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All India Coordinated Research Project on Weed Control

वार्षिक प्रतिवेदन

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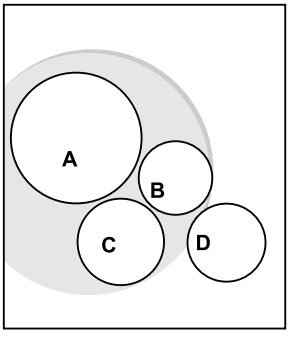

A. Manual weeding in hill slopes under *jhum* cultivation
B. *Leptochloa chinensis* infested rice field
C. *Ipomea pestigridis* infestation in sugarcane ratoon
D. Infestation of *Orobanche aegyptiaca* in tomato

Preface

It is my pleasure to present the Annual Report of the All India Coordinated Research Project on Weed Control (AICRP-WC) for the year 2011-12. This project, initiated by the ICAR in 1978, is mandated to meet the challenges posed by weeds in both the cropped and non-cropped lands in different agro-agroecological situations throughout the country. Presently operating in 22 centers located in 21 state agricultural universities and one central university, besides 6 volunteer centres, intensive research and development efforts related to weed management are being made in major crops including field and horticultural crops in network mode.

During the year under report, five major network programmes were executed: (i) Weed survey and surveillance, (ii) Weed management in crops and cropping systems, (iii) Management of parasitic, invasive, problematic and aquatic weeds, (iv) Herbicide testing, leaching behaviour, persistence, residues and toxicity, and (v) Transfer of technology. The identified technical programme was taken up by different cooperating centres as per protocol approved for the years 2010-11 and 2011-12. Besides, different centres also took up studies of local importance in their state.

All the AICRP-WC centres actively participated in human resource development and transfer of technology related to weed management. Parthenium awareness programme was organized from 16-22 August, 2011, in which, a large number of rallies, exhibitions, seminars and other meetings were organized at all centres as well as some of the ICAR institutes, SAUs and KVKs.

This report contains the significant findings on research and extension activities carried out by the cooperating centres during the period from 1 April, 2011 to 31 March, 2012. I find that the research achievements of direct practical utility have been made by most centres, which have the potential to increase productivity and profitability by a considerable margin. The technologies disseminated to the farmers' fields have shown a greater impact on farm income and livelihood security. I am sure that this information will be useful to the scientists, planners and farmers to further refine their strategies for weed management. I welcome critical comments and suggestions for improving the work efficiency of the AICRP-WC centers as well as quality of this report.

Date: 09.04.2012

(A.R. Sharma)

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The research work carried out in the project is the outcome of the commitment and hard work of the scientists and staff of all the Coordinating Centres. I would like to thank all of them for their active participation. My special thanks are for all the Principal Investigators of Coordinating Centres, viz. Drs. M.S. Bhullar, PAU, Ludhiana; B. Duary, VB, Sriniketan; T.V. Ramachandra Prasad, UAS, Bengaluru; R.A. Yadav, CSAUAT, Kanpur; S.S. Punia, CCSHAU, Hisar; C. Chinnusamy, TNAU, Coimbatore; S.S. Mishra, OUAT, Bhubaneshwar; V. Pratap Singh, GBPUAT, Pantnagar; R.L. Rajput, RVSKVV, Gwalior; J. Deka, AAU, Jorhat; Yogeshwar Singh, RAU, Pusa; M. Madhavi, ANGRAU, Hyderabad; R.B. Patel, AAU, Anand; A.S. Jadhav, MAU, Parbhani; C.T. Abraham, KAU, Thrissur; J. Shekhar, CSKHPKV, Palampur; Jaidev Sharma, NDUAT, Faizabad; R.R. Upasani, BAU, Ranchi M.J. Mane, DBSKKV, Dapoli; A.P. Singh, IGKVV, Raipur; Ramesh Babu, UAS, Dharwad; and O.L. Sharma, SKRAU, Bikaner for their help and cooperation in implementing the technical programme of the project. Thanks are also due to the PIs of the volunteer centres, viz. Dr. B.P. Singh, RBS College of Agriculture, Agra; Dr. Anil Kumar, SKUAT, Jammu, J&K; Dr. Raghuvir Singh, SVBPUAT, Meerut; Dr. S. Soma Sundarum, ADARI, Triuchirappalli; Dr. V.M. Bhale, DPDKV, Akola; Dr. Balasubramanian, ACRI, Madurai for generating and contributing research results in the project.

