02	85,369	62,443	1.1
Mesosulfuron+ iodosulfuron (RM)	14.4	19.8	0.9	80.0	95.9	10.9	4.88	84,909	60,344	1.0
Pendimethalin *fb* clodinafop	1000 *fb* 60	0.5	2.9	87.2	95.1	11.0	5.34	87,151	66,649	1.1
Pendimethalin *fb* sulfosulfuron	1000 *fb* 25	2.4	1.0	87.5	95.4	11.2	5.35	87,208	66,498	1.1
Pendimethalin *fb* pinoxaden	1000 *fb* 50	0.6	2.8	88.2	94.5	11.0	5.47	88,099	68,287	1.1
Pendimethalin *fb* meso+iodosulfuron	1000 *fb* 14.4	2.1	0.7	87.8	95.7	11.0	5.38	87,639	67,156	1.1
Pendimethalin *fb* clodinafop	1500 *fb* 60	1.0	1.9	88.7	95.5	10.9	5.39	88,099	66,298	1.1
Pendimethalin *fb* sulfosulfuron	1500 *fb* 25	1.8	0.4	88.5	94.1	10.9	5.42	88,156	67,080	1.1
Pendimethalin *fb* pinoxaden	1500 *fb* 50	0.8	1.7	89.2	95.3	11.1	5.49	89,047	67,442	1.1
Pendimethalin *fb* meso+iodosulfuron	1500 *fb* 14.4	1.0	0.2	89.0	95.6	11.0	5.32	88,587	65,009	1.1
Weed free		0.0	0.0	89.8	95.6	11.1	5.52	96,375	61,244	1.0
Weedy check		91.6	5.3	47.5	94.7	10.7	2.87	82,581	28,803	0.6
S Em ±		2.3	0.6	1.8	0.6	0.1	0.90			
LSD (P=0.05)		6.7	1.7	5.1	NS	NS	0.26			

Abbreviations: BLW- broadleaf weeds, RM- ready-mix, *fb*- followed by, mrl- meter row length, NS, non-significant, DAS- days after sowing

Sequential application of pendimethalin 1000 g / ha (PRE) *fb* clodinafop 60 g / ha, sulfosulfuron 25 g / ha, mesosulfuron+ iodosulfuron (RM) 14.4 g / ha or pinoxaden 50 g / ha at 35 DAS provided almost complete control of *Phalaris minor* along with effective control of broadleaf weeds. Sequential treatments resulted in high grain yield of wheat (5.3-5.4 t / ha) as compared to post-em herbicides alone (4.8-5.0 t / ha). The B: C ratio also increased from 0.07-1.1 to 1.1-1.1 (Table 2.1.c.1).

PAU, Ludhiana

Isoproturon, fenoxaprop, clodinafop recorded highest GR_{50} values (Table 2.1c.2). Calculated GR_{50} and associated RF indicated different levels of resistance to herbicides. *P. minor* showed very high level of resistance to fenoxaprop, isoproturon and clodinafop, low level to pinoxaden, sulfosulfuron and pre-mix of mesosulfuron and iodosulfuron, and no resistance to pre-mix of fenoxaprop+metribuzin and metribuzin. The results indicated that this biotype has developed multiple-resistance (Table 2.1.c.2).

Table 2.1c.2 GR_{50} and resistance level of *P. minor* biotypes to different herbicides

Herbicide	GR_{50}		Resistance factor
	Resistant	Susceptible	
Pinoxaden	48.0	45.1	1.06
Fenoxaprop	192.0	52.2	3.68
Clodinafop	105.6	55.0	1.92
Isoproturon	1736.0	874.0	1.98
Fenoxaprop+ metribuzin	138.3	138.1	1.00
Sulfosulfuron	29.5	22.4	1.31
Mesosulfuron+ iodosulfuron	15.6	13.8	1.12
Metribuzin	84.3	85.3	0.99

GR_{50}-Dose required for 50% retardation of growth in terms of biomass; RF=GR_{50} resistant / GR_{50} susceptible

WS 2.1d Viability / regeneration potential of glyphosate-treated *Cyperus rotundus*

KAU, Thrissur

After spraying herbicides, all the weeds dried within two weeks in all the treatments. They were then regularly irrigated and the germination count of *C. rotundus* was taken on 50th, 75th, 125th and 150th day after spraying. The maximum number of weeds was seen in the control treatment followed by 2, 4-D amine salt 125 g / ha. Lowest weed count was observed in 2, 4-D amine salt 125 g / ha *fb* glyphosate 750 g / ha and glyphosate 1.5 kg / ha. Herbicide sprays were repeated in all the treatments and after two weeks when the plants were completely dried the tubers were excavated and the number and weight of the tubers in each treatment was counted. Fifty tubers initially planted had multiplied to 226 tubers in the control while there was drastic reduction in the number of tubers in all other treatments.

Among the treatments, glyphosate 1.5 kg / ha and 2,4-D amine salt 125 g / ha *fb* glyphosate 750 g / ha were the best treatments both in the field and under controlled conditions.

UAS, Raichur

Application of glyphosate 3 kg / ha was found most effective in controlling *cyperus rotundus* indicated 89.5% shoot mortality. Regeneration of shoots was lower with the 3 kg / ha treated plot at both 40 and 80 DAS (2.3 and 3.2 out of 10) as compared to control (8.7 and 9.7 out of 10). This treatment was followed by application of glyphosate 1.5 kg / ha (3.3 and 4.3 out of 10) and 2,4-D amine salt (125 g / ha) to induced senescence for 48 h followed by glyphosate 750 g / ha (3.7 and 4.7 out of 10) were the next best treatments in suppressing the growth of C*yperus rotundus*. Viability was more with the tubers present at deeper depth (15 cm) as compared to lower depth (5 cm). Significantly higher viability of tubers was noticed with application of 2,4-D amine salt 125 g / ha at 10 and 15 days after sowing (3 and 4 out of 5) as against application of glyphosate 3 kg / ha (1.3 and 1.7 out of 5).

PAU, Ludhiana

All herbicide treatments significantly reduced *Cyperus* shoot populations, tuber number and tuber weight. 2,4-D amine salt 125 g / ha for 48 h followed by glyphosate 750 g / ha was most effective in controlling *C. rotundus* followed by glyphosate 1500 g / ha. Minimum tuber number and tuber weight per m^2 was observed in 2,4-D amine salt 125 g / ha for 48 h

followed by glyphosate 750 g / ha. Minimum number of tubers sprouted in treatments where tubers were collected from experimental plots treated with 2,4-D amine salt 125 g for 48h followed by glyphosate 750 g / ha, and glyphosate 1500 g / ha.

GBPUAT, Pantnagar

Effect of glyphosate and 2, 4-D at different doses to control *Cyprus rotundus* was evaluated during rainy season 2015. Percent mortality was highest in the glyphosate treatments. It ranged from 65.8% at 0.75 kg to 77.6 % at 1.5 kg. It was reduced to 51.7% when treated with 2, 4-D at 0.5 kg / ha alone. Combined application of 2,4-D (0.125 kg) and glyphosate (0.75kg) recorded 52.2% mortality. Lowest regeneration (7%) was recorded with glyphosate 1.5 kg followed by its lower dose or combined application of glyphosate and 2,4-D (14-15%). Tubers viability was lowest (6.6%) in the 2,4-D treatment (0.125kg).

TNAU, Coimbatore

Performance of glyphosate on propagation potential of *C. rotundus* was evaluated. In the experimental field, sedge weed mortality was found higher with the application of glyphosate at 1.5 kg / ha and it was followed by the application of 2,4-D amine salt (125 g / ha) to induce senescence for 48 h followed by glyphosate 750 g / ha. Higher density of *C. rotundus* was recorded with 2,4-D amine salt (125 g / ha) treated plot (Table 2.1d.1). Primary and secondary tubers from glyphosate applied 1.5 kg / ha were not regenarted. Tertiary tubers were regenerated only after 45 days after herbicide spray.

Table 2.1d.1 Effect of weed control treatments on *Cyperus rotundus* regeneration capacity

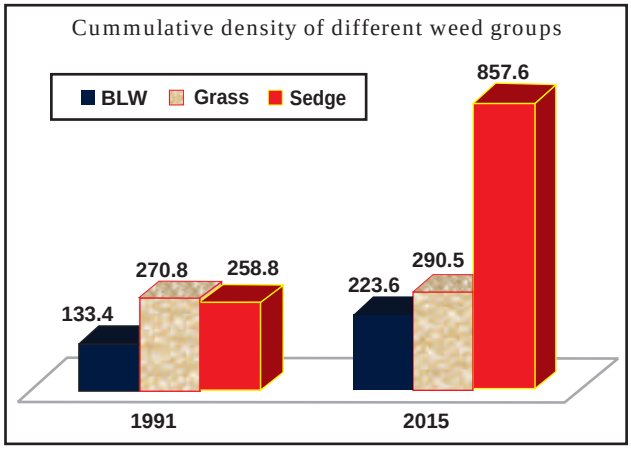
Treatment	*Cyperus rotundus* regeneration capacity (No of shoots/ten tubers)				Total biomass (g/pot)	
	15 DAI	30 DAI	45 DAI	60 DAI	30 DAI	60 DAI
Glyphosate at 1.5 kg / ha	0.0	0.0	3.2	4.3	0.0	2.3
Glyphosate at 0.75 kg / ha	1.9	2.5	5.1	6.3	1.9	4.2
2,4-D amine salt 500 g / ha)	2.4	3.9	5.7	6.4	2.7	4.8
2,4-D amine salt (125 g / ha)	3.4	4.5	5.7	7.1	3.5	5.2
2,4-D amine salt (125 g / ha) for 48 h followed by glyphosate 750 g / ha	1.3	3.3	4.9	5.4	1.9	3.7
Control	13.2	23.1	34.6	53.4	73.5	99.7

WS 2.3 Station trials based on location-specific problems

WS 2.3.1 Impact of climatic regime on changes of weed flora composition

AAU, Jorhat

Transplanted *Kharif* rice fields of eight blocks of Jorhat district were surveyed during 2015 and it was compared with that of 1991 to find out weed shifts and other changes in floristic composition. *Cyperus iria* dominated the crop at early part of its life span in almost all the blocks. Amongst the grasses, *Isachne himalaica* was recorded as the most dominant and common weed. Weed species prevalent in 1991 in the transplanted *Kharif* rice ecosystem at Jorhat district, but not recorded in 2015 were *Cyperus distans, Cyperus pilosus, Hemarthria protensa, Leersia hexandra, Penicum repens, Sacciolepis interrupta, Centala asiatica, Eichhornia crassipes, Enhydra fluctuans, Polygonum posumbu, Valisnaria natans* and *Ludwigia octevalvis.*



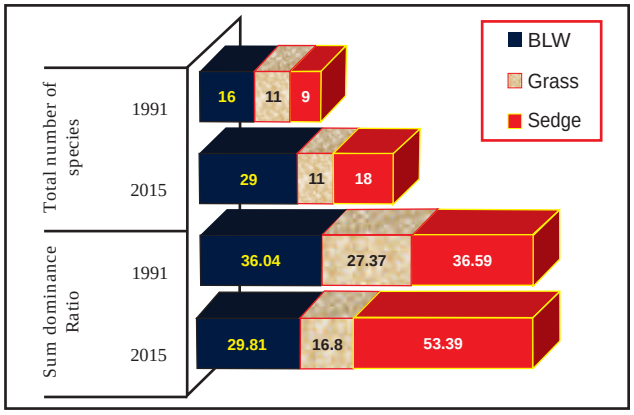


Fig. 2.3.1.1 Comparative cumulative density, number of species and sum dominance ratio of different groups of weeds between 1991 and 2015 in transplanted rice ecosystem at Jorhat district

WS 2.3.3 Threshold study of dominant weed species

AAU, Jorhat

Cyperus iria and *Echinochloa crus-galli* obligate weeds of rice were selected for the study. Densities of both the weeds were 0, 10, 20, 30, 40, 50, 60, 70, 80, 90,100, 110, 120 and 130. Desired population density of these weed species were maintained up to 80 days after transplanting by manual uprooting of all other weeds.

Echinochloa crus-galli: Rice var. Ranjit had maximum stuture of around 108 cm and the stature of *Echinochloa* was around 103 cm in their vegetative stage. Total number of tiller of rice per square meter area did not differer significantly because of competition with the weed; but the panicle / m^2 was the highest under zero competition (404.3), which was at par up to the weed density 40 / m^2 and 19.6% reduction of panicle number had significant difference in case of the variety Ranjit. Grain yield of the crop varied from 2917 to 5800 kg / ha and straw yield from 6854 to 13630 kg / ha. Rice yield under *Echinochloa* density from 0 to 60 / m^2 did not possessed significant difference with the highest yield, beyond which the yield reduced drastically. Significant yield reduction started at the weed density 70 / m^2 and therefore, this density of *E. crus-galli* can be considered as the threshold limit in transplanted *khrif* rice (var. Ranjit).

Cyperus iria: *Cyperus iria* was maintained at 1.0 to 0.7 raio in stature with its associated rice variety Ranjit. Weed dried up after 80 to 90 days after transplanting of rice and disappeared from the field after around 100 DAT releasing quite a huge amount of seeds in the crop field. Increase in weed density did not affect its height; but, its abundance in the rice field in the critical period of crop-weed-competition resulted in the reduction of paddy yield from 3 to 56%. Crop yield up to the *C. iria* density 90 / m^2 was at par with that of zero competition plots. Weed density 100 / m^2 was found to be the threshold level which was responsible for 32.5% grain yield loss of the transplanted *Kharif* rice *var.* Ranjit and that loss was statistically significant.

WS 2.3.4 Weed suppressing ability of upland direct seeded rice varieties

AAU, Jorhat

Eight local rice varieties, Kopili, Meghi, Guni, Kolong, Disang (Improved), Sahabhagi, Inglongkiri and Maizubairon were tested during autumn 2015. Variety Maizubairon produced the highest LAI (20.01), which was at par with var. Inglongkiri and Guni; var. Disang and Kolong produced the least LAI. Interestingly, LAI between weedy and weed free treatments did not differ significantly. Crop duration was shortest in var. Guni followed by var. Meghi, and that was 90 and 93 days, respectively. *Digitaria setigera* and *Eleusine indica* prevalence was recorded from the very beginning. Broadleaved weeds, *Ageratum houstonianum*, *Commelina diffusa*, *Ludwigia linifolia*, *Melochia corchorifolia* and *Physalis minima*, *Borreria articularis* and *Mikania micrantha* were recorded after 60 DAS. Amongst the sedges, *Cyperus* sp. *C. pilosus*, *C. rotundus*, *Fimbristylis bisumbellata* and *Scleria terrestris* were common. Variety Inglongkiri, performed the best in plains by yielding 2.9 t / ha grain and showing better weed suppressing ability with the help of its better canopy coverage, in the direct seeded upland condition of autumn season, when rice in Assam suffered from heavy competition of weeds coupled with several supplementary weed originated problems (Table 2.3.4.1).

Table 2.3.4.1 Canopy characters, grain yied and yield loss due to weeds of upland rice varieties under weedy and weed free treatments in 2015

Treatment	Plant height (cm)	Grain yield (kg/ha)	Flag leaf angle	Other leaf angle	Crop duration (days)	Yield loss due to weeds (%)
Rice variety						
Kopili	54.1	832	32.8	30.0	105	53.7
Meghi	84.6	1353	102.5	44.4	93	28.8
Kolong	39.3	924	31.6	22.5	100	62.2
Guni	83.6	2606	76.0	51.8	90	23.8
Disang	37.2	2450	23.5	37.9	100	28.3
Sahabhagi	68.4	-	41.4	17.0	125	-
Inglongkiri	124.0	2949	89.9	47.9	107	12.7
Maizubsiron	124.5	2425	48.0	24.0	107	18.3
LSD (P=0.05)	37.9	175	13.8	14.8	-	-
Management					-	-
Weedy	76.5	1627	-	-	-	-
Weed Free	77.4	2241	-	-	-	-
LSD (P=0.05)	NS	126.3	-	-	-	-

WS 3 Weed management in crops and cropping systems

WS 3.1 Herbicide combinations for control of complex weed flora in rice

WS 3.1.1 Herbicide combinations for control of complex weed flora in transplanted rice

Cooperating centres: Hisar, Ludhiana, Bhubaneswar, Faizabad, Pantnagar, Bengaluru, Coimbatore, Thrissur, Pusa and Karaikal

CCSHAU, Hisar

Weed flora of the field was dominated by *Echinochloa crus-galli* along with broadleaf weed *Ammannia baccifera* and sedges like *Cyperus difformis.* All the herbicidal treatments except pyrazosulfuron *fb* chlorimuron+metsulfuron (RM) provided effective control of grassy weed *Echinochloa crus-galli* in transplanted rice. Addition of ethoxysulfuron and chlorimuron+metsulfuron as tank-mix with bispyribac and in sequence with pretilachlor improved control of broadleaf weeds and sedges. Similarly, ready-mix treatments of pretilachlor + pyrazosulfuron 615 g/ha and triafamone + ethoxysulfuron 60 g/ha also provided effective control of grassy as well as broadleaf weeds and sedges. There was no phyto-toxicity of different herbicidal treatments on the crop.

All the herbicidal treatments except pyrazosulfuron *fb* chlorimuron+ metsulfuron (RM) produced effective tillers, grain yields and higher B: C ratio similar to weed free check.

PAU, Ludhiana

Pre-mix of triafamone+ethoxysulfuron, pretilachlor, pyrazosulfuron recorded poor control of *I. rugosum*. Tank-mix of bispyribac with ethoxysulfuron, and its sequential applications with pendimethalin or pre-mix of chlorimuron+ metsulfuron recorded complete control of all weeds (100% WCE) and recorded lowest depletion of N, P and K by weeds at harvest. Tank-mix of bispyribac with ethoxysulfuron and its sequential applications with pendimethalin or pre-mix of chlorimuron+ metsulfuron recorded the highest B: C ratio. The rice grain yield reduction in weedy check varied from 38 to 50%. All herbicides were safe to rice crop.

This study indicated that post-emergence application of tank-mix of bispyribac with

ethoxysulfuron, and its sequential applications with pendimethalin or pre-mix of chlorimuron+ metsulfuron are best ways for controlling complex weed flora and enhancing productivity and profitability from transplanted rice.

OUAT, Bhubaneswar

The floristic composition of the experimental site was dominated with grasses like *Digitaria ciliaris, Cynodon dactylon, Echinochloa colona* and broadleaf weeds like *Ageratum conyzoides, Cleome viscosa, Ludwigia parviflora, Physalis minima, Chrozophora rottleri.* Dominant sedge was *Cyperus rotundus.* Pre-emergence application of pendimethalin followed by bispyribac-Na recorded significantly least weed density at all stages of observation. Weed free treatment recorded significantly lowest biomass of 1.8, 2.1 and 2.3 g/m^2 at 30, 60 DAT and at harvest, respectively. At 30 DAT, application of pendimethalin + bispyribac recorded significantly lower biomass of 1.6 g/m^2 which was at par with triafamone + ethoxysulfuron (1.7 g/m^2) at later stages, also bispyribac + Almix treated plots exhibited lower values of biomass.

Application of pendimethalin+bispyribac recorded significantly higher grain yield of 4.8 t/ha and B:C ratio of 2.8 which was superior to application of triafamone + ethoxysulfuron (4.5 t/ha) and (2.7). Weed free plots recorded rice yield of 4.9 t/ha where as weedy treatment recorded the lowest yield(1.6 t/ha). Highest net return of ` 21,478/ha was obtained from post emergence application of pendimethalin+ bispyribac followed by triafamone+ ethoxysulfuron (` 20,713/ha).

NDUAT, Faizabad

Dominant weeds were *Echinochloa colona* and *E. crus-galli* among the grassy, *Eclipta alba, Caesulia axillaris* and *Ammannia baccifera* among broadleaved and *Cyperus spp.* and *Fimbristylis* spp. among sedges were recorded. Bispyribac-Na provided control of almost all type of the weeds but it was very effective against *Echinochloa colona* and *E. crus-galli.* Pretilachlor at 750 g /ha applied at 0-3 DAT *fb* Almix also controlled grassy weeds very effectively but *C. axillaris* was controlled moderately. Tank mixing of Almix at 4 g/ha with bispyribac-Na further improved control of grassy and non-grassy weeds significantly over single application. However, among weed control measures, maximum WCE (%) was recorded with the combination of triafamone + ethoxysulfuron (RM) (88.2%). No herbicide combination caused the phyto-toxocity on the rice crop.

Maximum grain (5.80 t/ha) and straw (6.96 t/ha) yield were recorded with triafamone + ethoxysulfuron (RM) application which was at par with penoxsulam + cyhalofop (135 g/ha at 15-20 DAT), bispyribac + chlorimuron + metsulfuron (20+4 g/ha at 25 DAT 3-4 leaf stage). Triafamone + ethoxysulfuron (RM) treatment recorded maximum net return (` 57,646) and BCR (` 2.3) than other weed control measures.

GBPUAT, Pantnagar

Experimental area was infested with *E. colona* (17.3%), *E. crus-galli* (28.8%), *L. chinensis* (11.5%) among the grasses, *C. axillaris* (15.4%), *A. baccifera* (11.5%) among broadleaved, *C. difformis* (9.7%) and *F. miliacea* (5.8%) among the sedges at 60 DAT.

Minimum population of grassy weeds was obtained with the combination of bispyribac-Na (25 g/ha)+ ethoxysulfuron (18.75 g/ha) applied as post-emergence and ready mix of penoxsulam+ cyhalofop-butyl (135 g/ha) which was at par with sequential application of pendimethalin at 1000 g/ha (pre) *fb* bispyribac-Na at 25 g/ha (post). Among the herbicidal application, the lowest dry matter accumulation (2.5 g/m^2) and highest weed control efficiency (98.8%) was obtained with the ready mix application of penoxsulam+ cyhalofop- butyl followed by pendimethalin 1000 g/ha as pre-emergence *fb* post-emergence application of bispyribac-Na 25 g/ha.

Twice hand weeding (25 and 45 DAT) recorded 57.1% increase in grain yield over the weedy check, whereas, maximum increase (69%) in grain yield was recorded with the application of penoxsulam+cyhalofop-butyl (135 g/ha) and pendimethalin (1000 g/ha) *fb* bispyribac-Na (25 g/ha) over the weedy check. Ready mix application of penoxsulam+cyhalofop-butyl (135 g/ha) and pendimethalin (1000 g/ha) *fb* bispyribac-Na (25 g/ha)

recorded the highest grain yield (7.1 t/ha) which was at par with alone application of penoxsulam at 22.5 g/ha (6.7 t/ha) and combination of bispyribac–Na+ ethoxysulfuron (6.8 t/ha) applied as post-emergence.

UAS, Bengaluru

In summer, 2015, major weed flora was, *Scirpus* sp., *Fimbristylis miliacea* (among sedges), *Panicum triferon, Paspalum distichum, (*among grasses*), Spilanthes acmella, Rotala verticillaris, Marselia quadrifolia, Ludwigia parviflora, Gnaphalium polycoulon (*among broad leaf weeds); which were higher than other weed species, indicated their dominance at 60 days after planting.

At 60 DAP, bispyribac 25 g/ha + ethoxysulfuron 18.75 g/ha -25 DAT, bispyribac 20 g/ha + chlorimuron + metsulfuron (Almix) 4 g/ha-25 DAT, and pretilachlor 750 g/ha-3 DAT *fb* ethoxysulfuron 18.75 g/ha-25 DAT recorded lower weeds' density and dry weight compared to application of single herbicides indicated the necessity of combination of herbicides to manage complex weed flora in transplanted rice. Hand weeding at 25 and 45 DAS had given significantly highest grain (5.9 t/ha) and straw yield (7.4 t/ha) followed by the plots treated with penoxsulam + cyhalofop 135 g/ha–15-20 DAT (5 t/ha) (6.7 t/ha), bispyribac 25g/ha + ethoxysulfuron 18.75 g/ha -25 DAT (5 t/ha) (7.3 t/ha). Unweeded control gave the lowest paddy grain yield (1.8 t/ha) and lowest B:C ratio (1.2) was due to severe competition from all types of weeds.

In Kharif, 2015, at 60 DAP, plots treated with herbicide combinations such as pretilachlor 750 g/ha-3 DAP *fb* ethoxysulfuron 18.75 g/ha-25 DAP, bispyribac 20 g/ha + chlorimuron + metsulfuron (Almix) 4 g/ha-25 DAT and bispyribac 25 g/ha + ethoxysulfuron 18.75 g/ha-25 DAT recorded lower weeds' density and dry weight compared to application of single herbicides indicated the necessity of combination of herbicides to manage complex weed flora in transplanted rice.

The plot treated with pretilachlor 750 g/ha-3 DAT *fb* ethoxysulfuron 18.7 g/ha-25 DAT recorded significantly higher paddy grain yield (5.15 t/ha) followed by bispyribac 20 g/ha + chlorimuron + metsulfuron (Almix) 4 g/ha-25 DAT (5 t/ha) and these were as par with the two hand weedings (25 and 45 DAP) (5.9 t/ha). Unweeded control gave the lowest paddy grain yield (1.8 t/ha). Bispyribac 20 g/ha + chlorimuron + metsulfuron (Almix) 4 g/ha-25 DAT (3.0), bispyribac 25 g/ha + ethoxysulfuron 18.75 g/ha -25 DAT (2.9) realised higher B:C ratio and hand weeding at 25 and 45 DAS (2.4) whereas, it was only 2.4 in hand weeded plots (Table 3.1.1.1).

KAU, Thrissur

Weeds in the experimental field were *Echinochloa* spp., *Leptochloa chinensis, Cyperus* sp., *Monochoria vaginalis, Fimbristylis miliacea* and *Ludwigia parviflora.* Weedy rice also occurred in moderate numbers in the field.

Bispyribac-sodium and penoxsulam were significantly effective in reducing the count of *Echinochloa* spp. *P*enoxsulam was also effective against *Leptochloa chinensis*, but bispyribac-sodium was ineffective. Triafamone + ethoxysulfuron significantly reduced *Leptochloa* and *Echinochloa* spp. population. The second flush of these weeds which emerged after 30 DAT could not be controlled by ethoxysulfuron and almix. However, pendimethalin *fb* bispyribac-sodium reduced population of *Echinochloa* spp., though it failed with *Leptochloa*, which recorded even higher counts than weedy check. Pyrazosulfuron followed by Almix reduced population of *Echinochloa* spp. significantly as compared with unweeded control, but was not effective against *Leptochloa chinensis.* Against the broad leaved weed *Ludwigia parviflora*, combination of pretilachlor and pyrazosulfuron followed by Almix, and triafamone with ethoxy sulfuron were effective.

At 60 DAT, the best treatment to reduce weed population was triafamone combined with ethoxysulfuron. Treatments including penoxsulam and pyrazosulfuron-ethyl followed by Almix were on par with this. There were no phytotoxicity effect on the crop. Grain yield of rice was highest under hand weeding (6.92 t/ha), followed by triafamone combined with ethoxysulfuron (5.96 t/ha) and bispyribac-sodium combined with Almix (5.69 t/ha), which were on par with hand weeding. All treatments

Table 3.1.1.1Effect of herbicide combinations on weed density and dry weight in transplanted rice (60 DAP)

Treatment	Dose (g/ha)	Hisar						Ludhiana							Bhubaneswar		Faizabad	
		Density (no/m²)			Dry weight of weeds (g/m²)			Density (no/m²)				Dry weight of weeds (g/m²)			Total weed density (m⁻²)	Total dry weight (g/m²)	Total weed density (m⁻²)	Total dry weight (g/m²)
		Echinochloa crus-galli	*Ammannia baccifera*	*Cyperus difformis*	Grassy	BLW	Sedges	*Echinochloa* sp.	*I. rugosum*	*C. axillaris*	*C. iria*	GLW	BLW	Sedge				
Bispyribac	25	1.6 (2.0)	8.6 (74.7)	1.9 (3.3)	0.6	6.9	3.0	2.1 (3)	2.0 (3)	2.6 (6)	1.6 (2)	11.2(125)	3.1 (8)	2.7 (6)	5.0(24.7)	4.7(21.5)	(19.5)4.5	(52.7) 7.3
Penoxsulam	22.5	1.9 (3.3)	7.5 (56.7)	1.0 (0.0)	1.2	2.0	0.0	2.0 (3)	2.0 (3)	1.6 (2)	1.0 (0)	9.2 (84)	1.5 (1)	1.0 (0)	5.8(32.7)	4.9(23.7)	(22.4)4.8	(41.2)6.4
Bispyribac+ethoxysulfuron	25+18.8	1.5 (2.0)	5.2 (28.0)	1.0 (0.0)	0.2	2.0	0.0	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	5.4(28.5)	4.9(23.8)	(12.3)3.6	(24.5)5.0
Bispyribac+ chlorimuron+ metsulfuron (RM)	20+4	1.7 (2.7)	5.7 (32.7)	1.4 (1.3)	1.4	1.5	0.6	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	5.3(27.8)	4.9(23.5)	(11.0)3.6	(21.7)(4.7)
Pretilachlor *fb* ethoxysulfuron	750 *fb* 18.8	2.8 (7.3)	5.4 (29.3)	1.0 (0.0)	6.0	1.1	0.0	2.2 (4)	2.8 (7)	1.0 (0)	1.0 (0)	16.9(285)	1.0 (0)	1.0 (0)	4.0(15.2)	3.3(10.5)	(18.7)4.4	(27.7)5.3
Pretilachlor *fb* chlorimuron+ metsulfuron (RM)	750 *fb* 4	2.8 (7.3)	4.6 (21.3)	1.0(0.0)	6.1	2.2	0.0	1.5 (1)	1.3 (1)	1.0 (0)	1.0 (0)	5.5(29)	1.0 (0)	1.0 (0)	2.1(13.8)	2.6(6.3)	(10.6)3.4	(22.8)(4.8)
Pyrazosulfuron *fb* chlorimuron+ metsulfuron (RM)	20 *fb* 4	3.7 (13.3)	4.7 (22.0)	1.0(0.0)	36.0	2.7	0.0	3.7 (13)	2.3 (4)	1.0 (0)	1.0 (0)	15.9(252)	1.0 (0)	1.0 (0)	4.6(20.5)	3.7(12.9)	(15.1)4.0	(33.0)5.8
Penoxsulam+cyhalofop (RM)	135	2.0 (3.3)	7.5 (56.7)	1.6(2.7)	2.7	2.7	1.0	1.3 (1)	1.6 (2)	1.4 (1)	1.0 (0)	7.6(56)	1.7 (2)	1.0 (0)	4.2(17.3)	2.9(7.9)	(13.4)3.7	(25.2)5.1
Triafamone+ethoxysulfuron (RM)	60	1.4 (1.3)	5.0 (25.3)	1.0(0.0)	2.3	1.8	0.0	2.0 (3)	2.3 (4)	1.0 (0)	1.0 (0)	11.9(142)	1.0 (0)	1.0 (0)	4.9(23.7)	4.2(17.3)	(9.8)3.2	(19.2)4.4
Pendimethalin *fb* bispyribac	750 *fb* 25	1.4 (1.3)	5.9 (34.7)	1.7(2.7)	0.7	1.7	0.9	1.0 (0)	1.0 (0)	1.0 (0)	1.1 (0)	1.0(0)	1.0 (0)	1.0 (0)	5.0(24.7)	4.5(19.5)	(14.8)3.9	(26.0)5.1
Hand weeding (2)		1.0 (0.0)	1.0 (0.0)	1.0(0.0)	0.0	0.0	0.0	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	1.0(0)	1.0 (0)	1.0 (0)	2.0(3.5)	2.4(5.2)	(10.8)3.4	(8.9)3.1
Weedy check		5.6 (30.7)	11.5 (133.3)	8.0(63.3)	87.2	12.0	8.2	3.9 (14)	2.7 (6)	2.6 (6)	2.2 (4)	20.4(416)	3.5 (12)	4.4(18)	10.0(100.5)	6.0(35.7)	(106.0)10.3	(163.3)12.8
S Em ±		0.37	0.49	0.28	2.0	1.0	0.6	0.1	0.1	0.1	0.1	0.3	0.1	0.1	0.15	0.10		
LSD (P=0.05)		1.07	1.40	0.80	5.7	2.8	1.8	0.3	0.4	0.2	0.2	1.0	0.3	0.2	0.45	0.31		

* Original values are in parentheses

Table 3.1.1.1 Continued

Treatment	Dose (g/ha)	Pantnagar		Bengaluru		Coimbatore		Karikal		Raichur	
		Total weed density (m^{-2})	Total dry weight (g/m^2)	Total weed density (m^{-2})	Total dry weight (g/m^2)	Total weed density (m^{-2})	Total dry weight (g/m^2)	Total weed density (m^{-2})	Total dry weight (g/m^2)	Total weed density (m^{-2})	Total dry weight (g/m^2)
Bispyribac	25	2.5 (5.3)	5.3 (26.9)	1.9 (94.7)	1.6 (46.0)	6.1 ^{ab} (37.6)	11.3 ^{def*} (131.5)	6.5 (40.7)	3.5 (10.2)	7.6 (57.8)	5.2 (26.6)
Penoxsulam	22.5	2.2 (4.0)	5.0 (23.9)	1.9 (96.0)	1.7 (50.8)	4.8 ^{bcd} (24.0)	11.4 ^{def} (130.8)	6.9 (51.3)	3.9 (14.8)	7.7 (59.9)	5.3 (27.9)
Bispyribac+ ethoxysulfuron	25+18.8	1.7 (2.0)	4.5 (19.4)	1.5 (33.0)	0.9 (7.9)	5.5 ^{abc} (30.6)	13.8 ^{abcd} (191.9)	2.6 (6.7)	2.9 (8.6)	6.7 (45.3)	4.7 (21.9)
Bispyribac+ chlorimuron+ metsulfuron (RM)	20+4	3.5 (11.3)	6.1 (35.9)	1.6 (42.0)	1.0 (11.0)	6.4 ^{a} (41.3)	10.3^{ef} (114.6)	3.1 (10.0)	2.1 (3.9)	-	-
Pretilachlor *fb* ethoxysulfuron	750 *fb* 18.8	3.2(9.3)	4.2 (16.4)	1.6 (44.0)	1.1 (12.6)	6.2^{a} (38.67)	12.8 ^{bcde} (170.7)	2.7 (5.3)	2.9 (6.0)	7.1 (51.3)	5.0 (24.6)
Pretilachlor *fb* chlorimuron+ metsulfuron (RM)	750 *fb* 4	3.2 (9.3)	4.6 (20.1)	1.8 (74.0)	1.3 (23.0)	6.1^{ab} (38.67)	15.6 ^{ab} (247.7)	3.2 (7.3)	2.0 (3.7)	6.9 (48.3)	4.9 (23.9)
Pyrazosulfuron *fb* chlorimuron+ metsulfuron (RM)	20 *fb* 4	3.6 (12.0)	6.2 (37.1)	2.0 (108.3)	1.7 (59.1)	5.3 ^{abcd} (28.00)	15.1 ^{abc} (229.48)	2.8 (5.3)	2.6 (4.3)	5.1 (26.0)	3.5 (11.9)
Penoxsulam+ cyhalofop (RM)	135	1.7(2.0)	2.5(5.3)	1.8 (77.3)	1.4 (26.2)	4.4 ^{cd} (20.00)	11.9 ^{cde} (144.19)	1.4 (2.6)	1.1 (1.1)	5.7 (32.3)	3.9 (15.1)
Triafamone+ ethoxysulfuron (RM)	60	3.8 (13.3)	6.2 (37.3)	1.9 (81.0)	1.4 (29.4)	4.2 ^{d} (17.33)	8.4 ^{f} (71.32)	1.0 (0.7)	1.1 (0.9)	7.5 (56.7)	5.0 (25.5)
Pendimethalin *fb* bispyribac	750 *fb* 25	2.6 (6.7)	3.2 (9.5)	1.7 (53.3)	1.2 (16.4)	6.0 ^{ab} (36.00)	14.1 ^{abcd} (200.53)	1.9 (3.3)	1.8 (2.5)	6.6 (43.5)	4.6 (20.9)
Hand weeding (2)		5.3 (27.3)	6.7 (44.6)	1.3 (23.3)	0.7 (3.9)	0.7 ^{e} (0.00)	0.7 ^{g} (0.00)	4.0 (14.7)	2.3 (3.5)	4.3 (18.7)	3.1 (9.4)
Weedy check		8.5 (70.7)	20.7 (432.2)	2.1 (159.7)	2.0 (126.2)	6.5 ^{a} (42.67)	16.7 ^{a} (281.44)	8.4 (62.7)	6.1 (32.4)	11.0 (121.3)	8.3 (69.9)
S Em $\pm$		0.22	0.39	0.07	0.07	-	-	-	-	0.35	0.31
LSD (P=0.05)		0.65	1.10	0.20	0.20	1.33	3.21	3.23	2.21	1.04	0.94

* Original value are in parentheses

were significantly superior to unweeded control (1.29 t/ha). Triafamone + ethoxysulfuron recorded highest B:C ratio of 4.8 followed by bispyribac sodium + Almix (4.2).

PJNCARI, Karikal

Dominant weed flora was *Echinochloa crus-galli*, *Leptochloa chinensis*, *Eclipta prostrata*, *Marselia quadrifoliata*, *Cyperus difformis* and *Cyperus iria*. Application of triafamone+ ethoxysulfuron significantly reduced weed density (0.7 no./m^2) and dry weight (0.9 g/m^2) and resulted in higher rice yield (5 t/ha). Excellent control of grass, sedge and broadleaved weeds and in particular, deformed growth of *Echinochloa* sp. was observed due to the triafamone spray. This treatment was followed by the application of penoxsulam + cyhalofop and pretilachlor *fb* (chlorimuron + metsulfuron) in terms of weed control and rice yield. Post-emergence application of bispyribac-sodium was found ineffective in controlling *Marselia quadrifoliata*. Unweeded control accounted for 37.2% yield loss in coastal ecosystem. Application of triafamone + ethoxysulfuron was better in terms of B: C ratio (2.8), followed by pre-emergence application of pretilachlor *fb* chlorimuron + metsulfuron (2.6) and pyrazosulfuron *fb* chlorimuron + metsulfuron (2.6), respectively (Table 3.1.1.2).

Table 3.1.1.2 Effect of herbicide combinations on grain yield and economics in transplanted rice

Treatment	Dose (g/ha)	Hisar			Ludhiana			Bhubaneswar			Faizabad			Pantnagar	Bengaluru			Coimbatore		
		Grain yield (t/ha)	Net return (`/ha)	B:C Ratio	Grain yield (t/ha)	Net return (`/ha)	B:C Ratio	Grain yield (t/ha)	Net return (`/ha)	B:C Ratio	Grain yield (t/ha)	Net return (`/ha)	B:C Ratio	Grain yield (t/ha)	Grain yield (t/ha)	Net return (`/ha)	B:C Ratio	Grain yield (t/ha)	Total return (`/ha)	B:C Ratio
Bispyribac	25	6.45	7,260	1.08	7.05	66,353	3.25	3.87	19,413	2.11	4.63	41,033	1.64	6.6	3.61	33,870	2.2	4.44	97,512	3.3
Penoxsulam	22.5	6.38	6,375	1.07	7.08	66,729	3.25	3.71	16,454	2.04	4.93	45,793	1.88	6.7	3.83	31,180	2.2	3.25	71,707	2.4
Bispyribac+ethoxysulfuron	25+18.8	6.42	6,140	1.07	7.26	68,590	3.27	3.88	18,266	2.45	5.41	51,306	2.00	6.8	5.03	52,450	2.9	4.29	95,793	3.2
Bispyribac+chlorimuron+metsulfuron (RM)	20+4	6.52	7,820	1.09	6.92	63,812	3.11	4.18	16,660	2.56	5.44	51,932	2.00	6.6	4.81	52,823	3.0	5.69	1,25,132	4.2
Pretilachlor *fb* ethoxysulfuron	750 *fb* 18.8	6.33	5,620	1.09	6.79	63,439	3.19	3.90	20,713	2.41	5.41	51,631	2.05	6.5	5.00	47,277	2.6	4.42	95,423	3.3
Pretilachlor *fb* chlorimuron+metsulfuron(RM)	750 *fb* 4	6.47	5,053	1.06	7.23	69,296	3.38	4.15	21,478	2.38	4.85	43,888	1.75	6.2	4.89	45,503	2.6	2.54	55,257	1.9
Pyrazosulfuron *fb* chlorimuron+metsulfuron(RM)	20 *fb* 4	6.27	1,157	1.01	5.76	48,122	2.59	4.16	20,054	2.17	5.00	46,806	1.93	6.4	3.62	26,973	2.0	3.58	77,535	2.6
Penoxsulam+cyhalofop(RM)	135	6.00	6,871	1.08	7.35	69,587	3.29	4.55	19,160	2.14	5.65	55,632	2.24	7.1	5.08	48,353	2.7	3.37	74,125	2.3
Triafamone+ethoxysulfuron(RM)	60	6.37	7,294	1.09	7.26	67,868	3.20	4.68	19,960	2.79	5.80	57,646	2.32	6.3	4.92	42,371	2.4	5.96	1,28,285	4.8
Pendimethalin *fb* bispyribac	750 *fb* 25	6.37	5,066	1.06	7.23	67,587	3.20	4.98	20,507	2.85	5.05	47,057	1.90	7.1	4.98	49,600	2.9	3.81	82,660	2.5
Hand weeding (2)	-	6.51	-3,226	0.99	6.43	52,598	2.51	4.53	18,790	2.59	5.84	51,211	1.61	6.6	5.89	46,933	2.4	6.92	1,49,423	2.7
Weedy check	-	5.23	-7,934	0.91	5.04	41,558	2.54	2.33	270	1.91	3.15	22,062	0.97	4.2	1.81	59,42	1.2	1.29	28,840	1.1
S Em $\pm$	-	0.12	-	-	0.37	-	-	0.08	-	-	0.16	-	-	0.12	0.27	-	-	-	-	-
LSD (P=0.05)	-	0.33	-	-	1.25	-	-	0.24	-	-	0.49	-	-	0.35	0.78	-	-	0.99	-	-

Contd.

Table 3.1.1.2 Continued

Treatment	Dose (g/ha)	Karikal			Raichur		
		Grain yield (t/ha)	Net return (Rs./ha)	B:C Ratio	Grain yield (t/ha)	Net return (Rs./ha)	B:C Ratio
Bispyribac	25	3.75	49,631	1.96	4.31	26,843	1.68
Penoxsulam	22.5	4.17	57,960	2.28	4.26	26,185	1.66
Bispyribac+ethoxysulfuron	25+ 18.8	4.50	63,938	2.45	4.61	-	1.75
Bispyribac+ chlorimuron+metsulfuron (RM)	20+4	4.58	66,337	2.62	4.74	29,574	1.82
Pretilachlor *fb* ethoxysulfuron	750 *fb* 18.8	4.31	60,893	2.41	4.43	32,387	1.76
Pretilachlor *fb* chlorimuron+metsulfuron(RM)	750 *fb* 4	4.58	66,787	2.68	4.60	39,195	1.84
Pyrazosulfuron *fb* chlorimuron+metsulfuron(RM)	20 *fb* 4	4.44	64,434	2.63	5.06	37,294	2.01
Penoxsulam+cyhalofop(RM)	135	4.78	67,685	2.43	4.90	28,535	1.97
Triafamone+ethoxysulfuron (RM)	60	5.08	75,042	2.82	4.38	32,436	1.73
Pendimethalin *fb* bispyribac	750 *fb* 25	4.58	64,961	2.43	4.72	28,354	1.80
Hand weeding (2)	-	4.44	63,639	2.52	5.15	11,007	1.55
Weedy check	-	3.19	40,889	1.78	3.15	29,574	1.29
S Em ±		-	-	-	0.13	0.07	0.07
LSD (P=0.05)		0.66	-	-	0.38	0.22	0.22

UAS, Raichur

Predominant grassy weeds associated with transplanted rice were *Echinochloa colona, Echinochloa crus-galli, Cynodon dactylon* and *Panicum repens, Cyperus iria, Cyperus difformis, Cyperus rotundus* and *Fimbristylis miliacea* among sedges and *Eclipta alba, Rotelia densiflora, Marsilea quadrifolia, Sphenoclea zeylanica, Ludwigia parviflora* and *Commelina benghalensis* among broad leaved and aquatic weeds.

At 60 DAT, hand weeding (25 and 45 DAT) recorded lowest total weed density and dry weight (4.39 /m^2 and 3.16 g/m^2, respectively) and it was found on par with pyrazosulfuron-ethyl 20 g/ha – 3 DAT *fb* chlorimuron-ethyl + metsulfuron- methyl 4 g/ha - 25 DAT (5.1 /m^2 and 3.5 g/m^2, respectively) as compared to weedy check (11/m^2 and 8.3 g/ m^2), respectively. Hand weeding twice at 25 and 45 DAT recorded significantly highest total dry matter (83 g/plant), number of tillers (517/m^2), number of panicles (389 m^2), grain yield (5.1 t/ha), straw yield (6.2 t/ha) and lowest weed index as compared to weedy check but was found on par with treatments comprising of pyrazosulfuron-ethyl 20 g/ha – 3 DAT *fb* chlorimuron- ethyl + metsulfuron- methyl 4 g/ha - 25 DAT and bensulfuron methyl + pretilachlor 660 g/ha – 3 DAT + hand weeding- 25 DAT. Application of pyrazosulfuron- ethyl 20 g/ha – 3 DAT *fb* chlorimuron -ethyl + metsulfuron- methyl 4 g/ha - 25 DAT recorded the highest benefit cost ratio (2.8).

RAU, Pusa

Lowest weed population, dry weight, highest weed control efficiency (75.9 %) and highest grain yield of rice (5.05 t/ha) were recorded under hand weeding at 25 and 45 DAT which was significantly superior and was at par with pendimethalin 750 ml/ha *fb* bispyribac-sodium 25 g/ha (4.84 t/ha). The highest weed control efficiency (75.9 %) was recorded under hand weeding at 25 and 45 DAS which There were not any phytotoxic effects on rice crop.The highest net return (` 42,525/ha) and B:C ratio (2.59) was recorded by the treatment pendimethalin 750 ml/ha *fb* bispyribac-sodium 25 g/ha which was found significantly superior over rest of the treatments.