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(A.R. Sharma)
Director

Contents

Executive summary

Weed survey and surveillance

- Survey and surveillance of weeds under cropped and non-cropped situations was continued at all the coordinating centres following revised protocols.
- In Punjab, survey indicated the development of cross resistance in *Phalaris minor* to clodinafop and sulfosulfuron in near future.
- In Bhind, Datia, Shivpuri and Sheopur districts of MP, mustard crop was infested with *Orobanche aegyptiaca*, whereas Gwalior and Morena was infested with *Asphodelus tenuifolius* weeds during *rabi*. In Bhind, Morena and Datia districts, weedy rice was observed as major weed.
- In Almora and Bageshwar districts of Gujarat, *Phalaris minor, Avena spp., Stelaria media* and *Vicia hirsuta* were the major weeds. During rainy season, in the Champawat district and Lohaghat area of Pithoragarh district, weed flora consisted of *Eluesine indica, Ageratum conyzoides, and Cyperus rotundus.*
- Survey of major crops in Hamirpur district of Himachal Pradesh indicated that *Echinochloa colona, Digitaria sanguinalis* and *Eleusine indica, Commelina* spp*, Ageratum conyzoides*, *Phyllanthus niruri* and *Cyperus iria* were the major weeds.
- Weed survey in Davanagere and Mandya districts of Southern Karnataka, revealed that major weeds in cropped fields were *Cyperus iria, Echinochloa colona, Fimbristylis miliacea, Marselia quadrifoliata* and *Monochoria vaginalis* (in transplanted rice). *Parthenium hysterophorus* is becoming new major weed in Southern dry and Southern transition zones. A new weed similar to *Solanum carolinense* L. is spreading in more areas in Mysore city. *Tithonia diversifolia* (Hemsl.) is slowly spreading all along roadsides around Chikkamagalur. A new weed similar to *Parthenium* with underground roots propagation were noticed on cropped fields and road sides in Southern Karnataka.
- In Jorhat, in tomato, *Panicum repens* and *Alternanthera philoxeroides* were found becoming most problematic. In *Jhum* or shifting cultivation areas with rice based cropping system, in Dima Hasao district, prevalence of Asteracean weeds is one of the interesting feature of this situation which included *Ageratum conyzoides, A. houstonianum, Bidens pilosa, Crassocephalum crepedioides, Elephantopus scaber, Galinsoga parviflora, Gynura* spp., *Mikania micrantha, Siegesbachia orientalis, Spilanthes paniculata, Synedrella nodiflora* and *Tithonia divaricata.*
- In north west zone of Gujarat, in major crops, *Eragrostis major, Dactyloctenium aegyptium, Eleusine indica, Digitaria sanguinalis, Echinochloa crus-galli, Commelina forskalaei, Amaranthus spinosus, Solanum xanthocarpum, Enicostema littorale, Cyperus* spp in *kharif* crops in Kutch district were the dominant weeds.
- *Parthenium hysterophorus* in Salem, Namakkal and Karur districts and *Cyperus*

rotundus were dominant in cropped and non-cropped areas of Krishnagiri, Erode, Dindigul and Vellore districts of Tamil Nadu.

- In rice field, infestation of weedy rice (*Oryza spp*.) and the Chinese sprangletop *(Leptochloa chinensis)* are seen fast spreading in all the major rice growing tracts of Kerala, namely, Kuttanad, Thrissur Kole and Palakad regions. *Leptochloa chinensis* was restricted to the high pH soils of chittur region in Kerala. *Alternanthera philoxeroides,* has been noticed spreading in Kuttanad and Koleland regions.
- In eastern parts of Uttar Pradesh in rice, *Echinochloa colona, E. crusgalli, Eclipta alba, Commelina benghalensis* and *Cyperus* species were the dominant. In the low lying areas of rice, weedy rice (*Oryza nivara, O. sativa f. spontanea* and *O. rufipogon*) were recorded and farmers noticed the increasing severity year after year. In wheat, *Chenopodium album, Rumex spp.*, *Anagallis arvensis* and *Medicago denticulata* were found predominant weeds.
- Weed survey in Southern Telangana Zone of Andhra Pradesh revealed that the predominant weeds in Rangareddy, Hyderabad, Mahabubnagar, Nalgonda, districts were *Echinochloa colona, Echinochloa crus-galli, Cyperus* spp, *Eclipta alba, Cynodon dactylon, Dactyloctenium aegyptium, Parthenium hysterophorus, Celosia argentia, Digera arvensis, Trianthema portulacastrum, Commilina benghalensis, Alternanthera sessilis* and *Amaranthus viridis.*
- In Hamirpur area of Uttar Pradesh, linseed and chickpea crops were severely infested by *Convolvulus arvensis.* In Jalaun district, in non-cropped area, *Croton sparsiflourus;* in Fatehpur district, in coriander, *Phalaris minor* and *Rumex dentatus;* in Banda district, in linseed crop *Pharthenium hysterophorus* were the dominant ones.
- Survey in Birbhum district under Red and Lateritic Zones in weeds in vegetables revealed infestation of weeds *viz. Ganphalium indicum, Gnaphalium purpureum Polygonum plebeium, Chenopodium album, Anagallis arvensis, Spergula arvensis, Digitaria sanguinalis* and *Cyperus rotundus* ; and in *rabi* pulses (chickpea and lentil), *Polygonum plebeium, Gnaphalium purpureum* and *Cyperus rotundus*.
- Weed survey in wheat and chickpea on Ranchi – Gumla road revealed that *Ludvigia parviflora*, *Cyperus iria, Fimbristylis milliaceae*, *Panicum repense* and *Digitaria sanguinalis* were the most dominant species in transplanted rice.
- In East and South-eastern Coastal Plain zone of Orissa, weed flora in pulses was dominated with *Echinochloa colona*, *Digitaria ciliaris*, *Ageratum conyzoides*, *Amaranthus viridis, Spaeranthus indicus* and sedges like *Cyperus rotundus*. From Bhubaneswar to Puri route, weed composition in transplanted rice was dominated with *Panicum repens*, *Echinochloa crus-galli*, *Paspalum scorbiculatum*, *Ludwigia parviflora*, *Alternanthera sessilis, Ammania bacifera, Cyperus iria* and *Fimbristylis miliaceae*.
- Based on information of 146 farmers, *P. minor* with IVI value of ≥ 70 was one of the major weeds in Karnal, Kaithal, Ambala, Fatehebad and Jind districts of Haryana, where as in Bhiwani, *Chenopodium album, Asphodelus tenuifolius* and *Chenopodium murale* were

the dominant weeds of wheat.