WS 3.1.2 Herbicide combinations for management of complex weed flora in drum-seeded rice (Puddled)

Cooperating centres: Hyderabad, Bengaluru and Coimbatore

PJTSAU, Hyderabad

Major weed flora consisted of *Echinochloa colona, Echinochloa crus-galli* and *Cyperus rotundus.* Lowest weed density was observed during 60 and 90 DAS with hand weeding twice at 20 and 40 DAS except at 30 DAS where the lower weed density was observed with pre-emergence application of pyrazosulfuron-ethyl *fb* hand weeding at 40 DAS and it was on par with PE application of bensulfuron-methyl + pretilachlor *fb* HW, pretilachlor + safener *fb* azimsulfuron as post emergence at 25-30 DAS, pretilachlor + safener *fb* HW and pyrazosulfuron-ethyl *fb* azimsulfuron and was followed by post emergence application of azimsulfuron, bispyribac sodium *fb* HW, oxadiargyl *fb* HW and oxadiargyl *fb* azimsulfuron and similar trend was observed at 60 and 90 DAS.

Significant increase in grain yield was observed with hand weeding twice at 20 and 40 DAS and was on par with pre-emergence application of pyrazosulfuron-ethyl *fb* hand weeding at 40 DAS, bensulfuron-methyl + pretilachlor *fb* HW, pretilachlor + safener *fb* azimsulfuron as post-emergence at 25-30 DAS and pyrazosulfuron-ethyl *fb* azimsulfuron treatments. Pre-emergence application of pyrazosulfuron-ethyl 20 g *fb* hand weeding at 40 DAS was effective in efficient weed control and to get higher profit with B.C ratio of 1.4 over hand weeding twice due to reduced cost of cultivation.

UAS, Bengaluru

Drum-seeded rice (dry) *Kharif*, 2015

Major weed flora observed in the experimental plots was *Fimbristylis miliacea* and *Cyperus difformis* (sedge), *Paspalum distichum* and *Echinochloa colona* (among grasses). Whereas among broadleaf weeds, major weeds were *Dopatrium junceum, Rotala verticillaris, Ludwigia parviflora, Gnaphalium polycoulon* and *Commelina benghalensis.* Among the weed species, densities of *E. colona, Fimbristylis miliacea* and *Commelina benghalensis* were more than other weed species.

At 60 DAS, combination of herbicides bensulfuron-methyl 60 g / ha + pretilachlor 600 g / ha *fb* HW / MW, bispyribac-sodium 25 g / ha *fb* HW / MW and oxadiargyl 80 g / ha *fb* HW / MW reduced the weeds' density and dry weight comparable to hand weeding at 25 and 45 DAS. Bensulfuron-methyl 60 g / ha + pretilachlor *fb* HW / MW 600 g / ha (3.8 t / ha, 5.82 t / ha) and bispyribac-sodium 25 g / ha *fb* HW / MW (3.8 t / ha, 5.7 t / ha) followed by oxadiargyl 80 g / ha *fb* HW / MW (3.6 t / ha, 5.5 t / ha) recorded grain and straw yields on par with hand weeding (4.0 t / ha, 6.1 t / ha) but significantly higher yields compared to unweeded check and other herbicide treatments. Unweeded control resulted in the lowest paddy grain and straw yields (1.2 t / ha, 2.2 t / ha) owing to severe weed competition. The higher B:C ratio was obtained in pretilachlor 450 g / ha+ safener *fb.* HW (2.1) followed by pyrazosulfuron-ethyl 20 g / ha *fb* azimsulfuron 35 g / ha (2.0) compared to unweeded check (1.0).

Drum-seeded rice (dry) summer, 2015

Major weed flora observed in the experimental plots were *Fimbristylis miliacea* and *Scirpus* sp.; (sedge), *Paspalum distichum* and *Echinochloa colona* (among grasses). Whereas among broadleaf weeds, major weeds were *Dopatrium junceum, Rotala verticillaris, Ludwigia parviflora, Gnaphalium polycoulon* and *Commelina benghalensis.*

At 60 DAS, application of combination of bispyribac -sodium 25 g / ha -20 DAS *fb* hand weeding / mechanical weeding 40 DAS reduced the weed density and dry weight compared with hand weeding treatment whereas other herbicide combinations, viz. bensulfuron-methyl 60 g / ha+ pretilachlor 600 g / ha 5 DAS *fb* hand weeding / mechanical weeding 40 DAS, and pyrazosulfuron-ethyl 20 g / ha - 8-10 DAS *fb* hand weeding / mechanical weeding 40 DAS also reduced weed density and dry weight compared and found superior to azimsulfuron, 35 g / ha- 25-30 DAS alone and unweeded control (Table 3.1.2.1).

Bispyribac-sodium 25 g / ha -20 DAS *fb* hand weeding / mechanical weeding 40 DAS (3.5t / ha, 5.1 t / ha), bensulfuron-methyl 60 g / ha+ pretilachlor 600 g / ha 5 DAS *fb* hand weeding / mechanical weeding 40 DAS (3.4 t / ha, 4.9 t / ha) and oxadiargyl 80 g / ha - 8-10 DAS *fb a*zimsulfuron 35 g / ha-25-30 DAS (3.3 t / ha, 4.3

t/ha) recorded grain and straw yield on par with hand weeding treatment (3.6 t/ha, 5.2 t/ha). Higher B:C ratio was obtained under pretilachlor + safener 450 g/ha- 3-5 DAS *fb h*and weeding - 40 DAS (2.1) as compared to unweeded check (1.0) (Table 3.1.2.2).

Table 3.1.2.1 Effect of herbicide combinations on weed density and dry weight in drum-seeded rice (Puddled)

Treatment	Bengaluru		Hyderabad
	Total weed density (no./m^2)	Total weed biomass (g/m^2)	Total weed biomass (g/m^2)
Azimsulfuron 35 g/ha – 25-30 DAS	2.0 (117.1)	1.9 (85.2)	6.0 (38.0)
Pretilachlor 450 g/ha+ safener *fb* HW – 3-5 *fb* 40 DAS	2.0 (99.7)	1.8 (63.6)	4.3 (18.3)
Pretilachlor 450 g/ha+ safener *fb* azimsulfuron 35 g/ha – 3-5 *fb.* 25-30 DAS	1.9 (92.2)	1.7 (56.4)	4.6 (20.9)
Bensulfuron-methyl 60 g/ha+ pretilachlor *fb* HW/MW 600 g/ha	1.7 (51.2)	1.4 (25.9)	4.9 (24.2)
Bispyribac-sodium 25 g/ha *fb* HW/MW	1.7 (55.5)	1.4 (29.7)	6.5 (44.1)
Pyrazosulfuron-ethyl 20 g/ha *fb* HW/MW	1.8 (70.6)	1.6 (40.6)	5.0 (22.0)
Oxadiargyl 80 g/ha *fb* HW/MW	1.8 (64.1)	1.5 (35.9)	5.4 (31.4)
Pyrazosulfuron-ethyl 20 g/ha *fb* azimsulfuron 35 g/ha	2.0 (101.4)	1.8 (66.7)	5.1 (28.2)
Oxadiargyl 80 g/ha *fb a*zimsulfuron 35 g/ha	1.8 (75.2)	1.6 (44.8)	5.5 (32.8)
Mechanical weedings 20 *fb* 40 DAS	1.8 (74.0)	1.6 (43.6)	-
Hand weedings 20 *fb* 40 DAS	1.6 (43.8)	1.3 (21.1)	4.1 (17.3)
Unweeded check	2.2 (189.7)	2.2 (164.2)	8.6 (75.3)
SEm±	0.07	0.07	0.4
LSD (P=0.05)	0.1	0.2	1.4

* Original value are in parentheses

Table 3.1.2.2 Effect of herbicide combinations on grain yield and economics in drum-seeded rice (Puddled)

Treatment	Bengaluru			Hyderabad		
	Grain yield (t/ha)	NMR (`/ha)	B:C Ratio	Grain yield (t/ha)	NMR (`/ha)	B:C Ratio
Azimsulfuron 35 g/ha – 25-30 DAS	3.18	16,668	1.6	0.89	-17,325	0.51
Pretilachlor 450 g/ha+ safener *fb.* HW – 3-5 *fb* 40 DAS	3.29	28,626	2.1	2.89	11,928	1.34
Pretilachlor 450 g/ha+ safener *fb* azimsulfuron 35 g/ha – 3-5 *fb.* 25-30 DAS	3.31	22,747	1.8	3.24	14,632	1.39
Bensulfuron methyl 60 g/ha+ pretilachlor *fb* HW/MW 600 g/ha	3.86	24,233	1.8	3.32	13,451	1.34
Bispyribac sodium 25 g/ha *fb* HW/MW	3.86	19,985	1.7	1.93	-6,344	0.84
Pyrazosulfuron ethyl 20 g/ha *fb* HW/MW	3.53	21,169	1.7	3.57	18,237	1.48
Oxadiargyl 80 g/ha *fb* HW/MW	3.68	19,480	1.7	2.18	-1,542	0.96
Pyrazosulfuron ethyl 20 g/ha *fb* azimsulfuron 35 g/ha	3.22	27,795	2.0	3.19	15,297	1.42
Oxadiargyl 80 g/ha *fb a*zimsulfuron 35 g/ha	3.36	21,547	1.8	2.37	3,954	1.11
Mechanical weedings 20 *fb* 40 DAS	3.44	21,922	1.7			
Hand weedings 20 *fb* 40 DAS	4.07	21,991	1.7	3.63	16,003	1.39
Un-weeded check	1.25	10,68	1.0	0.64	-19,096	0.42
SEm±	0.20	-	-	0.19	-	-
LSD (P=0.05)	0.58			0.59		-

WS 3.1.3 Herbicide combinations for control of complex weed flora in direct-seeded rice (dry/wet)

Cooperating centres:

- *Dry seeded:* Bhubaneswar, Bengaluru, Ranchi, Palampur, Jorhat, Dapoli, Raipur and Thrissur
- *Wet seeded:* Faizabad, Coimbatore and Pusa

OUAT, Bhubaneswar

The floristic composition of the experimental site was dominated with *Digitaria ciliaris, Cynodon dactylon, Echinochloa colona, Ageratum conyzoides, Cleome viscosa, Celosia argentea, Oldenlandia corymbosa, Ludwigia parviflora, Physalis minima* and *Amaranthus viridis.* The dominant sedges observed were *Cyperus rotundus* and *Cyperus iria*.

Application of pendimethalin *fb* bispyribac *fb* manual weeding recorded significantly lowest density at 30 and 60 DAS, but at harvest, oxadiargyl *fb* bispyribac treated plots recorded significantly lowest value of 5.6 per m^2 followed by pyrazosulfuron *fb* bispyribac (6.3) and pendimethalin *fb* bispyribac *fb* manual weeding (6.6). Application of pendimethalin *fb* bispyribac *fb* manual weeding exhibited significantly lowest weed biomass of 1.9, 2.2 and 4.6 g/m^2 30, 60 DAS and at harvest, respectively followed by oxadiargyl *fb* bispyribac treatment.

Significantly higher grain yield of 3.4 t/ha was obtained with application of pendimethalin *fb* bispyribac *fb* manual weeding which was at par with oxadiargyl *fb* bispyribac (3.3 t/ha), pyrazosulfuron *fb* bispyribac (3.2 t/ha). Highest net return and B:C ratio of Rs.18,900/ha and 2.7 were obtained, respectively from application of pendimethalin *fb* bispyribac *fb* manual weeding followed by oxadiargyl *fb* bispyribac (₹ 17,600/ha and 2.7).

UAS, Bengaluru

In *Kharif,* 2015, major weed flora was *Cyperus rotundus* (sedge), *Digitaria marginata, E. colona* (among grasses). Whereas, major broadleaved weeds were *Phyllanthus niruri, Spilanthes acmella, Commelina benghalensis, Acanthospermum hispida* and *Portulaca oleracea.* Among the weed species, densities of *C. rotundus, D. marginata, E. colona, S. acmella, E. geniculata* and *A. conyzoides C. benghalensis*, *Ocimum canum* and *P. oleracea* were more than other weed species indicated their dominance and competitiveness with the direct-seeded rice.

Effective control of weeds was noticed at 60 DAS with application of oxadiargyl 100 g/ha – 2 DAS *fb* bispyribac-sodium 25 g/ha – 25 DAS followed by pendimethlain 1000 g/ha (2 DAS) *fb* bispyribac 25 g/ha – 25 DAS. Three hand weedings (20, 40 and 60 DAS) recorded significantly higher paddy grain (3.6 t/ha) and straw yield (6.5 t/ha) compared to all other treatments except pendimethlain 1000 g/ha (2 DAS) *fb* bispyribac 25 g/ha – 25 DAS *fb* manual weeding – 45 DAS (3.5 t/ha) (6.4 t/ha), oxadiargyl 100 g/ha – 2 DAS *fb* bispyribac-sodium 25 g/ha – 25 DAS (3.4 t/ha) (6.2 t/ha) pendimethlain 1000 g/ha (2 DAS) *fb* bispyribac 25 g/ha – 25 DAS (3.4 t/ha) (6.1 t/ha) (Table 3.1.3.1).

In summer, 2015, major weed flora was *Cyperus rotundus* (sedge), *Digitaria marginata, Echinolchloa colona* (among grasses). Major broad leaf weeds were *Spilanthes acmella, Commelina benghalensis, Ageratum conyzoides, Euphorbia geniculata, Ocimum canum, Phyllanthus niruri etc.* At 60 DAS, pre-emergence application of pendimethlain 1000 g/ha (2 DAS) *fb* bispyribac 25 g/ha – 25 DAS *fb* manual weeding – 45 DAS, pendimethlain 1000 g/ha (2 DAS) *fb* bispyribac 25 g/ha – 25 DAS and pyrazosulfuron-ethyl 20 g/ha – 3 DAS *fb* bispyribac-sodium 25 g/ha – 25 DAS reduced the weeds density and dry weight comparable to three mechanical weeding by conoweeder (Table 3.1.3.2).

AAU, Jorhat

Weeds appeared in the field nearly 10 days after sowing of rice and the first emerged species were *Cynodon dactylon* and *Eleusine indica.* At 30 DAS, altogether 5 grasses, 5 broadleaved species and one sedge (*Cyperus rotundus*) were recorded in the experiment. Out of these, two other grasses were *Digitaria setigera*, *Axonopus compressus* and *Panicum repens* and the broadleaved weeds were *Ageratum houstonianum, Borreria articularis, Commelina diffusa, Ludwigia linifolia* and *Sonchus wightianus.* Weeds emerged nearly 30 to 50 days late and prevailed thereafter were mostly broadleaved, viz. *Amaranthus viridis, Impatiens balsamina, Melochia corchorifolia, Mimosa diplitricha, Mimosa pudica* and *Phyllanthus fraternus.* However, amongst all these species, the grasses along with *Ageratum* and *Melochia* dominated the entire vegetation.

Weed density was lowest due to pendimethalin 1000 g/ha *fb* manual weeding (25 DAS) and pendimethalin 1000 g/ha *fb* bispyribac-Na

25 g/ha + manual weeding (45 DAS) at 20 and 40 days after sowing. Weed dry weight also affected in similar manner and pendimethalin 1000 g/ha *fb* manual weeding (25 DAS) was at par with mechanical weeding 20, 40 and 60 DAS and weed free (hand weeding 20, 40 and 60 DAS) at all stages up to 60 DAS. Taller plants, higher number of tiller, panicle number and panicle length and filled grain caused increased grain yield due to pendimethalin 1000 g/ha *fb* manual weeding (25 DAS) and pendimethalin 1000 g/ha *fb* bispyribac-Na 25 g/ha + manual weeding (45 DAS).

DBSKKV, Dapoli

During the first year of the experimentation (2012) use of pendimethalin *fb* manual weeding significantly reduced growth of monocots as compared to use of bispyribic-Na, pendimethalin *fb* bispyribic-Na, pyrazosulfuron *fb* bispyribic–Na, weedy check and remained at par with rest of the treatments, while, during the year 2013, 2014, 2015 and in pooled results, use of pendimethaline *fb* manual weeding recorded significantly lowest weed growth than rest of the treatment except pendimethalin *fb* bispyribic-Na *fb* manual weeding and weed free check. Various weed control measures tried did not significantly influenced growth of broad leaved during individual years as well as in pooled results at 60 DAS.

Weed free check produced significantly higher grain and straw yield (3.8 and 4.6 t/ha, respectively), over rest of the treatments followed by use of pendimethalin *fb* manual weeding (3.6 and 4.3 t/ha) and pendimethalin *fb* bispyribic-Na *fb* manual weeding (3.5 and 4.3 t/ha) which were at par with each other. Highest net returns of ₹ 13,887/ha were obtained with the application of pendimethalin (PE) *fb* manual weeding, followed by weed free check (HW at 20, 40 and 60 DAS) ₹ 10,698/ha with B:C ratio of 1.28 and 1.19, respectively.

KAU, Thrissur

In wet direct-seeded rice, major weeds were *Sacciolepis interrupta*, *Cyperus* sp., *Echinochloa* spp., *Cyanotis axillaris*, *Lindernia* sp., *Fimbristylis miliacea*, and *Ludwigia parviflora*. There was severe infestation of weedy rice, which contributed to low yield. Most herbicide combinations were ineffective in controlling *Sacciolepis interrupta*, while all were effective in controlling *Cyperus* spp. The main reason for ineffective control of *Sacciolepis* was its late emergence. Bispyribac-sodium, was ineffective against *Sacciolepis*. Only those treatments which included hand weeding at 45 or 60 DAS could control this weed. All treatments were superior to unweeded control in the control of *Cyperus* spp. Lowest dry matter production of weeds was in the hand weeded control, which was on par with application of pendimethalin followed by bispyribac-sodium or hand weeding. Pendimethalin followed by manual weeding recorded the highest WCE (93.2%), followed by hand weeding (92%) and pendimethalin followed by bispyribac-sodium followed by hand weeding (90.6%).

Highest grain yield of 3.33 t/ha was recorded in the hand weeding treatment. Treatments, bispyribac-sodium, pyrazosulfuron-ethyl followed by bispyribac-sodium and bispyribac-sodium + (chlorimuron-ethyl + metsulfuron methyl) were significantly inferior. However, lowest grain yield was recorded in unweeded control. There were no detectable phytotoxic effects on the crop. After hand weeding, lowest uptake of N, P and K by weeds were recorded in the treatment pendimethalin *fb* hand weeding (8.3, 1.6 and 1.2 kg/ha, respectively), which also recorded lowest dry matter production. This was followed by the treatment pendimethalin *fb* bispyribac-sodium *fb* hand weeding. Highest B:C ratios of 2.1 were recorded in bispyribac- sodium and oxadiargyl *fb* bispyribac-sodium. Hand weeding resulted in a B:C ratio of 1.1. The lowest value of 0.5 was recorded in the unweeded control.

UAS, Raichur

Predominant weed flora of dry direct-seeded rice was grassy weeds, viz. *Dinebra retroflexa, Echinochloa colona, Panicum repens, Chloris barbata* and *Leptochloa chinensis*. Among sedges *Cyperus difformis, Cyperus iria* and *Fimbristylis miliacea* and among broadleaved weeds *Ammania baccifera, Cyanotis axillaris, Eclipta alba, Phyllanthus niruri* and *Amaranthus viridis* were present.

At 60 DAS, hand weeding thrice at 20, 40 and 60 DAS recorded lower total weed density and dry weight compared to all other treatments except with the treatment receiving pendimethlain 1000 g/ha (2 DAS) *fb* bispyribac 25 g/ha – 20 DAS *fb* manual weeding – 45 DAS. Herbicide combinations such as

pyrazosulfuron- ethyl 20 g/ha – 3 DAS *fb* bispyribac-sodium 25 g/ha – 25 DAS, penoxsulam+ cyhalofop 135 g/ha – 15 DAS, pendimethlain 1000 g/ha (2 DAS) *fb* bispyribac 25 g/ha – 25 DAS, mechanical weeding (passing cono-weeder – 20, 40 and 60 DAS) and oxadiargyl 100 g/ha – 2 DAS *fb* bispyribac-sodium 25 g/ha – 25 DAS recorded lower weeds density and dry weight next to hand weeding thrice.

Three hand weedings (20, 40 and 60 DAS) recorded significantly higher paddy grain and straw yield (4.2 and 5.3 t/ha) compared to all other treatments except pyrazosulfuron-ethyl – 3 DAS *fb* bispyribac-sodium – 25 DAS (4.1 and 5.2 t/ha), pendimethalin – 2 DAS *fb* bispyribac-sodium – 20 DAS with manual weeding - 45 DAS (4 and 5 t/ha).

Significantly higher uptake of nitrogen, phosphorus and potassium (33.1, 22.1 and 30.4 kg/ ha, respectively) was evident from weedy check compared to all other treatments. Cost of herbicides either alone or in mixture along with one hand weeding were found cheaper and also the mechanical weeding like passing cono-weeder – 20, 40 and 60 DAS, when compared to manual weeding alone. The herbicide treated plots saved the weeding cost by ₹ 5,184 to 9,912/ha as against three time manual weeding (₹12,000/ha) (Table 3.1.3.1).

WS 3.2 Herbicide combinations for control of complex weed flora in wheat

Cooperating centres: Ludhiana, Pantnagar, Faizabad, Palampur, Gwalior, Pusa, Ranchi, Anand and Jammu

PAU, Ludhiana

Phalaris minor, Medicago denticulata, Rumex dentatus and *Chenopodium album* were major weeds in wheat. Tank-mix of pendimethalin + metribuzin, pinoxaden + metribuzin, pre-mix of mesosulfuron + iodosulfuron, pendimethalin 0.75-1.0 kg *fb* sulfosulfuron 0.018 kg, metribuzin 0.21 kg/ha alone >80% WCE, provided effective control of all the weeds and significantly reduced the weed dry matter and nutrient depletion by weeds, as compared to unweeded control. All the weed control treatments except clodinafop 60 g/ha recorded significantly higher wheat grain yield and yield attributes than unweedeed control. Tank-mix application of pinoxaden+metsulfuron recorded the highest wheat grain yield and was at par with all other herbicidal treatments except pendimethalin 0.75 kg and clodinafop 0.06 kg/ha. This tank-mix also recorded highest net returns and B:C which was comparable to tank-mix of pendimethalin 1.0 kg + metribuzin 0.175 kg/ha, pendimethalin 1.0 kg *fb* sulfosulfuron 0.018 kg/ha and metribuzin 0.21 kg /ha treatments. The study concluded that sequential/tank-mix application of pre- and or post-emergnece grass and broadleaf killers could be adopted for broad-spectrum control of weeds in wheat.

NDUAT, Faizabad

Dominant weeds were *Phalaris minor, Chenopodium album, Melilotus alba, Anagallis arvensis, Vicia sativa, Fumaria parviflora* and *Rumex dentatus*. Application of pendimethalin 1 kg + metribuzin 0.175 kg/ha applied as pre-emergence followed by pendimethalin + sulfosulfuron (1.0+0.018 kg/ha, PRE and POE), sulfosulfuron+metsulfuron (0.03+0.002 kg/ha), pinoxaden + metsulfuron (premix) (0.06+0.004 kg/ha, 5 WAS) controlled all types of weed very effectively as compared to single herbicide molecule application. Among the different weed control measures maximum WCE was recorded (100%) under hand weeding treatment followed by pendimethalin 1.0 kg/ha + metribuzin 0.175 kg/ha (81.6%).

Highest grain and straw yield (4.22 and 6.14 t/ha) was recorded with pendimethalin + metribuzin application which was at par with pendimethalin+ sulfosulfuron, sulfosulfuron+ metsulfuron treatments and significantly superior with sulfosulfuron, metribuzin, pendimethalin (0.75 kg/ha, PRE). Pendimethalin + metribuzin (1.0 + 0.175 kg/ha, PRE) treatment recorded maximum BCR (₹1.96) than other weed control measures.

RVSKVV, Gwalior

Weed flora comprised of grassy weeds *Phalaris minor*, *Cyperus rotundus* and broadleaves weeds *Chenopodium album*, *Spergula arvensis*, *Convolvulus arvensis* and *Rumex dentatus*. Lowest weed dry weight was recorded in 2 HW and it was at par with all the weed control treatments. The highest weed control efficiency was achieved under 2 HW

Table 3.1.3.1 Effect of herbicide combinations on weed density and dry weight in direct-seeded rice (dry / wet) (60 DAS)

Treatment	Dose (g/ ha)	Bhubaneswar		Bengaluru		Jorhat		Dapoli*				Thrissur		Raichur	
		Total weed density (no./ m^2)	Total weed biomass (g/ m^2)	Total weed density (no./ m^2)	Total weed biomass (g/ m^2)	Total weed density (no./ m^2)	Total weed biomass (g/ m^2)	Total weed density (no./ m^2)		Total weed biomass (g/ m^2)		Total weed density (no./ m^2)	Total weed biomass (g/ m^2)	Total weed density (no./ m^2)	Total weed biomass (g/ m^2)
								Grasses & Sedges	BLW	Grasses & Sedges	BLW				
Bispyribac-Na	25	5.2(26.5)	3.6(12.5)	1.9 (90.6)	1.8 (61.9)	5.8 (28.0)	8.7 (67.2)	15.7 (4.0)	3.4 (1.9)	12.3 (3.5)	3.1 (1.9)	4.4^{bcde*} (20.0)	10.3^{cd} (105.6)	6.7 (44.3)	5.1 (25.9)
Pendimethalin* *fb* bispyribac	1000 *fb* 25	4.8(22.7)	3.0(8.6)	1.7 (59.0)	1.5 (32.6)	5.7 (27.7)	5.9 (29.9)	14.0 (3.8)	2.7 (1.8)	10.3 (3.2)	2.1 (1.6)	5.2^{bcd} (30.6)	8.0^{e} (64.4)	5.4 (29.8)	4.3 (18.6)
Oxadiargyl *fb* bispyribac	100 /25	3.9(14.7)	2.5(5.8)	1.7 (54.3)	1.4 (29.2)	5.1 (21.4)	5.8 (28.0)	13.1 (3.6)	1.9 (1.5)	10.2 (3.2)	1.6 (1.4)	5.1^{bcd} (28.0)	9.4^{de} (89.4)	5.7 (32.6)	4.5 (19.9)
Pyrazosulfuron *fb* bispyribac	20/ 25	5.1(25.3)	2.8(7.2)	1.8 (65.0)	1.5 (38.1)	5.6 (26.3)	5.6 (26.3)	18.6 (4.3)	1.8 (1.5)	14.5 (3.8)	1.4 (1.3)	6.0^{bc} (36.0)	11.7^{bc} (37.1)	5.1 (40.9)	3.9 (15.3)
Pendimethalin* *fb* bispyribac fb manual weeding	1000 *fb* 25	3.3(10.3)	2.1(3.8)	1.6 (45.0)	1.3 (21.9)	4.9 (19.3)	4.1 (13.1)	6.3 (25.1)	1.6 (1.4)	4.8 (2.2)	0.9 (1.1)	2.6^{de} (6.6)	5.5^{f} (30.1)	4.6 (21.0)	3.5 (12.2)
Pendimethalin* *fb* manual weeding	1000	4.9(23.8)	3.1(9.5)	1.8 (70.7)	1.6 (42.0)	5.3 (23.0)	5.4 (24.0)	4.0 (21.1)	1.3 (1.3)	2.3 (1.6)	1.2 (1.3)	4.9^{bcd} (25.3)	4.6^{f} (21.6)	6.2 (38.2)	4.9 (24.2)
Bispyribac + (chlorimuron + metsulfuron)	20+4	4.0(25.0)	3.2(9.8)	1.9 (83.3)	1.7 (56.5)	5.8 (28.0)	6.8 (40.5)	11.4 (34.6)	3.3 (1.9)	8.2 (2.9)	2.9 (1.8)	6.6^{ab} (44.0)	12.3^{b} (155.0)	6.0 (35.8)	4.7 (22.1)
Three mechanical weedings (cono / rotary weeder)	-	5.1(25.5)	3.3(10.5)	1.8 (77.3)	1.6 (48.4)	4.1 (13.1)	4.4 (15.7)	8.5 (29.6)	2.0 (1.6)	6.3 (2.5)	1.7 (1.4)	3.3^{cde} (12.0)	8.2^{e} (69.3)	5.7 (32.3)	4.5 (19.9)
Weed free (HW at 20, 40 and 60 DAS)	-	2.0(3.7)	1.4(1.9)	1.5 (36.3)	1.2 (16.6)	3.7 (10.6)	3.8 (11.3)	3.4 (19.8)	0.7 (1.1)	3.1 (1.9)	0.6 (1.0)	1.6^{e} (2.6)	4.8^{f} (25.5)	3.9 (15.4)	3.1 (9.6)
Weedy check	-	10.0(98.7)	4.6(20.8)	2.2 (161.3)	2.1 (137.1)	7.4 (48.5)	9.2 (76.2)	23.7 (49.2)	6.1 (2.5)	18.4 (4.3)	5.0 (2.3)	9.4^{a} (96.0)	17.9^{a} (320.7)	9.7 (94.6)	8.4 (70.8)
SEm ±		0.19	0.11	0.05	0.07	1.1	1.6	0.25	0.26	- (0.3)	- (0.1)	-	-	0.22	0.18
LSD (P=0.05)		0.55	0.33	0.10	0.21	12.4	15.5	0.70	- (N.S.)	- (0.8)	- (N.S.)	2.95	1.99	0.66	0.55

*DBSKKV, Dapoli: Four year pooled mean

** Figures in parentheses are original values.

*** Subjected to $\sqrt{X+1}$ transformation

Table 3.1.3.2 Effect of herbicide combinations on grain yield and economics in direct-seeded rice (dry / wet) at 60 DAS

Treatment	Dose (g/ha)	Bhubaneswar			Bengaluru			Ranchi	Dapoli*			Thrissur			Raichur	
		Grainy yield (t/ha)	Net return (`/ha)	B:C Ratio	Grain yield (t/ha)	Net return (`/ha)	B:C ratio	Grain yield (t/ha)	Grain yield (t/ha)	Net return (`/ha)	B:C ratio	Grain yield (t/ha)	Total return (`/ha)	B:C Ratio	Grain yield (t/ha)	Net return (`/ha)
Bispyribac-Na	25	2.66	11,500	2.39	2.07	28,626	2.1	1.05	2.23	-4,122	0.91	2.65	60,108	2.09	3.48	23,442
Pendimethalin* *fb* bispyribac	1000 *fb* 25	3.10	14,900	2.50	3.40	42,562	2.5	1.55	3.04	574	1.01	2.70	61,333	1.90	3.90	29,225
Oxadiargyl *fb* bispyribac	100 /25	3.32	18,900	2.78	3.49	14,650	1.5	1.63	3.11	1,355	1.03	2.78	63,158	2.06	3.84	28,171
Pyrazosulfuron *fb* bispyribac	20/25	3.27	17,100	2.59	3.32	31,962	2.2	1.68	2.61	829	1.02	2.65	61,083	1.96	4.14	33,231
Pendimethalin* *fb* bispyribac fb manual weeding	1000 *fb* 25	3.40	17,600	2.72	3.55	41,402	2.4	2.33	3.58	10,017	1.19	3.17	70,465	1.66	4.04	24,557
Pendimethalin* *fb* manual weeding	1000	3.00	12,500	2.39	3.13	26,279	2.0	2.22	3.68	13,887	1.28	2.75	61,583	1.60	3.70	21,376
Bispyribac + (chlorimuron + metsulfuron)	20+4	2.84	13,300	2.46	2.92	31,839	2.2	1.28	2.62	1,600	1.04	2.54	55,173	1.89	3.71	26,434
Three mechanical weedings (cono / rotary weeder)	-	2.79	11,300	2.35	3.10	26,887	1.9	2.42	2.90	-4,520	0.92	3.19	71,920	1.94	3.82	23,569
Weed free (HW at 20, 40 and 60 DAS)	-	3.47	12,100	2.32	3.64	39,197	2.2	2.58	3.88	10,698	1.19	3.33	74,808	1.15	4.25	25,299
Weedy check	-	0.84	-1,300	2.04	0.58	-13,417	0.4	0.51	1.48	-9,822	0.73	0.54	12,090	0.48	2.25	6,415
S Em $\pm$		0.15	-	-	0.19			0.54	0.29			-			0.12	
LSD (P=0.05)		0.44			0.55			0.08	0.80			0.57			0.37	

*DBSKKV, Dapoli: Four year pooled mean

(91.7%) followed by mesosulfuron + idosulfuron (87.6%), pinoxaden + metsulfuron (87.1%) and sulfosulfuron + metsulfuron (86.2%). Among alone application of herbicides sulfosulfuron gave highest WCE of 79.8%.

Highest grain yield of 5.4 t/ha was recorded in 2 HW followed by pinoxaden + metsulfuron, sulfosulfuron + metsulfuron and mesosulfuron + iodosulfuron and they were at par to each other. Two hand weedings at 30 and 60 DAS yielded 62.8% higher grain yield over weedy check. Highest net income and B:C ratio of ₹ 71,182/ha and 3.6 was obtained in treatment pinoxaden + metsulfuron (pre-mix) followed by sulfosulfuron + metsulfuron (₹ 70,128/ha and 3.6) and metsulfuron + iodosulfuron (₹ 68,961/ha and 3.5).

AAU, Anand

Major monocot weeds were *Phalaris minor, Avena fatua, Asphodelus tenuifolius, Setaria tomentosa* and *Cyperus iria.* The dicot weeds were *Chenopodium album, Chenopodium murale, Melilotus indica, Amaranthus viridis, Oldenlandia umbellata* and *Digera arvensis.* Among weed management practices, hand weeding carried out at 30 and 60 DAS and pre-emergence application of pendimethalin *fb* sulfosulfuron showed significantly lower total weed density and weed dry biomass. Highest grain (4.45 t/ha) and straw (7.03 t/ha) yield were recorded under hand weeding carried out at 30 and 60 DAS, but it was

Table 3.2.1 Effect of herbicide combinations on weed density and biomass in wheat (60 DAS)

Treatment	Dose (g/ha)	Ludhiana		Faizabad		Gwalior		Anand	
		Total weed biomass (g/m²)		Total weed density (no./m²)	Total weed biomass (g/m²)	Total weed density (no./m²)	Total weed biomass (g/m²)	Total weed density (no./m²)	Total weed biomass (g/m²)
		Grasses	Broad leaved						
Pendimethalin	0.75	4.8 (22)	3.0 (8)	92.4 (9.6)	107.8	1.5 (33.3)	64	4.0 [e] (15.7)	13.3 [b] (176.3)
Sulfosulfuron	0.025	4.2 (17)	3.5 (11)	92.3 (9.6)	106.4	1.3 (28.6)	44	2.3 [f] (4.7)	3.8 [d] (13.7)
Metribuzin	0.21	3.0 (8)	4.0 (15)	111.6 (10.6)	121.4	1.4 (30.3)	84	4.2 [e] (17.3)	13.2 [b] (173.7)
Clodinafop	0.06	5.2 (26)	2.2 (4)	97.6 (9.9)	111.5	1.5 (39.3)	65	13.0 [b] (170.7)	9.1 [c] (82.7)
Pendimethalin+ metribuzin	1.0+0.1 75	2.7 (6)	1.3 (1)	50.2 (7.1)	63.4	1.4 (26.6)	71	3.5 [e] (11.3)	13.2 [b] (175.7)
Pendimethalin *fb* sulfosulfuron	1.0 fb 0.018	2.1 (4)	1.0 (0)	56.9 (7.6)	71.3	1.5 (35.6)	78	1.0 [g] (0.0)	1.0 [e] (0.0)
Pre-mix of sulfosulfuron+ metsulfuron	0.03 +0.002	4.4 (19)	1.0 (0)	65.3 (8.1)	69.8	1.1 (14.6)	30	7.5 [c] (56.0)	4.4 [d] (19.0)
Pinoxaden+ metsulfuron (tank-mix)	0.06+ 0.004	2.0 (3)	1.0 (0)	76.7 (8.8)	82.3	1.4 (24.3)	28	3.3 [e] (10.7)	3.5 [d] (12.0)
Pre-mix of mesosulfuron + iodosulfuron	0.012 +0.0024	3.2 (10)	1.5 (1)	81.6 (9.0)	90.5	1.2 (20.0)	27	5.3 [d] (28.7)	3.9 [d] (14.7)
Pre-mix of clodinafop + metsulfuron	0.06 + 0.004	4.1 (16)	1.0 (0)	82.2 (9.1)	93.2	1.3 (23.3)	39	6.1 [d] (37.7)	3.2 [d] (10.7)
2 HW	-	1.0 (0)	1.0 (0)	0.0	0.0	1.2 (17.0)	18	1.0 [g] (0.0)	1.0 [e] (0.0)
Unweeded control		6.1 (36)	7.2 (51)	188.4 (13.7)	345.6	2.3 (185.6)	218	14.4 [a] (207.7)	18.2 [a] (332.7)
SEm ±		0.2	0.1	-	2.02	0.06	25	0.29	0.36
LSD (P=0.05)		0.6	0.4	-	5.86	0.18	73	-	-

* Original value are in parentheses

at par with clodinafop + metsulfuron, sulfosulfuron + metsulfuron, pinoxaden + metsulfuron, pendimethalin *fb* sulfosulfuron, sulfosulfuron, clodinafop and mesosulfuron + iodosulfuron. Nutritient depletion by the weeds in unweeded control treatment to the tune of 57.6 kg N, 51.0 kg P and 130.8 kg K was recorded at harvest (Table 3.2.1).

RAU, Pusa

Dominant weed species were *Avena fatua, Cynodon dactylon, Phalaris minor, Cyperus rotundus, Anagallis arvensis, Chenopodium album, Cirsium arvense, Convolvulus arvensis, Eclipta alba, Fumaria parviflora, Lathyrus aphaca, Launia pinnatifida, Melilotus alba, Physalis minima, Rumex dentatus* and *Vicia hirsuta.*

Lowest weed density (19/m^2) and weed dry weight (8.8 g/m^2) were recorded by sulfosulfuron + metsulfuron at 5 WAS which were statistically at par with clodinafop + metsulfuron (premix) pinoxaden + metsulfuron (premix). Among different herbicide combinations, the highest grain yield of wheat was recorded by sulfosulfuron + metsulfuron (4.5 t/ha) which was statistically at par with pendimethalin 1.0 kg/ha (PE) *fb* sulfosulfuron (POE) (4.4 t/ha) and found significantly superior over rest of the treatments. Highest B:C ratio (3.2) was recorded by sulfosulfuron +metsulfuron which was statistically at par with clodinafop + metsulfuron (pre-mix) (3.1) (Table 3.2.2).

BAU, Sabour

Major weed flora in experimental field was *Chenopodium album*, *Rumex dentatus, Medicago denticulata, Anagallis arvensis, Coronopus didymus* and *Fumaria parviflora, Polypogon monspeliensis* and *Phalaris minor* were dominant grassy weeds. Among the herbicidal treatments, maximum weed dry matter at 60 DAS was recorded with sulfosulfuron 25 g/ ha as

Table 3.2.2 Effect of herbicide combinations on grain yield and economics in wheat (60 DAS)

Treatment	Dose (g/ha)	PAU, Ludhiana			NDUAT, Faizabad			RVSKVV, Gwalior			AAU, Anand	
		Grain yield (t/ha)	Net return (`/ha)	B:C ratio	Grain yield (t/ha)	Net return (`/ha)	B:C ratio	Grain yield (t/ha)	Net return (`/ha)	B:C ratio	Grain yield (t/ha)	B:C ratio
Pendimethalin	0.75	4.55	39,797	2.67	3.30	33,835	1.32	3.50	42,993	2.63	2.23	1.15
Sulfosulfuron	0.025	4.84	43,368	2.88	3.45	37,715	1.54	4.19	55,353	3.11	4.03	2.12
Metribuzin	0.21	4.91	46,542	3.05	3.32	34,489	1.35	3.50	43,366	2.66	2.83	1.56
Clodinafop	0.06	3.79	29,804	2.28	3.29	34,302	1.37	3.74	47,600	2.80	4.03	2.11
Pendimethalin+ metribuzin	1.0+ 0.175	5.04	46,751	2.91	4.22	50,626	1.96	3.93	49,621	2.82	2.57	1.32
Pendimethalin *fb* sulfosulfuron	1.0 fb 0.018	5.09	46,718	2.91	4.13	49,315	1.93	4.26	57,260	3.10	4.05	2.02
Pre-mix of sulfosulfuron+ metsulfuron	0.03 + 0.002	4.94	45,072	2.87	3.95	46,120	1.83	4.96	70,128	3.67	4.28	2.22
Pinoxaden+ metsulfuron (tank-mix)	0.06+ 0.004	5.11	47,406	2.96	3.82	43,960	1.77	5.00	71,182	3.69	4.13	2.06
Pre-mix of mesosulfuron + iodosulfuron	0.012+ 0.0024	4.95	44,989	2.85	3.77	42,697	1.68	4.91	68,961	3.53	4.02	2.08
Pre-mix of clodinafop + metsulfuron	0.06 + 0.004	4.81	44,026	2.89	3.75	42,191	1.66	4.56	63,733	3.41	4.38	2.28
2 HW	-	4.99	44,094	2.71	4.30	51,284	1.92	5.03	65,199	2.98	4.45	1.93
Unweeded control		3.95	33,178	2.50	2.43	22,058	0.93	3.09	36,763	2.44	2.00	1.11
SEm±		0.15	-	-	0.13	-	-	0.09	-	-	0.23	
LSD (P=0.05)		0.43	-	-	0.38	-	-	0.26	-	-	0.10	

post- emergence, while minimum weed dry matter was recorded with pinoxaden + metsulfuron (premix) followed by clodinafop + metsulfuron (premix) Maximum grain yield of wheat (4.1 t/ha) was also recorded with application of pinoxaden 0.060 g/ ha + metsulfuron (pre-mix) as PoE. Maximum B: C ratio of 3 was obtained with pinoxaden 60 g/ ha + metsulfuron (premix) as PoE.

WS 3.3 Weed management in turmeric and other vegetables

WS 3.3.1 Integrated weed management with pre- and post-emergence herbicides in turmeric

Cooperating centres: Hisar, Palampur, Faizabad, Pusa, Jorhat, Ranchi, Bengaluru, Pantnagar, Raipur and Puducherry

CCSHAU, Hisar

Weed flora of the field consisted of *Dactyloctenium aegyptium, Brachiaria reptans, Digitaria reptans, Eragrostis tenella* among grasses; *Trianthema monogyna* among broadleaf weeds (BLW); and *Cyperus rotundus* among sedges. Treatments with straw mulch were found most effective against all type of weeds particularly against broadleaf weeds and sedges. Fenoxaprop provided effective control of grassy weeds as post-emergence herbicide. Glyphosate at 7.5 ml/litre of water (directed spray) provided effective control of most of the weeds at the time of application. Metribuzin or pendimethalin or atrazine *fb* mulching + one hand weeding provided excellent control of weeds and crop growth was also visibly better under these treatments. Hence, metribuzin 700 g/ha or pendimethalin 1000 g/ha or atrazine 750 g/ha *fb* mulching+ hand weeding at 75 DAS were realized to be the best options for effective weed control in turmeric.

NDUAT, Faizabad

Weed flora of the experimental field consisted of *Echinochloa* species, *Dactyloctenium aegyptium* and *Eleusine indica* among grasses *Ludwigia* sp., *Commelina benghalensis, Ammannia baccifera, Ageratum conyzoides* and *Solanum nigrum* among broad leaf weeds and *Cyperus rotundus* and *Fimbristylis* among sedges. At 60 DAP stage, PE metribuzin at 0.7 kg/ha *fb* straw mulch of 10 t/ha on 10 DAP *fb* one HW on 75 DAP, PE pendimethalin at 1.0 kg/ha *fb* straw mulch at 10 t/ha on 10 DAP *fb* one HW on 75 DAP, POE glyphosate at 7.5 ml/lit on 25 DAP *fb* two HW on 45 and 75 DAP and PE oxyfluorfen at 0.30 kg/ha *fb* two HW on 45 and 75 DAP in treatments provided very good control of all type of weeds in turmeric. However, atrazine + straw mulch + HW also provided effective control of weeds but it showed phytotoxicity on the crop. Oxyfluorfen 30 g and oxadiargyl 25 g/ha *fb* 2 HW proved very effective control to all the weeds and showed no phytotoxicity on the crop.

AAU, Jorhat

Grasses like *Panicum repens* and to some extent *Saccharum spontaneum* and broadleaved weed *Scoparia dulcis* appeared as the most troublesome weeds. Other grasses of this crop were *Cynodon dactylon, Eleusine indica* and *Digitaria setigera*. Broadleaved species, *Mimosa diplotricha* var. *innermis, Borreria articularis* and *Ageratum houstonianum* were rather common than *Alternanthera sessilis, A. philoxeroides, Cuphea balsamina* and *Spilanthes paniculata*. Sedges, *Cyperus brevifolius* and *Fimbristylis bis-umbellata* were seen during the rainy days only. Among these, *B. articularis, E. indica* and *M. diplotricha* were the early emerged species in the field.

Lowest density and dry weight of weeds were found with pendimethalin 1000 g/ha *fb* straw mulch 10 t/ha *fb* hand weeding 75 DAP. These treatments were at par with hand weeding 25, 45 and 75 DAP. The highest rhizome yield was obtained from pendimethalin 1000 g/ha *fb* straw mulch 10 t/ha *fb* hand weeding 75 DAP closely followed by metribuzin 700 g/ha *fb* straw mulch 10 t/ha *fb* hand weeding 75 DAP (Table 3.3.1.1).

BAU, Ranchi

Broadleaved weeds accounted maximum number (906/m^2) followed by narrow (367/m^2) and sedges (159/m^2) in weedy check treatment at 90 DAP. Total weed density and dry matter accumulation was reduced with application of glyphosate 7.5 ml/lit 25 DAP *fb* 2 hand weeding (45 and 75 DAP) similar to oxyfluorfen *fb* 2 hand weedings (45 and 75 DAP), oxadiargyl *fb* 2 hand weedings (45 and 75 DAP), glyphosate 25 DAP *fb* 2 hand weeding (45 and 75 DAP) and hand weeding (25, 45 and 75 DAP) at 30 DAP, while at 90 and 150 DAP application of metribuzin *fb* fenoxaprop + metsulfuron (45 DAP) significantly reduced total weed density and dry

matter accumulation compared to rest of the treatments except pendimethalin *fb* fenoxaprop + metsulfuron.

UAS, Bengaluru

Major weed flora was *Cyperus rotundus, Scirpus* sp. (among sedges), *Cynodon dactylon, Echinochloa colona (*among *grasses); Spilanthes acmella, Portulaca oleracea, Parthenium hysteropnorus, Phyllanthus niruri, Euphorbia geniculata* (broadleaf weeds) were higher than other weed species, indicated their dominance from the beginning of the crop cycle.