- In Raipur, weed surveillance study revealed that *Alternanthra triandra* in cropped fields especially direct seeded rice which occupies around 70% area in state, has emerged as a new havoc. Another weed invading the non-cropped area is *Malwa pusila.* The intensity of this weed is multiplying rapidly. However, it is replacing *Parthenium hysterophorus.* If the multiplication is continued, undoubtedly it is going to invade cropped area within a short period.

Biology and management of herbicide resistant biotypes- *P. minor*

- In Ludhiana, for management of isoproturon resistant populations of *P. minor,* pinoxaden and clodinafop were the most effective herbicides. Another study on development of cross/multiple resistance in *P. minor* clearly showed that there are strong indication that at farmers fields the *P. minor* is fast developing resistance against recently recommended herbicides *viz*. pinoxaden and meso + iodosulfuron along with commonly used herbicides clodinafop and sulfosulfuron.
- In Haryana, 163 farmers were interviewed for poor efficacy of herbicides against *P. minor* in wheat, and it was noted that only 4% farmers used recommended dose of clodinafop with 22% control of *P. minor* where as 25 % farmers used double to recommended dose of clodinafop with only 35.7 % control of *P. minor*, indicating development of cross resistance against clodinafop herbicide in Tohana, Kaithal, Pehowa, Safidon, Karnal areas. In Yamuna Nagar, parts of Ambala and Kurukshetra, where wheat is grown in sugarcane and potato based crop sequences, situation is comfortable. In these areas, 46 % farmers used recommended dose of clodinafop with 81.6% control of *P. minor* where as only 26% farmers who are not following crop rotation, have to go for sequential application or double dose of clodinafop with only 41 – 7.5 % control.
- Increased doses of clodinafop (75 g/ha), sulfosulfuron (30 g/ha), pinoxaden 50-60 g/ha and recommended doses of mesosulfuron + iodosulfuron (14.4 g/ha) and pinoxaden (50 g/ha) provided effective control of *P. minor* in wheat in Uttarakhand. Resistance was again observed in the seed lots collected from farmers' fields in Nainital and U.S. Nagar districts. Plants from 12 out of 16 locations exhibited resistance to isoproturon at recommended and double doses.
- *Echinochloa colona* showed no resistance against butachlor under red and lateritic zone of Sriniketan.

Effect of CO_2 enrichment on growth and development of weed species

- Bengaluru centre reported that, *Parthenium hysterophorus* and *Ageratum conyzoides* had higher ED_{50} in elevated CO_2 condition, whereas *Cyperus rotundus* had lower ED_{50}
- Thrissur centre reported that, in C3 plants like *Ludwigia,* positive effect of CO_2 enrichment on all the growth parameters was observed. However, in the case of a C4 plant like *Echinochloa* the effect is not so evident.

Study on biology and management of *Echinochloa* and wild rice

- *Oryza nivara* and *Oryza sativa* (*fatua*) are the two major species of weedy rice in the region (Raipur). Similar reports were also reported by Faizabad centre in rice fields in Ghazipur, Mau and Ballia districts of eastern Uttar Pradesh. Infestation of weedy rice varied from 10-50 % in direct-seeded rice (Palampur). Four species of weedy rice, namely, *Oryza rufipogon, O. barthii, O. minuta* and *O. nivara* were identified during the reporting period (Sriniketan).
- *Echinochloa colona* (0.20 g) recorded 9.1 % less dry weight than *Echinochloa crus-galli* (0.22 g) at 25 days after emergence (Bhubaneswar). Germination studies at Thrissur revealed the presence of staggered dormancy .

Weed management in crops and cropping systems

- Post-monsoon sowing lowered the dry weight of weeds and increased yield of rice (Kanpur, Bhubaneswar, Faizabad, Pantnagar, Coimbatore, Ranchi, Dapoli). While Parbhani centre reported paddy crop sown before onset of monsoon recorded significantly more grain yield. Time of sowing did not influence grain yield significantly (Raipur, Palampur and Bengaluru.
- Significantly higher grain yield and net return under direct seeded rice were recorded from butachlor 1.5 kg/ha *fb* one hand weeding followed by pretilachlor 0.5 kg/ha+ safener + hand weeding 30 DAS (Raipur, Kanpur, Bhubaneswar, Jorhat, Sriniketan, Bengaluru, Coimbatore, Dapoli, Parbhani. Pantnagar and Faizabad reported the similar results but followed by cyhalofop butyl 90 g/ha and 2, 4-D 0.5 kg/ha. Azimsulfuron, chlorimuron and cyhalofop butyl also proved as effective as weed free (Palampur).
- In direct-seeded rice, irrespective of time of sowing (before onset or after onset of monsoon), either pre-emergence application of butachlor at 1.5 kg/ha followed by one hand weeding at 30 DAS or post-emergence application of fenoxaprop-p-ethyl (60 g/ha) + metsulfuron methyl + chlorimuron ethyl (4g/ha) or cyhalofop-p-butyl (100 g/ha) + 2,4 D (0.5 kg/ha) were effective in realizing higher grain yield and efficient weed control as reported by Hyderabad centre.