At 75 DAP pendimethalin 0-5 DAP *fb* 2 HW 45 and 75 DAP, oxyfluorfen 0-5 DAP *fb* two HW 45 and 75 DAP, atrazine 0-5 DAP *fb* two HW45 and 75 DAP, metribuzin *fb 2* hand weeding 0-5 DAP *fb* two HW45 and 75 DAP and oxadiargyl 0-5 DAP *fb* two HW45 and 75 DAP reduced the weeds density and dry weight significantly and the herbicide treatments were superior to unweeded control with regards to weed density and dry weight.

Higher rhizome yield was obtained with application of pendimethalin *fb* 2 HW 45 and 75 DAP (23.2 t/ha), oxyfluorfen *fb* two HW 45 and 75 DAP (22.5 t/ha). Unweeded control gave the lowest fresh rhizome yield (6.4 t/ha). Higher B:C ratio was obtained under pendimethalin *fb* 2 HW 45 and 75 DAP(2.7), oxyfluorfen *fb* two HW 45 and 75 DAP (2.6) and atrazine *fb* two HW 45 and 75 DAP (2.6 each), whereas , B:C ratio was 2.4 in hand weeding treatment due to higher cost of cultivation. Unweeded check failed to realize any benefit (-0.9) (Table 3.3.1.2).

GBPUAT, Pantnagar

Dominant weed species in the weedy plot at 75 DAP were *E. colona* (8.2%), *D. sanguinalis* (17%), *D. aegyptium* (6.9%), *E. indica* (11.3%), *T. monogyna* (2.5%) and *C. rotundus* (54.1%). Least total dry matter accumulation of grassy weeds was recorded with application of pendimethalin *fb* straw mulch at 10 t/ha *fb* 1 HW at 75 DAP which was at par with the application of metribuzin at *fb* straw mulch at 10.0 t/ha *fb* 1 HW at 75 DAP and atrazine *fb* straw mulch at 10 t/ha *fb* 1 HW at 75 DAP. Among all the weed management practices, highest weed control efficiency was recorded with pendimethalin *fb* straw mulch at 10 t/ha *fb* hand weeding at *fb* followed by metribuzin *fb* straw mulch *fb* 1 HW at 75 DAP.

Application of pendimethalin *fb* straw mulch 10 t/ha supplemented with 1 HW at 75 DAP attained highest turmeric yield (33 t/ha) which was significantly superior to all other combination treatments except application of metribuzin at *fb* straw mulch at 10 t/ha supplemented with 1 HW at 75 DAP. However, the highest gross return (` 6,60,000 /ha), net return (` 5,39,236/ha) and B:C ratio of 4.4 was obtained with application of pendimethalin *fb* straw mulch at *fb* 10 t/ha along with 1 HW followed by metribuzin at *fb* straw mulch at *fb* 10 t/ha supplemented with 1 HW at 75 DAP.

RAU, Pusa

Lowest weed dry weight (7.1 g/m^2) was recorded under hand weeding thrice (HW at 25, 45 and 75 DAP) which was significantly superior over rest of the treatments except metribuzin 0.7 kg/ha at 0-5 DAP *fb 2* hand weeding at 45 and 75 DAP. The highest weed control efficiency (89.9%) was recorded with hand weeding thrice (HW at 25, 45 and 75 DAP) which was closely followed by metribuzin 0.7 kg/ha *fb 2* hand weeding (HW at 45 and 75 DAP) (87.4%), metribuzin 0.7 kg/ha *fb* fenoxaprop + metsulfuron 67+4 g/ha at 3 DAP *fb* 45 DAP (78.1%). There were no phytotoxic effects on the crop. The highest rhizome yield of turmeric (47.7 t/ha) was recorded under the treatment hand weeding thrice at 25, 45 and 75 DAP which was statistically at par with metribuzin *fb 2* hand weedings at 45 and 75 DAP (46.8 t/ha), metribuzin *fb* fenoxaprop + metsulfuron at 3 DAP *fb* 45 DAP (46.34 t/ha). Highest net return (` 2,20,708/ha) and B:C ratio(3.1) were recorded by metribuzin 0.7 kg/ha *fb* fenoxaprop + metsulfuron at 3 DAP *fb* 45 DAP which were statistically at par with metribuzin followed by two hand weedings.

WS 3.3.2 Integrated control of complex weed flora in garlic

Cooperating centres: Ludhiana, Pantanagar, Faizabad, Anand. Bengaluru and Raipur

PAU, Ludhiana

Rumex dentatus, Coronopus didymus, Oenothera laciniata, Phalaris minor and *Medicago denticulata* were major weeds in gralic. Uniform spreading of paddy straw mulch at 5 t/ha significantly reduced density of *M. denticulata, C. didymus, P. minor* and *O. laciniata*, and weed biomass compared to without mulch. Straw mulch at 7.5 t/ha further reduced weed density and

Table 3.3.1.1 Effect of Integrated weed management with pre and post emergence herbicides on weed density and dry biomass in turmeric

Treatment	Hisar						Faizabad		Jorhat		Ranchi						Bengaluru		Pantnagar		
	Density of weeds (No./m²)			Dry weight of weeds (g/m²)			Total weeds (no m⁻²) 60 DAP	Total dry weight (g) 60 DAP	Total weeds (no m⁻²) 60 DAP	Total dry weight (g) 60 DAP	Total weed density (no/m²) 90 DAP			Total weed biomass (g/m²) 90 DAP			Total weed density (no/m²) (75 DAP)	Total weed biomass (g/m²) (75 DAP)	Total weed density (no/m²) (Grassy) (75 DAP	Total weed density (no/m²) (BLW) (75 DAP)	Total weed biomass (g/m²) (75 DAP)
	Grassy	Sedges	BLW	Grassy	Sedges	BLW					BLW	Grassy	Sedges	BLW	Grassy	Sedges					
Metri 0.7 kg/ha *fb* 2 HW	3.3 (10.0)	15.9 (254.0)	10.0 (30.0)	14.3	30.3	6.3	3.5 (12.3)	9.0 (80.35)	4.8 (23.7)	5.1 (25.7)	21.8 (481)	15.0 (228)	5.2 (28)	14.8 (223.4)	16.7 (278.6)	6.4 (41.3)	1.7 (47.7)	1.4 (25.5)	4.5 (19.0)	1.0 (0.0)	7.6 (56.4)
Metri. 0.7 kg/ha *fb* POE fenozaprop 67 g/ha + met. 4 g/ha + 1HW	2.3 (4.7)	15.2 (233.3)	10.7 (55.3)	1.9	44.6	13.9	4.3 (17.4)	9.3 (85.5)	5.8 (34.0)	5.1 (26.1)	10.9 (118)	5.5 (30)	2.7 (7)	9.5 (94.8)	9.08 (82.3)	3.9 (15.8)	1.8 (66.0)	1.7 (47.5)	6.2 (38.0)	1.0 (0.0)	9.8 (95.7)
Metri. 0.7 kg/ha fb SM 10 t/ha *fb* 1HW	3.6 (12.7)	5.3 (29.3)	0.7 (7.3)	36.4	0.3	4.4	2.8 (6.6)	6.8 (45.3)	5.5 (30.7)	4.4 (19.4)	21.3 (461)	14.8 (221)	5.3 (28)	14.8 (223)	15.0 (229.6)	6.8 (47)	1.7 (55.3)	1.5 (34.5)	1.8 (2.7)	2.2 (4.0)	6.5 (41.7)
Pendi. 1.0 kg/ha *fb* 2HW	1.6 (2.0)	14.6 (214.0)	19.3 (30.7)	12.7	38.1	9.8	3.5 (11.4)	8.4 (81.2)	4.6 (22.0)	4.4 (20.0)	23.7 (574)	16.9 (288)	6.5 (42)	19.3 (375.3)	22.0 (494.8)	6.8 (46.6)	1.5 (31.7)	1.2 (15.2)	4.3 (18.0)	1.0 (0.0)	7.6 (57.6)
Pendi. 1.0 kg/ha *fb* fenozaprop 67 g/ha + Mets. 4 g/ha 1HW	1.0 (0.0)	15.8 (250.0)	24.0 (56.0)	0.0	49.5	16.5	4.2 (16.8)	9.0 (81.2)	5.5 (31.0)	5.2 (26.7)	11.6 (134)	7.0 (50)	3.7 (14)	10.7 (115.6)	11.5 (136.0)	5.0 (24.9)	1.9 (72.0)	1.8 (55.1)	6.4 (40.0)	1.0 (0.0)	10.5 (108.6)
Pend. 1.0 kg/ha *fb* SM 10 t/ha *fb* one HW	2.3 (4.7)	5.9 (35.3)	2.7 (6.0)	23.5	2.4	4.0	2.8 (7.5)	(6.9) 46.0	4.4 (19.7)	3.9 (15.4)	21.8 (481)	16.7 (280)	6.5 (42)	14.8 (223.1)	21.6 (473.9)	7.0 (49.3)	1.8 (59.0)	1.6 (37.8)	2.2 (4.0)	1.9 (2.7)	6.0 (34.6)
Atrazin 0.75 kg/ha *fb* 2 HW	3.6 (12.7)	11.4 (130.0)	16.0 (28.0)	20.3	21.0	7.9	4.4 (18.2)	9.4 (80.5)	5.2 (27.3)	4.6 (21.1)	21.5 (463)	14.8 (221)	4.9 (24)	14.8 (219.3)	14.8 (225.5)	5.9 (35.3)	1.6 (43.0)	1.4 (22.1)	5.1 (24.7)	1.0 (0.0)	8.9 (77.0)
Atrazin 0.75 kg/ha *fb* fenozaprop 67 g/ha + Mets. 4 g/ha 1HW	3.2 (9.3)	11.8 (140.7)	22.0 (47.3)	8.2	32.7	11.6	2.9 (7.7)	7.1 (49.7)	4.4 (19.3)	4.5 (20.6)	14.5 (212)	8.7 (78)	3.7 (14)	11.4 (131.7)	11.7 (139.6)	4.9 (24.1)	1.9 (76.3)	1.8 (60.9)	5.4 (28.7)	1.5 (1.3)	10.3 (104.5)
Atrazin 0.75 kg/ha *fb* SM 10 t/ha *fb* 1 HW	4.4 (18.7)	5.4 (29.3)	2.0 (8.0)	42.1	0.8	4.8	2.9 (7.5)	6.9 (47.0)	5.2 (27.7)	4.2 (17.2)	20.6 (430)	14.4 (210)	4.9 (25)	13.6 (187.8)	13.6 (186)	4.7 (25.3)	1.8 (60.3)	1.6 (40.3)	2.2 (4.0)	1.9 (2.7)	7.1 (49.3)
Oxyfluorfen at 0.30 kg/ha *fb* 2 HW	3.5 (12.0)	15.6 (243.3)	0.0 (64.7)	46.8	44.1	20.7	3.5 (11.0)	8.7 (75.0)	4.7 (22.3)	5.03 (25.1)	18.4 (342)	12.6 (160)	4.9 (24)	12.1 (149.9)	13.3 (178.3)	5.8 (34)	1.6 (38.0)	1.3 (18.8)	4.6 (20.0)	1.0 (0.0)	10.8 (115.3)
Oxadiargyl 0.25 kg/ha *fb* 1 HW	3.3 (10.0)	14.7 (216.7)	10.7 (87.3)	39.6	36.9	28.9	3.5 (11.0)	8.8 (75.5)	4.9 (24.3)	4.5 (19.9)	18.1 (331)	11.8 (140)	4.9 (25)	11.8 (142.6)	13.6 (188)	5.8 (34.5)	1.7 (50.0)	1.5 (27.9)	4.6 (20.0)	1.4 (1.3)	9.9 (97.8)
Glypho. 5.0 ml/lit *fb* 1HW	3.4 (11.3)	8.4 (71.3)	12.0 (93.3)	13.8	15.2	35.0	3.6 (12.3)	9.0 (79.7)	4.7 (22.0)	5.4 (29.9)	16.4 (273)	10.6 (112)	4.5 (21)	11.6 (138.8)	11.9 (144.4)	5.6 (32.4)	1.8 (64.7)	1.7 (44.9)	4.8 (22.0)	1.5 (1.3)	7.6 (56.9)
Glypho. 7.5 ml/lit *fb* 2HW	1.9 (2.7)	7.2 (52.0)	6.0 (48.0)	5.9	12.9	25.6	2.9 (6.6)	6.8 (45.7)	4.9 (24.0)	5.1 (26.8)	15.2 (232)	9.3 (87)	4.6 (21)	11.6 (136.8)	10.1 (103.1)	5.5 (31.0)	1.7 (53.0)	1.5 (30.5)	3.7 (12.7)	1.0 (0.0)	6.6 (43.1)
HW at 25, 45 and 75 DAP	3.4 (10.7)	9.4 (89.3)	10.0 (39.3)	22.5	19.0	18.9	2.9 (7.3)	6.6 (42.0)	4.5 (20.0)	4.1 (17.1)	17.4 (307)	11.7 (140)	4.5 (21)	11.7 (140.7)	12.5 (168.2)	5.6 (32.1)	1.8 (56.0)	1.5 (33.4)	4.9 (22.7)	1.0 (0.0)	7.7 (57.7)
Unweeded check	7.63 (57.3)	17.38 (301.3)	26.0 (123.3)	194.8	87.3	60.5	9.7 (92.3)	21.4 (456.2)	7.0 7(52.7)	7.23 (52.2)	30.09 (906)	19.14 (367)	12.62 (159)	22.21 (498.67)	25.77 (685.33)	9.76 (95)	2.2 (154.7)	2.2 (146.4)	9.6 (92.0)	2.5 (5.3)	14.6 (210.9)
SEm ±	0.16	0.53 13.3	2.4	3.3	6.1	3.4			1.33	1.00	1.15	0.45	0.43	1.12	1.47	0.56	0.07	0.07	0.22	0.16	0.31
CD (P=0.05)	0.47	1.52 38.3	6.8	9.5	17.6	9.8			15.54	12.21	3.34	1.30	1.26	3.26	4.27	1.62	0.21	0.20	0.63	0.46	0.90

* Original value are in parentheses, BLW - Broad Leaved Weeds

Table 3.3.1.2 Effect of Integrated weed management with pre and post emergence herbicides on rhizome yield and economics in turmeric

Treatment	Hisar			Faizabad			Jorhat	Bengaluru			Pantnagar		
	Rhizome yield (t/ha)	Net return (`/ha)	B:C ratio	Rhizome yield (t/ha)	Net return (`/ha)	B:C ratio	Rhizome yield (t/ha)	Rhizome yield (t/ha)	Net return (`/ha)	B:C ratio	Rhizome yield (t/ha)	Net return (`/ha)	B:C ratio
Metribugin 0.7 kg/ha *fb* 2 HW	14.25	800	1.01	27.5	3,40,610	3.41	12.70	21.4	127750	2.5	25.0	3,76,948	3.06
Metribugin0.7 kg/ha *fb* POE fenozaprop 67 g/ha + met. 4 g/ha + 1HW	16.01	30,569	1.24	23.8	2,84,710	2.95	13.65	13.8	58622	1.7	21.7	3,23,576	2.93
Metri. 0.7 kg/ha *fb* SM 10 t/ha fb 1HW	18.30	46,448	1.34	31.5	3,97,290	3.72	14.23	19.7	115309	2.4	31.0	4,98,948	4.12
Pendimethalin 1.0 kg/ha *fb* 2HW	14.42	2,667	1.02	29.5	3,72,130	3.73	12.20	23.2	145309	2.7	25.4	3,85,236	3.14
Pendimethalin 1.0 kg/ha *fb* fenozaprop 67 g/ha + Mets. 4 g/ha 1HW	15.86	29,289	1.23	25.0	3,03,430	3.14	13.60	12.0	40136	1.5	18.9	2,67,864	2.43
Pendimethalin1.0 kg/ha *fb* SM 10 t/ha *fb* one HW	18.60	49,656	1.36	30.7	3,87,497	3.60	15.18	17.4	91488	2.1	33.0	5,39,236	4.47
Atrazin 0.75 kg/ha *fb* 2 HW	14.05	-311	1.00	23.1	2,71,255	2.7	12.18	22.3	138100	2.6	23.0	3,38,225	2.78
Atrazin 0.75 kg/ha *fb* fenozaprop 67 g/ha + Mets. 4 g/ha 1HW	15.45	25,813	1.20	26.7	3,87,511	4.0	12.80	11.5	37306	1.5	20.4	2,98,853	0.73
Atrazin 0.75 kg/ha *fb* SM 10 t/ha *fb* 1 HW	17.94	43,726	1.32	27.5	3,34,175	3.1	14.73	15.6	75914	1.9	29.7	4,74,225	3.96
Oxyfluorfen at 0.30 kg/ha *fb* 2 HW	14.14	466	1.00	30.6	3,79,010	3.7	12.40	22.5	139108	2.6	19.8	2,71,836	2.19
Oxadiargyl 0.25 kg/ha *fb* 1 HW	12.62	-14,962	0.89	28.0	3,49,050	3.5	13.40	21.1	1,24,063	2.4	22.7	3,30,233	2.67
Glypho. 5.0 ml/lit *fb* 1HW	13.22	-8,972	0.94	28.3	3,53,620	3.5	12.28	14.8	63,545	1.8	22.8	3,33,900	2.73
Glypho. 7.5 ml/lit *fb* 2HW	16.09	18,984	1.13	30.2	3,83,815	3.8	13.24	20.7	1,22,530	2.5	23.7	3,51,400	2.87
HW at 25, 45 and 75 DAP	15.53	9,337	1.04	31.1	4,12,920	4.0	13.56	19.9	1,10,488	2.2	24.5	3,61,900	2.83
Unweeded check	6.73	-58,008	0.54	8.6	47,200	0.5	6.27	6.4	-10,667	-0.9	8.1	54,900	0.51
SEm ±	0.52	-	0.5	1.06	-	-	2.39	2.0	-	-	0.72	-	-
CD (P=0.05)	1.51	-	-	3.07	-	-	11.14	5.8	-	-	2.10	-	-

biomass significantly compared to mulch 5 t/ha. The WCE at mulch 5 and 7.5 t/ha was 20 and 66%, respectively, compared to without mulch. Similar results were recorded for nutrient depletion by weeds at harvest.Among weed control treatments, pendimethalin oxyfluorfen and 2 hand hoeings significanlty reduced population of all weeds and weed biomass compared to weedy check. The WCE under these three treatments was >93%.

Mulch at 7.5 t/ha recorded significantly higher garlic clove yield and economic returns than 5 t mulch/ha. B:C ratio varied from 0.7 under without mulch to 1.0 under 5 t and 1.5 under 7.5 t mulch/ha. Among weed control treatments, pendimethalin, oxyfluorfen and 2 hand hoeings significantly improved garlic yield, yield attributes and economic returns than weedy check. Garlic clove yield under herbicides and hand hoeing treatments were at par, however, the economic return under herbicides treatments were higher compared to hand hoeing owing to higher cost of manual labor. The integration of herbicides or hand hoeings with 7.5 t mulch/ha recorded significantly higher garlic yield compared to when these were integrated with 5 t mulch/ha or without mulch.

GBPUAT, Pantnagar

Dominant weed species in the experimental plot were *P. minor* (18.6%), *A. ludoviciana* (3.0%), *P. monspeliensis* (14.7%) among grassy weeds, *M. denticulata* (6.6%), *M. alba* (6.3%), *C. didymus* (25.6%), *P. plebeium* (12.5%), *C. album* (3.4%), *A. arvensis* (1.7%), *R. acetocela* (2.0%), *F. parviflora* (1.3%) among BLWs and *C. rotundus* (4.4%) as sedge at 75 DAS.

Population of all grassy as well as non-grassy weeds except *R. acetosela, F. parviflora* and *C. rotundus* were significantly reduced by the application of rice straw mulch at 5 t/ha over without mulch. There was complete control of *P. minor* and *A. ludoviciana* with twice hand weeding whereas *P. monspeliensis* was completely controlled with application of pendimethalin applied at 1 kg/ha. Pendimethalin and oxyflurofen at as pre-emergence provided effective control of *P. plebeium* and *R. acetocela.* Highest and significantly high yield (29.5 q/ha) and yield attributing characters like number of bulb (19.5/m^2), diameter of bulb (8.4 cm) and bulb weight (13.4 g) were achieved with the application of mulch material (5 t/ha) over without straw mulch. Both the recommended herbicides were found comparable in achieving the bulb yield of garlic crop.

NDUAT, Faizabad

Application of mulch at 10 t/ha reduced the weed population and recorded significantly lower weed density, dry weight, weed control efficiency and highest growth and yield of garlic as compared to without mulch plot. Maximum weed control effeciency (71.6%) was recorded with 10 t/ha mulch treatment followed by 5 t/ha. Application of oxyflurofen 0.223 kg/ha recorded significantly lower weed count, weed dry weight, higher weed control efficiency, growth and yield of garlic than weedy check but this was at par with pendimethalin 1 kg/ha application. Maximum BC ratio (1.4) was recorded under the paddy straw mulch 10 t/ha + pendimethalin 1 kg/ha pre-emergence treatments followed by paddy straw mulch 10 t/ha + oxyflurofen 0.223 kg/ha pre-emergence (1.3), respectively. No herbicide caused phytotoxicity on garlic crop.

AAU, Anand

The major dicot weeds of experimental field were *Chenopodium album, Chenopodium murale, Digera arvensis, Melilotus indica, Oldenlandia umbellata, Phylanthus niruri* and *Boerhavia repanda.* Monocot weeds were *Dactyloctenium aegyptium, Commelina benghalensis, Digitaria sanguinalis, Eleusine indica, Phyllanthus niruri, Cyperus iria* and *Cyperus rotundus.*

Weed density and weed dry biomass was lower in paddy straw mulch 5.0 t/ha. While these were significantly lowest in manual weeding carried out at 20 and 40 DAP, but remained at par with pre-emergence application of oxyfluorfen for dicot weed dry biomass. Bulb yield of garlic was significantly influenced by weed management treatments and the highest bulb yield of garlic (10.4 t/ha) was obtained in manual weeding at 20 and 40 DAP. Interaction effect of mulching and weed management practices was found significant and the highest bulb yield of garlic was obtained in the combination of manual weeding at 20 and 40 DAP with no paddy straw mulch, but it

was at par with the combination of mulching with manual weeding at 20 and 40 DAP and oxyfluorfen. Highest B:C ratio was obtained with mulching (5.0), hand weeding at 20 and 40 DAP (6.4) and interaction of paddy straw mulch 5.0 t/ha and hand weeding at 20 and 40 DAP (6.5). NPK uptake by weeds was lowest in the manual weeding carried out at 20 and 40 DAP treatment followed by oxyfluorfen .

UAS, Bengaluru

Major weed flora was *Cyperus rotundus*, (among sedges), *Echinochloa crus-galli, Cynodon dactylon* (among grasses), whereas, among broad leaf weeds, major weeds were *Ageratum conyzoides, Acanthospermum hispidum, Borrearia articularis, Euphorbia hirta* at 75 DAP.

At 75 DAP, hand weeding treatment recorded significantly lower weed density and weed dry weight followed by oxadiargyl 140 g/ha, oxyflurofen 0.223 kg/ha pre-emergence and pendimethalin 1.0 kg/ha pre-emergence herbicide treatments. Significantly higher bulb yield was obtained under oxadiargyl 140 g/ha (6.2 t/ha) which were on par with manual weeding (6.0 t/ha). The bulb yield (0.6 t/ha) was very low in weedy check plots. Use of herbicides was cheaper than hand weeding. It was observed that higher B:C ratio was obtained in oxadiargyl with and without paddy straw mulch (4.3 and 4.2) followed by oxyfluorfen (3.9) as compared to weedy check (0.4).

WS 3.3.3 Integrated weed management in ginger

Cooperating centres: Thrissur, Pusa, Ranchi, Bhubaneaswar, Jorhat, Faizabad and Raipur

BAU, Ranchi

Broadleaved weed population was maximum (101/m^2), followed by narrow (74/m^2) and sedges (47/m^2) in weedy check. Two years study revealed that glyphosate 0.80 kg/ha + oxyfluorfen 0.2 kg/ha applied just before emergence of sprouts of ginger was more effective in controlling weeds in all the growth stages of ginger and produced maximum ginger rhizome yield (29 t/ha), net returns (` 9,52,230/-) and B:C ratio (4.5).

OUAT, Bhubaneswar

Application of glyphosate *fb* pendimethalin recorded lowest weed population at all the growth stages followed by glyphosate *fb* oxyfluorfen. Weed free treatment (HW at 20, 40, 60 and 90 DAS) recorded significantly highest yield of 27.5 t/ha where as weedy check treatment recorded the lowest yield (11.5 t/ha). Among different herbicide combinations, significantly higher grain yield of 27.2 t/ha was obtained with application of glyphosate *fb* pendimethalin. Highest net return and B:C ratio of ` 1,85,426/ha and 3.7, respectively were obtained from application of oxadiargyl *fb* bispyribac weeding followed by pendimethalin *fb* bispyribac (` 17,600/ha and 2.7).

AAU, Jorhat

Scoparia dulcis and *Mimosa diplotricha* were the most troublesome weeds almost all along the cropping period. *Mimosa pudica, Cuphea balsamona, Ageratum houstonianum* and *Borreria articularis* appeared late but prevailed in the field till harvest of the crop. Problematic grasses were *Panicum repens, Cynodon dactylon* and *Digitaria setigera* and sedges were *Cyperus rotundus* and *Cyperus tenuispica.*

Lowest weed density and dry weight at different stages were recorded with pendimethalin 1.5 kg/ha *fb* hand weeding 30-35 DAP followed by oxyfluorfen 0.20 kg/ha *fb* hand weeding 30-35 DAP. These two treatments brought about significantly lower weed density till 60 days after planting as compared to hand weeding twice. At harvest, there was no significant difference among the treatments in respect of weed density. Plant growth characteristics like plant height, number of tillers, number of leaves and yield attributes like number of fingers and rhizome length were highest due to pendimethalin *fb* hand weeding 30-35 DAP. Hand weeding 30 and 60 DAP and oxyfluorfen 0.20 kg/ha *fb* hand weeding 30-35 DAP. Better growth and yield attributes were reflected in achieving higher rhizome yield under these three treatments.

RAU, Pusa

Lowest weed dry weight was recorded under hand weeding twice (HW at 30 and 60 DAP) treatment which was statistically at par with glyphosate 0.80 + pendimethalin 1.5 kg/ha and glyphosate 0.80 + oxyfluorfen 0.2 kg/ha at just before emergence of sprouts of ginger and significantly superior over rest of the treatments. Highest rhizome yield (22.4 t/ha) was recorded by hand weeding twice at 30 and 60 DAP which was statistically at par with glyphosate + oxyfluorfen (21.3 t/ha). The highest B:C ratio (2.1) was recorded by glyphosate + oxyfluorfen at just before emergence of sprouts of ginger which was statistically at par with hand weeding twice (HW at 30 and 60 DAP) (2.0) and glyphosate + pendimethalin at just before emergence of sprouts of ginger (1.9).

CAU, Pasighat

Major weeds observed in experimental field were *Cynodon dactylon, Digitaria sanguinalis, Panicum* sp., *Echinochloa* spp., *Eleusine indica, Cyperus* spp., *Commelina benghalensis, Murdania kiosak, Urena lobata, Ageratum conyzoids, Spilanthes acmella, Sida acuta,* etc. Application of oxyfluorfen supplemented with hand weeding at 30 DAP *fb* mulching showed a reduction in weed dry weight and increased WCE (59.4%). Hand weeding twice at 30 and 60 DAP resulted in significantly higher number of fingers per rhizome which was at par with application of oxyfluorfen alone *fb* mulching, Ginger crop performs well under Arunachal Pradesh conditions if planting is completed by mid May. Due to late planting, crop produced low yield than average yield (8.4 t/ha) of the state. No visual phytotoxicity was observed. Higher net return of ` 58,700 was recorded in hand weeded twice at 30 and 60 DAP followed by pendimethalin + hand weeding *fb* mulching and oxyfluorfen *fb* mulching. Higher benefit cost ratio of 1.7 was recorded with all weed control treatments except pendimethalin alone *fb* mulching and oxyfluorfen supplemented with one hand weeding *fb* mulching (Table 3.3.1.1 and 3.3.1.2).

Table 3.3.3.1 Effect of weed control treatments on weed density and dry biomass in ginger

Treatment	Dose (Kg/ha)	Ranchi		Bhubaneswar		Jorhat	
		Total weed density at (75 DAS) (no./m^2)	Total weed biomass at (75 DAS) (g/m^2)	Total weed density at (60 DAS) (no./m^2)	Total weed biomass at (60 DAS) (g/m^2)	Total weed density at (60 DAS) (no./m^2)	Total weed biomass at (60 DAS) (g/m^2)
Pendimethalin	1.5	9.7(95)	8.2(68.3)	5.2(26.5)	3.6(12.5)	5.4(29.3)	4.8(23.3)
Oxyfluorfen	0.20	7.5(56)	5.8(33.5)	4.8(22.7)	3.0(8.6)	5.2(27.3)	3.9(15.7)
Pendimethalin *fb* hand weeding	1.5	5.7(33)	4.3(18.7)	3.9(14.7)	2.5(5.8)	3.5(12.0)	2.8(7.7)
Oxyfluorfen *fb* hand weeding	0.20	5.4(29)	4.3(18.3)	5.1(25.3)	2.8(7.2)	3.5(12.0)	2.1(4.0)
Glyphosate	0.80	8.9(80)	6.9(47.8)	3.3(10.3)	2.1(3.8)	6.0(36.3)	4.1(16.7)
Glyphosate + pendimethalin	0.80 + 1.5	8.0(65)	6.3(39.2)	4.9(23.8)	3.1(9.5)	4.4(20.0)	2.3(5.0)
Glyphosate + oxyfluorfen	0.80 + 0.2	5.2(27)	3.8(14.5)	4.0(25.0)	3.2(9.8)	3.8(14.3)	2.6(6.7)
Hand weeding (2)	-	5.1(26)	4.0(16.2)	5.1(25.5)	3.3(10.5)	6.8(51.0)	3.3(11.0)
Weedy check	-	14.3(206)	12.1(146.3)	32.0(23.7)	21.4(31.9)	8.4(70. 0)	7.7(60.0)
SEm±		0.40	0.27	0.19	0.11	1.80	0.82
LSD (P=0.05)		1.10	0.80	0.55	0.31	19.82	12.69

Table 3.3.3.2 Effect of weed control treatments on rhizome yield and economics in ginger

Treatment	Dose (kg/ha)	Ranchi			Bhubaneswar			Jorhat
		Rhizome yield (t/ha)	Net return (`/ha)	B:C Ratio	Rhizome yield (t/ha)	Net return (`/ha)	B:C Ratio	Rhizome yield (t/ha)
Pendimethalin	1.5	9	1,56,373	0.75	18.8	1,45,630	3.39	11.63
Oxyfluorfen	0.20	15	4,05,025	1.96	21.2	1,54,263	3.50	11.23
Pendimethalin *fb* hand weeding	1.5	22	6,56,383	3.12	21.0	1,54,258	3.39	15.40
Oxyfluorfen *fb* hand weeding	0.20	21	6,25,839	2.99	23.0	1,61,523	3.59	14.27
Glyphosate	0.80	14	3,57,675	1.74	23.9	1,65,236	3.72	7.50
Glyphosate + pendimethalin	0.80 + 1.5	14	3,71,225	1.78	27.2	1,85,426	3.78	11.63
Glyphosate + oxyfluorfen	0.80 + 0.2	27	8,71,947	4.20	26.7	1,75,423	3.66	11.17
Hand weeding (2)	-	23	7,01,383	3.29	27.5	1,85,125	3.35	15.07
Weedy check	-	4	-60,143	-0.29	11.5	1,07,016	2.32	5.93
SEm±		1.58	63,154	0.30	0.25	-	-	-
LSD (P=0.05)		4.73	1,89,315	0.91	0.84	-	-	1.41

WS 3.4 Weed management in pulse and oilseed crops

WS3.4.1 Studies on time of application of imazethapyr and its ready mix combination with imazamox (Odyssey) against weeds in blackgram/ greengram and its residual effect on the succeeding mustard crop.

Cooperating centres: Gwalior, Hisar, Ludhiana, Palampur, Anand, Faizabad, Pantnagar, Meerut, Bhubaneswar and Coimbatore

RVSKVV, Gwalior

Major weed flora in blackgram during *Kharif* 2014 and 2015 was *Cyperus rotundus, Echinochloa crus-galli, Dactyloctenium aegyptium, Acrachne racemosa, Commelina benghalensis, Digera arvensis, Rumex dentatus* and *Phyllanthus niruri.* Hand weeding twice at 20 and 40 DAS proved effective in reducing weed density and dry weight of weeds followed by post and pre-emergence application of pre-mix herbicides imazethapyr + imazemox at 70 and 80 g / ha and pendimethalin + imazethapyr (pre mix) at 1000 g / ha as PE, respectively. Pre-mix herbicide was found more or less equally effective as two hand weeding treatment. Whereas, pre-mix herbicides imazethapyr + imazamox 70 and 80 g / ha as PoE followed by pendimethalin + imazethapyr 1000 g / ha as PE were found significantly effective than remaining other herbicide treatments. Post-emergence application was found more effective than pre-emergence application in case of imazethapyr alone as well as pre mix herbicide.

On the basis of two year data it was concluded that in blackgram two hand weeding at 20 and 40 DAS gave maximum seed yield (924 kg / ha) followed by pre-mix herbicides i.e. imazethapyr + imazamox as PoE (905 kg / ha) and pendimethalin + imazethapyr as PE. Whereas, net return and B:C ratio were higher in pendimethalin + imazethapyr PE (3.3) followed by application of imazethapyr + imazamox 80 g / ha PoE (3.1).

Population of *C. rotundus, A. arvensis* and *C. arvensis* were not influenced significantly by any weed management practices on succeeding mustard crop at 60 DAS. In case of *C. album* all the treatments except imazethapyr 70 g / ha PE significantly affected the weed population as compared to weedy check. On the basis of visual observation on 0-10 point scale none of the herbicide treatments applied on blackgram caused any phytotoxic effect on mustard crop. Maximum seed yield was recorded in treatment 2 HW (1.3 t / ha) followed by pendimethalin + imazethapyr (1.3 t / ha) and imazethapyr + imazamox PoE (1.3 t / ha), but it could not reach the level of significance as compared to weedy check (1.1 t / ha).

CCSHAU, Hisar

Weed flora in greengram was dominated by *Trianthema portulacastrum* constituting 42.6% of total weed flora. Other weeds present in experimental field were *D. aegyptium, E. crus-galli* and *Cyperus rotundus.* All PPI and pre-emergence herbicide treatments proved effective against predominant weed *T. portulacastrum*. Post-emergence application of imazethapyr and its combination with imazamox were very effective against grassy weed *E. crus-galli* but their efficacy against *T. portulacastrum* was very poor, and caused only stunted plants. PPI and PRE use of imazethapyr and its combination both at 70 and 80 g / ha provided good control of *C. rotundus* where as pendimethalin was not at all effective against this weed. None of PPI or PRE herbicide treatments caused suppression in crop growth since initial stages of crop growth. Seed yield was maximum (1003 kg / ha) in weed free treatment which was significantly higher than all treatments. Among herbicides, maximum seed yield (785 kg / ha) was obtained with PPI application of imazethapyr at 80 g / ha which was at par to its lower dose 70 g / ha (PPI), 80 g / ha (PRE), two hoeings employed at 20 and 40 DAS and pendimethalin + imazethapyr (RM) at 1000 g / ha but higher than all post emergence treatments. Maximum B:C ratio of 2.4 was obtained with PPI use of imazethapyr at 80 g / ha.

All herbicide treatments except pendimethalin and its ready mixture with imazethapyr caused less or more residual toxicity on mustard. Visual toxicity on mustard was more in PPI treatments (90-95%) but less in pre and post applications of various herbicides. Mustard crop in these treatments showed significant variation in plant height, germination percentage, number of leaves per plant as compared to untreated check, weed free and two hoeings. Maximum seed yield of mustard (2.66 t / ha) was obtained with weed free conditions imposed by hoeing and pulling in green gram which was at par with all treatments given in greengram except PPI application of imazethapyr at both use rates and its PRE and post emergence use at 80 g / ha.

PAU, Ludhiana

Cyperus rotunuds, Trianthema portulacastrum, Mollugo nudicalis, Acrachne racemosa and *Digitaria ciliaris* were the major weeds in blackgram crop. All herbicides, except pendimethalin as pre-emergence and imazethapyr as post-emergence, significantly reduced population of all weeds and weed biomass as compared to weedy check. Imazethapyr as pre-emergence was more effective against *T. portulacastrum* and as post-emergence against *C. rotunuds*; pendiemthalin did not control *C. rotundus.* All the weed control treatments recorded significantly higher blackgram seed yield compared to weedy check and were at par with hand weeded control. Pre-emergence applications of imazethapyr, pre-mix of imazethapyr + imazmox and of imazethapyr + pendimethalin recorded highest net returns and B: C ratio. All herbicides were safe to blackgram crop. The study indicated that pre-emergence application of imazethapyr alone or its pre-mix withpendimethalin / imazamox, depending on weed flora in the field, could be adopted for weed control in blackgram.

All the herbicides applied in blackgram did not show any residual effects on germination, growth and seed yield of succeeding Indian mustard indicated that all these herbicides could be adopted for weed control in blackgram- Indian mustard based cropping sequences.

AAU, Anand

Major monocot weeds observed in the greengram crop were *Eragrostis major, Eleusine indica, Digitaria sanguinalis, Commelina benghalensis, Dactyloctenium aegyptium* and *Cyperus iria.* Dicot weeds were *Digera arvensis, Phyllanthus niruri, Euphorbia hirta, Oldenlandia umbellata, Amaranthus viridis, Boerhavia repanda* and *Vernonia cinerea.* Significantly lowest density of monocot and total weeds were recorded at 40 DAS in pre-emergence application of imazethapyr + pendimethalin and remained at par with hoeing at 20 and 40 DAS. Whereas, lowest weed density and weed dry biomass of dicot weeds were recorded in post-emergence application of imazethapyr + imazamox. Weed control efficiency varied between 80 to 93 % recorded at 40 DAS. Phytotoxic effect of imazethapyr and

imazethapyr + imazamox (RM) was observed on greengram.

There was no carry over / residual phytotoxic effect observed on succeeding mustard crop. Seed and stalk yield of mustard showed non-significant effect of different weed management practices in greengram on succeeding mustard crop.

NDUAT, Faizabad

Blackgram was mainly infested with *Eleusine indica*, *Echinochloa* sp., *Panicum maxicum*, *Digitaria sanguinalis* and *Dactyloctenium aegyptium* among grasses; *Celosia argentea*, *Solanum nigrum*, *Trianthema monogyna*, *Cleome viscosa* and *Digera arvensis* among broadleaved weeds. However, *Cyperus rotundus* was the only sedge dominating.

Pre-mix combination of imazethapyr + imazamox at (PE) and imazethapyr + pendimethalin applied as pre-emergence was found more effective in reducing density of weeds as compared to alone application of imazethapyr applied as pre- and post-emergence application. However, alone application of imazethapyr as post-emergence recorded less weed dry weight and WCE (60.2%). Ready-mix formulation of imazethapyr + pendimethalin was at par with imazethapyr + imazamox, and recorded significantly highest seed yield over other herbicide treatments. Uncontrolled growth of weeds (weedy check) resulted in 61.4% reduction in seed yield of blackgram over twice hoeing. There was no residual effect of herbicides applied in blackgram on mustard crop.

GBPUAT, Pantnagar

Prominent weed species in blackgram were *E. colona* (5.8%), *E. indica* (19.4%), *D. aegyptium* (9.3%) and *D. sanguinalis* (9.3%), among the grasses, *C. argentea* (12.9%), *T. monogyna* (13.6%), *C. viscosa* (2.5%), *P. niruri* (3.6%), and *D. arvensis* (5.0%) among broadleaved and *C. rotundus* (18.7%) in sedges. Total dry matter accumulation of weeds was minimum with twice hoeing at 20 and 40 DAS which was at par with ready mix application of imazethapyr + pendimethalin as pre-emergence only. Highest weed control efficiency (100%) was achieved with twice hoeing at 20 and 40 DAS followed by ready-mix application of imazethapyr + pendimethalin as pre-emergence at (97.9%). Ready-mix application of imazethapyr + pendimethalin obtained maximum seed yield of black gram (1407 kg / ha) which was significantly higher to all other treatments except ready mix application of imazethapyr + imazamox as pre-emergence at 80 g / ha and twice hoeing at 20 and 40 DAS.

TNAU, Coimbatore

In blackgram, *Dinebra retroflexa*, *Setaria verticilliata* under grasses, *Trianthema portulacastrum*, *Digera arvensis*, *Parthenium hysterophorus*, *Amaranthus viridis*, *Boerhaavia diffusa* under broadleaved weeds and *Cyperus rotundus* and *Cyperus iria* under sedges were the predominant weeds. Imazethapyr + imazamox (RM) recorded significantly lower weed density (11.2 / m^2) at 40 DAS followed by hoeing twice on 20 and 40 DAS (13.2 / m^2) and it was comparable with EPOE imazethapyr + imazamox (RM). Lower weed dry weight (7.0 g / m^2) was recorded with EPOE imazethapyr + imazamox (RM) followed by hoeing twice on 20 and 40 DAS (8.5 g / m^2) and it was comparable with EPOE imazethapyr + imazamox (RM) at 40 DAS. Higher weed control efficiency of more than 76.4% was recorded with EPOE imazethapyr + imazamox (RM). PE imazethapyr + imazamox (RM) received higher net returns (` 24,880 / ha) and B:C ratio (3.5) followed by PE imazethapyr + imazamox (RM) (` 21,920).

Phytotoxicity symptoms were not observed in blackgram with application of pendimethalin, imazethapyr and imazamox or its combination during both pre-and post-emergence application. There was no reduction in the number of nodule formation in blackgram after application of imazethapyr, imazamox and pendimethalin in combination and / or alone.

Population of bacteria, diazotrophs and phosphobacteria were dropped slowly upto 7th day in the treatments imposed with either PE or EPOE herbicides compared with hoeing and weedy check. However, it was increased from 15th day onwards in the treatments imposed with either PE or EPOE herbicides. Imazethapyr + imazamox showed maximum number of total bacteria (109.8 x 10^6 cfu / g of soil), diazotrops (42.7x10^4 cfu / g of soil) and phosphobacteria (34.57x10^4 cfu / g of soil) at 30 days after herbicide application followed by imazethapyr + imazamox 70 g / ha. Similar trend was observed in the EPOE herbicides, viz. imazethapyr + imazamox as well (Table 3.4.1.1 and 3.4.1.2).

Table 3.4.1.1 Effect of weed management treatments on weed density and dry biomass in blackgram (60 DAS)

Treatment (g/ha)	Gwalior		Coimbatore		Anand		Faizabad	Pantnagar		
	Total no of weeds/ m^2	Dry weight of weeds (g/m^2)	Total No of weeds/ m^2	Dry weight of weeds (g/m^2)	Total No of weeds/m^2	Dry weight of weeds (g/m^2)	Dry weight of weeds (g/m^2)	Total weeds grasses density of ($No./m^2$)	Total density of BLWs	Dry weight of weeds (g/m^2)
Imazethapyr 70 PE	1.7	29.4	6.8 (46.6)	4.5 (20.6)	9.5^{a} (90.8)	5.8^{cd} (33.2)	60.2	7.6(56.0)	1.0(0.0)	6.4(39.9)
Imazethapyr 80 PE	1.6	28.3	6.4 (41.9)	4.5 (20.6)	8.2^{bc} (67.3)	5.1^{de} (25.4)	50.3	6.7(44.0)	1.0(0.0)	4.5(19.2)
Imazethapyr 70 PoE	1.6	20.6	6.1 (36.0)	3.6 (13.1)	9.1^{ab} (83.3)	5.6^{cd} (31.0)	50.5	8.8(77.3)	4.4(18.7)	9.9(96.2)
Imazethapyr 80 PoE	1.5	17.4	4.2 (17.2)	3.1 (9.3)	8.2^{bc} (67.3)	5.1_{de} (24.0)	40.0	7.3(53.3)	3.6(12.0)	8.5(70.7)
Imazethapyr + imazamox (RM) 70 PE	1.8	38.2	4.6 (21.5)	3.1 (9.6)	7.9^{cd} (62.5)	6.3^{c} (40.0)	31.5	8.0(62.7)	1.9(2.7)	7.3(52.7)
Imazethapyr + imazamox (RM) 80 PE	1.8	30.8	4.8 (23.3)	3.3 (11.4)	6.9^{de} (47.5)	4.4^{ef} (19.0)	26.2	7.3(52.0)	1.9(2.7)	6.4(40.7)
Imazethapyr + imazamox (RM) 70 PoE	1.5	17.2	3.6 (13.2)	2.9 (8.5)	6.6^{ef} (44.0)	6.3^{c} (39.0)	39.5	8.5(72.0)	4.6(20.0)	9.2(84.1)
Imazethapyr + imazamox (RM) 80 PoE	1.3	13.6	3.4 (11.2)	2.6 (7.0)	6.5^{ef} (42.5)	6.0^{cd} (35.4)	33.3	7.8(60.0)	3.2(9.3)	8.1(64.1)
Pendimethalin 1000 PE	1.8	42.7	5.5 (30.5)	4.2 (17.5)	5.7^{fg} (31.8)	8.7^{b} (76.3)	35.2	4.6(20.0)	3.8(13.3)	7.9(62.0)
Pendimethalin + imazamox (RM) 1000 PE	1.4	13.5	6.2 (37.4)	4.1 (16.9)	4.4^{h} (19.0)	3.03^{g} (8.6)	28.2	1.7(2.7)	1.5(1.3)	2.1(4.5)
2 H.W 20 & 40 DAS	1.0	4.8	3.6 (13.3)	2.9 (8.6)	4.7^{gh} (22.0)	3.63^{fg} (12.6)	22.5	1.0(0.0)	1.0(0.0)	1.0(0.0)
Weedy Check	2.1	96.0	6.8 (46.4)	4.8 (23.4)	10.1^{a} (101.5)	13.19^{a} (173.4)	100.5	9.1(81.3)	8.4(70.0)	14.5(213.8)
SEm±	0.05	2.99	2.7	1.8	5.16	3.54	-	0.34	0.15	0.44
LSD (p=0.05)	0.10	8.57	5.8	3.9	Sig	Sig.	-	1.0	0.43	1.31

* Original values are in parentheses.

Table 3.4.1.2 Effect of weed management treatments on seed yield and economics in blackgram

Treatment (g/ha)	Gwalior			Hissar		Ludhiana			Anand		Faiz abad	Coimbatore			Pantnagar		
	Seed yield (kg/ha)	Net return (`/ha)	B:C ratio	Seed yield (kg/ha)	B:C ratio	Seed yield (kg/ha)	Net return (`/ha)	B:C ratio	Seed yield (kg/ha)	B:C ratio	Seed yield (kg/ha)	Seed yield (kg/ha)	Net return (`/ha)	B:C ratio	Seed yield (kg/ha)	Net return (`/ha)	B:C ratio
Imazethapyr 70 PE	625	20,667	2.30	756	2.40	1,269	31,182	2.29	1258^{ab}	2.54	631	255	11,200	1.6	1,041	24,664	1.2
Imazethapyr 80 PE	690	24,113	2.50	785	2.49	1,390	35,936	2.46	1366^{a}	2.72	731	259	11,360	1.7	1,252	33,801	1.6
Imazethapyr 70 PoE	765	28,339	2.79	721	2.28	1,245	30,172	2.26	1373^{a}	2.76	791	384	16,360	2.3	804	14,177	0.7
Imazethapyr 80 PoE	859	33,397	3.08	778	2.46	1,222	28,628	2.17	1466^{a}	2.90	807	344	14,760	2.1	973	21,455	1.0
Imazethapyr + imazamox (RM) 70 PE	537	15,007	1.91	574	1.82	1,345	33,805	2.37	1366^{a}	2.70	885	550	23,000	3.2	1,165	29,601	1.3
Imazethapyr + imazamox (RM) 80 PE	557	15,875	1.95	587	1.86	1,372	34,723	2.39	1281^{ab}	2.51	1090	597	24,880	3.5	1,363	38,084	1.7
Imazethapyr + imazamox (RM) 70 PoE	788	29,249	2.77	454	1.44	1,227	28,650	2.16	1281^{ab}	2.53	739	523	21,920	3.1	825	14,556	0.7
Imazethapyr + imazamox (RM) 80 PoE	905	35,359	3.11	478	1.51	1,193	26,928	2.08	1011^{bc}	1.99	865	520	21,800	3.1	1,070	25,119	1.1
Pendimethalin 1000 PE	521	14,106	1.86	681	2.28	1,262	31,930	2.39	1173^{ab}	2.31	957	481	20,240	2.8	1,178	30,464	1.4
Pendimethalin + imazamox (RM) 1000 PE	879	35,489	3.32	772	2.45	1,301	33,274	2.43	1435^{a}	2.80	1107	492	20,680	2.9	1,407	40,060	1.8
2 H.W 20 & 40 DAS	924	32,525	2.57	745	1.13	1,343	30,203	2.07	1335^{ab}	2.80	625	545	22,800	2.5	1,346	34,560	1.4
Weedy Check	374	8,117	1.57	256	0.92	891	17,454	1.82	818^{c}	1.81	427	119	4,860	0.7	272	-7,964	0.4
SEm±	47	-	-	19	-	77	-	-	105.2	-	53.00	21	-	-	41.6	-	-
LSD (p = 0.05)	134	-	-	54	-	227	-	-	16.65	-	162.00	43	-	-	122.1	-	-

WS 3.5 Integrated weed management in cotton

Cooperating centres: Hyderabad, Anand, Bengaluru, Hisar, Ludhiana, Coimbatore and Akola.

AAU, Anand

Experiment on cotton was conducted to study bio-efficacy of combination of herbicides against complex weed flora, their effects on growth and yield of cotton along with to study the phytotoxic effects on the crop. Major dicot weeds observed in the experimental field were *Digera arvensis*, *Phyllanthus niruri*, *Oldenlandia umbellata* and *Boerhavia repanda*. Monocot weeds were *Dactyloctenium aegyptium*, *Digitaria sanguinalis*, *Commelina benghalensis*, *Eleusine indica*, *Cyperus iria* and *Cyperus rotundus*.

The highest plant height of cotton was recorded due to pendimethalin *fb* directed spray of glyphosate at 45 DAS and remained at par with weedy check due to competition of crop with weeds. Weed density at 90 DAS were recorded lowest due to pre-emergence application of pendimethalin 1000 g/ha *fb* pyrithiobac-sodium 62.5 g/ha. Weed control efficiency varied between 9 to 92% compared to weedy check (Table 3.5.1). Significantly higher seed cotton yield was recorded with PE pendimethalin *fb* 2 HW carried out at 20 and 50 DAS which was found at par with post-emergence application of pyrithiobac-sodium + quizalofop-p-ethyl *fb* directed spray of glyphosate 2000 g/ha at 60 DAS. Benefit cost ratio was the highest (2.57) in pendimethalin *fb* 2 hand weeding carried out at 20 and 50 DAS followed by post-emergence application of pyrithiobac-sodium + quizalofop-p-ethyl *fb* directed spray of glyphosate at 60 DAS (2.47).

Table 3.5.1 Effect of treatments on weeds, yield and economics of cotton.

Treatments	Weed density (no./m²)		Weed dry biomass (g/m²)		Seed cotton yield (t/ha)	B:C ratio
	90 DAS	Harvest	90 DAS	Harvest		
Pendimethalin *fb* 2 HW	11.2^{a} (125.3)	9.9^{cd} (98.7)	6.9^{f} (48.8)	9.35^{e} (86.6)	3.62	2.57
Pendimethalin *fb* pyrithiobac-sodium	7.1 ^{d} (50.7)	10.4^{bc} (109.3)	22.7^{ab} (518.4)	12.9^{c} (166.4)	2.26	1.58
Pendimethalin *fb* pyrithiobac-sodium + quizalofop-p-ethyl	7.8 ^{cd} (61.3)	10.3^{bcd} (105.3)	21.6^{b} (465.5)	13.3^{c} (176.2)	2.35	1.67
Pyrithiobac-sodium + quizalofop-p-ethyl	9.1 ^{b} (82.7)	12.7^{a} (161.3)	23.6^{ab} (562.3)	14.5^{b} (210.8)	2.09	1.55
Pyrithiobac-sodium + quizalofop-p-ethyl *fb* manual weeding	11.2^{a} (125.3)	9.2 ^{d} (85.3)	9.5 ^{e} (90.9)	11.0^{d} (121.7)	2.99	2.16
Pyrithiobac -sodium + quizalofop-p-ethyl *fb* directed spray of paraquat	9.0 ^{b} (81.3)	10.3^{bcd} (105.3)	15.9^{c} (253.3)	9.36^{e} (86.9)	3.25	2.31
Pyrithiobac-sodium + quizalofop-p-ethyl *fb* directed spray of glyphosate	7.6 ^{cd} (57.3)	10.0^{cd} (100.0)	11.5^{de} (131.1)	9.15^{e} (83.1)	3.52	2.47
Pendimethalin *fb* glyphosate directed spray	8.7 ^{bc} (76.0)	11.2^{b} (126.7)	16.4^{c} (269.9)	14.0^{bc} (194.9)	2.36	1.73
Mechanical weeding (3)	12.2^{a} (148.0)	10.2^{bcd} (104.0)	12.6^{d} (159.0)	10.1^{de} (102.6)	2.75	2.02
Weedy check	9.6^{b} (92.0)	11.2^{b} (126.8)	24.9^{a} (619.2)	17.9^{a} (322.8)	1.17	0.93
SEm±	0.3	0.3	0.6	0.3	0.105	-
LSD (P=0.05)	1.0	0.9	1.8	1.0	0.314	-
CV %	6.6	5.4	6.7	4.9	6.9	-

* Values in parentheses are original. Data transformed to square root transformation.

CCSHAU, Hisar

Experimental field was pre-dominantly infested with natural population of jungle rice (*Echinochloa colona* L.) and carpet weed (*Trianthema portulacastrum*) to the extent of 71 and 29% at 90 DAS and 74 and 26% at harvest, respectively. Pendimethalin 1.0 kg / ha as pre-emergence provided effective control of *Trianthema portulacastrum* and *Echinochloa colona* and this effect remained consistent up to 90 DAS. Application of pendimethalin at 1.0 kg / ha supplemented with two hoeings at 30 and 60 DAS, one hoeing and post emergence application of quizalofop-p-ethyl at 60 g / ha or propaquizafop-p-ethyl at 62.5 g / ha at 60 DAS caused significant reducted in density and dry weight of weeds as compared to weedy check up to harvest.

Protected spray of glyphosate (0.5%) integrated with pendimethalin and paraquat (0.3%) with parthiobac Na *fb* quizalofop-p-ethyl being at par with three mechanical weeding reduced population and dry weight of weeds at 90 DAS significantly over weedy check. Pendimethalin integrated with paraquat or glyphosate proved superior over application of pendimethalin *fb* quizalofop-p-ethyl or parthiobac Na *fb* quizalofop-p-ethyl against both type of weeds. Treatments involving directed spray of paraquat caused 5-8 % toxicity to cotton crop. Number of bolls / plant were maximum (46) in weed free treatment which were significantly higher than all treatments except three mechanical weedings and parthiobac Na *fb* quizalofop-p-ethyl *fb* directed spray of glyphosate. Weedy condition throughout crop growth period caused 47.2% reduction in seed cotton yield.

PAU, Ludhiana

Cyperus rotundus, Dactyloctenium aegyptium, Trianthema portulacastrum and *Acrachne racemosa* were major weeds in experimental plots. All treatments significantly reduced population and biomass of grass and broadleaf weeds compared to weedy check, however, glyphosate or hand weeding was required for significant reduction in sedges biomass. Sequential application of pendimethalin and pyrithiobac+quizalofop was more effective than pendimethalin *fb* pyrithiobac or pyrithiobac + quizalofop alone with respect to control of grass weeds. Pendimethalin *fb* pyrithiobac + quizalofop recorded the highest seed cotton yield and B: C and it was followed immediately by pendimethalin integrated with glyphosate and pyrithiobac+ quizalofop integrated with paraquat / glyphosate and 3 hand hoeings. All weed control treatments recorded significantly higher seed cotton yield than weedy check and prevented nutrient depletion by weeds. All the herbicides were safe to cotton.

UAS, Bengaluru

Major weed flora observed in the experimental plots were *Cyperus rotundus, Digitaria marginata, Dactyloctenium aegyptium, Echinochloa crus-galli, Cynodon dactylon* whereas, among broad leaf weeds, major weeds were *Spilanthes acmella, Ageratum conyzoides, Alternanthera sessilis, Acanthospermum hispidum, Borreria articularis, Euphorbia hirta, Commelina benghalensis* at 90 DAP and at harvest. Among herbicides, combination of pendimethalin 1000 g / ha PRE *fb* 2 HW-20 and 50 DAS, pendimethalin 1000 g / ha PRE *fb* pyrithiobac-sodium 62.5 g / ha-20 DAS + quizalofop- p- ethyl 50 g-20 DAS, pyrithiobac-sodium 62.5 g / ha-20 DAS + quizalofop –p- ethyl 50 g 20 DAS, *fb* directed spray of glyphosate 2000 g / ha -60 DAS recorded lower weed density and weed dry weight compared to other treatments indicating the necessity of combination of herbicides to manage complex weed flora in cotton.

Plot treated with herbicides recorded significantly higher cotton yield compared to all other treatments which were on par with the hand weeding treatment. Herbicides or herbicide mixtures were cheaper than hand weeding. Higher B:C ratio was obtained in pendimethalin 1000 g / ha PRE *fb* pyrithiobac-sodium 62.5 g / ha-20 DAS + quizalofop-p- ethyl 50 g-20 DAS (3.88), Pyrithiobac-sodium 62.5 g / ha-20 DAS + quizalofop–p-ethyl 50 g 20 DAS, *fb* directed spray of glyphosate 2000 g / ha -60 DAS (3.73) and it was only 2.44 in three mechanical weeding treatment.

PJTSAU, Hyderabad

No phytotoxicity was observed on cotton crop with application of any of the pre and post emergence

herbicide. Glyphosate and paraquat were applied as directed spray.

Important monocotyledonous weeds observed in the experimental plots during crop growing season were *Cyperus rotundus, Cynodon dactylon, Dactyloctenium aegyptium, Digera muricata, Digitaria sanguinalis, Dinebra retroflexa, Panicum* spp. while common dicotyledonous weeds observed were *Amaranthus polygamus, Commelina benghalensis, Parthenium hysterophorus* and *Trianthema portulacastrum*. Significantly lower weed dry matter was observed with mechanical weeding thrice at 20, 40 and 60 DAS at all the growth stages and was on a par with PE application of pendimethalin *fb* 2 HW, pendimethalin *fb* pyrithiobac- sodium + quizalofop-p-ethyl, however at 120 DAS early post-emergence application of pyrithiobac-sodium + quizalofop–p-ethyl *fb* directed spray of paraquat and pyrithiobac-sodium + quizalofop–p-ethyl *fb* directed spray of glyphosate treatments showed on par weed dry matter with mechanical weeding thrice at 20, 40 and 60 DAS treatment. Continued decrease in weed control efficiency was observed with advancement of crop growth stage. Similar trend was observed as that of weed dry matter.

It is concluded that, either mechanical weeding thrice at 20, 40 and 60 DAS or pre emergence application of pendimethalin *fb* 2 HW at 20 and 50 DAS was found to be more economical to get higher kapass yield and net returns.

TNAU, Coimbatore

Dinebra retroflexa and *Setaria verticillata* under grasses *Trianthema portulacastrum, Digeria arvensis, Parthenium hysterophorus, Amaranthus viridis* and *Boerhavia diffusa* under broad leaved weeds and *Cyperus rotundus* under sedge were the predominant weed flora in the experimental field. At 90 DAS, EPOE pyrithiobac-sodium+quizalofop–p-ethyl (62.5+50 g/ha) at 20 DAS *fb* directed spray of glyphosate 2000 g/ha at 60 DAS recorded lower total weed density (5.1/m^2) and total weed dry weigh (4.9 g/m^2) followed by POE Pyrithiobac + quizalofop-p-ethyl (62.5 + 50) g/ha *fb* directed spray of paraquat 600 g/ha at 60 DAS (9.2/m^2). At 90 DAS, higher weed control efficiency of 96% was recorded in EPOE pyrithiobac-sodium + quizalofop–p-ethyl (62.5 + 50 g/ha) at 20 DAS *fb* directed spray of glyphosate 2000 g/ha at 60 DAS. At 90 DAS, significantly higher DMP (3281 kg/ha) of cotton was recorded in EPOE pyrithiobac-sodium + quizalofop–p-ethyl (62.5 + 50 g/ha) at 20 DAS *fb* directed spray of glyphosate 2000 g/ha at 60 DAS. Phytotoxicity symptoms were observed up to 21 days after herbicide spray due to directed spray of glyphosate 2000 g/ha at 45 or 60 DAS.

PDKV, Akola

Cynodon dactylon, Cyperus rotundus, Commelina benghalensis, Ischaemum pilosum, Digitaria sanguinalis were dominant among monocot weeds and *Digera arvensis, Lagascea mollis, Euphorbia geniculata, Tridax procumbens, Parthenium hysterophorus, Celosia argentea* were dominant among dicot weeds in the field.

At 30 DAS, 3 HW at 20, 40, and 60 DAS recorded lowest weed count, weed dry matter and highest weed control efficiency but statistically found at par with pendimethalin PE 1.0 kg/ha *fb* 2 HW at 20 and 50 DAS. This might be due to better effect of pre-emergence herbicide used alone or with combination of post-emergence herbicide. While lowest weed index was noticed in pyrithiobac-sodium 0.062 kg/ha + quizalofop-ethyl 0.05 kg /ha PoE 20 DAS (Tank mix) *fb* directed spray of glyphosate 2.0 kg/ha 60 DAS (Table 3.5.2). Herbicide combination in T_6, T_7 and T_8 showed some phytotoxicity symptoms on the lower leaves of cotton due to directed spray of non-selective herbicide, no harmful effect on growth of plant were recorded. Number of monopodial branches was not affected by any treatment. The weedy check recorded lowest values of all the growth character. The highest seed cotton yield (2.1 t/ha) was registered with 3 HW at 20, 40 and 60 DAS which was at par with pyrithiobac-sodium 0.062 kg/ha + quizalofop-ethyl 0.050 kg/ha PoE 20 DAS (Tank mix) *fb* HW 50 DAS. Thus, the directed spray at 45 DAS was found most effective in controlling weeds and increasing seed cotton yield.

Table 3.5.2 Plant height, No. of monopodial and sympodial branches, number of functional leaves and dry matter at harvest as influenced by different treatments

Treatment	Plant height (cm)	Monopodial branches	Sympodial branches	No. of bolls / plant	Boll weight (g)	Seed cotton yield (t/ha)
T_1: Pendimethalin PE 1.00 kg / ha *fb* 2 HW 20 and 50 DAS	131.1	1.5	18.8	28.2	3.3	1.6
T_2: Pendimethalin PE 1.00 kg / ha *fb* pyrithiobac sodium 0.062 kg. / ha PoE 20 DAS	129.0	1.8	20.2	29.2	3.3	1.6
T_3: Pendimethalin PE 1.00 kg / ha *fb* pyrithiobac sodium 0.062 kg / ha + quizalofop-ethyl 0.050 kg / ha PoE 20 DAS (Tank mix)	128.7	1.7	20.2	28.9	3.6	1.6
T_4: Pyrithiobac-sodium 0.062 kg / ha + quizalofop-ethyl 0.050 kg / ha PoE 20 DAS (Tank mix)	124.4	1.8	20.0	30.5	3.5	1.6
T_5: Pyrithiobac-sodium 0.062 kg / ha + quizalofop-ethyl 0.050 kg / ha PoE 20 DAS (Tank mix) *fb* HW @ 50 DAS	127.6	1.6	20.5	31.3	3.5	1.9
T_6: Pyrithiobac-sodium 0.062 kg / ha + quizalofop-ethyl 0.050 kg / ha PoE 20 DAS (Tank mix) *fb* directed spray of paraquat 0.60 kg / ha 60 DAS	131.0	1.7	20.8	32.1	3.5	1.9
T_7: Pyrithiobac sodium 0.062 kg / ha + quizalofop-ethyl 0.050 kg / ha PoE 20 DAS (Tank mix) *fb* directed spray of glyphosate 2.00 kg / ha 60 DAS	132.3	1.7	21.0	32.0	3.5	2.0
T_8: Pendimethalin PE 1.0 kg / ha *fb* directed spray of glyphosate 2.0 kg / ha 45 DAS	135.4	1.7	22.3	31.8	3.5	2.0
T_9: 3 HW at 20, 40 & 60 DAS	141.3	1.7	25.0	34.3	3.6	2.1
T_{10}: Weedy check	112.3	1.8	13.9	15.7	2.9	0.9
SEm±	3.3	0.0	1.5	1.4	0.1	0.0
LSD (P= 0.05)	9.9	NS	4.5	4.3	0.4	0.2

WS 3.6 Weed management in conservation agriculture system

DBSKKV, Dapoli

At DBSKKV Dapoli, amongst various weed control measures, application of oxadiargyl + 1 HW at 40 DAS was the best treatment exhibited highest WCE% in terms of growth of weeds and consequently grain and straw yield of rice. Weed growth of monocots at all stages of observation was significantly least in CT (Transplanted rice) over all other tillage practices and resulted into increase in yield attributes and yield of rice. (Table 3.6.1)

IGKV, Raipur

Under direct-seeded rice, dry matter of weeds was significantly lower in hand weeding twice than rest. This was statistically at par with oxadiargyl 80 g / ha *fb* bispyribac 25 g / ha. Weed control efficiency also followed similar trend as that of weed dry matter at harvest. Significantly higher seed yield was recorded from the treatment of oxadiargyl 80 g / ha *fb* bispyribac 25 g / ha and this was at par with two hand weedings, pyrazosulfuron 25 g / ha *fb* hand weeding at 25 DAS, fenoxaprop 60g / ha + chlorimuron + metsulfuron 4 g / ha at 20 DAS. Reduction in seed yield was maximum under unweeded control and minimum under hand weeding twice by 92.5 and 3%, respectively. Benefit: cost ratio was also found to be highest under oxadiargyl 80 g / ha *fb* bispyribac 25 g / ha closely followed by fenoxaprop 60 g / ha + chlorimuron + metsulfuron 4g / ha at 20 DAS.

In unweeded plot, dominant weeds species were *Celosia argentea* (37.7%), *Echinochloa colona*

Table 3.6.1 Effect of tillage and weed control measures in Kharif rice as affected by different treatments.

Treatments	Plant height at harvest (cm)	Number of tillers at harvest	Grain yield (t/ha)	Straw yield (t/ha)
Tillage and residue management				
CT (Transplanted)	74.1	52.6	2.8	3.2
CT (Transplanted)	72.6	52.4	2.8	3.2
CT (Direct-seeded)	72.2	39.1	2.2	2.5
ZT (Direct-seeded)	69.6	38.0	2.1	2.4
ZT (Direct-seeded) +R	72.1	38.6		2.5
Sem±	0.5	3.4	0.1	0.1
LSD (P=0.05)	1.6	11.0	0.3	0.4
Weed control measures				
Oxadiargyl 0.1kg / ha	72.5	42.1	2.5	2.8
Oxadiargyl 0.1kg / ha+ HW at 40 DAS / DAT	72.7	49.0	2.5	2.9
W3 Weedy check	71.1	41.2	2.3	2.6
Sem±	0.3	1.5	0.0	0.0
LSD (P=0.05)	1.2	6.1	0.1	0.2
Interaction effects				
Sem±	0.7	3.0	0.1	0.1
LSD (P=0.05)	NS	NS	NS	NS

(19.6%), *Ischeamum rugosum* (14.7%), *Cyperus iria* (9.8%), whereas, initially dominant species *Alternanthera triandra* registered its presence by a reduced tune of 1.6% only. Oxadiargyl along with bispyribac reduced the microbial population and their activities up to harvest stage. Fenoxaprop, chlorimuron-ethyl and metsulfuron-methyl, persisted in soil for a longer period and their presence was found even up to harvest. Hand weeding practice found best among all treatments as it promoted microbiological activities including crop beneficial microbial population in the soil system (Table 3.6.2).

Table 3.6.2 Basal soil respiration rate (mg CO_2 / h / 100g) and dehydrogenase activity of soil (µg TPF / h / g) as influenced by long term weed management practices under rice-chickpea cropping system (*Kharif*)

Treatment	Days after sowing							
	0		30		50		At harvest	
	BSR	DHA	BSR	DHA	BSR	DHA	BSR	DHA
Oxadiargyl 80 g / ha *fb* bispyribac 25 g / ha	0.235	24.3	0.138	10.6	0.11 1	8.1	0.132	20.4
Pyrazosulfuron 25 g / ha *fb* hand weeding at 35DAS	0.244	25.6	0.202	21.0	0.350	68.2	0.228	25.7
Fenoxaprop-p-ethyl 60 g / ha + chlorimuron–ethyl + metsulfuron-methyl 4 g / ha	0.229	24.0	0.208	10.7	0.117	6.1	0.106	14.2
Hand weeding twice	0.247	26.1	0.312	41.4	0.374	73.1	0.234	22.9
Un weeded control	0.249	26.7	0.318	42.9	0.384	81.0	0.238	24.5
CD (P= 0.05)	N.S.	N.S.	0.022	2.67	0.027	5.3	0.020	2.26

DHA: Dehydrogenase enzyme activity, BSR: Basal soil respiration rate

KAU, Thrissur

In the backwater areas of Kerala, continuous zero tillage to a shift in the weed flora was in favour of perennial weeds. Zero tillage increased the soil organic matter content, compared to tilled plots. Tillage did not have any influence on the soil pH. Weed control by herbicides was cheaper and helped in improving the B: C ratio. It is recommended that for realizing maximum yield in rice, conventional tillage was the best (Table 3.6.3). Zero tillage can be practiced

Table 3.6.3 Effect of tillage and weed control methods on economics of rice cultivation in 2013 and 2014

Tillage	2013				2014			
	Yield (kg/ ha)	Cost of cultivation (`)	Net return (`)	B:C ratio	Yield (kg/ ha)	Cost of cultivation (`)	Net return (`)	B:C ratio
ZT-ZT	3754	37,500	30,072	1.8	3752	37,500	30,030	1.8
ZT-CT	5454	37,500 (ZT in this year)	60,672	2.6	5325	42,500 (CT in this year)	53,350	2.2
CT-CT	5667	42,500	59,506	2.4	5648	42,500	59,170	2.5

in alternate years without any adverse effect on the soil, weed flora, or net return. In situations where tillage is not at all possible, zero tillage can be practiced, though the yield will be reduced by 30% compared to conventional tillage. For increasing soil organic matter content, it is advisable to go for zero tillage, at least in alternate years. Wherever perennial weeds are a problem, continuous zero tillage is not advisable (Table 3.6.4).

PAU, Ludhiana

After two cropping cycles, retention of residues in rice and / or in wheat increased the organic carbon, available nitrogen and avaible phosphorous compared to conventional or zero tillage without residue retention. Available potassium decreased under all the tillage and residue management treatments. This indicated that soil health improved in two cropping cycles with the retention of crop residues (Table 3.6.4).

Table 3.6.4 Soil fertility status after one cycle of rice-wheat cropping system

Treatment				Organic C (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
Sr. No.	Rice	Wheat	*Sesbania* as green manure				
TRM1	CT (PTR)	CT	-	0.42	230.9	42.8	135.6
TRM2	CT (PTR)	ZT	ZT	0.43	232.9	44.0	138.8
TRM3	CT (DSR)	CT	ZT	0.45	250.8	44.2	140.2
TRM4	ZT (DSR)	ZT + R	ZT	0.56	268.8	56.8	179.8
TRM5	ZT(DSR)+ R	ZT + R	ZT	0.52	277.6	54.5	168.2
Initial Status	-	-	-	0.45	242.2	17.5	262.5

In *Rabi*, ZT-wheat with and without residue retention recorded lower density and biomass of *P. minor* compared to CT-wheat; broadleaf weed density and biomass were similar under different tillage and residue management treatments. Among weed control, recommended herbicides and IWM recorded significantly lower population and biomass of grass and broadleaf weeds compared to unweeded control in wheat. In soil, *P. minor* and *R. dentatus* were major weeds. Unlike last year, *Poa annua* was not observed this year. Among residue and tillage systems, CT-DSR *fb* CT-wheat system recorded significantly higher number of seeds of both weeds compared to CT-PTR *fb* CT-wheat system. ZT-DSR *fb* ZT-wheat+R recorded the lowest number of weed seeds. Among weed control, IWM and herbicide treatments recorded significantly, lower number of weed seeds compared to unweeded control.

In *Kharif*, PTR recorded significantly lower population and biomass of grass, broadleaf and sedges weeds compared to DSR at 30 and 60 DAS (Tables 3.6.5). Among DSR, weed population and biomass in CT-DSR and ZT-DSR+R were at par; however, ZT-DSR recorded significantly higher density and biomass of weeds. At harvest, weed biomass was lowest in PTR treatments and at par with ZT-DSR+R. Among weed control, recommended herbicides and integrated weed management (IWM) recorded significantly lower population and dry matter of grass, broadleaved and sedges as compared to unweeded control; grass weed dry matter was lower under IWM compared to recommended herbicides. In soil weed seed bank, *E. crus-galli, D. aegyptium* and *T. portulacastrum* were major weeds. Among tillage and residue management treatments, CT-DSR recorded lowest number of *E. crus-galli*, ZT-DSR and CT-PTR of *D. aegyptiacum* and ZT-DSR of *T. portulacastrum* than other treatments. Among weed control treatment, herbicides and IWM treatments recorded significantly lower numbers of weed seeds of three species compared to unweeded control. Interaction effect revealed minimum numbers of *E. crus-galli* seed under IWM in PTR (-ZT-wheat) and ZT-DSR.

Table 3.6.5 Effect of tillage, residue and weed management on weeds at 30 DAS in basmati rice (2015)

Treatment	Weed population at 30 DAS (No./m²)*								
	E. colona	*D. aegyptium*	*E. crus-galli*	*A. racemosa*	*D. ciliaris*	*C. Iria*	*C. compressus*	*P. niruri*	*D. arvensis*
Tillage and residue management									
TRM1	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	2.3	1.0 (0)	1.0 (0)	1.0 (0)
TRM2	1.2 (1)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	8.9	1.0 (0)	1.0 (0)	1.0 (0)
TRM3	1.8 (3)	1.4 (1)	1.2 (0)	1.4 (1)	1.1 (0)	20.1	3.9 (19)	1.8 (3)	2.6 (6)
TRM4	2.3 (7)	1.5 (2)	1.4 (1)	2.1 (4)	1.4 (1)	21.4	3.6 (17)	1.8 (3)	2.9 (8)
TRM5	2.2 (5)	1.2 (0)	1.4 (1)	1.0 (0)	1.1 (0)	12.1	2.7 (12)	1.6 (3)	2.4 (5)
SEm ±	0.09	0.06	0.05	0.05	0.03	0.9	0.08	0.05	0.06
LSD(P=0.05)	0.3	0.2	0.2	0.2	0.1	2.9	0.3	0.2	0.2
Weed management									
W1	1.2 (1)	1.1 (0)	1.0 (0)	1.4 (2)	1.0 (0)	14.1	1.5 (2)	1.0 (0)	1.9 (3)
W2	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	9.1	1.4 (1)	1.0 (0)	1.7 (2)
W3	2.8 (9)	1.5 (2)	1.6 (2)	1.5 (2)	1.3 (1)	15.8	4.4 (26)	2.3 (6)	2.4 (6)
SEm ±	0.04	0.04	0.05	0.04	0.02	0.8	0.1	0.06	0.06
LSD(P=0.05)	0.1	0.1	0.2	0.1	0.1	3.1	0.4	0.3	0.2
Interaction LSD	S	S	S	S	S	NS	S	S	S

Data subjected to square root transformation except that of *C. iria.* Values in parentheses are original.

OUAT, Bhubaneswar

Practice of CT (Transplanted) tillage methods reduced the weed densities over ZT (Direct seeded) in the *Kharif* rice. During the initial stages (60 DAP), application of pretilachlor (1.0 kg / ha) reduced the weed density by 57% over control and 64% in case of IWM over unweedy check. Yield reduction in ZT (Direct seeded) method was significant compared to CT (Transplanted) method. Composition of weed seed bank in ZT was comprised with dominated grasses (63%) followed by broad leaf weeds (24%) and sedges (13%) and the corresponding values in CT were 66%, 22% and 12%, respectively. At the initial stages of crop growth (25 DAS), pendimethalin 1 kg / ha recorded the lowest weed density of 43 / m^2. Integration of CT-ZT-ZT method and use of pretilachlor 1 kg / ha obtained the maximum B:C ratio of 3.85 in the rice based system (Table 3.6.6).

PJTSAU, Hyderabad

Higher grain yield (10111 and 9715 kg / ha), gross returns (` 1,32,454 and 1,27,264) and B:C (4.1 and 3.9) ratio was obtained in *Rabi* maize raised in sequence with conventional tillage practice after direct seeded and transplanted rice during *Kharif* respectively. Either PE application of atrazine 1000 g / ha + paraquat 600 g / ha *fb* HW at 40 DAS (IWM) or atrazine 1000 g / ha + paraquat 600 g / ha *fb* 2-4-D 1000 g / ha at 20-25 DAS as PoE was economical with higher grain yield (11820 and 10103 kg / ha), gross returns (` 1,54,838 and 1,32,343) and net returns (` 1,23,194 and

RVSKVV, Gwalior

Integrated weed management (isoproturon + 1 HW) gave maximum seed yield (1.4 t / ha) as well as reduced the weed density and dry weight of weeds followed by pendimethalin 1.0 kg / ha PE during first year in mustard crop under pearlmillet – mustard cropping system. Conventional tillage practice gave significant maximum seed yield (1.3 t / ha) as compared to other tillage practices. Lowest B: C ratio was obtained in conventional tillage practices. In case of weed management practices, the highest B: C ratio was obtained in pendimethalin (3.8) followed by IWM practices (3.4). In green gram under pearlmillet – mustard green gram cropping system, integrated weed management (pendimethalin 1.0 kg / ha PE + 1 HW) gave maximum seed yield (401 kg / ha) as well as reduced weed density and dry weight of weeds followed by imazethapyr + imazamox 80 g / ha PoE. Tillage practices (all zero tillage) could not affect the

Table 3.6.6 Effect of tillage and weed management practices on weed dry matter and WCE of rice in rice- maize - green manure cropping system (*Kharif*, 2015-16)

Main plots	Treatments	Weed dry matter (g/m^2)				WCE (%)			
		30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	Harvest
T_1	CT(Transplanted)	0.0(1.0)	3.4(14.0)	3.9(16.0)	3.4 (11)	79.7	75.2	68.3	68.3
T_2	CT(Transplanted)	0.0(1.0)	4.3(14.0)	3.9(17.0)	3.0 (11)	79.7	69.2	68.4	72.3
T_3	CT (Direct-seeded)	17.3(4.0)	12.7(196)	10.0(119)	9.6 (99)	22.7	9.6	19.6	10.7
T_4	ZT (Direct-seeded)	18.4(4.0)	13.7(196)	10.8(139)	10.3(109)	0.0	2.0	13.4	4.6
T_5	ZT(Direct-seeded) + R	18.5(4.0)	14.0(206)	12.5(167)	10.8(136)	18.4	0.0	0.0	0.0
SD		1.6	5.3	4.0	3.9	-	-	-	-
SEm		0.3	0.7	0.7	1.0	-	-	-	-
LSD(P=0.05)		1.3	2.5	2.5	3.4	-	-	-	-
Sub Plots									
W_1	Chemical	2.5(7.0)	9.1(107.0)	8.1(85.0)	7.6(73.0)	38.3	24.8	21.8	12.6
W_2	IWM	2.2(7.0)	7.8(80.0)	6.1(50.0)	6.0(43.0)	45.2	35.7	41.1	31.4
W_3	Unweeded	4.1(25.0)	12.1(195)	10.4(140.0)	8.7(102.0)	0.1	-0.0	0.0	-0.0
SD		1.0	2.2	2.1	1.3	-	-	-	-
SEm		0.3	0.9	0.7	0.5	-	-	-	-
LSD(P=0.05)		1.0	2.9	2.2	1.8	-	-	-	-

*Figures in parenthesis are original values and data is subjected to square root transformation.

yield of green gram and weed population and dry weight significantly in first year of experiment.

In case of pearlmillet crop under pearlmillet-mustard-green gram cropping system, IWM practices (atrazine 0.5 kg/ha + 1 HW) significantly reduced weed population and dry weight of weeds and resulted in higher yield (2.5 t/ha) (Table 3.6.7). Under conservation tillage practices C_5 (ZT+R-ZT+R – ZT) was found superior over other tillage practices in respect to yield (2.1 t/ha) as well as economics point of view (BC ratio 2.4).

TNAU, Coimbatore

Different tillage methods had no significant influence over grain yield of 1st maize crop in maize – sunflower cropping system; whereas, pre-emergence application of atrazine 0.5 kg/ha with hand weeding at 45 DAS recorded significantly higher grain yield. Microbial population and soil enzymes were increased during cropping period i.e., 60 days after sowing and declined after harvest in all the treatments in maize. Among the tillage method, conventional tillage recorded maximum number of microbial population and enzyme activities at 60 DAS. Among weed management practices, PE atrazine at 0.5 kg/ha + HW on 45 DAS recorded maximum number of microbial population and enzyme activities at 60 DAS.

UAS, Bengaluru

Performance of summer green gram under conventional tillage transplanted rice – chickpea and conventional tillage direct-seeded rice – chickpea and conventional tillage transplanted rice–zero tillage chickpea was better than continuous zero tillage directed seeded rice - chickpea with residues and without residues owing to better establishment, growth and yield attributes which contributed to higher green gram seed yield. Weed management practices significantly influenced yield and yield attributes of green gram. Integrated weed management practice of pendimethalin at 750 g/ha followed by passing cycle weeder – 30 DAS recorded significantly higher greengram grain yield (1084 kg/ha) and branches per plant (3.3) as compared to pendimethalin at 750 g/ha alone and unweeded

Table 3.6.7 Effect of different weed management & conservation tillage on practices pearlmillet under pearlmillet-mustard cropping system

Treatment		Grain yield (t/ha)			Stover yield (t/ha)			Weed biomass at harvest (kg/ha)	
		2014	2015	Mean	2014	2015	Mean	2014	2015
Conventional tillage (CT-CT)	Atrazine + 2,4-D	3.6	2.5	3.1	8.8	5.1	6.9	176	1015
	Atrazine + 1 HW	3.8	2.0	2.9	8.9	4.3	6.6	154	545
	Weedy check	3.2	1.4	2.3	7.7	2.6	5.2	1763	2244
	Mean	3.5	2.0	2.7	8.5	4.0	6.2	698	1268
Conventional tillage (CT-ZT-ZT)	Atrazine + 2,4-D	4.0	2.0	3.0	10.0	6.2	8.1	179	855
	Atrazine + 1 HW	4.0	2.7	3.3	10.2	5.2	7.7	155	556
	Weedy check	3.3	1.6	2.4	8.6	2.5	5.5	1795	1870
	Mean	3.7	2.1	2.9	9.6	4.6	7.1	710	1093
Zero tillage (ZT-ZT-ZT)	Atrazine + 2,4-D	3.9	1.7	2.8	9.3	3.7	6.5	191	1143
	Atrazine + 1 HW	4.0	2.1	3.0	10.2	4.7	7.4	159	470
	Weedy check	3.3	0.8	2.0	8.0	1.3	4.6	1974	1870
	Mean	3.7	1.5	2.6	9.2	3.2	6.2	775	1161
Zero tillage (ZT-ZT+R-ZT)	Atrazine + 2,4-D	3.5	2.2	2.8	8.8	6.0	7.4	192	1250
	Atrazine + 1 HW	3.6	2.6	3.1	10.0	5.2	7.6	160	566
	Weedy check	3.0	1.1	2.0	7.7	2.0	4.9	1978	2083
	Mean	3.4	2.0	2.7	8.9	4.4	6.6	777	1300
Zero tillage +crop residue (ZT+R-ZT+R-ZT)	Atrazine + 2,4-D	3.8	2.1	2.9	9.3	5.3	7.3	199	1335
	Atrazine + 1 HW	3.8	3.2	3.5	10.4	5.9	8.2	167	556
	Weedy check	3.4	1.1	2.3	9.0	2.0	5.5	1987	2511
	Mean	3.7	2.1	2.9	9.6	4.4	7.0	784	1467
	SEm (±)	0.1	0.1	-	0.3	0.3	-	-	67
	CD at 5 %	NS	0.3	-	NS	1.0	-	-	217
Overall mean of sub treatment									
	Atrazine + 2,4-D	3.8	2.1	2.9	9.2	5.3	7.3	187	1120
	Atrazine + 1 HW	3.8	2.5	3.2	9.9	5.1	7.5	159	538
	Weedy check	3.2	1.2	2.2	8.2	2.1	5.1	1899	2115
	Main treatment								
	SEm (±)	0.1	0.1	-	0.1	0.4	-	-	63
	CD at 5 %	0.5	0.6	-	0.6	1.8	-	-	249

control. Unweeded check recorded highest weed index (68.4%) due to severe weed competition which had detrimental effect on the yield and yield attributes of green gram. The interaction of tillage and weed management practices was not significant.

RAU, Pusa

In rice, lowest weed count (9.3, 10.4 and 8.2 / m^2) and weed dry weight (15.4, 20.1 and 9.6 g / m^2) were recorded at 30 and 60 DAS and at harvest respectively under CT (Transplanted)-ZT-ZT which were statistically at par CT (Transplanted)-CT under tillage and residue management. However, the highest grain yield of rice (4.8 t / ha) was recorded under CT (Transplanted) – CT which was statistically at par with CT (Transplanted)-ZT-ZT (4.6 t / ha). The lowest grain yield of rice (3.4 t / ha) was recorded under treatment ZT (Direct-seeded)–ZT-ZT. Amongst the weed management treatments, the lowest yield of rice (3.4 t / ha) and highest weed count (21.4, 28.4 and 15 / m^2) and weed dry weight (30.8, 4.10 and 17.8 g / m^2) at 30 and 60 DAS and at harvest respectively were recorded under un-weeded treatment. However, the highest grain yield of rice (4.6 t / ha) and the lowest weed count (10, 13.9 and 7.7 / m^2) and weed dry weight (16.8, 26.4 and 10.6 g / m^2) at 30, 60 DAS and at harvest were recorded under integrated weed management (herbicide + hand

weeding) which was at par with recommended herbicides.

In wheat, lowest weed count (7.6 and 23.6 / m^2) and weed dry weight (9.2 and 12.4 g / m^2) were recorded at 30 and 60 DAS under CT (Transplanted)-CT- however, at harvest the lowest weed count (6.8 / m^2) and weed dry weight (9.7g / m^2) were recorded under CT (Transplanted)-ZT-ZT under tillage and residue management. However, highest grain yield of wheat (4.7 t / ha) was recorded under CT (Transplanted) – CT. The lowest grain yield of wheat (3.9 t / ha) was recorded under treatment ZT (Direct-seeded)– ZT-ZT. Amongst the weed management treatments, the lowest yield of wheat (3.3 t / ha) and highest weed count (13.7, 58.3 and 11.7 / m^2) and weed dry weight (23.5, 32 and 17.7 g / m^2) at 30 and 60 DAS and at harvest respectively were recorded under un-weeded treatment. However, the highest grain yield of wheat (5.4 t / ha) and the lowest weed count (8.7, 14.3 and 7.9 / m^2) and weed dry weight (9.8, 8.9 and 9.8 g / m^2) at 30 and 60 DAS and at harvest respectively were recorded by the treatment integrated weed management (herbicide + hand weeding).

In greengram, lowest weed count (7.2, 33.8 and 6.2 / m^2) and weed dry weight (8.4, 18.9 and 9.1 g / m^2) were recorded at 30, 60 DAS and at harvest under CT (Transplanted)-ZT-ZT under tillage and residue management. However, the highest grain yield of greengram (2.6 t / ha) was recorded under CT (Direct seeded)– CT-ZT. The lowest grain yield of greengram (1.88 t / ha) was recorded under treatment ZT (Direct-seeded) – ZT- ZT. Highest grain yield of greengram (2.74 t / ha) and the lowest weed count (5.9, 12.7 and 5.3 / m^2) and weed dry weight (8.4, 4.8 and 8.3 g / m^2) at 30, 60 DAS and at harvest were recorded under integrated weed management (herbicide + hand weeding). The highest gross return (` 1,84,231 / ha), net return (` 1,16,017 / ha) and B: C ratio (2.7) were recorded under treatment CT (Transplanted)-ZT-ZT under tillage and residue management. The highest gross return, net return and B: C ratio was obtained under TCT (Transplanted)-ZT-ZT which was statistically at par with CT (Direct-seeded) – CT-ZT under Tillage and residue management. Under weed management practices the highest gross return (` 1, 89,933 / ha) was recorded by CT (Transplanted)-ZT-ZT however, the highest net return (` 1,20,151 / ha) and B:C ratios (2.9) were recorded under recommended herbicides.

Effect of conservation techniques under rice cultivation with different weed control measures showed significant influence on soil properties (chemical and biological). The pH was not significantly affected in initial and post harvest soil however, ZT+R resulted maximum reduction in pH as compared to rest of the conservation tillage practices. Significant variation with respect to conservation agriculture practices and weeds management were observed in available nitrogen 239.2 to 256.5 kg / ha and 236.6 to 253.7kg / ha in initial and post harvest soil, phosphorus 37.1 to 47.5 kg / ha in initial and 40.6 to 48.3 kg / ha in post harvest soil and available potassium content varied from 255.8 to 268.1 kg / ha in initial and 262.6 to 277.2 kg / ha in post harvest soil. ZT+R resulted significantly higher available nitrogen (256.5kg / ha) under initial conditions than available nitrogen under post harvest conditions (253.7 kg / ha) in main plot.

ZT+R also resulted in higher *Azotobacter* population (3.96 x 10^4 cfu / g), *Pseudomonas* population (8.27 x 10^5 cfu / g) and *Bacillus* population (6.01x 10^5 cfu / g). Similarly the ZT+R also resulted in significantly higher total PSB population (9.46 x 10^5 cfu / g) and CO_2 evolution (94.0 mg / 1000 g soil). Zero tillage with crop residue enhanced the microbial activity expressed as CO_2 evolved mg / 1000 g of soil and the same treatment also enhanced the total microbial population. P solublizationg efficiency of *Pseudomonas* and *Bacillus* was more in ZT+R. The enhanced population of *Azotobacter*, *Pseudomonas* and *Bacillus* and their efficiencies were more in post harvest soil as compared to initial soil samples.

WS 3.7 Long-term herbicide trial in different cropping systems

Cooperating centres: All centres (Except Pantnagar and Bhubaneswar)

DBSKKV, Dapoli

Green manuring treatment stimulated

significantly higher microbial population due to more availability of nutrient as compared to without green manuaring treatment in both the crops. Microbial population was not affected by herbicides during all the stages of the groundnut crop during *Rabi* season. All microbial population and associated parameters initially suppressed due to toxic effect of herbicides at initial stage (30DAT) in rice crop in *Kharif* season. From four years study it can be concluded that incorporation of green manures and application of fixed herbicide pretilachlor for *Kharif* rice and pendimethalin for *Rabi* groundnut reduced weed growth with increased in total REY (186.7 q / ha) in rice groundnut cropping system under Konkan region of Maharashtra (Table 3.7.1). Dry weight of nodules g / plant of groundnut crop was not significantly influenced by green manuaring as compared to the without green manuaring at 50 DAS. While the number of nodules per plant was significantly influenced by green manuaring (24.8) as compared to without green manuaring. The significantly higher number of nodules (24.8) found in green manuaring as compared to the without green manuaring (17.8).

Table 3.7.1 Effects of green manuring and weed control measures on economics of rice-groundnut cropping system at Dapoli

Treatment combination	Total REY of system (t/ha)	Cost of cultivation (`/ha)	Net returns (`/ha)	B:C ratio
M1T1	186.7	1,48,980	1,31,160	1.8
M1T2	175.7	1,50,110	1,13,485	1.7
M1T3	195.0	1,65,100	1,27,535	1.7
M1T4	156.1	1,43,100	91,140	1.6
M2T1	169.6	1,48,180	1,06,265	1.7
M2T2	163.3	1,49,310	95,640	1.6
M2T3	193.6	1,64,300	1,26,130	1.7
M2T4	140.0	1,42,300	67,775	1.4

IGKV, Raipur

Effect of treatments applied to direct seeded rice during *Kharif* and chickpea during *Rabi* on seed yield was not found significant. Tillage practices had significant effect on seed yield of chickpea, whereas; seed yield was significantly higher under zero tillage than conventional tillage, however, in previous years, the trend was reversed. Effect of weed control methods was found significant on seed yield of chickpea. Among weed control methods, pre-emergence application of pendimethalin 1.0 kg / ha produced significantly higher seed yield as compared to weedy check and farmer's practice but both were statistically superior over weedy check (Table 3.7.2). B: C ratio was also high under oxadiargyl 80 g / ha *fb* bispyribac Na 25 g / ha applied to rice during *Kharif*, zero tillage and application of pendimethalin 1.0 kg / ha in chickpea. Rice yield equivalence also followed the same trend as that of obtained from the seed yield.