Effect of rice establishment techniques under different weed management practices

- Transplanted method of rice establishment technique performed better in terms of significant reduction in weed intensity and higher grain yield (Jorhat, Bhubaneswar, Kanpur) . Application of pretilachlor 0.75 kg/ha + mechanical weeding resulted significantly lowest values of weed density and dry matter production at all the growth stages followed by use of 'cono weeder' (Jorhat). Reports from Ranchi indicated that drum seeded rice recorded significantly higher total (379/m^2) and effective (257/m^2) tillers.
- Normal transplanting and SRI were superior to drum seeding and broadcasting of rice (Bengaluru, Pantnagar, Sriniketan, Coimbatore, Hyderabad, Thrissur and Pusa). Pre-

emergence application of pyrazosulfuron ethyl 25 g/ha fb mechanical weeding (45 DAS/P) was very effective in lowering weeds of all types and gave higher yield (Bengaluru, Bhubaneswar, Kanpur, Sriniketan, Coimbatore, Hyderabad, Ranchi and Pusa). Chemical weeding was economical and equally effective (Thrissur).

Efficacy of herbicides for controlling weeds in direct-seeded rice

- Pretilachlor 750 g/ha, hand weeding at 20 and 40 DAS, pyrazosulfuron 25 g/ha and oxyfluorfen 300 g/ha +2,4-D 500 g/ha resulted lowest weed density and dry weight at different growth stages (Jorhat, Coimbatore, Bengaluru, Ranchi and Meerut).
- Combined application of fenoxaprop along with chlorimuron 60 + metasulfuron 20 g/ha gave the highest grain yield in direct dry seeded rice (Pantnagar, Bhubaneswar, Bengaluru, Parbhani, Hyderabad, Dapoli and Meerut).
- Minimum weed population/m^2 and dry weight was recorded with application of cyhalofop butyl (90 g/ha) + almix (4 g/ha) fb application of bisbyribac (25 g/ha) (Palampur, Bhubaneswar, Bengaluru, Hyderabad and Sriniketan).
- Two hand weeding, azimsulfuron, bispyribac sodium and fenoxaprop + ethoxysulfuron were effective at Pusa.
- Post-emergence mixture of fenoxaprop + ethoxysulfuron on 30 DAS was found effective in aerobic rice at Coimbatore.

Evaluation of metribuzin in combination with clodinafop, sulfosulfuron and pinoxaden for weed control in wheat

- In wheat, clodinafop and pinoxaden alone provided effective control of *Phalaris minor*. Tank mixing of these herbicides with metribuzin helped in controlling *Rumex dentatus* and *Chenopodium album*. Sulfosulfuron alone provided effective control of *P minor, Medicago denticulata and C. album* (Ludhiana and Hisar).
- Tank mix application of pinoxaden 50 + metribuzin 122.5 g/ha or clodinofop – propargyl 60 + metribuzin 122.5 g/ha were found most effective against grassy as well as broad leaved weeds (Pantnagar, Faizabad and Palampur).
- Combined application of sulfosulfuron + pinoxaden (25 +40 g/ha) was effective to control grassy as well as broad leaf weeds in wheat at Gwalior.
- Application of clodinafop +metribuzin 60+122.5 g/ha) and sulfosulfuron + metribuzin 25 + 105 were significantly superior herbicides in wheat (Pusa, Raipur, Meerut and Agra).
- Tank mixing of sulfosulfuron + pinoxaden showed antagonism at Ludhiana.

Integrated weed management in maize

- Integration of all the herbicides with one hoeing reduced the population of grasses as compared to use of respective herbicide alone (Ludhiana and Bengaluru). Oxyfluorfen 0.2 kg/ha alone and oxyfluorfen/ atrazine both fb one hoeing and two hoeing recorded the highest maize grain yield (Ludhiana and Parbhani).

- Application of pendimethalin, oxyfluorfen or atrazine as pre-emergence at 3 DAS fb mechanical weeding at 30 DAS and oxyfluorfen fb 2,4-D Na salt at 30 DAS were effective at Bengaluru, Palampur, Dharwad, Hyderabad and Akola.

Weed management in sugarcane-ratoon

- Pre-emergence application of metribuzine 0.88 kg/ha with one HW at 45 DAP and application of 2,4-D Na salt 0.5 kg/ha at 90 DAP recorded significantly the lowest weed density both at 120 DAS and at harvest. Integration of metribuzine with hoing and POE application of 2,4-D recorded the highest net return (Bhubaneswar, Pantnagar and Ludhiana).
- Best combinations against complex weed flora in sugarcane ratoon were found to be atrazine 1500 g/ha *fb* 2,4-D amine 750 g/ha, or metribuzin 880 g/ha *fb* hoeing *fb* 2,4-D amine 750 g/ha (Hisar).

IWM in autumn planted sugarcane intercropping system

- Farmers practice treatment of weed control (3 manual weeding) in sugarcane + wheat fb sugarcane + mustard intercropping was found most promising combination to reduce the weed density and dry weight and recorded highest cane equivalent yield and net return(Faizabad and Kanpur).