In *Rabi* application of post-emergence herbicide pendimethalin and two hand weeding (farmers' practice) were compared with weedy check with respect to their effect on microbial, biochemical properties of soil and nodulation in chickpea crop. Application of pendimethalin significantly reduced BSR, DHA, AP, MBC and population of free N-fixing and P-solubilizing bacteria in rhizosphere soil of chickpea crop after its application and the effect was found up to 30 DAS. No residual effect of above applied herbicide was observed on the above studied parameters at 50 DAS. Application of pendimethalin did not affect nodule number of chickpea.

PJTSAU, Hyderabad

Significantly lowest weed dry matter was recorded at all the crop growth stages with pretilachlorat 3-5 DAT *fb* HW at 25-30 DAT, however it was on par with hand weeding twice at 20, 40 DAT at 30 DAT and this was followed by post emergence application of bispyribac sodium at 20-25 DAT at 25 g / ha *fb* HW at 40-45 DAT, and this was on par with PE application of pretilachlor *fb* ethoxysulfuron at 25 DAT (3-4 leaf stage). However, at harvest this was on par with hand weeding twice at 20, 40 DAT and post emergence application of bispyribac-sodium at 20-25 DAT 25 g / ha *fb* HW at 40-45 DAT (Table 3.7.3).

In *Kharif*, B:C ratio either pre-emergence application of pretilachlor at 3-5 DAT *fb* HW at 25-30 DAT (` 1,36,214, ` 95,493 and 3.35) or hand weeding twice at 20 and 40 DAT (` 1,34,657, ` 90,656 and 3.0) was found to be more economical with increased weed control efficiency and reduced weed dry matter at critical period of crop weed competition.

Table 3.7.2 Weed growth, seed yield and economics as influenced by long-term weed management in rice-chickpea cropping system

Treatment	*Rabi* 201415					
Weed management (*Kharif*)	Weed dry weight, at 60 DAS (gm^2)	Weed control efficiency (%)	Seed yield t/ha	Weed index	B:C ratio	Rice yield equivalence t/ha
Oxadiargyl 80 g / ha *fb* bispyribac 25 g / ha	4.0(15.6)	47.8	0.9	-	1.7	2.15
Pyrazosulfuron 25 g / ha *fb* 25 g / ha at 35 DAS	4.9(23.6)	21.0	0.9	4.0	1.7	2.06
Fenoxaprop-p-ethyl 60 g / ha +chlorimuron –ethyl + metsulfurən methyl 4 g / ha	4.6(21.3)	28.8	0.9	3.0	1.7	2.08
Hand weeding twice at 20 and 35 DAS	4.3(18.4)	38.5	0.9	1.0	1.7	2.13
Un weeded control	4.3(29.9)	-	0.8	10.1	1.6	1.93
LSD (P= 0.05)	0.3	-	N.S.	-	-	-
Tillage (*Rabi*)						
Conventional	4.9(24.4)	-	0.9	-	1.6	2.04
Zero	4.4(19.1)	-	0.9	-	2.1	2.10
LSD (P= 0.05)	0.2	-	0.0	-	-	-
Weed Management (*Rabi*)						
Farmers practice	4.5(20.1)	27.7	1.1	-	1.7	2.54
Pendimethalin 1.0 kg / ha	4.2(17.3)	37.8	1.3	11.0	2.2	2.82
Un weeded Control	5.3(27.8)	-	0.3	67.5	-0.6	0.82
LSD (P= 0.05)	0.3	-	0.08	-	-	-

Table 3.7.2 Influence of weed management practices on weed dry matter, weed control efficiency of rice in rice - maize cropping system (*Kharif*, 2015)

Treatment	WDM (g/m^2)			WCE (%)		
	30 DAT	60 DAT	Harvest	30 DAT	60 DAT	Harvest
Pretilachlor 750 g / ha as PE at 3-5 DAT *fb* HW at 25-30 DAT	2.8 (I7.5)	6.9(46.8)	3.8(15.3)	89.7	69.8	93
Bispyribac sodium as PoE at 20-25 DAT 25 g / ha *fb* HW at 40-45 DAT	5.8 (33.1)	7.9(62.8)	4.5(20.5)	54.5	54.2	91
Pretilachlor *fb* ethoxysulfuron 750 / 18.75 at 25 DAT (3- 4 leaf stage)	6.0 (36.3)	8.5(73.0)	12.3(151.5)	50.2	46.8	33
Farmers practice (20, 40 DAT HW)	4.1 (16.7)	7.7(59.5)	4.0(16.8)	77.0	50.3	93
Unweeded check	8.5 (72.9)	11.7(137.3)	15.0(226.3)	0.0	0.0	0.0
SEm±	0.3	0.3	0.7	-	-	-
LSD (P=0.05)	1.0	1.1	2.2	-	-	-

Figures in parenthesis are original values and data is subjected to square root transformation

TNAU, Coimbatore

During base year of experiment (*Kharif* 2015), *Echinochloa crus-galli*, *Echinochloa colona*, *Panicum repens* in grasses, *Cyperus difformis*, *Cyperus nutan* were dominant sedge and *Ludwigia parviflora*, *Ammania baccifera*, *Monochoria vaginalis* and *Marselia quadrifoliata* were among the broad leaved weeds. Significantly lower total weed density (7.3) and dry weight was recorded with PE pyrasosulfuron-ethyl *fb* POE bispyribac-sodium at 60 DAT (Table 3.7.4). Application of PE pyrasosulfuron-ethyl *fb* POE bispyribac sodium positively influenced growth characters, yield attributes and yield and had better weed control which was on par with PE pyrazosulfuron-ethyl *fb* hand weeding during *Kharif*. Total bacteria, phosphobacteria, fungi populations were decreased up to 5 DAHA and gradually increased from 7 DAHA in both the case of PE pyrazosulfuron- ethyl and POE bispyribac-sodium in rice. Diazotrophs populations were decreased up to 7 DAHA and increased from 15 DAHA and in case of actinobacteria there was no reduction in the population after application pyrazosulfuron-ethyl and bispyribac -sodium in rice.

Table 3.7.4 Total weed density and weed dry weight at 60 DAT and productive tillers, grain yield and economics in transplanted lowland rice (*Kharif*, 2015)

Treatment combination	Total weed density (No./m^2)	Total weed dry weight (g/m^2)	Productive tillers (No./m^2)	Grain yield (kg/ha)	Net return (` / ha)	B:C ratio
PE pyrazosulfuron -ethyl *fb* hand weeding	6.5 (43.2)	8.3 (69.0)	355	5880	16,364	2.1
PE pyrazosulfuron-ethyl *fb* hand weeding + PE bensulfuron-methyl (0.6%) + pretilachlor *fb* hand weeding	3.4(12.2)	5.4 (29.7)	385	5953	26,000	2.2
PE pyrasosulfuron- ethyl *fb* POE bispyribac-sodium	2.7 (7.3)	4.6 (21.2)	396	6142	27,701	2.5
PE pyrasosulfuron ethyl (10% WP) *fb* POE bispyribac sodium + PE bensulfuron- methyl (0.6%) + pretilachlor (6.6%) *fb* POE bispyribac -sodium	4.5 (20.9)	5.9 (34.9)	367	5926	22,455	2.1
Hand weeding twice	7.3 (53.9)	9.2 (85.4)	351	4676	10,401	1.7
Unweeded check	10.8 (117.4)	14.5(212.6)	311	3087	9,904	1.5
SEm±	1.6	2.3	13.4	174	-	-
LSD (P= 0.05)	3.2	4.6	26.2	415	-	-

Figures in parenthesis are original values and data is subjected to square root transformation

RAU, Pusa

Neem cake of 200 kg / ha at sowing *fb* soil drenching of metalaxyl MZ 02.% at 20 DAP reduced *Orobanche* shoot density with better weed control and higher tobacco yield (2.45 t / ha). Imazethapyr 30 g / ha at 40 DAP caused severe phytotoxicity on tobacco leaves. The growth of plant was severely stunted and size of leaves was decreased leading to loss in yield of the crop.

WS 3.8 Station trials based on location-specific problems

WS 3.8.1 Chemical and mechanical weed management in direct-seeded rice (*Kharif* 2015)

IGKV, Raipur

Experimental field was dominated by broad leaf weeds and sedges including *Alternanthera*

triandra, Spilanthes acmella and *Cyperus iria* whereas, *Echinochloa colona* was the dominant weed among grasses. Significantly lower weed dry matter was recorded under oxadiargyl 80 g / ha PE *fb* bispyribac - Na 20 g / ha at 25 DAS as compared to weedy check, whereas, at harvest stage, weed dry matter was significantly lower under oxadiargyl 80 g / ha PE *fb* bispyribac-Na at 20 g / ha 25 DAS and was at par with hand weeding at 20 and 35 DAS. Significantly higher seed yield was recorded under oxadiargyl 80 g / ha PE *fb* bispyribac-Na 20 g / ha 25 DAS and was at par with hand weeding at 20 and 35 DAS. It may be concluded that significantly lower weed dry matter and higher seed yield as well as benefit: cost ratio may be obtained under the combination of oxadiargyl 80 g / ha PE *fb* bispyribac Na 20 g / ha at 25 DAS closely followed by oxadiargyl 80 g / ha PE (row spraying) *fb* penoxsulam 22.5 g / ha at 18 DAS and thus load of herbicide mainly pre-emergence may be reduced up to 60% without significant reduction in yield and benefit: cost ratio.

WS 3.8.2 Weed management in beetroot

PJTSAU, Hyderabad

Predominant weed flora observed in beetroot during season were *Cyperus rotundus, Parthenium hysterophorus, Melilotus alba, Commelina benghalensis, Digera muricata, Trianthema portulacastrum, Argemone mexicana, Amaranthus polygamus, Amaranthus viridis, Trichodesma indicum, Sonchus arvensis, Datura stramonium, Dactyloctenium aegyptium, Echinochloa colona* and *Dinebra retroflexa.* Lowest weed dry matter was recorded in pre-emergence application of alachlor 1000g / ha *fb* hand weeding at 30 DAS. At 60 DAS, pre-emergence application of metribuzin 500g / ha *fb* HW at 30 DAS showed lowest weed dry matter and was on par with oxyfluorfen 150 g / ha *fb* hand weeding. At harvest lowest weed dry matter was noticed in hand weeding twice and was significantly superior over rest of the treatments. Significantly more tuber length, tuber girth and tuber yield were observed with pre-emergence application of alachlor 1000g / ha *fb* hand weeding at 30 DAS and was on par with pre-emergence application of metribuzin 500g / ha and was on par with hand weeding twice at 20 and 40 DAS followed by pre-emergence application of metribuzin 500 g / ha *fb* hand weeding at 30 DAS.

WS 3.8.3 Weed control in carrot

BAU, Ranchi

Application of carfentrazone 0.31 kg / ha post-emergence between rows was similar to glyphosate (41%) 1 kg / ha pre-plant burn down recorded significantly higher carrot yield (218 q / ha), net return (Rs 277134 / ha) and B: C ratio (5.2) compared to rest of the treatment in 2015-16. When the data of two years were pooled, application of carfentrazone (40%) 0.31 kg / ha post-emergence between rows being similar to glyphosate (41%) 1 kg / ha pre-plant burn down and Paraquat (24%) 1 kg / ha 3 days before sowing recorded significantly higher carrot yield (209 q / ha), net return (Rs 2, 63,634and B: C ratio (5.2).

WS 3.8.4 Weed management in egg plant

BAU, Ranchi

Application of carfentrazone 0.31 kg / ha post-emergence between rows was similar to all treatments except carfentrazone (40%) 0.03 kg / ha 4 days before sowing and weedy check (during 2015-16 and recorded significantly higher yield of eggplant (256 and 203 q / ha). Net return and B:C ratio recorded higher with application of glyphosate (41%) 1 kg / ha pre-plant and it was at par with rest of the treatments except application of carfentrazone (40%) 0.03 kg / ha 4 days before sowing, oxyfluorfen (23.5%) 0.25 kg / ha 3 days before sowing (and weedy check during 2015-16 as well as when data of two years were pooled.

WS 3.8.5 Alternatives for pre-emergence herbicide in pineapple

KAU, Thrissur

There were no weeds up to 60 days in the plots applied with diuron 2 and 3 kg and oxyfluorfen 0.2 and 0.3 kg / ha. By the 90th day weeds were observed in the fields and the growth was lower in diuron 3 kg and oxyfluorfen 0.2 to 0.4 kg / ha applied plots. Total weed count and weed dry matter were significantly lower in the case of diuron 3 kg and oxyfluorfen 0.2 and 0.3 kg / ha applied plots as compared to pendimethalin and all other treatments. Weed control efficiency was highest for diuron 3 kg / ha (99%). Oxyfluorfen 0.2 to 0.4 kg / ha gave up to 95% weed control efficiency. Diuron residues were detected in the fruits of

pineapple at the dose of 3kg/ha. Hence, oxyfluorfen 0.2kg/ha can be used as a viable and safe alternative for diuron for the control of weeds in pineapple fields up to 150 days. Result indicated that weeds suppressed growth of the pineapple plants and this resulted in 5 months delay in harvest of the unweeded plot as compared to the hand weeded and herbicide applied plots. Average fruit weight of the hand weeded and diuron 3 kg/ha plots were significantly superior to all other treatments and were on par and they were superior to the unweeded plot which yielded less than half kg (0.41 kg/ fruit).

W.S.3.8.10 Effect of different herbicide combinations on weeds and yield of maize

SVPUAT, Meerut

Major weeds of experimental field were *Trianthema portulacastrum, Digera arvensis, Commelina benghalensis, Echinochloa colona, Dactyloctenium aegyptium, Cyperus iria* and *Parthenium hysterophorus.* Among the herbicide treatments, lowest weed population and dry weight were recorded in atrazine + pendimethalin closely followed by treatment alachlor + metribuzin and metribuzin. Highest weed control efficiency (89.5%) was recorded in treatment atrazine + pendimethalin followed by alachlor + metribuzin. Yield attributes of maize i.e. cob length (19.7 cm), test weight (251.5 g) and no. of grains per cob (485) were recorded maximum in treatments two hand weedings. While in case of herbicidal treatments, the maximum test weight (239.1 g), No. of grains per cob (480) were recorded in treatment atrazine + pendimethalin followed by treatment alachlor + metribuzin. Highest grain yield (51.5 q/ha) of maize was recorded in two hand weedings followed by atrazine+ pendimethalin (48.3 q/ha) and alachlor + metribuzin (47.0 q/ha).

PDKV, Akola

Major weed flora in maize during *Kharif* was *Xanthium strumarium, Celosia argentea, Tridax procumbens, Phyllanthus niruri, Portulaca oleracea, Lagascea mollis, Euphorbia geniculata, Euphorbia hirta, Phyllanthus niruri, Abutilon indicum, etc.* At 15 DAS, treatment weed free-recorded significantly lower weed count and dry matter accumulation followed by atrazine 1.0 kg/ha PE and atrazine 0.50 kg + pendimethalin 0.50 Kg /ha PE. Highest weed control efficiency was recorded under application of atrazine 0.50 kg/ha *fb* 2,4-D sodium salt 0.5 kg PoE at 30 DAS. Lowest weed index was recorded in treatment atrazine 0.50 kg/ha *fb* 2, 4-D sodium salt 0.5 kg POE at 30 DAS. Maximum cob weight grain weight per cob at harvest was found in weed free which was at par with atrazine 0.50 kg /ha *fb* 2,4-D sodium salt 0.5 kg POE at 30 DAS and atrazine 1 kg/ha PE. Maximum grain yield was observed in weed free treatment (4.7 t/ha) while among herbicidal treatments, application of atrazine 0.50 kg/ha *fb* 2, 4-D sodium salt 0.5 kg PoE 30 DAS recorded higher grain yield (4.1 t/ha) which was closely followed by atrazine 0.50 kg + pendimethalin 0.50 kg/ha PE and atrazine 1 kg/ha PE.

BAU, Ranchi

The experimental field was infested with broadleaved weeds like *Alternanthera sessilis, Commelina benghalensis, Commelina nudiflora, Ageratum conyzoides, Phyllanthus niruri,* among grassy weeds *Echinochloa colona, Echinochloa crus-galli, Digitaria sanguinalis, Paspalum distichum, Dactyloctenium aegyptium* and among sedges *Cyperus rotundus, Cyperus iria* and *Fimbristylis miliacea.*

Pooled analysis of 2014 and 2015 revealed that application of atrazine + pendimethalin (0.5+0.5 kg/ha) PE recorded significantly reduced narrow, broadleaved weeds, sedges as well as total weed density at 30 and 60 DAS being similar to 2 hand weedings at 20 and 40 DAS under broadleaved weeds and sedges. Application of atrazine + pendimethalin (0.5+0.5kg/ha) PE recorded significantly higher gross return, net return and B:C ratio however, it was similar to 2 hand weedings at 20 and 40 DAS in case of gross return, having 54.5, 66.1 and 48.8% higher gross return, net return and B:C ratio as compared to weedy check. It may be concluded that for higher productivity, profitability and effective weed control in maize, atrazine + pendimethalin (0.5+0.5 kg/ha) as pre emergence can be applied.

WS 3.8.11 Effect of fertility levels and herbicides on weeds and yield of wheat

Meerut

Major weeds in experimental field were

Phalaris minor, Poa annua, Chenopodium album, Rumex maritimus, Melilotus indica, Coronopus didymus and *Fumaria parviflora*. Lowest weed density and dry weight were recorded in treatment sulfosulfuron + metsulsulfuron-methyl followed by clodinofop + 2,4-D. Significantly highest grain yield (42.55 q/ha) was obtained in treatment two hand weedings which was at par with treatment, sulfosulfuron + metsulfuron methyl (41.3 q/ha) and clodinofop + 2, 4-D (40.5 q/ha). The lowest grain yield was recorded in weedy check treatment. Lowest weed density and weed dry weight were recorded due to treatment 75% NPK followed by 125% NPK application and 125% NPK application gave significantly maximum grain yield (40.2 q/ha) as compared to other treatments, similar results were found in straw yield.

WS 3.8.14 Weed management in direct-seeded finger millet

UAS, Bengaluru

Major weed flora in the experimental plots was *Cyperus rotundus* (sedge), *Digitaria marginata, Echinochloa colona* (among grasses). Whereas among broadleaf weeds, major weeds were *Borreria articularis, Spilanthes acmella, Commelina benghalensis, Acanthospermum hispidum* and *Ageratum conyzoides*. Oxadiargyl *fb* bispyribac-sodium 25 g/ha(3DAS *fb* 25 DAS), oxyfluorfen *fb* bispyribac-sodium 25 g/ha (3DAS *fb* 25 DAS), pendimethalin *fb* bispyribac-sodium (3DAS *fb* 25 DAS) and isoproturon *fb* bispyribac-sodium 562 *fb* 25 g/ha (3 DAS *fb* 25 DAS) were better in controlling weeds at 60 DAS and gave higher grain yields which were on par with the hand weeding. Two hand weedings (20 and 45 DAS) recorded significantly higher grain yield (3.7 t/ha) and straw yield (5.6 t/ha) compared to all other treatments except oxadiargyl *fb* bispyribac-sodium 80 *fb* 25 g/ha – 3 DAS *fb* 25 DAS (3.3 t/ha, 5.2t/ha) which were on par with hand weeding treatment. Highest B:C ratio was observed in oxyfluorfen *fb* bispyribac- sodium 80 *fb* 25 g/ha – 3 DAS *fb* 25 DAS, butachlor *fb* bispyribac -sodium 750 *fb* 25 g/ha – 3 DAS *fb* 30 DAS and oxadiargyl 80 g/ha – 3 DAS (2.5 each) as compared to other treatments. Unweeded control recorded the least B: C ratio (1.5).

WS-3.8.16 Integrated weed management in soybean

PDKV, Akola

Major weed flora during *Kharif* season in soybean crop in the selected area composed of *Cynodon dactylon, Cyperus rotundus, Commelina benghalensis, Ischaemum pilosum, Digitaria sanguinalis, Dinebra retroflexa, Poa annua, Cyanotis axillaris* among monocot weeds and *Digera arvensis, Lagascea mollis, Euphorbia geniculata, Tridax procumbens, Parthenium hysterophorus* among dicot weeds.

Among herbicides, highest weed control efficiency was noticed at early growth period (20 DAS) in pendimethalin 1.0 kg /ha PE. At 40 DAS and at harvest maximum WCE was recorded in imazethapyr 0.100 kg /ha PoE + quizalofop-ethyl 0.05 kg /ha PoE 15 DAS (Tank mix). Highest grain yield was recorded (1.9 t/ha) in weed free treatment which was closely followed by imazethapyr 0.100 kg/ha PoE + quizalofop-ethyl 0.050 kg/ha PoE 15 DAS (Tank mix) (1.9 t/ha). However, highest benefit cost ratio (2.2) was also registered with imazethapyr 0.100 kg/ha PoE + quizalofop ethyl 0.050 kg/ha PoE at 15 DAS (Tank mix) and closely followed by weed free treatment (2.1).

WS 3.8.17 Effect of weed management on growth and seed yield of *Sesbania*

PJNCARI, Karaikal

Major grasses, sedge and broad leaved weed observed in the experimental field were *Dactyloctenium aegyptium*, *Cleome viscosa* and *Cyperus rotundus*, respectively. Hand weeding twice at 15 and 30 DAS significantly reduced weed density (163.3 no./m^2) and dry weight (23.1 g/m^2) and resulted in higher daincha seed yield (0.9 t/ha). It was on par with the application of pre-emergence application of pendimethalin 1.0 kg/ha. Unweeded control accounted for 69.5% yield loss of daincha seed at Karaikal, Puducherry UT. Economic analysis revealed that pre-emergence application of pendimethalin 1.0 kg/ha was better in terms of B:C ratio (2.1) closely followed by the hand weeding twice (2.0).

WS 3.8.18 Effect of allelopathic plant products on seed germination and seedling length of *Parthenium hysterophorus*

PJNCARI, Karaikal

Minimum reduction in germination percentage was observed with the 10% tamarind leaf leachates (50.5%) and maximum with eucalyptus leaf leachates (100%) in comparison to control (Table 3.8-18.1). Reduced germination using leaf extract of eucalyptus leachates might be attributed to the release of phenolic acids and volatile oils, which functioned as allelopathic agents (Table 3.8.18.1).

Table 3.8.18.1 Percentage reduction in *Parthenium* germination compared to control

Treatments	Reduction in germination (%)	Seedling length (cm)	Vigour index
Control (Distilled water)	-	1.5	49.0
Leucaena leaf leachate 10%	88.8	0.5	1.7
Leucaena leaf leachate 20%	95.8	0.3	0.6
Tamarindus leaf leachate 10%	50.5	0.7	12.0
Tamarindus leaf leachate 20%	85.2	0.4	2.0
Eucalyptus leaf leachate 10%	100.0	0.0	0.0
Eucalyptus leaf leachate 20%	100.0	0.0	0.0
Eucalyptus oil 0.5%	81.5	0.6	3.1
Eucalyptus oil 1.0%	95.9	0.1	0.4
LSD (P= 0.05)		0.33	4.91

Seedling growth and vigour index was significantly higher with distilled water control and was 1.5 cm and 48.4, respectively. However, vigour index of *Parthenium* seedling was significantly lesser with the leucaena and eucalyptus oil at both concentrations. Eucalyptus and leucaena was found to be promising in inhibiting germination and growth of *Parthenium* under controlled conditions.

UAS, Raichur

A laboratory experiment was conducted to know the allelopathic potential of fresh leaf leachates of *Eucalyptus, Tamarindus* and *Prosopis* at 10 and 20 % concentrations and eucalyptus oil at 0.5 and 1.0 % on seed germination and seedling length of *Parthenium hysterophorus.* Maximum reduction of germination percentage was noticed with 20% eucalyptus fresh leaf leachate (99.1%), 10% eucalyptus fresh leaf leachate (97.3%), 20% *Prosopis juliflora* leaf leachate (96.2%), 10% *Prosopis juliflora* leaf leachate (96.2%) and 1.0% eucalyptus oil (94.7%) as compared to control distilled water treatment (2.65%). Minimum reduction in germination percentage of *Parthenium hysterophorus* was recorded with 10% tamarind fresh leaf leachate (53.2%). It may be concluded from experiment that fresh leaf leachates of both eucalyptus and *Prosopis* were found promising in inhibiting the germination and seedling growth of *Parthenium hysterophorus* under laboratory conditions.

WS 4 Management of problematic / invasive / parasitic / aquatic weeds

WS 4.1a Management of *Orobanche* in mustard and solanaceous crops

WS 4.1.a Crop: Mustard

Cooperating centres : CCSHAU, RVSKVV

Bio-efficacy of neem cake, pendimethalin and post-emergence application of glyphosate at very low concentrations was evaluated at Hisar. Data on number of *Orobanche* panicle / m^2, per cent visual control of weed was collected after 60, 90 and 120 days of sowing.

Soil application of neem cake at sowing *fb* pendimethalin (PPI) at 0.75 kg / ha *fb* soil drenching of metalaxyl 0.2% at 25 DAS, neem cake *fb* metalaxyl 0.2% at 25 DAS did not prove useful in minimizing population of *Orobanche aegyptiaca* at 60, 90 and 120 DAS (Table 4.1a.1). Glyphosate application at 25 g / ha at 30 DAS and 50 g / ha at 55 DAS alone provided 81% control of *Orobanche* up to 120 days after sowing. Addition of 1% $(NH_4)_2SO_4$ during glyphosate spray at recommended as well as 125% of fertilizer dose (N and P) slightly improved *Orobanche* control but caused 5 % toxicity to mustard crop in terms of leaf chlorosis and necrosis which disappeared at 30 DAT without any yield penalty. Use of neem cake *fb* metalaxyl 0.2% at 25 DAS in combination with glyphosate 40 g / ha at 45 DAS provided 65% control of *Orobanche* up to 120 DAS. Maximum seed yield of mustard (1.9 t / ha) was observed with use of glyphosate 25 g / ha at 30 DAS and 50 g / ha at 55 DAS along with 1% $(NH_4)_2SO_4$ at 125% of R.F. which was at par with its use at recommended fertility as well as recommended practice of glyphosate. Presence of *Orobanche* throughout crop season caused 27.4% reduction in

Table 4.1a.1 Effect of treatment on various parameters of *Orobanche* and *mustard*

Treatment	*Orobanche* panicles /m²			Crop phytotoxicity (%)			*Orobanche* control (%)			Seed yield (t/ha)	B:C
	60 DAS	90 DAS	120 DAS	10 DAT	20 DAT	30 DAT	60 DAS	90 DAS	120 DAS		
Glyphosate at 25 and 50 g/ha at 30 DAS and 55 DAS (Recommended practice)	1.7(2)	2.6(5.7)	1.8(2.7)	0	0	0	70.1(88.3)	65.9(83.3)	64.2(81)	1.9	2.1
Recommended fertility (N and P)+ glyphosate with 1% solution of $(NH_4)_2SO_4$ at 25 and 50 g/ha at 30 DAS & 55 DAS	1(0)	1.6(1.7)	1.7(2)	5	5	0	85.7(98.3)	76.2(91.7)	76.2(91.7)	1.9	2.1
125% of recommended fertility (N and P)+ glyphosate with 1% solution of $(NH_4)_2SO_4$ at 25 and 50 g/ha at 30 DAS & 55 DAS	1(0)	1(0)	2.2(4)	5	5	0	81.4(96.7)	79.5(95)	71.6(90)	1.9	2.0
Neem cake 400 kg/ha at sowing *fb* soil drenching of metalaxyl MZ 0.2% at 25 DAS *fb* glyphosate at 40 g/ha at 45 DAS	2.7(6.3)	6.4(40.3)	6.1(36)	0	0	0	55.7(68.3)	63.5(80)	53.7(65)	1.6	1.5
Neem cake 400 kg/ha *fb* pendimethalin (PPI) at 0.75 kg/ha *fb* metalaxyl 0.2% at 25 DAS	4.1(15.7)	10.3(104.7)	10.6(112)	0	0	0	18.4(10)	14.8(6.7)	10.4(5)	1.4	1.2
Neem cake 400 kg/ha *fb* soil drenching of metalaxyl MZ at 0.2% at 25 DAS	4.6(20)	9.9(98)	9.1(82)	0	0	0	1(0)	16.6(8.3)	18 (10)	1.4	1.3
Weedy check	4.3(17.3)	11.5(132.3)	11.1(123)	0	0	0	1(0)	1(0)	1 (0)	1.4	1.2
LSD (P=0.05)	0.6	0.6	0.5	-	-		6.6	11.2	11.2	43	

*Figures in parameters are original values and data is subjected to square root transformation.

seed yield of mustard as compared to use of glyphosate 25 g/ha at 25 DAS and 50 g/ha at 55 DAS (RP). Maximum B:C ratio 2.1 was obtained with recommended practices of glyphosate applied twice.

At Gwalior, emergence of *Orobanche* panicles started at 60 DAS in all treatments except glyphosate 25 and 50 g/ha at 25-30 and 55-60 DAS with or without 1% ammonium sulphate. Neem cake at 400 kg/ha *fb* pendimethalin at 0.75 kg/ha PE *fb* metalaxyl MZ 0.2% at 25 DAS and neem cake at 400 kg/ha at sowing *fb* soil drenching of metalaxyl MZ 0.2% at 25 DAS were not effective in reducing population of *Orobanche* significantly. Slight yellowing of mustard leaves were observed after spraying of glyphosate 25 g/ha at 30 days after sowing which was recovered within one week (Table 4.1a.2). Highest significant yield of mustard with minimum population and dry weight of *Orobanche* was obtained under glyphosate 25 and 50 g/ha with 1% ammonium sulphate (125% recommended N and P) and glyphosate 25 and 50 g/ha at 30 and 60 DAS.

Another field experiment was conducted in *Rabi* 2014-15 at Gwalior in sandy clay loam soil with organic carbon 0.21% and 7.5 pH, low in available nitrogen and medium in phosphorus and potassium. Weed control treatments consisted of soil drenching of fungi *Fusarium abar* at 30 and 60 DAS, *Penicillin oxalicum* at 30 and 60 DAS, Borex 5 mmols solution at 30 and 60 DAS, thiourea 5 mmols solution at 30 and 60 DAS and weedy check. Emergence of *Orobanche* started at 90 DAS. There was no significant effect of fungi *Fusarium abar* and *Penicillin oxalicum* or Borex and thiourea on the population of *Orobanche* emerged although all the treated plots gave numerically lower population as compared to weedy check. Lowest and highest population of *Orobanche* was recorded in plot with application of thiourea 5 mm solution 30 and 60 DAS and weedy check, respectively. Highest significant yield of mustard was obtained by the application of thiourea 5 mmol solution at 30 and 60 DAS followed by *Fusarium abar* and *Penicillium oxalicum* drenching which were at par with each other (Table 4.1a.3).

Table 4.1a.2 Effect of different treatments on seed yield, stover yield and economics of mustard (2014-15)

Treatment	Seed yield (t/ha)	Stover yield (t/ha)	Net return (`/ha)	B:C ratio
Glyphosate 25 & 50 g / ha at 25-30 and 55-60 DAS	1.50.1	4.2	46,328	3.9
Glyphosate 25 & 50 g / ha with 1% $(NH_4)_2 SO_4$ at 25-30 and 55-60 DAS	1.5	4.5	47,351	3.9
Neem cake at 400 kg / ha at sowing *fb* soil drenching of metalaxyl MZ 0.2%at 25 DAS *fb* glyphosate at 40 g / ha at 45 DAS	1.4	3.7	36,205	2.6
Neem cake at 400 kg / ha at sowing *fb* pendimethalin at 0.75 kg / ha PE *fb* metalaxyl MZ 0.2% at 25 DAS	1.3	3.7	35,340	2.6
Neem cake at 400 kg / ha at sowing *fb* soil drenching of metalaxyl MZ 0.2% at 25 DAS	1.3	3.7	33,401	2.5
Weedy check	1.1	2.9	28,046	2.9
LSD (P= 0.05)	0.2	0.6	-	-

Table 4.1a.3 Effect of different weed management practices on population of *Orobanche* and yield of mustard (2014-15)

Treatment	No. of *Orobanche* panicles /m^2				Grain yield (kg/ha)	Straw yield (kg/ha)
	90 DAS	105 DAS	120 DAS	AH		
Fusarium abar 30 and 60 DAS	0.8(0.3)	1.1(1.4)	1.1(1.2)	1.5(2.3)	1.3	3.7
Penicillin 30 and 60 DAS	0.8(0.1)	0.9(0.9)	1.0(1.1)	1.3(2.0)	1.4	4.0
Borex 5 mmols solution 30 and 60 DAS	0.8(0.2)	0.8(0.8)	0.9(0.9)	1.2(1.6)	1.4	4.1
Thiourea 5 mmols solution 30 and 60 DAS	0.7(0.1)	0.8(0.7)	0.8(0.8)	1.2(1.5)	1.5	4.2
Weedy check	0.8(0.2)	1.2(1.5)	1.2(1.4)	1.6(2.6)	1.3	3.6
CD at 5%	N.S	N.S	N.S	N.S	0.11	NS
LSD (P= 0.05)	$\sqrt{x+0.5}$	$\sqrt{x}$	$\sqrt{x}$	$\sqrt{x}$	-	-

*Figures in the parameters are original values and data is subjected to square root transformation.

WS 4.1.a (ii) Crop: Tomato and brinjal

Cooperating centre: CCSHAU, PJTSAU

At Hissar, tomato hybrid *Himsona* was planted on January 15, 201. Broom rape panicles did not appear in any of the treatment up to 90 DAT. Application of neem cake at sowing in combination with pendimethalin or metribuzin followed by soil drenching of metalaxyl MZ 0.2 % at 20 DAT did not cause any inhibition in broom rape emergence (Table 4.1a.4). *Orobanche* appeared only in weedy check and neem cake treatments up to 120 DAP. Ethoxysulfuron and sulfosulfuron treated plots remained free from *Orobanche* to 120 DAP and gave 96.7 to 98.3% control of *Orobanche* up to harvest without any crop suppression. Only 1.7 spikes / m^2 of *Orobanche* were recorded with use of ethoxysulfuron 25 g / ha at 60 and 90 DAT. Maximum B:C ratio (7.75) was obtained with post-emergence use of sulfosulfuron at 60 and 90 DAT and minimum with use of neem cake at sowing *fb* soil drenching of metalaxyl at 20 DAT.

At Hyderabad, no phytotoxicity was observed on tomato with application of the above herbicides. *Orobanche* infestation was observed in all the treatments in the farmer's field but in pendimethalin treated plot of another farmer, infestation was observed only at 90 DAP. Per cent infestation varied from 0.3 to 2.8% but the intensity of infestation reduced with advancement of crop growth. Significantly more fruit yield (69 and 64 t / ha) was obtained either with application of neem cake at sowing *fb* pendimethalin as pre-emergence 3 DAP *fb* soil drenching of metalaxyl at 20 DAT and was on par with application of sulfosulfuron at 15 and 45 DAT (Table 4.1a.4).

Table 4.1a.4 Effect of different herbicide treatments on growth and fruit yield of tomato tomato (2014-15)

Treatment	Plant height (cm)	No of fruits per plant	Fruit weight per plant (kg)	Final fruit yield (t/ha)
Neem cake 200 kg / ha at sowing *fb* pendimethalin 1.0 kg / ha as pre -emergence 3 DAP *fb* soil drenching of metalaxyl MZ 0.2% at 20 DAT	64	66	2.8	69
Neem cake 200 kg / ha at sowing *fb* metribuzin 0.5 kg / ha pre-emergence, 3 DAP *fb* soil drenching of metalaxyl MZ 0.2% at 20 DAT	61	51	2.1	51
Neem cake 200 kg / ha at sowing *fb* soil drenching of metalaxyl MZ 0.2% at 20 DAT	58	41	1.2	30
Ethoxysulfuron 25 and 50 g / ha as PRE and at 45 DAT	60	41	1.5	38
Sulfosulfuron 25 and 50 g / ha at 15 and 45 DAT	65	86	2.6	64
Weedy check	63	34	0.8	21
LSD (P= 0.05)	NS	10.0	0.1	10

WS 4.1 Crop: Brinjal

Cooperative centre : OUAT

At OUAT, Bhubaneswar, a field trial as OFT on management of *Orobanche* in brinjal crop was initiated in *Orobanche* infested vegetable tract of Cuttack district (Talabasta village) during October, 2012 in farmers' field. The emergence of the shoot takes around 49 days and there were on an average 5.2 shoots per a single brinjal plant. The shoot of *Orobanche* goes up to a height of 14.3 cm. Application of neem cake 200 kg / ha at sowing *fb* pendimethalin 1.0 kg / ha as pre-emergence, 3 DAP *fb* soil drenching of metalaxyl at 20 DAT recorded highest *Orobanche* control efficiency (67.1%) at 30 DAP. Two hand weedings were observed best (64.3%) at harvest. Hand weeding twice recorded highest yield (34.7 t / ha) which was at par with neem cake at sowing *fb* pendimethalin 1.0 kg / ha as pre-emergence, 3 DAP *fb* soil drenching of metalaxyl MZ 0.2 % at 20DAT (34.3 t / ha). The lowest yield of 11.6 t / ha was obtained from the control plot.

WS 4.1.a Crop: Tobacco

Cooperating centres: TNAU, AAU and NDUAT and RAU

At AAU, visual phyto-toxicity of post-emergence application herbicides was observed on leaves of tobacco. Tobacco leaves was severely affected by the application of imazethapyr 30 g / ha at 40 DATP. Plants were stunted and affected leaves were not recovered from the effect. Number of *Orobanche* shoots emerged at 60, 90 DATP and harvest of tobacco were not influenced by the treatments. There was no positive effect of applied herbicides or combination of organic and fungicides on the emergence of *Orobanche*. *Orobanche* shoots were emerged after 70 DATP of tobacco crop. Plant height recorded at harvest was affected by different post emergence application of herbicides. Lowest plant height was recorded in imazethapyr 30 g / ha at 40 DATP. Yield of tobacco leaves was lowest in imazethapyr 30 g / ha at 40 DATP followed by application of glyphosate 0.2 g / L at 20 DATP of tobacco, indicated that these herbicides showed phytotoxic effect on tobacco leaves as tobacco crop is very sensitive (Table 4.1a.5).

Table 4.1a.5 Effect of weed management treatments on emergence of *Orobanche* shoots

Treatment	*Orobanche* shoots emerged (No./m^2)			Plant height at harvest (cm)	Yield (t/ha)
	60 DATP	90 DATP	Harvest		
Neem cake 200 kg / ha *fb* soil drenching of metalaxyl MZ 0.2 %	0	12.2	8.7	96.4	3505
Imazethapyr 30 g / ha	0	1.85	1.91	58.8	1328
Glyphosate 0.2 g / l	0	10.9	6.67	80.6	2832
Soil drenching of metalaxyl MZ 0.2 %	0	3.21	1.97	95.8	3358
Weedy check	0	1.54	1.72	96.2	3465

AT TNAU, experiment was taken up in the hot-spot areas in the farmer's field of Erumanaic-kenpalayam village of Coimbatore District, where tobacco is grown as the only commercial crop during *Rabi* season. At 45 DAT, lower *Orobanche* shoot density

was observed in application of neem cake at sowing *fb* soil drenching of metalaxyl at 20 DAP and drenching of metalaxyl at 20 DAP (Table 4.1a.6).

Table 4.1a.6 Effect of weed management treatments on emergence of *Orobanche* in tobacco

Treatments	No. of *Orobanche* shoots/ tobacco plant*				Tobacco leaf yield. g/plant
	45 DAT	60 DAT	90 DAT	Harvest	
Neem cake 200 kg / ha at sowing *fb* soil drenching of metalaxyl MZ 02.% at 20 DAP	5.8	8.8	11.7	19.2	2841
Imazethapyr 30 g / ha at 40 DAT	10.3	13.9	16.8	22.9	2327
Glyphosate 0.2 g / L at 20 DAT	10.0	13.4	17.2	23.5	1902
Drenching of metalaxyl MZ 0.2% at 20 DAT	6.8	10.1	14.1	21.6	2340
Weedy check	17.7	29.9	35.0	43.2	1146

Neem cake at sowing *fb* soil drenching of metalaxyl at 20 DAP recorded higher leaf yield per plant (2841 g / plant). Similarly, application of imazethapyr registered leaf yield of 2327 g / plant and it was followed by drenching of metalazyl at 20 DAT. Lower leaf yield of 1146 g / plant was recorded by weedy check. Neem cake at sowing *fb* soil drenching of metalaxyl at 20 DAP reduced *Orobanche* shoot density with better weed control and higher tobacco leaf yield.

At, Faizabad, emergence of *Orobanche* shoots as well as dry weight was affected adversely due to neem cake only up to 45 DAP stage. As the stage advanced, *Orobanche* shoots growth was not declined to the reasonable level while other treatments imazethapyr and glyphosate applied at 20 DAP substantially declined number of shoots and shoot dry weight at 90 DAP stage. Neem cake treatment was effective over imazethapyr and glyphosate. About 89.2% increase in tobacco leaf yield was recorded due to use of 200 kg / ha neem cake as compared to control consequently higher leaf yield per plant (262.5 g) was also achieved than other treatments. Use of neem cake treatment proved economically superior having the net profit of ` 3,44,660 / ha with BCR of ` 4.5 followed by imazethapyr, soil drenching of metalaxyl at 20 DAP and glyphosate at 20 DAP (Table 4.1a.7 and 4.1a.8).

Table 4.1a.7 Management of *Orobanche* in tobacco on farmers field (Average of 3 farmers) (2015)

Treatment	No. of *Orobanche* shoots/ plant		Dry weight of *Orobanche* (g/tobacco plant)		Control efficiency of *Orobanche* (%)	Tobacco leaf yield (g/plant)		Yield (t /ha)	Yield increase (%)
	45 DAP	90 DAP	45 DAP	90 DAP	45 DAP	90 DAP	120 DAP		
Neem cake 200 kg / ha (PPI) + soil drenching of metalaxyl MZ 0.2% at 20 DAP	6.5	16.5	24.5	65.7	25.2	59.5	262.5	2.36	89.2
Imazethapyr 30 g / ha at 40 DAP	6.5	17.5	26.4	90.5	18.7	44.3	237.0	2.24	79.4
Glyphosate 0.2 g / L at 20 DAP	7.4	8.5	25.4	95.5	21.8	41.19	192.0	1.92	55.4
Soil drenching of metalaxyl MZ 0.2% at 20 DAP	7.3	8.4	25.2	85.2	21.2	47.5	194.0	1.94	56.0
Weedy check	8.7	46.5	32.5	162.4	-	-	132.5	1.26	-

Table 4.1a.8 Economics of various *Orobanche* management treatments in tobacco (2015)

Treatment	Common Cost of cultivation (`/ha)	Addl. cost (`/ha)	Total cost of cultivation (`/ha)	Net return (`/ha)	B:C ratio
Neem cake 200 kg / ha (PPI) + soil drenching of metalaxyl MZ 0.2% at 20 DAP	72,500	4,100	7,660	3,44,660	4.5
Imazetha pyr 30 g / ha at 40 DAP	72,500	6,100	78,600	3,23,700	4.1
Glyphosate 0.2 g / L at 20 DAP	72,500	9,900	73,400	2,74,900	3.7
Soil drenching of metalaxyl MZ 0.2% at 20 DAP	72,500	7,600	73,260	2,76,300	3.7
Weedy check	72,500		72,50 0	1,51,790	2.0

No. of plants / ha: 10000, Sale rate of dry tobacco ` 180 / kg.

WS 4.1a.9 Management of *Orobanche* in tobacco

Treatment	Number of *Orobanche*/ tobacco plant			Tobacco yield (t/ha)
	60 DAP	90 DAP	Harvest	
Neem cake 200 kg/ha at sowing *fb* soil drenching of metalaxyl MZ 02.% at 20 DAP	4.5	7.5	11.7	2.45
Imazethapyr 30 g/ha at 40 DAP	11.5	14.2	16.5	1.71
Glyphosate 0.2 g/L at 20 DAP	9.9	12.8	15.2	1.92
Soil drenching of metalaxyl MZ 0.2% at 20 DAP	7.2	9.6	14.9	2.08
Weedy check	21.8	26.4	27.3	1.12
SEm±	0.23	0.62	0.72	0.05
LSD (P=0.05)	0.75	1.85	2.19	0.15

At Pusa, maximum yield was recorded in the treatment of neem cake

WS 4.1b Management of *Cuscuta*

4.1. (i) Crop: Niger

Cooperating centres: OUAT and BAU

At Bhubaneswar, *Cuscuta chinensis*, a dreaded parasitic weed, is a serious threat in Niger growing areas such as the hilly tracts of South Eastern Ghat, Eastern Ghat High Lands and Northern Plateau agro-climatic zones of the state. An experiment was undertaken at farmer's field as OFT in the district of Koraput. Stale seedbed *fb* pendimethalin 1.0 kg/ha – pre-emergence recorded lowest *Cuscuta* density of 3.2 / m^2 and 12.4/m^2 at 30 and 60 DAS followed by pendimethalin 1.0 kg/ha PE (4.3 and 13.1/m^2). Stale seed bed *fb* pendimethalin 1.0 kg/ha PE recorded highest grain yield followed by pendimethalin (Table 4.1b.1).

Table 4.1b.1 Effect of weed management on germination, density of *Cuscuta* and yield of niger

Treatment	Germination of *Cuscuta*		Density of *Cuscuta* (m^{-2})		Yield of niger (Kg/ha)	B:C ratio
	(DAS)	No/m^2	30 DAS	60 DAS		
Pendimethalin 1.0 kg/ha – pre-emergence	18.0	2.4	4.3	13.1	710.0	1.8
Stale seedbed *fb* pendimethalin 1.0 kg/ha – pre-emergence	12.0	2.0	3.2	12.4	792.5	1.7
Imazethapyr 75 g/ha as PPI	14.0	2.8	4.8	12.8	702.5	1.8

At Ranchi, a field experiment was conducted in the field of farmer Khurshid, village Jaher, Ranchi district. Application of imazethapyr 75 g/ha as PPI was not suitable for niger crop as it caused phytotoxicity during both the years under stale bed method followed by application of pendimethalin 1.0 kg/ha pre-emergence. Application of pendimethalin 1.0 kg/ha pre-emergence was found safe as it produced niger yield 423, 550 kg/ha and 350 and 430 kg/ha during 2013-14 and 2014-15 respectively owing to comparatively less phytotoxicity (Table 4.1b.2).

Table 4.1b.2 Effect of weed management practices on *Cuscuta* growth

Treatment	2013-14			2014-15		
	Germination of *cuscuta* (DAS)/ m^2	Yield of niger (kg/ha)	Phytotoxicity on niger*	Germination of *cuscuta* (DAS)/ m^2	Yield of niger (kg/ha)	Phytotoxicity on niger *
Pendimethalin 1.0 kg/ha	Not visible	350	2	Not visible	430	2-3
Stale seedbed *fb* pendimethalin 1.0 kg/ha	Not visible	423	3	Not visible	550	4-5
Imazethapyr 75 g/ha as PPI	Not visible	045	7	Not visible	135	7-8
Weedy check	25 to 30 days after sowing	332	0	40-50 DAS	230	6-7

*Phytotoxicity on the effect of herbicide on niger crop was in the scale of 1 to 10 scale

4.1b Crop: Lucerne

Cooperating centre: AAU (Anand)

Green and dry fodder biomass of lucerne at 45 and 60 DAS were influenced by different treatments and the highest green biomass of lucerne was recorded in the application of imazethapyr at 20 DAS followed by pre-emergence application of butachlor *fb* foliar spray of metalaxyl 20 DAS. Pendimethalin showed phytotoxic effect on lucern (Table 4.1b.3).

Table 4.1b.3 Green and dry biomass of lucern as influenced by different treatments

Treatment	Plant stand (No./m²)	Green biomass of lucerne fodder (kg/m²)		Dry biomass of lucerne fodder (kg/m²)	
		45 DAS	60 DAS	45 DAS	60 DAS
Butachlor *fb* foliar spray of metalaxyl 20 DAS	144	1.6	3.1	0.2	0.6
Imazethapyr 40 g / ha 20-25 DAS	134	1.7	3.3	0.3	0.6
Pendimethalin 0.5 kg / ha (as sand-mix) PE	23	1.0	2.2	0.1	0.4
Foliar spray metalaxyl at 20 DAS	129	1.4	2.6	0.2	0.5
Weedy check	136	1.3	2.1	0.2	0.4

4.1b.Crop: Barseem

Cooperating centre: Ludhiana

At PAU, Ludhiana, experiment was done on barseem. Imazethapyr at 75 g / ha, with or without stale bed, was phytotoxic to berseem and it significantly reduced germination and growth of berseem plants. It did not allow germination of *Cuscuta* plants till March. It reduced the berseem forage yield by 13-23%; Maximum yield reduction (23-36%) was observed in first two cuttings (Table 4.1b.4). The seed treatment and spray with metalaxyl show fair efficacy against *Cuscuta* and berseem yield were comparable to weedy check. Results indicated that pre-plant application of imazethapyr 75 g / ha was not safe for use in berseem.

Table 4.1b.4 Effect of different weed control treatments on weeds and berseem yield

Treatment	*Cuscuta* plants (No./m²)		Crop phytotoxicity (%)	Berseem forage yield (t/ha)
	30 DAS	60 DAS	30 DAS	
Imazethapyr 75 g / ha as PPI	0	0	70	68.7
Stale seedbed *fb* imazethapyr 75 g / ha as PPI	0	0	70	77.5
Seed treatment *fb* foliar spray with metalaxyl MZ 0.2% on 20DAS	0	0.10	0	89.2
Weedy check	0	0.15	0	86.0
LSD (P=0.05)	NS	NS	10	8.0

WS 4.1.c Management of *Cuscuta* in onion

Cooperating centre: UAS (B)

AT UAS, Bengaluru experiment was initiated in the farmer's field at Kurudihally, ChallakereTaluk

WS 4.1d Intensive survey on the incidence of *Orobanche/ Striga/Cuscuta/Loranthus*

Cooperative centres: All centres working on parasitic weeds

At AAU, survey was done at 101 places with the help of GPS for the incidence of parasitic weeds. Heavy infestation of *Orobanche* in tomato and brinjal in winter season at Anagara Block of Ranchi District crop was seen. In Haryana state, mustard crop was severely infested with *Orobanche aegyptiaca* locally known as margoja or rukhri which resulted in heavy yield reductions in mustard. Bhiwani, Hisar, Mahender Garh, Rewari and Sirsa were main mustard growing regions but infestation level varied from place to place and year to year. Infestation of *Orobanche* was classified as nil (0), less (between 1- 20 shoots / m^2), moderate (between 20-50 shoots / m^2) and severe (more than 50 shoots / m^2). Data collected during the survey was analysed using the desirable statistical tools and techniques (Z-test and one-way ANOVA) to generate fruitful inferences regarding *Orobanche* infestation in Indian mustard in Bhiwani and Hisar districts of Haryana.

In 2013-14, no infestation of *Orobanche* was observed in most of the area of Hisar district except some parts of Agroha, Hisar 1 and Hisar 2 blocks. Moderate or severe infestation of *Orobanche* was observed in parts of Hisar 1 and Hisar 2 blocks adjacent to Bhiwani district. Whereas, most of the Bhiwani district showed severe infestation of *Orobanche* except some parts of Bahal, Bawani khera, Bhiwani, Siwani and Tosham blocks. No infestation of

Orobanche was observed in some parts of the Bawani khera and Bhiwani block of Bhiwani district. Infestation of *Orobanche* was less in Hisar (9.1 / m^2) as compared to Bhiwani (37.7 / m^2). However, *Orobanche* population was 24.9 / m^2 and 21.9 / m^2, respectively in the years 2013-14 and 2014-15 (pooled mean of both districts) which did not differ significantly.

There was a decreasing trend of *Orobanche* population with the delay in date of sowing over both the years across the two districts. However, in Hisar, in both the years it was found that sowing of mustard after 15th October significantly reduced the population of *Orobanche* compared to sowing before 15th October There was no significant difference in *Orobanche* population if the sowing of mustard was done between 15 October to 31 October and after Novemeber, whereas in Bhiwani, in both the years, it was found that sowing of mustard after 31st October significantly reduced the population of *Orobanche* compared to sowing before 31st October. No significant difference in *Orobanche* population was observed when the sowing was done before 15th

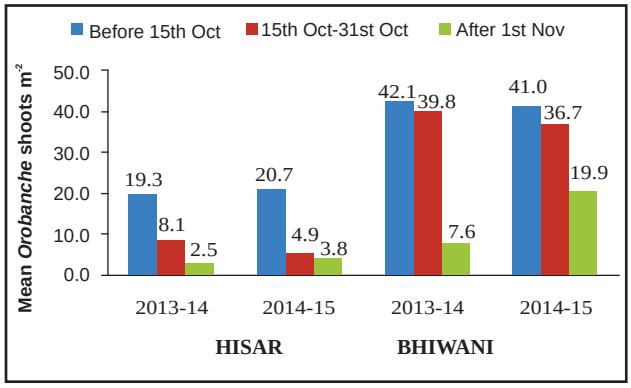


Figure 4.1c.1 Mean *Orobanche* shoots / m^2 in Indian mustard in Hisar and Bhiwani districts of Haryana as influenced by different dates of sowing

In Punjab, eighteen farmers' fields from different villages of districts Jalandhar, Kapurthala and Moga were surveyed. Sixty seven percent farmers reported *Cuscuta* infestation in berseem fields, and on mustard plants; however, degree of infestation varied between 5-15%. *Cuscuta* problem was more severe during first cut in October and or in March-April. *Cuscuta* appearing regularly in fields from last 3-4 years, and infestation is on the increase. The yield losses varied between 5 and 10% and farmers forced to harvest berseem crop before schedule and harvesting more difficult.

WS 4.1e Management of *Striga* in sugarcane

Cooperating centres: TNAU, and PJTSAU

Experiment was done in Zahirabad Mandal of Central Telangana Zone. Crop was abandoned by the farmer 90 DAS without prior information. However no *Striga* infestation was observed in the crop. TNAU, Coimbatore standardized the application of atrazine as pre-emergence 1.0 kg / ha 3 DAP+ HW on 45 DAP *fb* earthing-up on 60 DAP *fb* post-emergence spraying of 2, 4-D sodium salt at 5 g / L + urea 20 g / L on 90 DAP *fb* trash mulching 5 t / ha on 120 DAP and included in the package of practices of the state.

WS 4.1f Management of *Loranthus*

Cooperating centre: KAU, UAS (B) and SKAUT, Jammu

At Bengaluru, infestation of *Dendrophthoe falcata* was considerably reduced and about 55 and 90% control was achieved after 30 and 60 days by imposing cotton padding of 4 g copper sulphate + 0.5 g 2,4-D sodium salt followed by directed spray of glyphosate 71% WP 1% solution (35 and 55%). Cotton padding of 4 g copper sulphate + 0.5 g 2, 4-D sodium salt found safes to the sapota plant without any phytotoxicity symptoms and satisfactory control of the parasite (Table 4.1f.1).

Table 4.1f.1 Effect of different weed control treatments on *Loranthus*

Treatment	Parasite control (%)	
	06.09.2015	08.10.2015
Cotton padding of 4 g copper sulphate + 0.5 g 2,4 - D sodium salt	55	90
Directed spray of paraquat SL 5 ml / litre of water	60	20
Directed spray of glyphosate 1% solution	35	55
Directed spray of glyphosate 1 ml in 5 ml of water	32	50

In Jammu, three treatments, viz. cotton padding of 4 g copper sulphate + 0.5 g 2, 4-D sodium salt, directed spray of 0.5% paraquat and directed spray of 1% glyphosate were applied in each selected parasitic weed infested fruit tree. Impact assessment was done in respect of the treatments imposed on various tree species regarding which the assessment report is given as under in Table 4.1e.2.

Table 4.1f.2 Effect of different weed control treatments on *Loranthus*

Fruit tree	Treatments	Effect observed after one month of treatment (% foliage dried)
Walnut	Cotton padding of 4 g copper sulphate + 0.5 g 2, 4-D sodium salt	10-20
	Directed spray of 0.5% paraquat	80-90
	Directed spray of 1% glyphosate	80-90
Pomegranate	Cotton padding of 4 g copper sulphate + 0.5 g 2, 4-D sodium salt	60-70
	Directed spray of 0.5% paraquat	80-90
	Directed spray of 1% glyphosate	80-90
Timbru	Cotton padding of 4 g copper sulphate + 0.5 g 2, 4-D sodium salt	50-60
	Directed spray of 0.5% paraquat	80-90
	Directed spray of 1% glyphosate	80-90
Dhaman	Cotton padding of 4 g copper sulphate + 0.5 g 2, 4-D sodium salt	100
	Directed spray of 0.5% paraquat	100
	Directed spray of 1% glyphosate	100
Apricot	Cotton padding of 4 g copper sulphate + 0.5 g 2, 4-D sodium salt	100
	Directed spray of 0.5% para quat	80-90
	Directed spray of 1% glyphosate	80-90
Fig	Cotton padding of 4 g copper sulphate + 0.5 g 2, 4-D sodium salt	30-40
	Directed spray of 0.5% paraquat	80-90
	Directed spray of 1% gl yphosate	80-90
Citrus (Hill lemon)	Cotton padding of 4 g copper sulphate + 0.5 g 2, 4-D sodium salt	20-30
	Directed spray of 0.5% paraquat	60-70
	Directed spray of 1% glyphosate	50-60
Fig	Cotton padding of 4 g copper sulphate + 0.5 g 2, 4-D sodium salt	40-50
	Directed spray of 1% glyphosate	50-60
	Directed spray of 0.5% paraquat	

AT KAU, cotton padding of 4 g copper sulphate + 0.5 g 2, 4-D sodium salt did not lead to the complete drying of the plant. Only the twig which was tied with the chemical dried. Application of 1% glyphosate lead to the defoliation of a few leaves but visible symptoms of drying was not seen. Application of ethrel 25 ml/L showed complete defoliation and drying of the weed and regrowth was not observed even after 6-8 months of application

WS 4.1g Nutrient analysis of *Loranthus* species and its host

Cooperative center: KAU

Loranthus species infected host plants were collected from Wayanad district. In *Ficus* three parasitic species viz. *Macrosolen capitellatum*, *Viscum capitellatum* and *Dendrophthoe falcata* were found to infect different branches of the same host plant. In coffee, *Helixanthera* sp. and *Taxillus cuneatus* were found attached with the plant. Nutrient status of these parasites along with the host plants was analyzed. It was observed that all the parasitic species accumulated high amounts of K. In some cases, K content was higher than the host plant. There were also significant differences in the amount of Mg accumulated by the different parasitic species and their host. Heavy metals like iron, mercury, lead etc. were also seen in the parasitic species which might be the reason for their medicinal uses.

WS 4.2 Making of *Parthenium* free campus

It was decided that each centre should make efforts to make their campus *Parthenium* free and to put a board after achieving the target. Most of the centres except KAU did a few activities to contain the *Parthenium* in their vicinity like uprooting, spray of chemicals and to make people aware. But at most of the centres, more rigorous efforts are required to make the campus *Parthenium* free and to put the board. Good efforts were done by Pantnagar, Jammu, Hissar, Gwalior, Ranchi and Ludhiana centres where they were able to mobilize different departments of the university and involved people for uprooting of *Parthenium* from the campus. But so far non of the centers has claimed to put the board on the gate of the University.

WS 4.3 Biological control of water hyacinth by *Neochetina bruchi*

All the centres except Thrissur, Bengaluru and Pantnagar were assigned the programme of biological control of water hyacinth using *Neochtina* spp. The centres were asked to select the perennial ponds in their jurisdiction and to release the weevil *Neocthian* spp and take occasional sampling and observations. Biological control work was initiated by selecting ponds and releasing of bioagent by Anand, Ranchi, Hisar, Dapoli, Raipur, Bhubaneswar, Ludhiana, Hyderabad, Pusa and Coimbatore centres. None of the centres adhered with the technical programme. There were no reports from other centres. At Gwalior, 500 beetles in each pond were released. *Neochetina bruchi* weevils could not multiply at both the locations. At Coimbatore, 173 *Neochetina* weevils were released in 2015. The symptoms on water hyacinth plants were negligible (rating - 1) and feeding was very less.

At Anand, experiment was conducted by selecting one pond infested with water hyacinth at village Sadanapur, Taluka Anand. Total 500 adult of *Neochetina bruchi* were released on the water hyacinth infested pond. The data recorded at quarterly basis let showed that there was no buildup of the population of the weevil on the water hyacinth. No feeding scars were observed on the water hyacinth plant. No dieback symptoms were recorded on the water hyacinth plants by the weevil as well.

WS 5 Herbicide residues and environmental quality

WS 5.1 Herbicides residues in long-term herbicide trial

At Karnal, rice and wheat were grown in *Kharif* and *Rabi* season in 2013-14 at Karnal in long-term herbicide trial. Butachlor and clodinafop were applied as rotational herbicides at 1.5 kg / ha. *Sesbania* crop was grown after harvest of wheat crop before transplanting rice for incorporation as green manuring. Persistence of continuously used herbicides in rice-wheat system viz., butachlor (1.5 kg / ha) and anilophos (0.375 kg / ha) for 21 years, pretilachlor (0.75kg / ha) for 18 years to rice crop, pendimethalin (0.75 kg / ha) for 4 years and clodinafop-propargyl (0.06 kg / ha) for 13 years to wheat crop was studied. Soil (0-20 cm) and grain samples were collected at harvest for residue analysis. GC-MS / MS was used for the quantification of pretilachlor, butachlor, anilophos and clodinafop-propargyl while both HPLC and GC-MS / MS were used for the quantification of pendimethalin residues. Residues of pretilachlor, butachlor and anilophos in soil and rice grain at harvest were found below the maximum residue limits (MRL's) (Table 5.1.1).

Table 5.1.1 Residue of herbicides used in rice-wheat cropping system

Treatment dose (kg/ha)	Experimental year	Crop	Herbicide residue at harvest (µg/g)	
			Soil	Grain
Pretilachlor 0.75	18	Rice	0.007	0.006
Butachlor 1.5	21		0.003	<0.003
Anilophos 0.4	21		<0.003	<0.003
Pendimethalin 0.75	3	Wheat	<0.01	0.008
Clodinafop propargyl 0.060	13		<0.009	<0.009

Immediately after 5 hrs (0 day) of treatment, the average pendimethalin residues in the soil at 0-20 cm depth were 0.246 µg / g. The residues decreased successively as a function of time and more than 61% and 89% of the pendimethalin residues dissipated within 30 and 90 days of application, respectively. Residues declined below the detection limit (0.01 µg / g) in soil samples collected at harvest (Table 5.2).Disappearance of pendimethalin residues were according to equation: y= -0.0097x + 1.2957showing a half life of 31.30 days (Fig 5.1(b)).

Table 5.1.2 Residues of pendimethalin from wheat field soil at 0.75 kg / ha

Days after application	Residue (µg/g)	Dissipation (%)
0 (5 hrs)	0.246	0
3	0.168	31.7
15	0.130	47.2
30	0.095	61.4
60	0.051	79.3
90	0.027	89.0
120	0.014	94.3
Harvest	BDL	100

BDL (Below Detectable Limit) = 0.01µg / g

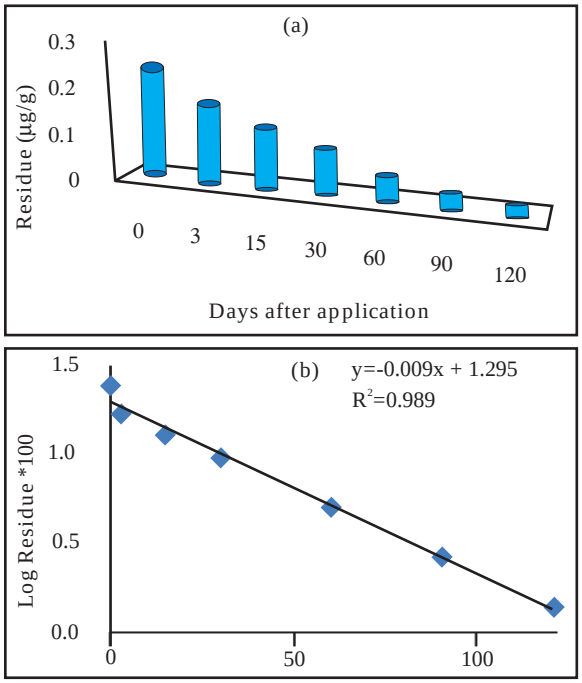


Figure 5.1.1 (a) Residues (b) Dissipation kinetics of pendimethalin in soil

Pendimethalin residue at harvest in soil and crop produce were below the limit of quantification < 0.01µg / g. Residues of pendimethalin in wheat grain were found 0.008 µg / g which were below the MRL's. Clodinafop-propargyl residues were below the detectable limit (0.003 µg / g) in soil, grain and straw at harvest.

At AAU, Jorhat herbicide residues were evaluated at the permanent site during *Kharif (Sali)* and *Rabi* seasons. Soil samples at depths, 0 – 15 cm and 15 – 30 cm were collected after harvest of rice (18 th crop) for analysis of macro and micro nutrients, bulk density, organic carbon, carbon stock and pH. Soil texture under rice – rice cropping system was sandy loam and CEC of soil was 6.18 mol(p^+) / kg. Available N , P_2O_5, and K_2O (kg / ha) increased significantly with butachlor and pretilachlor treatments and decreased with depth over surface soil which may be due to the less weed competition and higher root uptake. Similarly, available Zn, Cu, Mn, Fe and Ca increased significantly with butachlor and pretilachlor treated soil and higher concentration was associated with the surface soil . Bulk density was significantly lower in surface soil (0 – 15 cm) than the subsurface (15 – 30 cm) soil due to deposition of organic matter content on surface soil for rice crop grown years together which finally reflects on the carbon stock of soil.

Soil samples (0-15 cm) were collected at 0, 7, 14, 21, 30, 45 and 60 days after herbicide application to rice from for total count for azotobcter, azospirillum and pseudomonas. Collected soils were also analyzed for microbial biomass carbon (microgram g^1soil), dehydrogenase activity (microgramTP / gsoil / d), acid phosphatase activity (microgram pNP / gsoil / h).

Table 5.1.3 Soil available Organic C, bulk density and carbon stock after harvest of rice (18thcrop)

Treatment	Organic C (%)		Bulk density (g/cc)		Carbon stock (mg/ha)	
	0–15 cm	15–30 cm	0–15 cm	15–30 cm	0–15 cm	15–30 cm
Weedy	0.7c	0.5c	1.3a	1.6b	15.4c	18.3b
Mechanical weeding	1.0a	0.8a	1.3a	1.6b	20.4a	22.0a
Butachlor 1000 g / ha	0.9b	0.7b	1.3a	1.6a	19.5ab	17.9b
Pretilachlor 750 g / ha	0.8c	0.5c	1.4a	1.6a	18.0b	13.3c

Table 5.1.4 *Azotobacter* population at various days of herbicide application (in 10^6 cfu g / soil)

Treatment	0 D	7 D	14 D	21 D	30 D	45 D	60 D
Weedy	28.6a	25.6a	26.6a	27.3a	29.6a	28.0a	28.3a
Mechanical weeding	25.0a	25.0a	26.0a	24.6a	25.0b	23.0b	25.0b
Butachlor 1000 g / ha	13.0b	8.3b	6.6c	12.0c	17.0c	16.6c	18.0c
Pretilachlor 750 g / ha	15.0b	10.3b	11.0b	15.0b	16.0c	18.0c	19.0c

Table 5.1.5 *Azospirillum* population at various days after herbicide application (in 10^6 cfu g / soil)

Treatment	0 D	7 D	14 D	21 D	30 D	45 D	60 D
Weedy	33.0a	32.6a	32.6a	35.3a	34.0a	35.0a	33.3a
Mechanical weeding	29.0b	27.3b	30.0b	29.0b	28.0b	25.3b	26.0b
Butachlor 1000 g / ha	17.0d	12.6d	9.3d	11.0d	15.0d	17.3d	19.0c
Pretilachlor 750 g / ha	21.0c	16.6c	15.3c	18.0c	19.3c	21.0c	20.3c

Table 5.1.6 PSB population at various days after herbicide application (in 10^6 cfug / soil)

Treatment	0 D	7 D	14 D	21 D	30 D	45 D	60 D
Weedy	23.0a	23.3a	22.0a	23.6a	20.3a	21.6a	24.0a
Mechanical weeding	21.3a	21.0b	20.3a	23.0a	21.6a	24.3a	23.0a
Butachlor 1000 g / ha	10.0c	7.0d	7.3b	9.0b	13.0b	15.0b	17.6c
Pretilachlor 750 g / ha	13.0b	11.0c	8.3b	9.6b	13.3b	17.3b	20.0b

Table 5.1.7 Deydrogenase activity at various days after herbicide application (g TPFg / dry soil / 7days)

Treatment	0 D	7 D	14 D	21 D	30 D	45 D	60 D
Weedy	184.1c	197.5c	199.7c	200.2c	198.1c	195.9c	196.9c
Mechanical weeding	185.5d	188.1d	182.4d	188.5d	184.0d	183.6d	185.3d
Butachlor 1000 g / ha	207.1a	220.2a	237.3a	229.7a	226.2a	214.0a	215.8a
Pretilachlor 750 g / ha	191.5b	205.2b	217.6b	222.0b	219.4b	208.7b	211.6a

Microbial population was relatively higher in soil under application of herbicides i.e. butachlor 1.5 kg / ha or pretilachlor 0.75 kg / ha. Microbial biomass carbon, dehydrogenase activity and acid phosphatase activity were relatively higher in soil under application of i.e. butachlor 1.5 kg / ha or pretilachlor 0.75 kg / ha. Application of pretilachlor 0.75 kg / ha resulted relatively higher acid phosphatase activity and microbial biomass carbon over application of butachlor 1.5 kg / ha (Table 5.1.3 to 5.1.7)..

At CCSHAU, Hisar a long-term herbicide trial is under operation from 1999. In *Rabi*, clodinafop (60 g / ha) remained as permanent herbicide treatment where as sulfosulfuron was also applied as rotational herbicide at of 25 g / ha. Butachlor applied at 1.5 kg / ha remained as permanent herbicide treatment whereas pretilachlor was used as rotational herbicide at 1 kg / ha. *Sesbania* crop was grown after harvest of wheat crop and before sowing of paddy for incorporation as green manuring. Under green manuring and non-green manuring, residues of clodinafop were found to dissipate 100% after 30th day under non-green and green manuring. Half life of clodinafop was found 6.4 days under non-green manuring condition; whereas, under green manuring, it was 5.7 days. Residues of clodinafop were not detected in wheat grains and straw at harvest. Residues of sulfosulfuron dissipated slightly faster under green manuring than non-green manuring conditions. Half life of sulfosulfuron was 3.9 and 5.6 days under green manuring and non-green manuring conditions, respectively.

Average initial deposit of pretilachlor (in non-green manuring) applied at 1 kg / ha was found 0.99 µg / g. On 7th day, residues reached to 0.66 µg / g with dissipation of 33.3%. In green manuring, average initial deposits were 0.95 µg / g. Pretilachlor dissipated rapidly and about 88% of pretilachlor dissipated up to 15th days. Half life of pretilachlor in non-green manuring was found 8.8 days, whereas it was .8 days under green-manuring (Table 5.1.8).

Butachlor residues dissipated faster than non-green manuring conditions and dissipated to near 89 and 100 % on 30th and 45 days under green manuring. Under non-green manuring, 75% degradation of butachlor was observed up to 30th day.

Table 5.1.8 Pretilachlor residues in non green-manuring and green-manuring conditions

Days after treatment	Non-green manuring		Green manuring	
	Average residues (µg/g)* ±SD	Dissipation (%)	Average residues (µg/g)* ±SD	Dissipation (%)
0 (1h)	0.99±08	-	0.95±05	-
1	0.93±02	6.1	0.86±0.3	9.5
3	0.73±04	26.3	0.68±1.3	28.4
7	0.66±01	33.3	0.57±0.5	40
10	0.45±03	64.6	0.31±0.3	67.4
15	0.15±08	82.4	0.11±0.1	88.4
30	0.06±07	93.9	0.04±0.6	95.8
45	0.01±02	99.0	0.008±0.3	99.4
60	BDL	100	BDL	100
	Correlation coefficient r = -0.9831 Regression equation y = 2.903-0.0335 x $t_{1/2}$= 8.8 days		Correlation coefficient r = -0.9639 Regression equation y = 1.074 -0.0395 x $t_{1/2}$= 7.8 days	

Half life of butachlor was found 13.3 and 9.2 days, under non-green manuring and green manuring, respectively. There were no residues of butachlor and pretilachlor in paddy grains and straw at harvest.

At Hyderabad, a long-term field experiment is being conducted with *Kharif* rice and *Rabi* maize (zero tillage). Determination of initial representative composite soil samples before transplanting of rice and soil samples from different weed management treatments at the time of harvest revealed no significant changes in physico-chemical (pH, EC, OC) and fertility properties of the soil (Available N, P_2O_5 and K_2O) due to different herbicidal treatments. Grain and straw / plant samples of rice collected at harvest showed 0.346 and 0.351 mg / kg pretilachlor residues in soil at 1 DAA in two treatments. Pretilachlor residues persisted up to 30 DAA in the soil and reached below detectable level by 45 DAA. Residues of pretilachlor in soil, rice grains and straw collected at harvest were below detectable level. Residues of bispyribac-sodium in the soil, rice grains and straw collected at the time of harvest were below the detectable limit of 0.02 ppm. In no-till maize soils, atrazine residues in soil were detected up to 60 DAA when applied as pre-emergence herbicide in combination with the paraquat. In post-emergence application residues could be detected up to 45 DAA. Atrazine residues were not detected in the maize grains or plant samples collected at harvest. Oxyfluorfen residues in soil were detected up to 45 DAA under zero tillage conditions. However, oxyfluorfen residues were not detected (<0.05 mg / kg) in soil, plant and grain at the time of harvest.

At TNAU, post harvest soil samples were collected in *Rabi*. Soil samples were analyzed for the available nutrients (N, P, K), organic carbon pH and EC. In both the season, weed control treatments did not have significant effect on soil reaction, EC and other parameters. However, green manure application during *Rabi* reduced pH during both the seasons. Soil, plant and grain samples collected during *Rabi*, 2014 were analyzed for butachlor, 2, 4-D and pretilachlor residue. A progressive decline in butachlor residue content was observed with advancement of crop growth. Nearly 80% pretilachlor got degraded within 30 days and it was found below detectable level at harvest. Pretilachlor degradation rate was higher under 75% inorganic N source + 25% organic source treatment. Pretilachlor residue was not found in grains and straw of 26th crop under the treatment of alternate application of butachlor / pretilachlor. More than 90% butachlor degraded from the soil within 30 days in both the seasons. Continuous application of either butachlor + 2, 4-D or butachlor / pretilachlor + 2, 4-D herbicide mixtures did not show build up of butachlor residue in the post harvest soil of 30th crop.

In another experiment, nearly 80% of applied pyrazosulfuron-ethyl got degraded within 5 days of its application and it was found below detectable level at harvest. Grains and straw samples collected at the time of harvest were found to have below detectable level of pyrazosulfuron-ethyl residues. The rate of disappearance of pyrazosulfuron in soil followed first-order kinetics. Half-life of pyrazosulfuron calculated from the regression equation were ranged from 2.6 to 3 days and 0.6 to 0.7 days across different treatments in the soil and field water, respectively.

At Bengaluru, butachlor residues were found below the limit of quantification in soil, grains and straw samples at harvest (113 days after herbicide application). At KAU, Thrissur residues analysis in soil in the rice - rice system for 14 years (2001-2014) revealed that recommended levels of application of butachlor, pretilachlor and 2, 4-D in the rice field did not caused build up of any residues in the soil at the time of harvest. Their residues were below the detectable level in the grains and straw at harvest during the entire study period. Studies on the effect of herbicides on the population of bacteria and fungi showed that there was reduction in the population of soil microflora up to 30 days after spraying in all the herbicide applied plots. After 30 days, their populations increased and tend to reach the original level by the time of harvest. This indicated that long term application of herbicides at the recommended rates under arable conditions is not likely to cause serious threat to the rice ecosystem. Residues of oxyfluorfen and pendimethalin were below the detectable level in the ginger rhizome after the harvest of the crop. While using diuron, residues were detected in fruits at higher levels of application; therefore it is not advisable to recommend diuron at levels greater than 2.0 kg / ha. At Faizabad, butachlor residue in post harvested soil of rice under rice-wheat cropping system were determined by bioassay. Herbicide applied in rice under rice-wheat-summer green gram cropping system did not leave there toxic level of residue in soil of rice field.

WS 5.2 Studies on herbicide persistence in water

Ground water samples were collected from tube-wells at Ludhiana at Moga and Kapurthala districts where farmers had applied pretilachlor, butachlor and anilophos in rice and clodinafop-propargyl and pendimethalin in wheat in rice-wheat cropping system. Residues of pretilachlor, butachlor, anilophos, clodinafop-propargyl and pendimethalin in water samples were found below detectable limit (<0.01 µg / mL). In another study, residues of paraquat and 2, 4-D in aquatic environment were evaluated in concrete ponds with one meter deep standing water at Ludhiana. Water hyacinth (*Eichhornia crassipes*) was grown in a tank of 2.2 sq.m. Tanks were sprayed with gramoxone (0.25 and 0.5%), and dimethyl amine salt and ethyl ester formulations of 2, 4-D (0.25 and 0.5%). It was observed that pH of water in different treatments declined up to 13th day beyond which it increased (Table 5.2.1). The electrical conductance of water (EC) remained almost same throughout the experiment.

Table 5.2.1 Periodic pH of water samples collected at different intervals

Treatment (%)		Days after application							
		0	3	6	10	13	19	24	36
Paraquat	Gramoxone 0.25	7.5	7.2	7.1	7.0	6.9	7.2	7.5	-
	Gramoxone 0.5	7.1	6.9	6.8	6.1	6.0	6.6	7.1	7.2
2,4-D	Amine salt 0.25	6.4	6.3	6.2	6.2	6.2	7.1	7.2	-
	Ester 0.25	6.8	6.5	6.2	6.1	6.1	6.4	6.9	-
	Amine salt 0.5	6.9	6.7	6.5	6.4	6.4	6.9	7.0	7.1
	Ester 0.5	6.9	6.6	6.4	6.2	6.1	6.3	7.1	-

Table 5.2.2 Persistence of herbicides (µg / mL) in water at different intervals

Treatment (%)	Days after spray								
	0	3	6	10	13	19	24	36	45
Gramoxone 0.25	0.660	0.515	0.379	0.216	0.117	0.062	0.037	BDL	BDL
Gramoxone 0.50	0.959	0.914	0.669	0.570	0.452	0.280	0.108	0.035	BDL
Amine salt 0.25	0.769	0.433	0.201	0.146	0.100	0.069	0.039	BDL	BDL
Ethyl ester 0.25	0.666	0.330	0.169	0.115	0.069	0.036	BDL	BDL	BDL
Amine salt 0.50	1.002	0.640	0.330	0.161	0.115	0.097	0.069	0.025	BDL
Ethyl ester 0.50	0.925	0.537	0.268	0.144	0.095	0.060	0.034	BDL	BDL

BDL= 0.03 µg / mL

About 80% 2, 4-D and 40 to 67% paraquat dissipated within 10 days after application to water. 2,4 D dimethyl amine salt degraded to below the detectable limit (0.03 µg / mL) within 36 and 45 days at 0.25% and 0.50% applied doses. However, dissipation of 2,4-D ethyl ester was comparatively faster and residues were reached to below the detection limit (0.03 µg / mL) within 24 and 36 days at dose rate of 0.25% and 0.5%, respectively. Paraquat residues were found to degrade below the detectable limit within 36 and 45 days at 0.25% and 0.5% application rate, respectively.

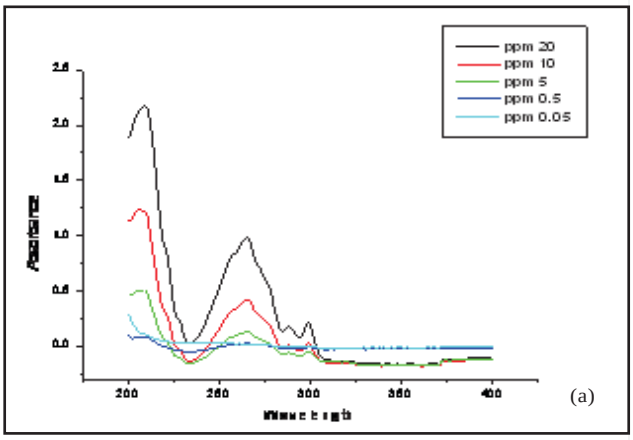
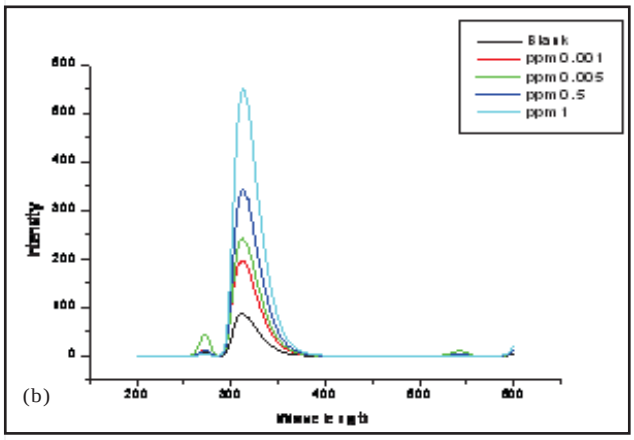


Figure 5.2.1 (a) UV-Visible



(b) Fluorescence spectra of glyphosate

At Jorhat experiment was conducted in *Rabi* and *Kharif* by collecting water samples during January / February 2015 and August and September 2015 from water bodies at different locations adjacent to fields where herbicides were applied in winter rice crop. Butachlor residue in water declined up to 4 days slowly after which faster decline took up to 12 days for recommended levels. Butachlor residues were detected up to 20 days of application. At , Hisar water samples from the tube-wells at farmers' fields were taken after 30-45 days of pretilachlor, butachlor, oxadiargyl, pendimethalin, metribuzin, sulfosulfuron and meso-iodosulfuron application. None out of 11 samples were having sulfosulfuron, meso+ iodosulfuron, pendimethalin and metribuzin residues in ground water samples collected in *Rabi* 2014-15. In *Kharif* 2015, ten samples out of 35 were having pretilachlor residues between 0.042 and 0.075 µg / ml. Residues of oxadiargyl and butachlor were not observed in any sample (Table 5.2.3).

Field experiment was conducted to evaluate glyphosate residues in water at Ludhiana Wali drain, adjoining Village Sakkanwali in district Muktsar at Ludhiana. Roundup was applied at 1, 1.5 and 2% for control of sarkanda. Water samples were collected 3 hrs after the application of herbicide. For the quantification of glyphosate residues from water samples, samples were derivatized with FMOC-Cl and analyzed by fluorescence spectrophotometer. Fluorescence spectrophotometer was found most sensitive for estimation of glyphosate. In fluorescence spectrophotometric samples were excited at 268 nm and the emission spectra was recorded (Fig 5.13b).

At Pantnagar, water samples at 0-5, 15-20 and 30-35 days after application of herbicides in nearby fields were collected to determine herbicide persistence in water and change in water quality. 2,4-D residues in water collected from different places and location in both *Rabi* and *Kharif* season were below detectable limits of 0.009 g / mL. Study under laboratory condition, did not show presence of herbicide residue (0.01 g / ml) after 30 days of application. 2,4-D persistence was less under field conditions. At Hyderabad, persistence and contamination of the aquatic bodies by rice herbicides (pretilachlor and oxadiargyl) was determined by collecting water samples from the aquatic bodies in rice growing areas under Nagarjuna Sagar Project Left canal command area. In 2015, water samples were collected at two occasions from the Karimnagar district. At the time of first and second sampling drawn from the irrigation tanks, open wells or bore wells were found below the detection limit irrespective of the source. pH of the water samples was neutral to moderately alkaline.

Table 5.2.3 Pretilachlor, butachlor and oxadiargyl residues status in ground water at farmer's field in rice belt of Haryana (*Kharif* 2015)

Particulars	Water depth (ft)	Herbicide	Residues (µg/ml)
Ravi, Village Batta (Kaithal)	30	Pretilachlor	BDL
Sandeep, Village Batta, behind peer majaar (Kaithal)	25	Pretilachlor	BDL
Teja Patwari, Village Sain Majra (Ambala)	25	Pretilachlor	0.044
Nanak Ram, Village Chamal Majra (Ambala)	30	Butachlor	BDL
Baljeet Singh, Village Mangat Majra (Ambala)	30	Butachlor	BDL
Ravi, Village Sherpur (Y. Nagar)	25	Pretilachlor	BDL
Ramesh, Village Khanwala near Ledi (Y. Nagar)	20	Pretilachlor	0.056
Rajender village Khanwala near Ledi (Y. Nagar)	20	Pretilachlor	0.071
Near Railway crossing on road from Lapra to Kalanour (Y. Nagar)	20	Pretilachlor	BDL
Khilaram Narwal, Village Kalanour (Y. Nagar)	15	Pretilachlor	0.066
Razzaq, Village Kalanour (Y. Nagar)	20	Butachlor	BDL
Ashok Dhika, on Yamuna river bank Village Gumthala (Y. Nagar)	20	Pretilachlor	0.054
Kulvinder Village Naharpur (Y. Nagar)	20	Pretilachlor	0.042
Suresh, Village Jathlana (Y. Nagar)	15	Pretilachlor	0.075
Harpal, Village Jathlana (Y. Nagar)	20	Pretilachlor	0.053
Jaswinder, Village Labkari, Gadi Birbal (Karnal)	15	Pretilachlor	0.060
Newal Singh, Village Ghir (Karnal)	30	Butachlor	BDL
Gurchant Singh, Village Nasirpur (Ambala)	20	Butachlor	BDL
Ramchander, Village Kharak Pandwa, Kalayat (Kaithal)	25	Pretilachlor	0.048
Dalbir, Village Dhakal (Jind)	20	Pretilachlor	BDL
Devilal, Near Railway crossing Narwana (Jind)	25	Pretilachlor	BDL

At Coimbatore, water samples were collected from the cropped field bore well, pond (tail end of the area where the drained water from the rice ecosystems) during 3, 7 and 30 days after herbicide applications. Change in physico- chemical parameters influenced by different herbicides was also determine. A laboratory experiment was conducted in concrete tubs of height 90 cm with an internal diameter of 78 cm. To each pot 20 kg of soil was added to create natural environment and to study the partitioning of herbicides to the soil sediments. Then water hyacinth (*Eichornia crassipes*) was introduced into the tubs at 10 plants / tub and the plants were allowed for complete establishment to cover the entire tubs. After one week, 2, 4-D dimethylamine was sprayed at recommended and double the recommended dose. The two sets of herbicides treatments were followed as main treatments - W_1- with *Eichornia crassipes*; W_2 – without *Eichornia crassipes* and sub treatments: T_1- 2,4-D – 1.0 kg/ha; T_2 – 2,4-D – 2.0 kg/ha; T_3 – control (no herbicide). Soil sediment and water samples were collected after spraying of herbicides at an interval of 0, 1, 3, 5, 10, 15, 20, 25 and 30 DAHA to study the residue of herbicides and the changes in pH, EC etc.

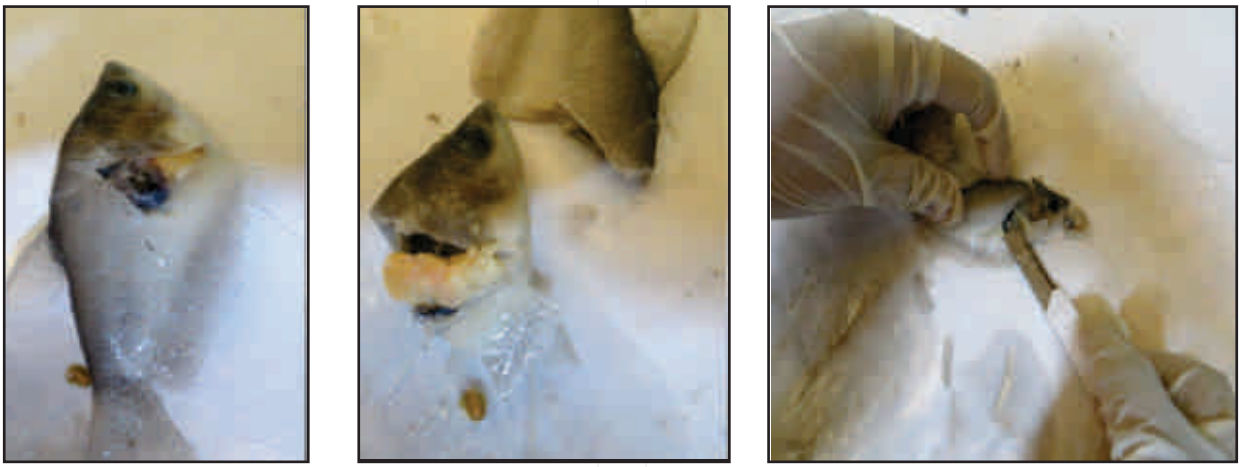
Under field conditions, water samples collected from garden land area did not contain residues of any herbicides in 1st week of June to December 2015 months. Under submerged ecosystem, residues of herbicides analyzed were below detectable limit irrespective of source of water except for 2, 4 D and pretilachlor in the field water. In laboratory conditions, dissipation of 2,4-D from 2,4-D dimethylamine was relatively rapid and followed similar trends at both the concentrations in both water and sediments. Presence of water hyacinth reduced the quantity of 2, 4-D that reached the water surface and also the soil sediment.

At Bengaluru, persistence of pyrazosulfuron-ethyl in water in transplanted rice was determined. Pyrazosulfuron-ethyl residues were found in the range of 0.0067 to 0.0022 mg/kg on 15th to 30th day.

However on 45th day it was below limit of quantification at recommended and double the recommended level of application. At KAU, persistence of glyphosate and POEA in aquatic system and their effect on fish were determined. *Hgrophila polysperma* bioassay was used to determine POEA in water. *H. polysperma* exposed to varying concentration of POEA (0.01, 0.02, 0.05, .075, 0.1, 0.5, 1.0, 2.0, 5.0, 10, 100, 1000µg / mL) and from dose response curve concentration of POEA was determined.Two sensitive parameters, *viz.* percentage of leaves fallen and the percent leaves discoloured were compared. Half life of POEA in water was between 30 and 60 days in the glyphosate treatment with *Salvinia.* In the case of POEA without *Salvinia* treatment, the corresponding values were between 60 and 90 days. It could be seen that POEA persisted for longer period than glyphosate.

Fish samples were taken from each treatment under the experiment on 'persistence of glyphosate and POEA in aquatic system and their effect on fish. Visual observations on the dissected organs showed that neither glyphosate nor POEA (surfactant) caused changes in fish organs. However, the formulation Roundup® caused discoloration in the internal organs namely gills, intestine, heart, liver, ovary (with eggs). At 5 DAS, reddish tinge was observed in ovary (with eggs) and gills of the fish samples taken from the Roundup® treatment with *Salvinia.* However, at 45 DAS, Roundup® with and without Salvinia did not show any difference from control except in the colour of gills (pale colour) which was common in all the chemical treatments.

Effect of Roundup at 5 days after application



Reddish tinge over gills and eyes

Control- Normal

WS 5.3 Testing of persistence of herbicides in the farmers' field (soil and crop produce)

Soil and crop samples were collected at harvest from farmer's fields from Ludhiana, Moga, and Kapurthala districts of Punjab in rice / wheat cropping system to determine extent of herbicides contamination in the soil and crop samples. Residue of butachlor, pretilachlor, anilophos, clodinafop-propargyl and pendimethalin were found below detectable limit (<0.01µg / g) in soil and crop produce. At, Jorhat, soil samples at 0-15 and 15-30 cm were collected during June / July 2015 from farmers' field growing winter rice after butachlor application. Butachlor residue at 1 kg / ha in soil, grains and straw after harvest of winter rice was found below detectable level (0.01 ppm). At , Hisar, soil, wheat and rice grains and straw samples were collectedf from the sites where farmers were continuously using pretilachlor and sulfosulfuron from many years. It was observed that 9 samples out of 20 locations were having sulfosulfuron and meso+iodosulfuron (RM) residues in soil which were ranget between 0.011 to 0.048 µg / g which was less than MRL of sulfosulfuron (0.05 µg / g) (Table 5.3.1).