Long term trial of tillage in different cropping systems

- Wheat sown with zero till methods gave significantly higher grain and straw yield over conventional methods of sowing. Highest grain yield of wheat was obtained with hand weeding twice and at par with application of isoproturon 1.0 kg + metsulfuron methyl 4 g/ha. In transplanted rice application of butachlor 1.5 kg/ha fb 2,4–D 0.5 kg/ha recorded at par grain yield over hand weeding twice (GBPUAT, NDUAT).
- Conventional - conventional method and conventional-zero method of tillage and butachlor 1.5 kg/ha pre-emergence + 2,4-D 0.5 kg/ha post- emergence in rice and isoproturon 0.75 kg/ha + 2,4-D 0.5 kg/ha post-emergence in wheat produce significantly higher grain yield at Ranchi.
- At Kanpur, in rice, conventional tillage and application of pendimethalin (1.0 kg/ha) followed by chlorimuron+metsulfuron (4 g/ha) was recommended for rice to reduce the weed density, their dry weight significantly and enhancing the net income.
- In rice-rice cropping system, integration of ZT-ZT method and use of butachlor 1.5 kg/ha gave the maximum B: C ratio of 1.85 at Bhubaneswar.

Long term herbicide trial in different cropping systems

- In transplanted lowland rice-rice cropping system, at Coimbatore, shift in weed species from *Echinochloa colona* to *Panicum distachyon* and absence of *Eclipta alba* was observed. Integration of weed control by butachlor + 2,4-DEE with 100% inorganic nitrogen recorded maximum yield.

- In summer rice- *kharif* transplanted rice cropping system, use of pretilachlor during summer and hand weeding resulted in higher paddy yield at Bengaluru.
- In rice-wheat cropping system, In wheat, 2,4-D against *Coronopus* and *Rumex dentatus*; sulfosulfuron against *Rumex dentatus.* Metsulfuron effectively controlled all the broadleaf weeds. In rice, anilofos gave good control of *Ischaemum rugosum* and was relatively more effective and metsulfuron effectively controlled broadleaf weeds and sedges at Ludhiana. The highest grain yield of rice was found with application of bispyribac sodium 25 g/ha while in wheat with application of sulfusulfuron 25 g/ha at Pantnagar.
- At Hisar, in wheat, broadleaf weeds were more and *Phalaris minor* was less under non-green manured plots. Grain yield of rice and wheat was more under green manuring. The performance of continuously used clodinafop in wheat and butachlor in rice provided effective control of weeds.
- Application of chlorimuron+metsulfuron 4g/ha PoE alone or in combination with butachlor 1.5 kg/ha PE in rice and isoproturon 1.5 kg/ha + 2,4-D 0.5 kg/ha in wheat can be practiced for higher productivity and profitability of rice – wheat cropping system at Ranchi.
- In rice fallow maize system, highest grain yield was obtained with hand weeding twice and pre-emergence application of butachlor 1.0 kg/ha, post-emergence application of cyhalofop-p-butyl at 100g/ha at Hyderabad. In rice-groundnut system, application of butachlor + 2, 4-DEE rotated with pretilachlor without OM in rice along with use of alachlor in groundnut recorded significantly the lowest weed density (53.0 $m/^{2}$) in groundnut during initial stages of crop growth (25 DAS).In rice, at the initial stages of crop growth (25 DAS), use of herbicides reduced the weed density by 70 % over hand weeding and the treatment of butachlor 0.75 kg/ha + 2,4-DEE 0.4 kg/ha without OM recorded the lowest weed density at Bhubaneswar.
- In maize, IC + HW twice and pre emergence application of tank mix of pendimethalin (0.25 kg/ha) with atrazine (0.50 kg/ha) at 30 DAS produced lowest weed density. In wheat, **higher** grain yield was recorded in hand weeding and pre-emergence application of pendimethalin 0.50 kg/ha and post-emergence application of MSM 4.0 g/ha at Anand.

Long term trial

- In rice-chickpea cropping system, in rice, butachlor or anilofos fb by one hand weeding recorded the highest grain yield. In chickpea crop at 60 DAS, alone application of pendimethalin 1.0 kg was found effective against all the sedges and broad leaved weed except *Medicago denticulata* and *Fumaria parviflora* where pendimethalin 0.75 kg supplemented with one hand weeding also recorded the lowest density. Free living bacteria P solubilizers were more under hand weeding as compared to herbicidal application at Pantnagar, Faizabad and Pusa.

Rice-wheat cropping system

- In rice-wheat cropping system, treatments applied to rice did not have any residual effect on the performance of wheat crop at Jorhat and Jammu. Microbial population over five years showed an initial decrease during first three years in herbicide treated soil in both the crops. Nevertheless, the microbial population of *Azotobacter*, *Azospirillum* and PSB remained smaller than the untreated weedy or mechanical weeding plots at Jorhat.
- In rice, application of anilophos 0.5 kg/ha was effective for minimizing weed density and increasing grain and straw yield over weedy check. Grain yield of wheat was recorded highest under mechanical weeding treatment which was at par with isoproturon 1.0 kg/ha and isoproturon 0.75 kg/ha tank mix 0.1% surfactant at Pusa.