Table 5.3.1 Residual of sulfosulfuron and meso+iodosulfuron (RM) in soil, wheat grain and straw at farmer's fields in Haryana (*Rabi* 2014-15)

Name & address of farmer	Herbicide/s sprayed	Dose (g/ha)	Residues (µg/g)		
			Soil	Grain	Straw
Virender, Village Danoda (Jind)	Leader (sulfosulfuron)	25	BDL	BDL	BDL
Raja, Village Samain (Tohana)	Leader (sulfosulfuron)	25	BDL	BDL	BDL
Dalbir Mann, Village Rasida (Jind)	Atlantis (meso+iodosulfuron RM)	14.4	0.03	BDL	BDL
Malkeet, Village Danoura (Ambala) (3)	Atlantis (meso+iodosulfuron RM)	14.4	0.026	BDL	BDL
Malkeet, Village Danoura (Ambala) (4)	Leader (sulfosulfuron)	25	0.018	BDL	BDL
Malkeet, Village Danou ra (Ambala) (5)	Atlantis (meso+iodosulfuron RM)	14.4	0.032	BDL	BDL
Karam Singh, Village Rampur, (Ambala)	Leader (sulfosulfuron)	25	0.021	BDL	BDL
Malkeet, Village Garhi Birbal (Karnal)(1)	Leader (sulfosulfuron)	25	BDL	BDL	BDL
Sajjan, Village Samain (Toh ana)	Leader (sulfosulfuron)	25	BDL	BDL	BDL
Tarsem, Village Nangla (Tohana)	Atlantis (meso+iodosulfuron RM)	14.4	0.033	BDL	BDL
Tarsem, Village Nangla (Tohana)	Leader (sulfosulfuron)	25	0.048	BDL	BDL

Nine out of 21 samples were having pretilachlor residues ranging between 0.004–0.024 µg/g in soil. Three out of 21 samples were having pretilachlor residues in rice grain ranging from 0.005 to 0.089 µg/g and 9 out of 21 samples were having pretilachlor residue between 0.014 to 0.089 µg/g in straw. Oxadiargyl residues were not observed in soil, grains and straw samples. At Pantnagar, soil and plant samples treated with 2,4-D at 0.50, clodinafop-propargyl at 0.06 kg/ha in wheat and butachlor 1.5, anilofos 0.75 kg/ha and 2,4-D at 0.50 kg/ha treated rice field were collected at harvest for its residue components. Residues of the herbicides were below MRL limits (0.01 µg/g) in all components at the time of harvest of wheat and rice.

At Hyderabad, oxyfluorfen treated soil and onion samples were collected from the farmers' fields. In all the soil samples collected at the time of harvest of the oxyfluorfen residues were below the detection limit. None of the onion bulb samples exhibited oxyfluorfen residues above the detection limit of 0.05 mg/kg. At Coimbatore, soil samples from the farmers fields of sattakkal pudur area was collected from four different locations during *Kharif 2015* cropped with brinjal and banana treated with metribuzin and pendimethalin. Soil samples were also collected at the time of harvest from the sugarcane and maize grown fields during 2015 from Thondamuthur block. Coimbatore district that received atrazine and metribuzin. Concentrations of the studied herbicide residues in soil and crop produce were below BDL. At Thrissur Soil samples were collected from the farmer's field at Chithali and Palakkad. Application of herbicides did not reduce enzyme activity in the soil. All the herbicide treated plots registered higher enzyme activity than in the hand weeding treatment. soil. Unweeded control treatment recorded higher enzyme activity than the other treatments.

Table 5.3.2 Biometric observations regarding visual phytotoxic effect on cucumber as influenced by herbicides applied in rice in the farmers field at different intervals (in days)

Treatments	0	10	30	45	60	At harvest
Control	0	0	0	0	0	0
Butachlor 1500 g /ha pre-emergence	+++	++	+	0	0	0
Anilofos 400 g /ha pre-emergence	+++	++	+	+	0	0
Pretilachlor 780 g /ha pre - emergence	+++	+++	++	+	0	0
Bispyribac-sodium 25 g /ha pre - emergence	+++	++	+	0	0	0

Visual phytotoxic rating
No toxicity = 0; Slight toxicity = +; Medium toxicity = ++; Severe toxicity = +++

At Faizabad, bioassay technique was used to determine adverse effect of herbicide on plants in soil samples taken at 0, 10, 30, 45, 60 days and at harvest. Visual phytotoxic effect on cucumber as influenced by herbicides applied in rice at different intervals was recorded (Table 5.3.2). Butachlor (1500 g/ha) and bispyribac-sodium (25 g/ha) at pre-emergence persisted up to 30 days in soil of rice while pretilachlor (780 g /ha) and anilofos (400 g /ha) at pre- emergence persisted up to 45 days in soil of rice.

WS 5.4 Studies on metabolites of herbicides

Maize crop was grown in *Kharif* season in 2015 at Karnal. Tembotrione was applied at 120 and 240 g/ha at 2-4 leaf stage of weeds. Residues of tembotrione metabolite (AE1417268) were determined in immature and mature maize grain, straw and soil collected at harvest. Limit of detection (LOD) and limit of quantification (LOQ) of tembotrione metabolite (AE1417268) was 0.003 and 0.005 ppm, respectively. Residues of tembotrione metabolite (AE1417268) were not detected in immature as well as mature maize grains, maize straw and soil samples taken at harvest. At, Coimbatore determination of atrazine & its metabolites viz., hydroxy atrazine, desethyl atrazine, desethyl deisorpopyl hydroxy atrazine (DEDIPHA) by HPLC was optimized. Soil samples collected from maize field which received atrazine 0.5 kg / ha were subjected to atrazine and its metabolites detection. It was found that no residues were detectetd in soil at harvest.

WS 5.5 Herbicide residues in conservation agriculture

At Ludhiana, persistence of pendimethalin and pinoxaden in soil (0-20 cm), rice grain and wheat samples at harvest under different tillage and residue management techniques was studied. Residue in soil and rice grains under different tillage and residue management techniques were found below detectable limits at the time of harvest. Pinoxaden residues ranged from 0.059 to 0.079 µg/g in the 0-20 cm soil depth 3 hr after the application and the concentration reduced to less than 0.01 µg/g in 30-45 days in all the treatments. Dissipation was comparatively faster under zero tillage treatment CT (T)-ZT-ZT, ZT (DS)-ZT+R-ZT and ZT (DS) +R-ZT+R-ZT. DT_{50} ranged from 10.1 to 17.5 days in different treatments under recommended herbicide (W1) whereas, under integrated weed management, DT_{50} was comparatively lower and ranged from 8.8 to 11.8 days under different treatments (Table 5.5.1).

Table 5.5.1 R^2, k, and DT_{50} of pinoxaden in soil under different planting pattern

Treatment		W1			W2		
		R^2	K (/days)	DT 50 (days)	R^2	K(/days)	DT 50 (days)
T1	CT(T) -CT	0.961	0.039	17.5	0.962	0.059	11.8
T2	CT(DS) -CT-ZT	0.973	0.041	17.0	0.997	0.063	11.1
T3	CT(T) -ZT-ZT	0.997	0.053	13.1	0.978	0.076	9.1
T4	ZT(DS) -ZT+R -ZT	0.993	0.054	12.7	0.992	0.078	9.0
T5	ZT(DS)+R -ZT+R -ZT	0.997	0.068	10.1	0.998	0.079	8.8

At Hisar, sampling of soil, grain and straw was done at harvest for analysis of pendimethalin. Pendimethalin residues (0.066 µg/g) in rice grains were observed in ZTDSR+(R)-ZTW+(R). In all other treatments, residues of pendimethalin were not detected in rice grains. In straw samples, pendimethalin residues varied from 0.007 to 0.059 µg/g in three DSR treatments. Pendimethalin residues (0.059 µg/g) in CTDSR-ZTW+(R) were above than MRL value of 0.05 µg/g. In soil, residues of pendimethalin were found to range from 0.040 to 0.070 µg/g in DSR treatments only. Residues of pretilachlor, bispyribac-sodium and pyrazosulfuron were not detected in any of the soil, grain and straw samples.

Table 5.5.2 Pendimethalin residues (µg/g) in rice grains, straw and soil in conservation agriculture under rice-wheat cropping system

Treatment	Pendimethalin residues* (µg/g)		
	Soil	Paddy grains	Straw
ZTDSR+(R) -ZTW+(R)	0.070	0.066	0.032
ZTDSR-CTW	0.040	BDL	0.007
CTDSR-ZTW+(R)	0.045	BDL	0.059
CTR (PTR) -ZTW	BDL	BDL	BDL
CTR (PTR)-CTW	BDL	BDL	BDL

*Average of three replicates

AT Pantnagar, residue of clodinafop-propargyl, metsulfuron-methyl in wheat and bispyribac -sodium in rice were found below MRL (0.1 g/g) in both tillage and residue management techniques. At Hyderabad, significant changes in physico-chemical (pH, EC, OC) and fertility properties of the soil (Available N, P_2O_5 and K_2O) due to different treatments after harvest of the rice crop in different methods of establishment were not found. Pretilachlor residues persisted in the soil up to 30 DAA in the puddled rice soils where rice was established through transplanting and pretilachlor was applied at 600 g/ha dose. Pretilachlor residues in soil, rice grain and straw at harvest were below detectable level (BDL). In transplanted rice soils bispyribac- sodium persisted up to 8 days and reached to below the detection limit by 15 DAA. Residues of bispyribac-sodium in the soil samples, rice grain and rice straw samples collected at the time of harvest were below the detectable limit of 0.010 ppm in aerobic and transplanted rice treatments. Lower concentration of pendimethalin was observed in aerobic rice soils covered with residue of *Daincha* compared to the tilled soils. In all the treatments residues persisted up to 30 DAA. Initial concentration of atrazine in soil applied to maize as pre-emergence herbicide varied from 0.348 to 0.411 mg/kg. Atrazine and pendimethalin residues were below detection limit of 0.05 mg/kg in rice grain, plant and soil at the time of harvest.

AT Gwalior, persistence of herbicides in soil at 0, 15, 30, 45, and 60 days applied to pearlmillet under pearlmillet-mustard and pearlmillet-mustard-green gram cropping system in conservation agriculture system was evaluated by cucumber and barley bioassays. A significant reduction in plant height and fresh weight of test plants was recorded up to 60 days after application of herbicides while dry weight was reduced up to 45 days only. Dry weight of cucumber plant was significantly reduced up to 30 and 45 DAS by isoproturon and pendimethalin respectively. No significant reduction in growth of cucumber and barley was recorded in soil after harvest of mustard and pearlmillet. Atrazine 750 g/ha PE + 2, 4-D 500 g/ha PoE and atrazine 750 g/ha PE + 1HW at 25 DAS applied to pearlmillet persisted in soil for 45 days. Different tillage practices in pearlmiillet-mustard-green gram cropping system did not affect the persistence of herbicides applied to pearlmillet. At TNAU, butachlor and pretilachlor residues were below detectable level (BDL, 0.005 ppm) in the post harvest soil, rice straw and grain irrespective of method of planting and type of tillage. During *Kharif* atrazine residues from different plots were below 0.01 mg/kg and no residues were detected in the control also.

WS 5.6 Herbicide residues in crops and cropping systems

At Ludhiana, dissipation behaviour of pendimethalin in soil at 0-20cm depth applied at 1.0 and 2.0 kg/ha in rice fields under direct seeded and flooded transplanted conditions in loamy sand soil was determine. Pendimethalin residues declined to 79.1-86.3% and 80.4-84.2% within the span of 6 and 10 days under TPR and DSR soil, respectively. However, with passage of time, residues decreased slowly in DSR and TPR soil. Soil samples collected 90 day showed residues of 0.010 and 0.017 µg/g at 1.0 and 2.0 kg/ha, respectively under DSR, however, the residues were found to be below detectable limit (BDL <0.003 µg/g) under TPR in both the treatments. DT_{50} value was in the range of 2.2 to 2.8 days for the initial phase and 23.5 to 24.7 days for the final phase in under TPR soil. However, under non flooded aerobic conditions, dissipation was comparatively slow and DT_{50} values for the initial and final phase were in the range of 3.7 to 4.3 and 34.2 to 34.9 days in DSR soil, respectively. Dissipation was comparatively rapid under flooded TPR than DSR soil conditions. Residues of pendimethalin in post harvest soil samples were below detectable limit (<0.003 µg/g) at both application rates in DSR and TPR; however, in grain samples, 0.005 and 0.007 µg/g residues were detected in DSR and 0.003 and 0.005 µg/g in TPR at 1.0 and 2.0 kg/ha, respectively. Residues in straw samples

ranged from 0.003-0.006 µg / g in DSR and TPR, in both the treatments (Table 5.6.1).

At Hyderabad, persistence of pendimethalin, oxyfluorfen, alachlor, oxadiargyl and metribuzin residues in soil and beetroot was determined. Dissipation of the all the herbicides was biphasic with first 50 % of the initial detected amount dissipated more rapidly than the remaining soil residue. Oxyfluorfen was more persistent compared to the other two other herbicides and the residues of atrazine persisted for shortest period. Residues of metribuzin and pendimethalin persisted up to 60 DAA. Oxyfluorfen residues could be detected in the soil up to 90 DAA. Alachlor and oxadiargyl residues were detected up to 30 DAA. At Coimbatore, persistence and residues of imazethapyr and pendimethalin in soil of blackgram were determined. Soil samples were collected from the black gram field from 0 days after the application of above herbicides onwards and analyzed for the residues of imazethapyr. Residue of imazethapyr in soil on 1st day varied from 0.047 to 0.20 mg / kg. On day 15, imazethapyr residues become BDL (0.01 mg / kg) irrespective of the doses, sources and time of application. Pendimethalin residue ranged from 0.048 to 0.78 mg / kg across different treatments. At harvest, pendimethalin residues were detected (BDL-0.001 ppm) irrespective of the dose (Table 5.6.1).

Table 5.6.1. Persistence of pendimethalin in soil treated with pendimethalin and its combination

Days after herbicide application	Pendimethalin residue in soil (mg/kg)		
	Pendimethalin	Imazethapyr + pendimethalin	Control
0	0.0777	0.0475	BDL
1	0.0206	0.0318	BDL
3	0.0045	0.0041	BDL
7	0.0062	0.0061	BDL
15	0.0057	0.0071	BDL
30	0.0082	0.0087	BDL
45	0.0040	0.0031	BDL
60	0.0022	0.0028	BDL
Harvest	0.0054	0.0021	BDL

At Hisar, experiment was conducted to determine dissipation of imazethapyr and imazethapyr+imazamox (RM, Odessey) in soil under field conditions at two application rates i.e. 70 and 140 g / ha (POE) of imazethapyr and pre-mix formulation of imazethapyr and imazamox. Half life of imazethapyr was observed 10.6 to 12.5 days with 81.5% dissipation of residues in 60 days at dose of 70g / ha. Residues on 90th day were below detectable limit of 0.003 ppm. Residues of imazethapyr and imazamox was not detected any sample of in green-grams.

Ws 6.0 Transfer of technology

WS 6.1 On-farm trials

At Hissar, OFTs conducted at 6 locations revealed that new herbicide tembotrione at 100 g / ha as post-emergence was very effective to control weeds (85-92%), viz. *Cyperus rotundus, Sorghum helepense, Cynodon dactylon, Brachiaria reptans, Commelina* sp., *Digitaria sanguanalis* and *Elusine indica* in maize crop. These weeds were not controlled by the existing farmer's practice of atrazine application. New chemical proved very effective for control of diverse weed flora without any phytotoxic effect on the maize crop. B:C ratio with use of tembotrione varied 2.3-2.8 against 1.9-2.2 in farmer's practice. In another OFT, bio-efficacy of ready mix combination of clodinafop + metribuzin was tested against complex weed flora in wheat at 10 locations and compared with earlier recommended herbicide i.e. clodinafop + metsulfuron. On an average, clodinafop + metribuzin had an edge over farmer's practice as it provided more than 85% control of *P. minor* as against 65% by use of clodinafop + metsulfuron. New molecule showed good efficacy against grassy and broadleaf weeds but with toxicity to some of varieties viz: 'PBW 550', 'HD 2967' and 'HD 2891' under high moisture conditions at some location and regeneration of *P. Minor* in some cases.

At Ludhiana, four on-farm trials were conducted in transplanted rice with pre-mix herbicide metsulfuron+ chlorimuron (Almix) 20 g / ha at 25 days after transplanting, which gave effective control of broadleaved and sedges weeds, and recorded similar rice grain yield and economic return compared to already recommended herbicide ethoxysulfuron in all locations. Similarly, four on-farm trials for the control of *Phalaris minor* in wheat with Pendin 30 EC (newformulation of pendimethalin) as pre-emergence were conducted which gave effective control of *P. minor* in wheat and significantly

increased wheat grain yield and economic returns compared to unsprayed control.

At Pantnagar, OFTs on rice and soybean were conducted at three locations of the Districts, US Nagar (Tarai area), and Nainital (Bhabar area) during *Kharif*, 2015. In Tarai region of Uttarakhand, application of bispyribac-Na at 25 g/ha and pretilachlor 750 g/ha was found more effective against weeds in rice compared to farmers practice (butachlor 1000 g/ha) and it recorded an highest (41.9%) increase in grains yield due to application of bispyribac-Na followed by pretilachlor (35.5%) and farmers practices (32.2%). Among the different weed control treatments, highest grain yield (4.4 t/ha), gross return (` 62,040 /ha), net return (` 30,165/ha) and B:C ratio (1.9) was recorded with bispyribac-Na followed by pretilachlor (4.2 t/ha), gross return (` 59,220/ha), net return (` 28,020/ha) and B:C ratio (1.8) followed by farmer's practice. Similarly, in soybean, imazethapyr 0.1 kg/ha at 15 DAS and alachlor 2.5 kg/ha (PE) were used for evaluation. The highest grain yield was obtained with early post-emergence application of imazethapyr (1.7 t/ha) followed by pre-emergence application of alachlor (1.6 t/ha) and farmer practice (1.5 t/ha). During *Rabi* four OFTs were conducted in the Districts, US Nagar and Nainital. In Tarai and Bhabar regions of Uttarakhand, application of ready mix of clodinafop-propargyl + metsulfuron-methyl (60+4 g) /ha) in wheat crop was found more effective against weeds at farmer's field as compared to application of Sulfosulfuron+ metsulfuron-methyl (30+2 g/ha).

At Thrissur, OFTs conducted at one location. *Sphenocea zeylanica, Marsilea quadrifolia, Monochoria vaginalis, Ludwigia parviflora* and *Cyperus iria* were the major weeds in the locality which contributed to considerable yield loss in rice. Clincher followed by 2, 4-D was found to be more effective than Nominee gold and resulted in higher grain yields and economic benefits. At Anand, OFTs conducted at two locations showed that IC +HW carried out at 20 and 40 DAS was more effective for weed management in soybean as compared to post-emergence application of quizalofop-ethyl 50 g/ha *fb* HW at 30 DAS. At Gwalior, 10 OFTs using sulfosulfuron 25 g/ha were conducted at Gwalior, Morena and Datia districts in wheat which gave 21.0% higher yield (4.05 t/ha) as compared to farmer practices (3.34 t/ha).

At Dapoli, 4 OFTs were conducted at Lanja tehsil of Ratanagiri district in rice. Tested weed management technology oxadiargyl PE gave overall good result in term of yield and net returns with higher B:C ratio compared to other treatment and farmer's practice of weed management. In *Kharif* groundnut, 4 OFTs were also conducted at same locations. Application of pendimethalin at 1.0 kg/ha PE recorded higher yield with net profit of ` 55,000/ha. At Faizabad, 3 OFTs were conducted in wheat. Application of clodinafop + metsulfuron-methyl (60 g+4 g/ha) as PO or clodinafop 60 g/ha as PO *fb* one hand weeding at 45 DAS in wheat showed higher grain yield and economic benefits, whereas in rice, application of pretilachlor 1000 g/ha as PE *fb* one hand weeding recorded higher grain yield (5.5 t/ha) with net profit of ` 48,048/ha.

At Pusa, 10 OFTs were conducted using the chemical weed management technologies for rice crop (5 OFT) in *Kharif* and wheat (5 OFT) in *Rabi* at different farmers' field. Pendimethalin at 1000 g/ha at 0-2 DAS followed by bispyribac-sodium 25 g / ha at 25 DAS in rice, pinoxaden 50 g + carfentrazone 20 g/ha at 28 DAS in wheat were found superior in term of grain yield and B:C ratio over farmers practices. At Coimbatore, 3 OFTs were carried out in transplanted rice during 2015. Application of pretilachlor 750 g/ha at 3 DAT *fb* chlorimuron + metsulfuron (Almix) 4 g/ha at 25 DAT was very effective to farmers practice in terms of broad spectrum weed control, seed yield (2.4-3.6 t/ha) and net returns (` 49,958-46,467 /ha). Similarly 3 OFT were conducted for weed control in wet seeded rice at Thondamuthur block using pendimethalin 1.0 kg/ha PE *fb* bispyribac-sodium 25 g /ha at 25 DAS *fb* HW on 45 DAS showed higher grain yield (3.1-3.3). Gross and net returns were also higher in these treatments.

At Jorhat, 3 OFTs were carried out in brinjal under rice-fallow sequence using oxadiargyl 90 g/ha followed by garden hoeing at 30, 50, 80 DAP at Khanamukh Gharphalia Gaon, Khanamukh, Jorhat during 2015. Fruit yield in all the three farmers' field was higher (9.7%) due to the improved technology as compared to their own practice. Accordingly mean benefit: cost ratio of three farmers also increased in the improved technology. Similarly, three OFTs in chilli after harvest of transplanted winter rice were conducted in same location. Fruit yield from the improved technology i.e. metribuzin 500 g/ha + garden hoe 30, 60 DAP was higher over farmers' practice, resulting higher benefit: cost ratio.

At Raipur, six OFTs were carried out at village Sisdevari, district Balodabazar in direct line seeded rice (seed rate 60 kg/ha) with application of pyrazosulfuron 20 g/ha as PE followed by POE application of bispyribac 20 g/ha + metsulfuron 4 g/ha. There was 24.8% increase in grain yield due to recommended practice over farmers practice along with a B: C ratio of 2.8 and 2.4, respectively. At Jammu, two OFTs were carried out using stale seed bed with glyphosate 1.5 kg/ha, paraquat 0.8 kg/ha and quizalofop-ethyl 0.16 kg/ha in transplanted basmati rice for the management of weedy rice at village Rattan and Makhanpur Gujran of RS Pura block of Jammu region during *Kharif* 2015. Application of stale seed-bed with glyphosate was found to be significantly superior to all other treatments in terms of grain yield (2.9 t/ha), net returns (` 59947/ha) and B:C ratio (1.90) of transplanted rice.

WS 6.2 Frontline demonstrations

At Ranchi, 19 FLDs were conducted on direct seeded rice in Arko semar villages of Bero block of Ranchi district using pretilachlor 1.0 kg/ha (PE). Demonstrated technology performed better than farmers practice (one hand weeding at 25 days after sowing) and recorded higher net return and B: C ratio (` 8, 000 and 1.46). Similarly, 41 demonstration were conducted for weed management in maize using atrazine 1.0 kg/ha. Application of atrazine as PE gave higher net return and B: C ratio (` 13,000 and 1.9). At Anand, two FLDs on weed management in *Kharif* maize were conducted at farmers' fields in Amalimenpur, village of Dahod district. Higher grain yield (2.8 t/ha) and B:C ratio (1.9) was recorded with improved weed management technology over farmers practice.

At Raipur, FLDs were conducted on weed management in rice in 9 tribal villages of Kanker, Balrampur and Sarguja Districts. Forty demonstrations in transplanted rice and 90 in direct seeded rice were conducted during *Kharif* with the help of KVK's of respective district. Overall average benefit cost ratio of recommended weed management practices was recorded as 26.1 and 58% in transplanted rice and direct seeded line shown rice respectively, and these values were higher than farmer's practices.

At Jammu, three sites in three districts were identified under the FLD on *Lantana* management in collaboration with forest, rural development and sheep husbandry departments viz., Simbalehar (Distt. Jammu; Block Nagrota), Tahlem (Distt. Reasi; Block Painthal) and Hardomoh (Distt. Kathua; Block Rajbagh), where a 2-year long pilot project for the herbicidal eradication of *Lantana* was finalized. Regular meetings and deliberations with Chief Conservator Forest, Director Rural Development and Director Sheep husbandry have been done for allocation of manpower so that interventions are started in either in Feburary, or May-June, 2016

At Hisar, results of 119 FLDs conducted on 436 acres in different blocks of Bhiwani, Hisar and Mahender Garh districts revealed that post-emergence application of glyphosate 25 g/ha at 25-30 DAS followed by its repeated application at 50-55 DAS provided effective control (83%) of *Orobanche aegyptiaca* in mustard with yield increase of 13.5%. Similarly, ready-mix combination of pretilachlor + pyrazosulfuron was demonstrated against complex weed flora in transplanted rice at 15 locations in various parts of Haryana and compared with existing herbicide pretilachlor. Results showed 92.6% control of complex weed flora with pretilachlor+ pyrazosulfuron against 85% with pretilachlor and also yield increase of 353 kg/ha.

At Pantnagar, 13 FLDs using herbicides for managing weeds in rice (4), soybean (3) and wheat (6) were conducted at farmers' field in different locations of Bhabar area and Tarai area. In rice, bispyribac-sodium 20 g/ha at 25 DAT gave broad spectrum weed control and increased mean net returns with higher B: C ratio over farmers practice. In soybean, application of imazethapyr 0.1 kg/ha as post-emergence produced 12.5% higher grain yield as compared to farmer's practice. Similarly in wheat ready-mix application of clodinafop-propargyl + metsulfuron at 64 g/ha at 30 DAS effectively controlled broadleaved weeds in all locations and increased grain yield, net returns and B: C ratio. In some location reduction in grain yield was recorded 20-23% in farmers' practice due to uncontrolled weeds because farmers are generally used weeds as fodder for their livestock.

At Dapoli, during *Kharif* 2014, 8 FLDs were conducted on weed management technology in rice and groundnut at different location application of oxadiargyl 0.1 kg/ha as PE in rice and pendimethalin

(PE) in groundnut was compared with farmers practice. On an average, improved weed management practices gave higher seed yield, economic benefit with high B: C ratio in both the crops.

At Ludhiana, fifty four demonstrations on weed control in direct seeded basmati rice with pendimethalin at 750 g/ha as pre-emergence *fb* bispyribac-sodium at 25 g/ha and metsulfuron + chlorimuron 20 g/ha or fenoxaprop-p-ethyl with safener 67.5 g/ha as post-emergence and one spot weeding were conducted in nine districts of Punjab. All demonstrations showed effective control of mixed weed flora. Direct seeded rice recorded similar grain yield but higher net returns and B: C ratio than farmers practice (puddle transplanted rice). In *Rabi*, nine demonstrations on weed management in wheat using zero tillage sowing with residues + herbicides were conducted in four districts. All demonstrations recorded effective weed control and higher grain yield and net returns than farmers practice i.e. conventional tillage sowing + herbicides.

At Hyderabad, 14 FLDs were conducted in Kummera village of Chevella Mandal of Ranga Reddy district and Balapur village of Saroornagar mandal of Reddy district for rice. Integrated weed management involving pre-emergence application of bensulfuron-methyl + pretilachlor *fb* one hand weeding at 35-40 DAT or oxadiargil 80 g/ha *fb* hand weeding at 40 DAT resulted in higher B:C ratio (1.6-2.6) compared to farmers practice (1.4-1.8) of hand weeding twice at 25 and 50 DAT, indicated the superiority of the demonstrated technology. At Faizabad, 10 FLDs were conducted during *Rabi* 2014-15 in wheat with improved weed management technologies using 0.4 ha land for each FLD in Ambedkar Nagar district. Compared to the farmer's practices, yield increase ranged from 13.7 to 35.1% (average 21.4%). Results further revealed that herbicidal weed control methods increased additional net return in the tune of `. 10,703/ha.

At Pusa, 10 farmers were selected from Darbhanga, Madhubani, Samastipur, Muzaffarpur, Rohtas and Vaishali districts of Bihar for FLDs during *Kharif* 2015 to demonstrate performance of pendimethalin at 1000 g/ha at 0-2 DAS, followed by bispyribac-sodium 25 g/ ha at 25 DAS. Total area for this demonstration was 4 ha. Highest grain yield of rice (4.3 t/ha) was recorded with the demonstrated weed management technology which was 26% higher than farmers practice. Similarly FLDs were conducted in 10 farmers' fields using pinoxaden 50 g + carfentrazone 20 g/ha at 28 DAS for managing weeds in wheat in Madhubani, Samastipur, Muzaffarpur, Sitamarhi and Nawada districts. Compared to the farmers practice, wheat yield was 32.9% higher with the application of pinoxaden + carfentrazone (4.5 t/ha).

At Coimbatore, 5 FLDs were carried out in tomato crop at Chokkanur village, Kinathukadavu block of Coimbatore. Due to adoption of improved weed management technology (pendimethalin 1000 g/ha as PE + hand weeding on 30 DAS), tomato yields increased by 25.7-33.9% over farmers' practice (two hand weedings). Highest income was also obtained in improved practice over farmers practice. Majority of the farmers (70%) were fully satisfied with the performance of improved technology.

Table 6.1 Extension activities undertaken by coordinating centres

Centre	Trainings imparted	Radio talks	TV programmes	Kisan melas/ Kisan Day	Handouts/ folders/pamphlets	Bulletins/ booklet	Training participated	On-farm trials	Frontline demonstrations
PAU, Ludhiana	-	1	1	-	-	2	1	8	54
UAS, Bengaluru	5	-	-	-	-	-	-	170	-
RVSKVV, Gwalior	-	-	-	-	-	05	01	10	75
GBPUAT, Pantnagar	1	3	-	2	-	1	-	10	13
CSKHPKV, Palampur	-		-	-	-	-		-	-
AAU, Jorhat	5	8	-	-	-	-	3	6	-
AAU, Anand	4	1	2	3	-	1	-	2	2
TNAU, Coimbatore	-	-	-	-	-	-	2	6	5
NDUAT, Faizabad	1	5	-	-	-	2	-	6	10
BAU, Ranchi	-	3	-	-	-	-	-	2	104
KAU, Thrissur	-	-	-	-	-	-	4	-	-
OUAT, Bhubaneswar	2	-	-	1	-	-	-	7	2
PJTSAU, Hyderabad	-	-	5	-	-	2	-	-	-
CCSHAU, Hisar	57	4	-	8	-	-	-	16	134
RAU, Pusa	-	1	5	2	-	-	1	-	20
DBSKKV, Dapoli	-	-	-	-	-	-	-	4	12
IGKVV, Raipur	-	6	8	-	-	-	-	6	110
PDKV, Akola	-	2	4	1	-	9	1	-	-
CAU, Pasighat	-	-	-	-	4	-	-	-	-
UAS, Raichur	11	-	-	-	-	-	-	-	-
SKUAST, Jammu	-	-	-	-	-	1	1	2	-
MPUAT, Udaipur	1	-	-	-	-	-	3	-	6

4. RECOMMENDATIONS FOR PACKAGE OF PRACTICES

AAU, Anand

- Mulching of paddy straw 5 t/ha with pre-emergence herbicide is recommended for higher garlic bulb yield.
- Pre-emergence application of pendimethalin *fb* hand weeding at 20 and 50 DAS, or post-emergence application of pyrithiobac-sodium + quizalofop-p-ethyl (62.5 + 50 g/ha)*fb* directed spray of glyphosate (2000 g/ha) at 60 DAS is recommended for weed maangement in cotton.
- Tank-mix of pendimethalin (0.25 kg/ha) with atrazine (0.50 kg/ha) or atrazine alone 1.00 kg/ha as pre-emergence was equally effective to IC *fb* HW carried out at 20 and 40 DAS in maize. In succeeding wheat crop, pre-emergence application of pendimethalin 0.50 kg/ha or post-emergence application of metsulfuron 4.0 g/ha or hand weeding at 30 DAS were found effective.

AAU, Jorhat

- Application of pretilachlor 0.75 kg/ha followed by grubber at 35 DAS is recommended for weed management in direct-seeded upland rice.
- Application of oxyfluorfen 150 g/ha pre-emergence followed by hand weeding 20 DAS is recommended for weed management in lentil.
- Application of pendimethalin 1.5 kg/ha as pre-emergence followed by garden hoeing 35 DAP is recommended for weed management in brinjal after rice.

BAU, Ranchi

- Application of atrazine 0.75 kg/ha + straw mulch + hand weeding at 75 DAP was effective to get higher turmeric yield (29.0 t/ha).
- Application of glyphosate + oxyfluorfen 0.80 kg/ha + 1.5 kg/ha just before emergence of sprouts of ginger was found effective for maximum ginger yield (31.0 t/ha).
- Application of imazethapyr + imazamox (RM) 80 g/ha POE was effective to reducing grassy and broad leaved weed density at 30 DAS in blackgram.

CCSHAU, Hisar

- Application of pendimethalin 1.5 kg/ha just after sowing in a spray volume of 500 litres of water/ha followed by recommended post-emergence herbicides, clodinafop 60 g/ha, pinoxaden 50 g/ha, sulfosulfuron 25 g/ha, sulfosulfuron+ metsulfuron (RM) 32 g/ha, or mesosulfuron+ iodosulfuron (RM) 14.4 g/ha at 35 days after sowing was found effective to manage resistant populations of *P. minor* in wheat. There should be sufficient moisture on the top soil layer at the time of application of pendimethalin.
- Apply ready mixture of pretilachlor + pyrazosulfuron-ethyl at 10.0 kg/ha as uniform broadcast in standing water at 0-5 days after transplanting for control of complex weed flora in puddle transplanted rice.
- Spray halosulfuron 67.5 g/ha at 35-45 DAP or 3-6 leaf stage for control of *Cyperus rotundus* in sugarcane.

IGKV, Raipur

- Oxadiargyl 80 g /ha *fb* post-emergence bispyribac 25 g/ha is recommended in direct-seeded rice.

PAU, Ludhiana

- Lucky seed drill with automatic spraying attachment for simultaneous sowing of wheat and spray of pre-emergence herbicides has been included in the package of practices of PAU.
- Uniform spreading of paddy straw mulch at 10 t/ha immediately after planting of turmeric followed by one hand/spot weeding three months after planting, if needed, provides effective control of weeds.
- Sulfosulfuron 24.4 g/ha as early post-emergence (14-21 days after sowing), before first irrigation, provides effective control of *P. minor*.
- Post-emergence application (30-35 days after sowing of wheat) of pinoxaden 50 g and sulfosulfuron 25 g/ha is effective for control of grasses; metsulfuron 5 g/ha and carfentrazone-ethyl 20 g /ha for broadleaved; and pre-mix of sulfosulfuron + metsulfuron 30 g/ha and of

mesosulfuron + iodosulfuron 14.4 g/ha for mixed weed flora.

- Fenoxaprop 67 g/ha at 20 days after sowing/transplanting is effective for control of grassy weeds like *Dactyloctenium aegyptium, Leptochloa chinensis, Eragrostis* sp. and *Ischaemum rugosum* in transplanted and direct-seeded rice.

PJTSAU, Hyderabad

- In rice-zero tillage maize cropping system, PE application of pretilachlor 750 g/ha at 3-5 DAT followed by hand weeding at 25-30 DAT for *Kharif* rice and in sequence PE application of atrazine 1000 g/ha + paraquat 600 g/ha for *Rabi* maize is recommended for economically remunerative.
- Pre-emergence application of pendimethalin *fb* 2 HW at 20 and 50 DAS or pre-emergence application of pendimethalin *fb* combined application of pyrithiobac-sodium 62.5 g/ha + quizalofop- p- ethyl 50 g/ha can be adopted when the cotton crop is grown at a spacing of 60 x 30 cm.
- Pre-emergence application of alachlor 1000 g/ha *fb* hand weeding at 30 DAS or pre-emergence application of oxadiargyl 75 g/ha *fb* hand weeding at 30 DAS are the remunerative and effective weed management practices in beetroot.

RVSKVV, Gwalior

- Application of pinoxaden 40 g/ha (25 DAS) followed by carfentrazone 25 g/ha as post-emergence (one week after pinoxaden spray) or sulfosulfuron 25 g/ha, 2,4-D 0.5 kg/ha + isoproturon 1.0 kg/ha as PoE is recommended for controlling grassy and broad leaved weeds, higher yield and net returns from wheat.
- In mustard, fluchloralin 1.0 kg/ha as PPI or oxadiargyl 90 g/ha or isoproturon 0.75 kg/ha as PE application controlled majority of weeds under blackgram mustard cropping system.
- For obtaining higher bulb yield of onion and net returns 3 hand weedings at 30, 45 and 60 DAT (weed free) or pre-emergence application of oxyfluorfen 250 g/ha + 1 HW at 40 DAT or oxadiargyl at 900 g/ha with 1 hand weeding at 45 DAT transplanting is recommended.
- Alachlor 2.0 kg/ha as PE or imazethapyr 100 g/ha as PoE or imazethapyr + imazamox (pre-mix) 50 g/ha as PoE pendimethalin + imazethapyr (pre mix) 1000 g/ha PE can be applied for controlling of weeds in blackgram and obtained higher yield.

SKUAST, Jammu

- Tank-mix application of clodinafop + metribuzin 60+210 g/ha or sulfosulfuron + metsulfuron 30+2 g/ha or pinoxaden + metribuzin 40+210 g/ha is recommended for broad-spectrum weed management in wheat.

TNAU, Coimbatore

- For higher grain yield of rice, sowing after onset of monsoon with POE application of chlorimuron + metsulfuron (almix) 4 g/ha is recommended.
- Pre-emergence application of oxyfluorfen 250 g/ha followed by POE- imazethapyr 100 g/ha + quizalofop-ethyl 50 g/ha on 15 DAS is effective for broad-spectrum weed control and higher seed yield and economic returns in groundnut.
- Post-emergence application of glufosinate ammonium at 1000 g/ha is recommended for higher weed control efficiency in tea.
- Plant whole application of neem cake at 200 kg/ha on 30 DAT or DCA of imazethapyr 3 g/ha on 55 DAT is recommended for weed control in tobacco.

UAS, Bengaluru

- 2, 4-D sodium salt 940 g/ha at 15-20 DAP (2–4 leaf stage of weeds) as post-emergence is recommended in transplanted finger millet.
- 2, 4-D sodium salt 625 g/ha at 30 DAS (2–4 leaf stage of weeds) as post-emergence herbicide is recommended in maize.
- Oxadiagryl 300 g/ha or pendimethalin within 3 days of sowing as pre-emergence is recommended in sunflower.

GBPUAT, Pantnagar

- In maize, application of atrazine 2.5 kg/ha or alachlor 2 kg/ha as pre–emergence is recommended for control of *Echinochloa colona, Dactyloctenium aegyptium, Cynodon dactylon, Ageratum conyzoides, Commelina benghalensis, Celosia argentia, Galinsoga parviflora, Oxalis latifolia, Trianthema portulacastrum.*
- In sorghum, atrazine 1.0 kg/ha as pre-emergence found effective in controlling grasses (*Eleusine*

indica, Cynodon dactylon, Digitaria sanguinalis and broad leave weeds (*Celosia argentia, Trianthema portulacastrum).*

- After emergence of sugarcane, irrigate at 40-45 days stage and do hoeing to destroy emerged weeds followed by spray of atrazine at 2.0 kg / ha or metribuzin at 1.0 kg / ha before emergence of weeds. Irrigate field as and when required to maintain proper soil moisture. 2, 4-D at 500 g / ha may be sprayed to control *Ipomoea* spp. In ratoon crop, do mulching with the available trash in field after harvest of main crop.
- In potato, do mulching with available materials immediately after potato planting. In case of non-availability of mulching material, spray paraquat at 500 g / ha when weeds have emerged but potato emergence is not more than 5%. It should be followed by earthing-up at appropriate stage. Pendimethalin at 1.0 kg / ha or metribuzin at 350 g / ha may be applied as pre-emergence followed by manual weeding and earthing-up at appropriate stage.

NDUAT, Faizabad

- In direct-seeded rice (aerobic rice), pendimethalin at 3.3 lit / ha applied at pre-emergence (0-2 DAS) is effective to control annual grasses and broadleaved weeds. Sufficient moisture is required in the upper soil layer to make herbicide effective. In the later stage, 2, 4-D at 500 g / ha is recommended to control annual broadleaf weeds.
- For control of *Saccharum spontaneum*, deep plough the field in summer or just before rainy season. Collect rhizomes and destroyed them. After 35-40 days, application of glyphosate is recommended to spray on fast growing plants (6-8 leaf stage) by using flat fan nozzle.

OUAT, Bhubaneswar

- In groundnut, pre-emergency application of oxyfluorfen 0.02 kg / ha in 500 liter of water at 1-2 days after sowing is recommended to control grassy weeds along with the problematic weed like *Celosia argentea*. Application of quizalofop-ethyl 0.05 kg / ha in 500 liters of water at 20-25 DAS effectively controls most of the grassy weeds.
- In rice-groundnut cropping system, apply butachlor 0.75 kg / ha + 2, 4 D 0.4 kg / ha (4 DAS) in *Kharif* and alachlor 1.0 kg / ha (2DAS) + hoeing at 35 DAS in *Rabi* groundnut for control of annual weeds.

KAU, Thrissur

- In transplanted rice, application of chlorimuron-ethyl + metsulfuron-methyl 0.004 kg / ha after 2-25 DAS / DAT with 0.2% surfactant is recommended for control of broadleaved weeds and sedges including *Marselia quadrifolia* and *Sphenoclea* sp.
- For weedy rice management, drain the field to retain only a thin film of water. Apply oxyfluorfen 0.2 kg / ha either by spraying or sprinkling with a rose can or broadcasting after mixing with sand. Allow the water in the field to evaporate. After three to four days, when the standing water has evaporated, broadcast pre-germinated rice seeds.

5. TRIBAL SUB-PLAN PROGRAMME

Frontline demonstration, trainings, distribution of farm input etc. were done in a systematic manner in the farmer's field to show the importance and the performance and profitability of proven weed management technologies among the tribal farming community with the objective to make them aware and adopt these technologies for enhanced crop productivity and socioeconomic upliftment.

AAU, Anand

In 2015-16, Dahod district was chosen to distribute weed management inputs *i. e.* ASPEE bakpak sprayer plastic pumps, hand hoe *Dharti* brand, spray nozzles XL-54 and spray nozzles FFP / 95 / 900. Forty farmers for spray pumps and 94 farmers for hand hoe were selected. Herbicide spraying nozzle was distributed to all farmers who participated in group meeting at village level. Selection and distribution of inputs was carried out in collaboration of KVK, Dahod and tribal women farmer, Training Centre, Devgadh Baria (Dahod district). Collection of land records and Election Voters Card of each beneficiary was done.

Input distribution to tribal farmers

AAU, Jorhat

One training programme 'weed management in cropped and non-cropped situation' was conducted at Diphu in the tribal district of Karbi Anglong with collaboration of KVK, Karbi Anglong on 6 April, 2015. Demonstration and hands on training on safe herbicide spraying were given to farmaers. About 40 tribal farmers participated in the programme. Weed control implements including rotary weeder, dry land weeder and backpack sprayers purchased in the previous year were distributed among the farmers groups.

BAU, Ranchi

Nine training programmes on weed management under tribal sub plan of AICRP on Weed Management were conducted and 362 tribal farmers from tribal dominated districts of Ranchi, Gumla, Khunti and Saraikela-Kharsawan were participated. Seeds and herbicides were provided to 85 tribal farmers. The installation of drip irrigation system was also completed at four farmers' field.

OUAT, Bhubaneswar

TSP programme was operated in three tribal dominated villages of Keonjhar district for overall development of their livelihood by supplying different farm machineries implements and agricultural inputs such as improved sickle, khurpa, cono-weeder, trench hoe, sprayer, improved spade, polythene sheet. About 254 farmers were directly benefited.

IGKV, Raipur

In an area of 110 acres, front line demonstrations on weed management in rice were laid down in 9 tribal villages in districts of Kanker, Balrampur and Sarguja. Of which, 40 demonstrations were taken on puddled rice and 70 demonstrations were laid down in direct seeded line sown rice. A total of 110 farmers were the participants. Demonstrations were conducted by KVK's of respective district and AICRP-Weed Management, Raipur. An average increase of 41 % in benefit :cost ratio was obtained due to recommended practice over farmers practice in rice established either direct line seeded or broadcast puddled rice. Training on weed management and distribution of inputs such as herbicides, seeds, flat fan nozzles and fertilizers were also provided to the participating farmers before the conduction of FLDs.

RVSKVV, Gwalior

Thirty FLDs on wheat were conducted on weed management practices during *Rabi* 2014-15.

Demonstration of wheat was conducted each in 1 acre area. Wheat demonstrations were conducted in Sejwani, Mailpada, Bisoli (Jhabua block) and Sad, Mokampura Villages (Rama block). Inputs like seed, herbicides and insecticides were provided to these farmers. Average yield in the demonstration plots of wheat (metsulfuron-methyl 4 g/ha PoE) was 4144 kg/ha while in farmers field average yield was 2837 kg/ha. Yield of demonstration plot were higher by 46.2 % as compared to farmers field. Maximum yield in the demonstration plot was 4350 kg/ha while minimum was 3900 kg/ha. Average B: C ratio generated in FLD's was 2.9 as against 2.10 in farmers' practices.

Fifteen FLDs on gram were conducted on weed management practices under TSP programme during *Rabi* 2014-15. Demonstrations of gram were conducted each in 1 acre area. Gram demonstrations were conducted in Sad (Rama block). Inputs like seed, herbicides and insecticides were provided to these farmers. Average yield in the demonstration plots of gram (pendimethalin 0.75 kg / ha PE) were 1147 kg / ha while in farmers field average field were 817 kg / ha. Yield of demonstration plot were higher by 40.6% as compared to farmers field. Maximum yield in the demonstration plot was 1275 kg / ha while minimum was 1075 kg/ha. Average B: C ratio generated in FLD's was 1.8 as against 1.3 in farmers' practices.

Fifteen FLDs on soybean were conducted on weed management practices during *Kharif* 2015. Demonstrations of soybean were conducted each in 1 acre area. Soybean demonstrations were conducted in Padalghati, Sad and Rotla (Rama block) and Mailpada (Jhabua block) villages. Inputs like seed (JS-335), herbicides (imazathapyr 100 g/ha) and insecticides were provided to these farmers. Average yield in the demonstration plots of soybean was 1235 kg / ha while in farmers field average yield were 997 kg / ha. Yield of demonstration plot were higher by 23.8% as compared to farmers field. Maximum yield in the demonstration plot was 1350 kg / ha while minimum was 1150 kg / ha. Average B: C ratio generated in FLD's was 2.3 as against 1.9 in farmers' practices.