Maize/ pearl millet-chickpea/ lentil/ pea cropping system

- In maize/ pearl millet-chickpea/ lentil/ pea system, weed control treatments applied to maize did not influence the infestation of weeds in succeeding crops at Pusa. Pendimethalin 0.75 kg/ha fb hoeing significantly reduced the dry matter of *P minor*, *Rumex* and *Coronopus,* and recorded the highest field pea and chickpea seed yield and was significantly better at Ludhiana.
- In chickpea rhizosphere, at 3 DAT bacterial population in pendimethalin treated plot was very low as compared to mechanical weeding at Hisar.
- In pearl-millet, pre-emergence application of atrazine at 0.75 kg/ha gave higher yield levels. Pre-emergence pendimethalin 0.75 kg/ha followed by a mechanical weeding treatment gave higher pooled seed yield of gram 1420 kg/ha than weedy check (570 kg/ha), the increase in seed yield with this treatment over weedy check was 850 kg/ha at Bikaner.
- At Pantnagar, in maize, application of atrazine+2,4-D (0.75 + 0.5 kg/ha) had significant effect on grain yield of pea.
- In maize, application of atrazine 0.75 kg/ha as PE fb 2,4-D as PoE (30 DAS) and in chickpea, application of pendimethalin 0.75 kg/ha fb hand weeding (30 DAS) significantly reduced weed population, weed dry matter ,gave highest weed control efficiency and resulted in maximum grain yield of crop at Akola.

Management of parasitic/ invasive/ problematic/ aquatic weeds

Management of *Cuscuta* in Lucerne

- In lucerne, deep summer ploughing; application of imazethapyr at 75 g/ha and pre-emergence pendimethalin at 1.0 kg/ha applied as sand mix controlled dodder (*Cuscuta*) a and produced significantly higher pooled green fodder yield at Bikaner. In niger, similar treatments gave significant control of dodder at Bhubaneswar. For effective control of *cuscuta* in *rabi* lablab bean crop the field should be ploughed before sowing and pendimethalin 1.0 kg/ha be applied as pre- emergence with sand mix for obtaining higher yield and net returns at Dapoli.

Management of Orobanche in tomato, potato, tobacco and brinjal-based system

- Application of pendimethalin 1.0 kg/ha recorded the lowest density per brinjal plant (9.2) at 30 DAP followed by neem cake 200 kg/ha (10.2). Soil solarization resulted 6.7% more yield at Bhubaneswar. In tomato, use of metribuzin 0.5 kg/ha, pendimethalin 1.0 kg/ha and oxyfluorfen 0.1 kg /ha – all at 3 DAP lowered and delayed emergence of *Orobanche* by 10 – 15 days than usual emergence of 50 – 60 days after planting at Bengaluru.

Management of *Striga* in maize, sorghum, pearl millet and sugarcane based system

- In early planted sugarcane, pre-emergence application of atrazine 1.0 kg/ha +2,4-D Na salt 1.0 kg/ha + urea 1% + soap solution 1% as POE on 75 DAP followed by mulching with cane trash after final interculitvation on 120 DAP was found effective at Coimbatore.

Herbicide residues, persistence, leaching behaviour and toxicity

Studies on herbicide residue in food chain, soil and ground wate

- In wheat, 2,4-D sodium salt at double the recommended dose (1.0 kg/ha) and sulfosulfuron 25 g/ha persisted in soil up to 45 days after application. 2,4-D 0.5 kg/ha, Clodinafop (60 g/ha), metribuzine (175 g/ha) and pinoxadin (50 g/ha) persisted in soil up to 30 DAA and pendimethalin applied to soybean 1.0 and chlorimuron ethyl 9 g/ha persisted in soil up to 45 days. Atrazine applied to pearlmillet 0.5 kg/ha either alone or along with 10 q/ha FYM to pearlmillet persisted in soil for 45 days. No residues of atrazine were left after harvest of crop as per bioassay method using barley as test crop at Gwalior.
- Residues of pretilachlor in direct-seeded rice soils when applied at recommended dose of 1.0 kg/ha were recorded up to 45 days and at 2. 0 kg/ha were observed up to 60 days. In post harvest soil, grain and straw samples, the residues were below detectable limit of 0.001ppm at Bhubaneswar.
- Residues of butachlor and pretilachlor in rice grain and straw and in groundwater after harvest of the crop were below detectable level (10 ppb) at Jorhat. No residues of isoproturon and butachlor were detected in ground water at Pantnagar. No residue of atrazine, pendimethalin was detected in maize-chickpea and field pea cropping systems at Ludhiana.
- Residues of pendimethalin and oxyfluorfen applied to cabbage (*B oleracea* var capitata) transplants, peas (*Pisum sativum*) and garlic (*Allium sativum*) are safe for use in vegetable crops at Ludhiana.
- In maize soil and crop produce, atrazine at 1 kg/ha persisted in soil up to harvest while up to 90 days at 0.5 kg/ha at application rate. However, fifty per cent of applied herbicide was degraded from the soil before 30 days after application and residue of atrazine was below detectable limit in maize grain and straw at Coimbatore.

- In tea plants more than 75 per cent of glyphosate was lost in 15 days after herbicide application. Half life in tea leaves varied from 5.8 to 7.9 days at Palampur.

Studies on herbicide persistence in water

- Paraquat residues were detected up to the fifteen days from the application of herbicide. pH and EC(dSm^{-1}) of water at various intervals were influenced by application of paraquat in water for management of water hyacinth at Anand.
- Dissipation of 2,4-D was relatively rapid and more than 90 per cent of applied amount was degraded from the aquatic system and only 2 per cent of the applied 2,4-D was recovered in the water at 10 days after its application at double dose in water hyacinth at Coimbatore. Persistence of paraquat residues in the aquatic system covered with *Alternanthera philoxeroids* was less than two weeks at Thrissur.

Adsorption and desorption behaviour of herbicides

- Total amount of atrazine adsorbed increased with increasing initial concentration from 2.5 to 25 µg/ml of equilibrium solution (25 µg to 250/µg/g soil). The amount of atrazine adsorbed varied from 18.0 to 141.2 µg/g at Anand. Adsorption of oxyfluorfen in different soil types was evaluated. Increase in the concentration of oxyfluorfen increased its adsorption. Amount of adsorbed oxyfluorfen desorbed from soil is in the range of 0.38 to 35.2 per cent at Coimbatore.
- Butachlor and pretilachlor are strongly adsorbed on laterite soil and their adsorption onto soils is enhanced by the presence of organic matter i.e. FYM retained more quantity of herbicides than vermicompost at Thrissur.

Transfer of Technology

Parthenium- management by *Zygogramma* beetles

- Use of bioagent, *Zygogramma* bicolorata against *Parthenium* resulted in significant control at Raipur, Pantnagar, Coimbatore, Bengaluru, Hyderabad, Palampur. Larval population, eggs and adults of *Zygogramma* beetles were highest during August to September at Pantnagar and Hisar. Large scale establishment of the beetles under natural condition and considerable damage on *Parthenium* have been successfully observed in 2011 at Sriniketan.

On Farm trial (OFT)

- In pearlmillet, imazethapyr 100 g/ha PoE gave 43.99% (Rs. 8072/ha net return) higher yield. In pigeon pea crop, atrazine 0.5 kg/ha PE was more effective for controlling weeds and resulted 42.11% higher yield over weedy check (Net income Rs. 36380/ha) at Gwalior.
- On Farm trials on groundnut in Mangalpur, Pipili, Puri district during 2010-11 revealed that highest yield was obtained in the plots applied with oxyfluorfen 0.05 kg /ha (2570 kg/ha) followed by pendimethalin 0.5 kg/ha (2400 kg/ha). The saving in weeding cost over farmers practice was in the tune of Rs 1950 to Rs 2100/ha at Bhubaneswar.

- On farmer's field, application of clodinofop (60 g/ha) + metsulfuron methyl (4 g/ha) in transplanted rice, atrazine (500 g/ha) in barnyard millet and finger millets in hills, whereas, application of vesta 15 W. P. (clodinofop 15% + metsulfuron methyl 1 %) (60 g/ha) in wheat and Bispyribac – sodium (20 g/ha) in transplanted rice recorded higher yield in plains as compared to farmers practices at Pantnagar.
- At Jorhat, weed management in upland direct-seeded rice was conducted in 8 locations during 2011 in two districts, viz., Golaghat and Jorhat of the state with the treatments pretilachlor 0.75 kg/ha + grubber 35 DAS, butachlor 1.0 kg/ha + grubber 35 DAS and Farmers' practice. The highest mean grain yield of 3230 kg/ha was observed with pretilachlor 0.75 kg/ha + grubber at 35 DAS.
- Weed management in potato at farmer's field revealed that metribuzin applied 0.35 kg/ha at 10 days after transplanting or post emergence application of paraquat 0.5 kg/ha before emergence of crops showed higher potato yield at farmer's fields at Anand.
- At Hisar, based on results of 7 on farm trials, Taarak at 250 g/ha provided 80% control of *Echinochloa spp* where as bispyribac at 250 g/ha gave 82 % control of grassy weeds. Maximum grain yield of 7000 kg /ha was obtained with the use of Nominee Gold which was 2.94 % higher than Taarak.
- At Sriniketan, ten on-farm trials in rice, two in yellow sarson and two in potato were conducted to demonstrate the effect of improved weed management practices on weed management and yield as compared to farmer's practice. Pyrazosufuron ethyl + HW, reduced tillage (paraquat / glyphosate 1.0 kg/ha before puddling + one puddling) + HW, pretilachlor + HW, Almix + HW in rice; isoproturon, fenoxaprop-p-ethyl in yellow sarson and metribuzin, pendimethalin + EU effectively controlled weeds and gave more yield economic return.
- At Coimbatore, at three locations, pre-emergence application of pendimethalin 0.75 kg + imazethapyr 60 g/ha on 15 DAS for broad spectrum weed control and higher seed yield and economic returns in green gram and black gram was observed.
- At Bengaluru, under on-farm trials in transplanted rice in southern dry zone, use of bensulfuron methyl 0.6% G at 60 g /ha + pretilachlor 6% G at 600 g /ha - 3 DAP and pyrazosulfuron ethyl 25 g/ha – 3 DAS gave 12 - 17% higher yield than hand weeding and gave additional returns of Rs. 8590 to 12,930/ha over farmers' practice.
- Chemical weed control in farmers' field could increase the grain yield of transplanted and direct-seeded puddled rice by 15.2 and 25.2%, respectively over the farmers' practice at Palampur.
- At Hyderabad, in rice, application of bensulfuron methyl + pretilachlor at 5 DAT resulted effective weed control with a saving of Rs 1200-2200/ha on cost of weed management and with a net profit of Rs. 2900-6200/ha. In groundnut, application of imazethapyr (PO) coupled with pendimethalin (PE) resulted in a net profit of around Rs.3014 to 11590/ha when compared with farmers' practice.