Fifteen FLDs on maize were conducted in Sad, Rotla (Rama block) and Mailpada (Jhabua block) villages. Seed (Pro Agro 4794), herbicides (atrazine 0.5 kg/ha) and insecticides were provided to these farmers. Average yield in the demonstration plots of maize was 2.68 t/ha while in farmers field average yield was 2.04 t / ha. Yield of demonstration plot were higher by 31.5 % as compared to farmers field. Maximum yield in the demonstration plot was 2875 kg / ha while minimum was 2550 kg / ha. Average B: C ratio generated in FLD's was 2.1 as against 1.6 in farmers' practices.

DBSKKV, Dapoli

Tribal sub-plan plan was implemented in two villages in Sakri Tahsil of Dhule district in Maharashtra by selecting 120 farmers'. Awareness programme regarding the use of pre-emergence and post-emergence herbicides along with the application, calibration of sprayer, maintenance of spray pumps etc. was conducted. Demonstrations with the use of different hand tools, implements like weeders, weeding hooks, toothed spades and spray pumps were organized. Along with farmers, Gramsevak and Sarpanch and progressive farmers from village Rohod and Tembhe Pawasi in Sakri tahasils were actively involved in the programme. About 250 farmers from two villages participated for one day awareness programme on weed management.

6. LINKAGES AND COLLABORATION

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

BAU, Ranchi

There were 5 cropping systems with various crops, selection of crops based on nutritional requirements of farm and farm family. Cropping systems with their corresponding area were as follows:

1. Rice – wheat 2500 m^2
2. Maize + black gram (1:2) – lentil 2000 m^2
3. Maize + soybean (1:2) – mustard 1000 m^2
4. Groundnut – mustard 1000 m^2
5. Fodder maize + cowpea – berseem + *Japani* mustard 1500 m^2

A number of weed species from all the three categories i.e. grassy, broad leaf and sedges were found in different cropping systems. Major three species of weeds in each cropping system in *Kharif* and *Rabi* were *Ludivigia parviflora, Echinocloa crusgalli, Cyperus iria, Ageratum conizoides, Digitaria sanguinalis, Paspalam distichun* and *Cleome viscos* (Table 1). Dry weight of total weeds at 20-25 DAS in *Kharif* and 30-35 DAS in *Rabi* or before manual weeding or spray of pre-emergence herbicide, from 1 m^2 area was as follows:

Table 6.1 Weed population and weed dry weight in different cropping systems.

Weed species	Cropping system				
	CS1	CS2	CS3	CS4	CS5
	Kharif				
1	*Ludivigia parviflora*	*Ageratum conizoides*	*Ageratum conizoides*	*Ageratum conizoides*	*Ageratum conizoides*
2	*Echinocloa crusgalli*	*Digitaria sanguinalis*	*Digitaria sanguinalis*	*Cleome viscosa*	*Cleome viscose*
3	*Cyperus iria*	*Paspalam distichun*	*Paspalam distichun*	*Digitaria sanhuinalis*	*Digitaria sanhuinalis*
Total dry weight (g/m^2)	142	63	57	62	49
	Rabi				
1	*Chenopodium albun*	*Melilotus alba*	*Melilotus alba*	*Melilotus alba*	*Melilotus alba*
2	*Coronopus dydimus*	*Coronopus dydimus*	*Vicia sativa*	*Vicia sativa*	*Vicia sativa*
3	*Fumaria parviflora*	*Vicia sativa*	*Vicia hirsuta*	*Vicia hirsuta*	*Spergula arvensis*
Total dry weight (g/m^2)	34	42	56	58	22

PAU, Ludhiana

Development of organic farming package for system base high value crops in maize-potato-onion cropping system was done. Different organic farming treatments recorded diverse weed flora included grasses, sedges and broadleaf weeds in all the three crops. Organic farming treatments influenced weed species density in different crops, however, effects could not be generalized e.g. *Dactyloctenium aegyptium* recorded highest density in T_3 in maize and lowest in potato. Similarly, *Cyperus rotundus* density was the highest in T_4 in maize and potato and the lowest in onion. The weeds diversity likely to stabilize and differences will become more prominent over the years.

Another experiment was conducted on evaluation of bio-intensive complementary cropping systems. Weed flora in *Rabi* consisted of annual grass and broadleaf weeds, whereas in *Kharif*, annual grass and broadleaf weeds and perennial sedges were present. Cropping system showed differential effect on weed species in *Rabi* season e.g. *Poa annua* was the highest in hyola, radish and potato based systems and *Anagallis arvensis, Coronopus didymus, Polygonum plebium* and *Sorghum halepense* in turmeric based system. The cropping systems did not show much variation in weed diversity in *Kharif* season.

7. PUBLICATIONS

AAU, Anand

Saras, P.K., Patel, B.D. and Parmar, S.K. (2014). Weed management by cultural and chemical practices and their effect on phytotoxicity and growth, quality and yield parameters of clusterbean. *Trends in Biosciences* 7(24): 4196-4199.

Patel, K.R., Patel, B.D., Patel, R.B. and Patel, V.J. and Darji, V.B. (2015). Bioefficacy of herbicides against weeds of blackgram. *Indian Journal of Weed Science* 47(1): 87-90.

AAU, Jorhat

Baruah, A., Gogoi, P.K., Barua, I.C. and Baruah, D. (2014). Agronomic manipulation in Brahmi (*Bacopa monnieri*) for higher productivity in Assam Plains. *Journal of Krishi Vigyan* 2(2): 11-13.

Barua, C.C, Haloi, P. and Barua, I. C. (2015). *Gnetum gnemon* Linn.: A comprehensive review on its biological, pharmacological and pharmacognostical potencials. *International Journal of Pharmacognosy and Phytochemical Research* 7(3): 1-11.

Barua, C.C., Haloi, P., Patowary, P., Bora, M., Barua, A.G., Bordoloi, M.J. and Barua, I.C. (2015). Evaluation of anti-amnestic activity of few medicinal plants against scopolamine induced amnesia. *Indian Journal of Traditional Knowledge* 14(4): 581-589.

Barua, C.C, Bora, M., Saikia, B.N., Hazarika, M. and Barua, I.C. (2015). Quantatitative analysis of proximate and mineral composition of a few important medicinal plants of north-east region. *International Journal of Applied Biology and Pharmaceutical Technology* 6(3): 6.

Chandana, C.B, Anindita T, Anindhya, S.D., Acheenta, G.B., Debesh, C.P. and Barua, I. C. (2015). Ulcer protective activity of ethanolic extract of *Homalomena aromatica* (Spreng.) Schott. (Araceae) Root. *Advanced Techniques in Biology and Medicine* 2(1): 1-8.

BAU, Ranchi

Barla, S., Upasani, R.R. and Puran, A.N. (2015). Growth and yield of turmeric (*Curcuma longa* L.) under different weed management. *Journal of Crop and Weed* 11: 179-182.

Hassan, D. and Upasani, R.R. (2015). Effect of crop establishment and weed control methods on productivity and profitability of rice (*Oryza sativa* L). *Journal of Crop and Weed* 11: 228-230.

Upasani, R.R. and Barla, S. (2014). Weed control methods in direct seeded rice under medium land condition. *Journal of Crop and Weed* 10(2): 445-450.

Upasani, R.R., Barla, S. and Singh, M.K. (2014). Tillage and weed management in direct seeded rice (*Oryza sativa*) - wheat (*Triticum aestivum*) cropping system. *Indian Journal of Agronomy* 59 (2): 75-79.

CCSHAU, Hisar

Bhullar, M.S., Punia, S.S., Tomar, S.S., Singh, V.P. and Sharma, Jai Dev. (2014). Little seed canary grass resistance to clodinafop in Punjab: farmers' perspective. *Indian Journal of Weed Science* 46(3): 237-240.

Kumar S., Bhatto, M.S., Punia, S.S. and Punia, R. (2015). Bioefficacy of pre-and post-emergence herbicides in blackgram and their residual effect on succeeding mustard crop. *Indian Journal of Weed Science* 47(2): 99-102.

Punia, S.S. and Yadav, D. (2014). Carfentrazone and pinoxaden with and without surfactant against grasses and broad-leaf weeds in wheat. *Indian Journal of Weed Science* 46(3): 283-285.

Punia, S.S. (2015). Control of *Orobanche aegyptiaca* in Indian mustard. *Indian Journal of Weed Science* 47(2): 63-66.

Punia, S.S. and Duhan, A. (2015). New innovations in management of *Orobanche* in mustard. *Indian Farming* 65(7): 29-33.

Punia, S.S., Yadav Dharambir, Garg R. and Malik Y. P. (2014). Floristic composition of weeds in ratoon crop of sugarcane in Haryana. *Haryana Journal of Agronomy* 30(2): 161-163.

GBPUAT, Pantnagar

Joshi, Neeshu, Singh, V.P., Dhyani, V.C. and Pratap, T. (2015). Effects of planting geometry and weed management practices on weeds, growth and yield of direct-seeded (aerobic) rice (*Oryza Sativa* L.). *Journal of Environmental Biology Sci*ence 29(1): 23-28.

Singh, V. Pratap, D., Vipin, C., Singh, S.P., Kumar, A., Manalil, S. and Chauhan, B.S. (2015). Effect of herbicides on weed management in dry-seeded rice sown under different tillage systems. *Crop Protection* 80: 118-126.

Singh, S., Singh S. P., V.P. and Mahapatra, B.S. (2015). Dynamics of *Phalaris minor* in wheat (*Triticum aestivum* L.) under different establishment methods and weed control measures. *International Journal of Environmental and Agriculture Research* 1(5): 20-25.

Singh, S., Singh, S.P., Singh V.P. and Mahapatra, B.S. (2015). Effect of establishment methods and weed control measures on broad leaf weeds, yield attributes and harvest index of wheat (*Triticum aestivum* L.). *International Journal Of Engineering Research and Science* 1(6): 34-37.

Singh, V.P., Pratap Tej, Singh, S.P., Kumar, A., Banga, A., Bisht, N. and Neeshu. (2015). Comparative efficacy of post – emergence herbicide on yield of wheat. *Indian Journal of Weed Science* 47(1): 25-27.

Joshi, N., Singh, V.P., Dhayni, V.C. and Pratap, Tej (2015). Effect of plant geometry and weed management practices on weed growth and yield of direct seeded rice (*Oryza sativa* L.) *Journal of Environment and Bioscience* 29(1): 23-28.

Singh, V.P., Pratap Tej, Dhyani V.C., Kumar A., Banga A., Tripathi, N. and Bisht, N. (2015). Performance of post-emergence herbicide on weed flora and yield on soybean (*Glycine max* L.). *Journal of Environment and Bioscience*. 29(1): 51-56.

Singh, V.P., Pareek, N., Kumar A., Satyawali K., Banga A., Bisht, N. and Singh, D.B. (2015). Efficacy of ACM-9 (clodinafop propargyl + metribuzin) on weeds, growth and yield of wheat. *Journal of Environment and Bioscience* 29(2): 361-366.

Tandon, S., Kumar, S. and Sand, N.K. (2015). Development and validation of GC-ECD method for the determination of metamitron herbicide in soil. *International Journal of Analytical Chemistry* 2015: 1-5.

IGKV, Raipur

Singh, A.P., Jha, S.K., Dwivedi, S.K. and Kolhe, S.S. (2015). Efficacy of metamifop 10 EC against grassy weeds of direct-seeded rice and its residual effect on subsequent crop of wheat. *Ecoscan* 9(1 & 2): 527-529.

Dipika and Tapas, C. (2015). Effect of different post-emergence herbicides on biochemical and physicochemical properties of rice soil. *Ecoscan* (7): 51-56.

Singh, A.P., Gupta, Bajaj, S., Tiwari, S. and Singh S. (2015). Biodiversity of weeds present in Durg district of Chhattisgarh. *Progressive Research* 10: 1203-1209.

Singh, A.P., Gupta, S., Bajaj, Tiwari, S. and Kaushik, S. (2015). Predominant weed flora in Mahasamund district of Chhattisgarh. *Progressive Research* 10: 1193-1202.

Kujur, A., Singh, A.P., Chowdhury, T. and Sahu, B. (2015). Effect of herbicide combination on yield and soil micro flora in direct seeded rice. *Progressive Research* 10 (4): 2437-2440.

Sahu, B., Shrivastava, G.K., Singh, A.P. and Kujur, A. (2015). Combined effect of herbicides and cultural method on growth and yield of transplanted rice. *Progressive Research* 10 (4): 2063-2065.

Gupta, S., Singh, S. and Singh, A.P. (2015). Assessment of weed flora in Raipur district of Chhattisgarh: A scientific survey. *Trends in Biosciences* 8 (12): 3163-3170.

Chowdhury, T, Singh, A.P. and Gupta, S.B. (2014). Influence of tillage and weed management on soil properties of rice fields. *Indian Journal of Ecology* 41 (1): 139-142.

Chandrakar, D.K., Chandrakar, K., Singh, A.P., Nair, S.K. and Nanda, H.C. (2014). Efficacy of different herbicides on weed dynamics and performance of rajmash (*Phaseolus vulgaris* L.). *Journal of Food Legumes* 27 (4): 344-346.

Chandrakar, D.K., Chandrakar, K., Singh, A.P., Nanda, H.C., Nair, S.K. and Nagre, S.K. (2014). Effect of weed management on weeds growth, yield and economics of rajmash (*Phaseolus vulgaris* L.). *Journal of Agricultural Issues* 19 (2): 10-15.

Kujur, A., Singh, A.P., Shrivastava, G.K., Chowdhury, T. and Urkurkar, J.S. (2014). Effect of herbicide combination on productivity of direct-seeded rice. *Journal of Agricultural Issues* 19 (2): 64-67.

Sahu, B., Shrivastava, G.K., Singh, A.P. and Pandey, N. (2014). Effect of combination of herbicides on

productivity and economics of transplanted rice. *Journal of Agricultural Issues* 19 (2): 78-81.

OUAT, Bhubaneswar

Duary, B, Mishra, M.M, Dash, R. and Teja, K.C. (2015). Weed management in lowland rice. *Indian Journal of Weed Science* 47(3): 224-232.

Dash, R. and Mishra, M.M. (2014). Bio-efficacy of halosulfuron-methyl against sedges in bottle gourd. *Indian Journal of Weed Science* 46 (3): 267-269.

Dash, R., Mishra, M.M. and Ranasingh, N. (2015). Management of cuscuta in niger under south eastern hilly regions of Odisha. *Environment and Ecology* 33 (1): 605-606.

DPDKV, Akola

Kale, N.M., Mankar, D.M., Deshmukh, J.P., and Wankhade, P.P. (2015). Herbicide adoption pattern of cotton farmers in Vidarbha, *Journal of Agricultural Extension* 49(6): 9-14.

Mahajan, R.V., Bhale, V.M., Deshmukh, J.P. and Patil, S.P. (2015). Influence of see weed extract as biostimulent for enhancing the biochemical constituents of soybean (*Glycine max*). *Annals of Plant Physiology* 29(1): 57-61.

PAU, Ludhiana

Bhullar, M., S., Kumar, S., Kaur, S., Kaur, T., Singh, J., Yadav, R., Chauhan, B.S. and Gill, G. (2016). Management of complex weed flora in dry-seeded rice. *Crop Protection* 83: 20-26.

Bhullar, M.S., Kaur, T., Kaur, S. and Yadav, R. (2015) Weed management in vegetable and flower crop-based systems. *Indian Journal of Weed Science* 47 (3): 277-287.

Kaur, N. and Bhulla, M.S. (2015). Harvest time residues of pendimethalin and oxyfluorfen in vegetables and soil in sugarcane-based intercropping systems. *Environmental Monitoring and Assessment* 187 (5): 1-6.

Kaur, N., Bhullar, M.S. and Gill, G. (2015). Weed management options for sugarcane-vegetable intercropping systems in north-western India. *Crop Protection* 74: 18-23.

Kaur, N., Bhullar, M.S. and Gill, G. (2016). Weed management in sugarcane-canola intercropping systems in northern India. *Field Crops Research* 188: 1-9.

Kaur, P., Kaur P. and Bhullar, M.S. (2015). Persistence behavior of pretilachlor in puddled paddy fields under subtropical humid conditions. *Environ Monitoring and Assessment* 187(8): 524.

Kaur, S., Singh S. and Chander, M. (2015). Impact of crop establishment and weed control on disease infestation and rice productivity. *Ecology Environment and Cons*ervation 21 (3): 163-66.

Kaur, S. and Surjit, S. (2015). Rice productivity and profitability under different crop establishment methods, plant densities and weed control in North-Western Indo-Gangetic plains. *Journal of Krishi Vigyan* 3(2): 84-88.

Kaur, S. and Singh, S. (2015). Impact of crop establishment methods and weed control on weeds, insect-pest and disease infestation in rice in North-Western Indo-Gangetic Plains. *International Journal of Agricultural Science* 7 (4): 487-91.

Kaur, S. and Singh, S. (2015). Bio-efficacy of different herbicides for weed control in direct-seeded rice. *Indian Journal of Weed Science* 47 (2): 106-109.

Kaur, T., Bhullar, M.S. and Walia, U.S. (2015). Bio-efficacy of ready-mix formulation of clodinafop-propargyl + metsulfuron for control of mixed weed flora in wheat. *Indian Journal Weed Science* 47 (2): 121-124.

Kaur, T. and Bhullar, M.S. (2015). Weed management in lentil (*Lens culinaris* Medic. L.) in north west India. *Pesticide Research Journal* 27 (1): 111-114.

Kaur, T., Kaur, S. and Bhullar, M.S. (2015). Testing of new brand formulations of sulfonylurea herbicides for control of mixed weed flora in wheat. *Journal of Krishi Vigyan* 4 (1): 5-9.

Singh, A.P., Bhullar, M.S., Yadav, R. and Chowdhury, T. (2015) .Weed management in zero-till wheat. *Indian Journal Weed Science* 47 (3): 233-239.

PJTSAU, Hyderabad

Ram Prakash, T., Madhavi, M. and Yakadri, M. (2015). Dissipation of atrazine in alfisols and maize. *Annals of Plant and Soil Research* 17(5): 260-263.

Pragathi, K.C, Saritha, J.D. and Ramprakash. T. (2015) Challenges in weed management in conservation agriculture. *Annals of Plant and Soil Research* 17(5): 238-242.

Ramprakash, T., Madhavi. M., Yakadri, M. and Srinivas, A. (2015). Bispyribac-sodium

persistence in soil, plant and grain in direct-seeded rice and its effect on soil properties. *Nature Environment and Pollution Technology* 14(3): 605-609.

Ramprakash, T, Yakadri, M. and Madhavi M. (2015). Dissipation of atrazine in Alfisols and sweet corn. *Bioscan* 10(1): 343-346.

Uma, G., Venkataramana, M., Ramprakash, T. and Sharana, B. (2015). Efficacy of sulfonylurea herbicides for broad-spectrum weed control in transplanted rice (*Oryza sativa* L.*) Ecology Environment and Conservation* 21 (2): 927-932.

KAU, Thrissur

Durga, K.M.D., Abraham, C.T. and Upasana, C.N. (2015). Leaching behavior of four herbicides in two soils of Kerala. *Indian Journal of Weed Science* 47(2): 193-196.

Durga, D. K.M., Hasna, K. and Abraham, C.T. (2015). Persistence of butachlor and pretilachlor residues in lateritic soil under non-flooded soil conditions. *Pesticide Research Journal* 27(2): 205-211.

Durga, D.K.M., Hasna, K. and Abraham, C.T. (2015). Effect of sources of organic matter on the persistence of butachlor and pretilachlor residues in lateritic soil under flooded soil conditions. *Pesticide Research Journal* 27(2): 199-204.

Girija, T., John, L. and Abraham, C.T. (2015). Seasonality of emergence of selected annual weeds in coconut gardens. *Indian Journal of Weed Science* 47(1): 55-58.

TNAU, Coimbatore

Prabhakaran, N.K., Sakthivel, N. and Nithya. C. (2015). Effect of herbicide combinations on weed control efficacy and grain yield of transplanted rice. *Research Journal of Agricultural Sciences* 6(10): 220-222.

Janaki, P., Sundaram, K.M., Chinnusamy, C. and Sakthivel, N. (2015). Determination of residues of metribuzin in soil and sugarcane by QuEChERS. *Asian Journal of Chemistry* 27(10): 3692-3696.

Janaki, P., Meena, S. and Chinnusamy, C. (2015). Dynamics of metolachlor in sandy clay loam soil and its residues in maize and soybean. *Trends in Biosciences* 8: 131-137.

Janaki P., Chinnusamy, C., Prabhakaran, N.K. and Senthil, K. (2015). Dissipation kinetics of ethofumesate in sugar beet under tropical Indian condition by GC-MS. *Asian Journal of Chemistry* 27(11): 4017-4021.

Janaki P., Neelam Sharma, C. Chinnusamy, N. Sakthivel and C. Nithya. 2015. Herbicide residues and their management strategies. *Indian Journal of Weed Science* 47(3): 329-344.

Janaki P., C. Chinnusamy, N. Sakthivel and Nithya, C. (2015). Field dissipation of pendimethalin and alachlor in sandy clay loam soil and its terminal residues in sunflower (*Helianthus annus* L.). *Journal of Applied and Natural Science* 7(2): 702-709.

Babu, C., Janaki, P. and Chinnusamy, C. (2015). Effect of rate of application on degradation of imazethapyr in groundnut and soil under tropical Indian condition. *Journal of Applied and Natural Science* 7(2): 714-718.

Sondhia, S., Sharma, N., Janaki, P. and Kaur, P. (2015). Herbicide residue hazards and their mitigation. *Indian Farming* 65(7): 34-39.

Mynavathi, V.S., Prabhakaran, N.K. and Chinnusamy, C. (2015). Manually-operated weeders for time saving and weed control in irrigated maize. *Indian Journal of Weed Science* 47(1): 98–100.

Sathiyavani, E., Prabhakaran, N.K., Chinnusamy, C., R. Shanmugasundram and Soorianath-sundaram, K. (2015). Integrated weed management in turmeric-A Review. *Genomics and Applied Biology* 6 (3): 1-15.

UAS, Bengaluru

Dhanapal, G.N., Sanjay, M.T., Hareesh, G.R. and Vinay, B.P. (2015). Weed and fertility management effect on grain yield and economics of finger millet following groundnut. *Indian Journal of Weed Science* 47(2): 139-143.

Siddappa, Jayaprasad K.V. and Sanjay, M.T. (2015). Effect of herbicides on management of weeds in lawn. *Bioscan* 10(1): 285-289.

Siddappa, Lithika, R., Geeta, B.L., Jayaprasad, K.V. and Sanjay, M.T. (2015). Economics of weed management in lawn. *Trends in Biosciences* 8(12): 3074-3076.

Hatti, V., Sanjay, M.T., Prasad T.V.R., Kumbar, B. and Geetha, K.A. (2015). Effect of weed management practices on weed growth and yield of irrigated maize (*Zea mays* L.). *Environment and Ecology* 33(4A): 1684-1688.

Hatti, V., Sanjay, M.T., Prasad T.V.R, Kumbar, B. and Geetha, K.A. (2015). Influence of chemical weed management practices on growth, yield and economics of irrigated maize (*Zea mays*). *Environment and Ecology* 33(4A): 1689-1692.

SKUAST, Jammu

Kour, R., Kumar, A., Sharma, B.C., Kour, B.P. and Sharma, N. (2014). Weed indices in chickpea + mustard intercropping system. *Indian Journal of Weed Science* 46(4): 333–335.

Kour, P., Kumar, A., Kour, R. and Sharma, N. (2014). Nutrient uptake as influenced by weed management in winter maize+potato intercropping system. *Indian Journal of Weed Science* 46(4): 336–3341.

Kumar, A., Kumar, J., Puniya, R., Mahajan, A., Sharma, N. and Stanzen, L. (2015). Weed management in maize-based cropping system. *Indian Journal of Weed Science* 47(3): 254–266.

Publications by the Coordinating Centres

Centres	Research paper	Popular articles	Paper presented in seminars/ symposia/ conferences	Books	Book Chapter	Lectures delivered during training	Students guided	
							M.Sc.	Ph.D
PAU, Ludhiana	15	6	11	-	-	15	7	2
UAS, Bengaluru	5	1	-	-	-	-	6	-
RVSKVV, Gwalior	-	-	-	-	-	-	-	-
GBPUAT, Pantnagar	9	4	7	-	-	13	5	3
CSKHPKV, Palampur	-	-	-	-	-	-	-	-
AAU, Jorhat	6	5	9	-	7	8	1	4
AAU, Anand	5	2	2	-	3	16	9	-
TNAU, Coimbatore	10	-	8	-	-	8	3	1
NDUAT, Faizabad	-	2	4	-	-	-	7	3
BAU, Ranchi	4	-	6	-	-	-	1	3
KAU, Thrissur	4	-	16	-	1	4	6	4
OUAT, Bhubaneswar	3	1	7	-	-	-	1	-
PJTSAU, Hyderabad	-	-	25	-	2	1	1	2
CCSHAU, Hisar	6	4	8	-	-	-	3	3
RAU, Pusa	-	2	6	-	-	2	-	-
DBSKKV, Dapoli	-	-	-	-	-	-	3	-
IGKVV, Raipur	12	1	8	-	-	25	4	2
PDKV, Akola	2	-	14	-	-	5	3	-
CAU, Pasighat	-	-	1	-	-	-	-	-
UAS, Raichur	-	-	-	-	-	-	2	-
SKUAST, Jammu	3	-	12	1	-	5	3	1
MPUAT, Udaipur	-	3	2	-	-	-	2	3
Total	80	31	146	1	13	102	67	31

8. AWARDS AND RECOGNITIONS

AAU, Anand

Dr B.D. Patel, was awarded with 'Best Poster Paper award' in 25th Asian-Pacific Weed Science Society Conference on "Weed science for sustainable agriculture, environment and biodiversity" held at PJTSAU, Hyderabad during October 13-16, 2015.

PJTSAU, Hyderabad

Dr. Ramprkash T. received "Best Oral Presentation Award" 2nd international conference on Bioresource and stress Management at Hyderabad 7-10 January 2015.

AAU, Jorhat

A patent has granted under Indian Patent Act of a wound healing drug using a tropical weed *Achyranthes aspera.* Application No. 426/KOL/2007, in the name of Assam Agricultural University. (Dr I. C. Barua and his team)

Best Paper Award (Poster session) for the paper "Comlizer (compost and fertilizer mixture) for nutrient management in tuberose (*Polianthes tuberosa* L.) with black polythene mulch or pre-emergence herbicide" in the International Conference organized by the Soil Conservation Society of India held at New Delhi during 10-13 Feb. 2015.(Dr. N. Borah, Dr. J. Deka, Dr. IC. Barua, Dr. P. Mahanta and Mr. H. Uddin).

CCSHAU, Hisar

Dr. Dharam Bir Yadav, has been conferred upon with 'PPIC Distinguished Teacher Award 2010-12' by CCS HAU, Hisar presented by Chief Minister, Haryana on the occasion of 24th Convocation on 26 July, 2015.

Dr Anil Duhan received 'Dr V.D. Kashyap Memorial Gold Medal' for Best Researcher in Ph.D. for the year 2009-10 in 24th Convocation of CCS Haryana Agricultural University Hisar.

GBPUAT, Pantnagar

G.B.Pant University of Agriculture & Technology Pantnagar honoured with Best Center Award for the year 2014-2015 by Directorate of Weed Research at Hyderabad during 17-18 October, 2015.

OUAT, Bhubaneswar

Dr.M.M.Mishra received Life Time Achievement Award for significant contribution in the field of weed science by the Hon'ble VC, OUAT, Bhubaneswar

SKUAST, Jammu

Dr. Ramphool Puniya, awarded with 'Best Poster Presentation Award' for research paper on "Bio-efficacy of triasulfuron against weeds in transplanted rice" during 25th Asian Pacific Weed Science Conference held at PJSTAU, Hyderabad w.e.f. October 13 to 16, 2015.

Dr. A. P. Singh, has been awarded with 'Scientist of the Year Award' during National Conference on "Global Research Initiatives for Sustainable Agriculture & Allied Sciences" held on December 12-13, 2015.

UAS, Raichur

AICRP on Weed Management, UAS, Raichur centre has got first prize (best exhibition stall award) in the Krishimela held at UAS, Raichur campus from 29th January to 31st January 2016.

RVSKVV, Gwalior

Dr B.S. Kasana, received Young Sceintist Award from SSDAT, Meerut during GRISAAS-2015 at RVSKVV, Gwalior held on 12 -13 December 2015.

UAS, Bengaluru

Dr. G.N. Dhanapal, Chaired a session on "Ecology, phylogeny and evolution in parasitic plants" in the 13th World Congress on Parasitic Plants held at Kunming, China from 5-10th July, 2015.

CAU, Pasighat

Dr. Dinesh Shah secured 3rd position during poster presentation session of National conference on "Horticulture for North East Region" during 16-18 January, 2016 at College of Horticulture and Forestry, Pasighat.

9. RECOMMENDATIONS OF XXII ANNUAL REVIEW MEETING

Recommendations of XXII Annual Review Meeting of All India Coordinated Research Project on Weed Management held at PJT State Agricultural University, Hyderabad (Telangana) during 17-18 October, 2015 are given below:

General comments

1. Results on *Orobanche* control should be reviewed and reported properly.
2. Economics of conservation agriculture should also be worked out.
3. Basic studies on herbicide residue on microflora, chemical properties of soil etc. should be taken up and development of prediction models would help to predict the herbicide residues.
4. Studies on effect of climate change on weed shift should be encouraged.
5. Develop specific recommendation for weed control in aerobic rice.
6. Emphasis should be given on developing weed flora maps also.
7. Phytoremediation studies using aquatic weed should be included in the technical program.
8. Possibilities of sand mix application of herbicides in dryland areas should be explored.
9. Compatibility of different agrochemical inputs should be studied.
10. There should be alternate option for *Zygogramma* for *Parthenium* control as it is not working effectively in many places.
11. Uniformity should be observed in reporting the results.

Recommendations

1. It was realized that specific recommendations for some individual centers and most of the general recommendations made in the earlier review meetings in 2012, 2013 and 2014 have not been fully acted upon. Therefore, all such points should be duly considered and a convincing ATR should be presented in the next meeting in 2016.
2. Publication record of most centers has not shown any improvement over the last 5 years despite repeated emphasis and recommendations by the QRT. This issue will also be thoroughly discussed in the next meeting.
3. Long-term trials on tillage and herbicides have been conducted for 15-20 years or even more at some centres, which have yielded a vast volume of data. An article on each experiment as per the guidelines should be prepared by each centre and submitted by 31st December, 2015.
4. An article on herbicide residues data generated over the years has been submitted by most centers but it is not in the required format / shape. A thoroughly revised version should be submitted by 15 November, 2015 so that this publication can be released at the next ARM in April, 2016.
5. Long-term experiments which have been conducted for more than 10 years should be terminated. Based on the information generated, new experiments should be proposed and presented at the next meeting. Such experiments should include the latest available herbicide molecules / mixtures for a given crop / situation.
6. Data recording, analysis and presentation needs considerable improvement. PIs should check / verify the data carefully and should be clear about the reported results.
7. Annual report must be presented as per the guidelines uniformly. Nodal officers should go through the reports critically and present their observations in the meeting.
8. A farm pond infested with aquatic weeds like water hyacinth should be selected in the city or in the village, and a success story on weed eradication should be developed and widely publicized. Similarly, *Parthenium* eradication

programme must be undertaken in the campus. Such centers showing visible impact of weed control technology will be suitably recognized at the ARM and provided additional grants for infrastructure development.

9. An exercise should be initiated by each centre from now onwards to plan the Technical Programme for the next biennium 2015-16 and 2016-17. This should be based on the results obtained previously, resources / manpower available, collaboration with other AICRPs, emerging weed problems and farm-oriented problem-solving research. Emphasis should be on fewer experiments but on generation of quality data with visible outputs.
10. Economic analysis has still not been standardized despite development of a common protocol. Dr. P. K. Singh and Dr. Yogita Gharde should develop an MS EXCEL sheet for economic analysis, which must be uniformly followed by all centres from the current year. Dr. Yogita Gharde will finalize the Information System for data acquisition/ analysis of the AICRP trials before the next meeting.
11. Work on herbicide residues is missing from most presentations. This should be adequately highlighted during discussion / presentation, annual report as well as in publications.
12. Studies on herbicide residues must be conducted in high-value crops, vegetables, spices and fodder crops; and must specify the soil depth, moisture, minimum detectable limits / limit of detection.
13. Formulation of *Alternaria alternata* should be tested at all centres for the control of water hyacinth. Shelf-life of the product should be tested.
14. Studies on weed management in organic farming may be conducted at the centers located in hilly regions such as Jammu & Kashmir, Himachal Pradesh and Uttarakhand. Extract of weeds / plants can be used to control weeds.
15. Technology on *Orobanche* management developed at HAU centre should be demonstrated on a large scale at all other centres including Gwalior, Udaipur and others, for which additional funding support can be provided from the HQ.
16. Directorate will process the specific cases received from the centers, which are related to herbicide recommendations not included in the label claim, and submit to the DPPQS / CIRBC for consideration.
17. Center which still do not have adequate facilities for estimation of herbicide residues can continue with herbicide/enzyme bioassay studies to generate practical information on residual effect of herbicides.
18. Preliminary studies on weed biology / ecology for which the results are well established need not be conducted. It is essential that only meaningful studies on problem weeds of the area are conducted on a scientific basis.
19. Some centers have not shown any progress in herbicide residue research over the last many years despite the availability of good facilities and posting of a residue chemist. The post of residue chemist will be withdrawn from such centers.
20. TSP funds still left unutilized at some of the centers should be spent only for the specified purpose in the identified districts, preferably for development of permanent assets in the area. No revalidation of such funds is required from the HQ.
21. Work on crop modelling should be taken up at centers which have the requisite expertise, e.g. Hyderabad under the guidance of Dr. D. Raji Reddy, Director of Research and an expert in this field.
22. Fund availability in the AICRP has been curtailed by the ICAR in the XII Plan, but the better performing centers will be given special consideration under resource constraints.
23. Centers graded as 'Average' and 'Below average' must improve their performance as per the criteria / guidelines issued earlier, failing which the QRT may recommend closure / shifting of these centers in the next plan as done during this plan.
24. Project proposals for external funding in the identified priority area like herbicide residues, aquatic weeds, conservation agriculture, climate change should be submitted by the centres for funding under the NICRA, NASF, Extra-Mural programme of the ICAR and others.
25. It should be attempted not to hold the ARM and the ISWS Conference together, rather these should be held in the early and later part the given year, respectively. The next ARM will be held at the Jain Irrigation Systems, Jalgaon or at AAU, Jorhat during April, 2016.

10. STATUS OF EXPERIMENTS

SL. No	Coordinating Centres	Network Programmes					
		WS 1: Weed surveillance	WS 2: Weed biology and physiology	WS 3: Weed management in crops and cropping systems	WS 4: Management of problematic / invasive / parasitic / aquatic weeds	WS 5: Herbicide residues and environmental quality	WS 6: Transfer of technology
1.	PAU, Ludhiana	WS1.1a WS 1.2 WS 1.3	WS 2.1a WS 2.1b WS 2.1c WS 2.1d	WS 3.1.1 WS 3.2 WS 3.3.2 WS 3.4.1 WS 3.5 WS 3.6 WS 3.7	WS 4.1b WS 4.1c WS 4.3	WS 5.1 WS 5.2 WS 5.3 WS 5.5	WS 6.1 WS 6.2
2.	UAS, Bengaluru	WS 1.1a WS 1.2 WS 1.3	WS 2.1a * WS 2.1b WS 2.1d*	WS 3.1.1 WS 3.1.2 WS 3.1.3 WS 3.3.1 WS 3.3.2 WS 3.5 WS 3.6 WS 3.7 WS 3.8.14 WS 3.8.15	WS 4.1a * WS 4.1b* WS 4.1c WS 4.1e WS 4.2	WS 5.1 WS 5.2 WS 5.3 WS 5.5	WS 6.1 WS 6.2
3.	RVSKKV, Gwalior	WS 1.1a WS 1.2 WS 1.3	WS 2.1a* WS 2.1e*	WS 3.2 WS 3.4.1 WS 3.6 WS 3.7	WS 4.1a WS 4.1c WS 4.2 WS 4.3	WS 5.1 WS 5.2 WS 5.3 WS 5.5	WS 6.1 WS 6.2*
4.	GBPUAT, Pantnagar	WS 1.1a WS 1.2 WS 1.3	WS 2.1a WS 2.1d	WS 3.1.1 WS 3.2 WS 3.3.1 WS 3.3.2 WS 3.4.1 WS 3.6 WS 3.8.12* WS 3.8.13*	WS 4.2	WS 5.2 WS 5.3 WS 5.5	WS 6.1 WS 6.2
5.	CSKHPKV, Palampur	WS 1.1a WS 1.2 WS 1.3	WS 2.1a WS 2.1b	WS 3.1.3 WS 3.2 WS 3.3.1 WS 3.4.1 WS 3.6 WS 3.7 WS 3.8.6	WS 4.1c* WS 4.1e WS 4.3	WS 5.1 WS 5.2 WS 5.3 WS 5.4 WS 5.5	WS 6.1 WS 6.2
6.	AAU, Jorhat	WS 1.1a WS 1.2 WS 1.3	WS 2.1a WS 2.1b WS 2.2, WS 2.3.1 WS 2.3.3	WS 3.1.3 WS 3.3.1 WS 3.3.3 WS 3.7	WS 4.3*	WS 5.1 WS 5.2 WS 5.3 WS 5.5	WS 6.1 WS 6.2

7.	AAU, Anand	WS 1.1a WS 1.2 WS 1.3	WS 2.1a	WS 3.2 WS 3.3.2 WS 3.4.1 WS 3.5 WS 3.6 WS 3.7	WS 4.1a WS 4.1b WS 4.1c WS 4.2 WS 4.3	WS 5.1* WS 5.2* WS 5.3* WS 5.5*	WS 6.1 WS 6.2
8.	TNAU, Coimbatore	WS 1.1a WS 1.2 WS 1.3	WS 2.1a WS 2.1b* WS 2.1d	WS 3.1.1 WS 3.1.2 WS 3.1.3* WS 3.4.1 WS 3.5 WS 3.6 WS 3.7	WS 4.1a WS 4.1c* WS 4.1d* WS 4.2 WS 4.3	WS 5.1 WS 5.2 WS 5.3 WS 5.4 WS 5.5	WS 6.1 WS 6.2
9.	NDUAT, Faizabad	WS 1.1a WS 1.2* WS 1.3*	WS 2.1a WS 2.1b	WS 3.1.1 WS 3.1.3 WS 3.2 WS 3.3.1 WS 3.3.2 WS 3.4.1 WS 3.6 WS 3.7	WS 4.1a WS 4.1c* WS 4.2 WS 4.3*	WS 5.1 WS 5.2 WS 5.3 WS 5.5	WS 6.1 WS 6.2
10.	BAU, Ranchi	WS 1.1a WS 1.2 WS 1.3	WS 2.1a WS 2.1b WS 2.1d	WS 3.1.3 WS 3.2 WS 3.3.1 WS 3.3.3 WS 3.6 WS 3.7 WS 3.8.3 WS 3.8.4	WS 4.1b WS 4.1c WS 4.2 WS 4.3	-	WS 6.1 WS 6.2
11.	KAU, Thrissur	WS 1.1a WS 1.2 WS 1.3*	WS 2.1a WS 2.1b WS 2.1d	WS 3.1.1 WS 3.1.3 WS 3.3.3 WS 3.6 WS 3.7 WS 3.8.5	WS 4.1e WS 4.1f WS 4.2	WS 5.1 WS 5.2 WS 5.3 WS 5.5	WS 6.1 WS 6.2
12.	OUAT, Bhubaneshwar	WS 1.1a WS 1.2 WS 1.3	WS 2.1a WS 2.1b*	WS 3.1.1 WS 3.1.3 WS 3.3.3 WS 3.4.1 WS 3.6* WS 3.8.8* WS 3.8.9	WS 4.1a WS 4.1b* WS 4.1c WS 4.2* WS 4.3*	WS 5.1 WS 5.2* WS 5.3 WS 5.5*	WS 6.1 WS 6.2
13.	PJTSAU, Hyderabad	WS 1.1a WS 1.2 WS 1.3	WS 2.1a	WS 3.1.2 WS 3.5 WS 3.6 WS 3.7 WS 3.8.2	WS 4.1a WS 4.1c* WS 4.1d WS 4.2* WS 4.3	WS 5.1 WS 5.2 WS 5.3 WS 5.5 WS 5.6	WS 6.1 WS 6.2
14.	CCSHAU, Hisar	WS 1.1a WS 1.2 WS 1.3	WS 2.1c WS 2.1e	WS 3.1.1 WS 3.3.1 WS 3.4.1 WS 3.5 WS 3.6 WS 3.7	WS 4.1a WS 4.1c WS 4.2 WS 4.3	WS 5.1 WS 5.2 WS 5.3 WS 5.5	WS 6.1 WS 6.2
15.	RAU, Pusa	WS 1.1a WS 1.2 WS 1.3	WS 2.1a, WS 2.1b	WS 3.1.1 WS 3.2 WS 3.3.1 WS 3.3.3 WS 3.6 WS 3.7	WS 4.1a WS 4.1c WS 4.2 WS 4.3	WS 5.1* WS 5.2* WS 5.3* WS 5.5*	WS 6.1 WS 6.2

16.	D BSKKV, Dapoli	WS 1.1a WS 1.2* WS 1.3*	WS 2.1a	WS 3.1.3 WS 3.6 WS 3.7	WS 4.2* WS 4.3		WS 6.1 WS 6.2
17.	IGKVV, Raipur	WS 1.1a WS 1.2 WS 1.3	WS 2.1a	WS 3.1.3* WS 3.6, WS 3.7 WS 3.8.1	WS 4.2 WS 4.3	-	WS 6.1 WS 6.2
18.	SKUAST-Jammu	WS 1.1a WS 1.2 *	-	WS 3.4.1	WS 4.1e WS 4.2	-	WS 6.1 WS 6.2
19.	PDKV, Akola	WS 1.1a* WS 1.2*	-	WS 3.3.1 WS 3.5 WS 3.8.10 WS 3.8.11 WS 3.8.16	WS 4.2*	-	WS 6.1* WS 6.2*
20.	CAU, Pasighat	WS 1.1a*	-	WS 3.3.3	WS 4.2*	-	-
21.	UAS, Raichur	WS 1.1a WS 1.3	WS 2.1a WS 2.1d	WS 3.1.1 WS 3.1.3 WS 3.8.10 WS 3.8.18	WS 4.2*	-	-
22.	MPUAT, Udaipur	WS 1.1a	-	WS 3.4.1 WS 3.6 WS 3.8.10 WS 3.8.16	WS 4.2	-	WS 6.1* WS 6.2

* Experiment not conducted

11. NEW INITIATIVES DURING 2015-16

- Research themes were reorganized in tune with the research programmes of the Directorate based on the emerging challenges in weed management.
- Network experiments related to weed management in conservation agriculture, organic farming, input-use efficiency and herbicide use in cropping systems were proposed.
- Effective system of monitoring and evaluation of research and extension work was developed through nomination of Nodal Officers for different themes and regions.
- New regular centres were opened at MPUAT, Udaipur; UAS, Raichur; PDKV, Akola; SKUAST, Jammu; BCKVV, Kalyani and CAU, Pasighat w.e.f. April, 2015. Voluntary centers were also started at CIARI, Portblair and IVRI, Izatnagar.
- Collaboration with other AICRPs at the university like integrated framing systems, dryland agriculture, organic farming, pesticide residues, and others dealing with crops like rice, wheat, maize, soybean, sugarcane, pulses etc. was proposed.
- Compilation of the work done so far on herbicide residues, biology and management of major weeds of cropped and non-cropped lands in each state / region, long-term trials on herbicides / tillage and technologies generated were undertaken.
- A skill development programme was organized for residues chemists to expose them to the latest techniques on herbicide residue analysis at the Directorate.
- Evaluation of the centers based on score card and 'Best Centre Award' were initiated. Additional grants and incentives were given to the better performing centre and winner of the Best Centre Award.
- Greater emphasis was given on publication of the research data generated over the years and bringing out quality publications in reputed journals.
- It was decided to follow a uniform nomenclature as "Annual Review Meeting" instead of workshop or group meeting.
- XXIII Annual Review Meeting was organized for the first time outside the ICAR / SAU system at Jain Irrigation Systems Limited, Jalagaon to expose the participants to corporate culture.
- Salient achievements and happenings of the Directorate were presented and shared with the scientists of AICRP-Weed Management during the Annual Review Meeting. It was desired that all scientists of the project should attend the meeting every year.
- An initiative to maintain 'Parthenium-free campus' was taken with the involvement of students and other staff of the University.

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13. STATUS OF SUBMISSION OF ANNUAL REPORT - 2015

Sl No.	Centre	Received	
		Before due date (31.01.2016)	After due date
Regular centres			
1.	PAU, Ludhiana	-	18.2.2016
2.	UAS, Bengaluru	-	06.2.2016
3.	RVS KVV, Gwalior	30.1.2016	-
4.	GBPUAT, Pantnagar	30.1.2016	-
5.	CSKHPKVV, Palampur	-	16.4.2016
6.	AAU, Jorhat	-	15.2.2016
7.	AAU, Anand	28.1.2016	-
8.	TNAU, Coimbatore	-	09.2.2016
9.	NDUAT, Faizabad	-	02.2.2016
10.	BAU, Ranchi	-	15.2.2016
11.	KAU, Thrissur	27.1.2016	-
12.	OUAT, Bhubaneswar	-	15.2.2016
13.	PJTSAU, Hyderabad	30.1.2016	-
14.	CCSHAU, Hisar	-	15.2.2016
15.	RAU, Pusa	-	24.2.2016
16.	DBSKKV, Dapoli	30.1.2016	-
17.	IGKVV, Raipur	-	11.2.2016
18.	SKUAST-Jammu	-	12.2.2016
19.	PDKV, Akola	31.1.2016	-
20.	CAU, Pasighat	29.1.2016	-
21.	UAS, Raichur	-	13.2.2016
22.	MPUAT, Udaipur	-	11.3.2016
Volunteer Centres			
1	SVBPUAT, Meerut	-	01.2.2016
3.	SKUAST-Kashmir	-	-
3.	PJNCA&RI, Karaikal	29.1.2016	-
4.	BAU, Sabour	-	23.2.2016
5.	ICAR-CIAS, Port Blair	-	16.2.2016

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