WS 5.5 Impact analysis of weed management

- At Gwalior, maximum farmers are using inter-cultivation operation for control of weeds. Two third are aware of chemical method of weed control, whereas only 5% farmers were using mechanical weed control method (Hand hoe).
- At Pantnagar, mechanical weeding, hoeing and intercultivation tillage operations were more prominent in sugarcane. Small and marginal farmers are still using the mechanical and manual weeding in wheat, rice, pulses and vegetables. Use of herbicides was higher in *Tarai* and Bhabar areas compared to *Bhabar* and hilly areas of Uttarakhand, particularly in wheat and rice crop. Majority of the farmers are adopting mechanical and chemical weed control methods at Jorhat.
- At Palampur, extent of yield gain due to adoption of weed management technology was 8-10 q/ha in wheat, where as in rice crop it was 12-15 q/ha. Sixty eight percent (68%) farmers are satisfied with weed management technology adopted by them in wheat crop where as in rice, 100% are satisfied by adopting weed management technology. Farmers are well aware of weed management options in wheat and adopt chemical means to control weeds in wheat crop because of severe infestation of *P. minor* in rice-wheat cropping system.
- Adopters of integrated weed management obtained an increased onion yield to the level of 3.88 t/ha. The difference in the farm income was Rs.59957/ha between the adopters and the non adopters. It has clearly indicated the importance of IWM in controlling the weed flora in onion at Coimbatore.
- At Ranchi, farmers have adopted butachlor 1.5 kg/ha PE in rice for weed control.

1.0 Organization and Functioning of AICRP on Weed Control

1.1 Introduction

Weed research programme in the country started with the 'All India Coordinated Research Project on Weed Control (ICAR) in collaboration with the United States Department of Agriculture (FERRO) at six locations, i.e. 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.) to take up both fundamental as well as applied aspects of weed management in different field and plantation crops. The coordinating unit of project was attached initially with the Central Rice Research Institute, Cuttack (Orissa). The project came into operation in April, 1978 with the financial outlay of Rs. 42,97,039 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 further extended covering seven 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. 58,10,750 for five years. The work at these centres was effectively implemented since 1982-83 to 1986-87.

In the third phase, nine 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 a total outlay of Rs. 63,85,734 for four years (1985-86 to 1989-90) with the assistance of USDA under USIF funds.

In the 8th Plan, four 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 at a total outlay of Rs. 16,41,000. Seventy five per cent of the total budget required by each centre (100% budget to Visva Bharati, Sriniketan) is provided by the ICAR and the remaining 25% is met from the state department of agriculture as a state share.

The coordinating unit of the project was shifted from CRRI, Cuttack to Jabalpur after the establishment of NRC Weed science in 1989. Later in 2009, NRC for Weed Science was upgraded to Directorate of Weed Science Research.

1.2 Mandate

- To conduct coordinated trials for developing location-specific weed management technology.
- To demonstrate the weed management technologies.

1.3 Objectives

- ❖ Survey of weed flora, mapping their distribution, ecology and habitat
- ❖ Identification of new herbicides and working out weed competition threshold levels
- ❖ Improving efficiency of existing herbicides
- ❖ To work out effective and economic weed control schedules for field and plantation crops and in different aquatic conditions
- ❖ Studies on biology and control of problem weeds including aquatic and parasitic weeds
- ❖ To study long-term residual and cumulative effects of herbicides, if any
- ❖ To standardize bioassay technique for estimating herbicide residues in soil, crop and water systems
- ❖ Basic research at different centres having adequate laboratory facilities for rendering support to adoptive research.
- ❖ To work out soil-herbicide interaction with reference to pollution hazards
- ❖ Testing of available tools/implements for weed management under various management systems

Training extension personnel in weed management at different centres, on-farm research programme etc.

AICRP-WC Coordinating Centres

1	CSKHPKV, Palampur
2	PAU, Ludhiana
3	CCSHAU, Hisar
4	GBPUAT, Pantnagar
5	RAU, Bikaner
6	NDUAT, Faizabad
7	CSAUAT, Kanpur
8	RVSKVV, Gwalior
9	RAU, Pusa
10	BAU, Ranchi
11	VB, Sriniketan
12	AAU, Anand
13	IGKV, Raipur
14	**HQ, DWSR, Jabalpur**
15	OUAT, Bhubaneswar
16	AAU, Jorhat
17	MAU, Parbhani
18	DBSKKV, Dapoli
19	ANGRAU, Hyderabad
20	UAS, Dharwad
21	TNAU, Coimbatore
22	KAU, Thrissur
23	UAS, Bengaluru

2.0 Staff Position and Expenditure

AICRP-Weed Control is presently under operation in 22 State Agricultural Universities in 19 different states of the country. These centres also represent 19 agro-ecological regions. Altogether, 72 scientists of different disciplines (Agronomy, Plant Physiology, Taxonomy, Residue Chemistry, Microbiology and Economics) are working in inter-disciplinary mode. Besides 22 main centres, 6 volunteer centres are also in operation. The details of staff position and funds allocated in the financial year 2011-12 are given below:

Staff position and expenditure during 2011-12

Centre	Total		
	S	F	Budget Allocation (Rs in lakh)
PAU, Ludhiana	10	08	138.16
UAS, Bengaluru	10	09	93.84
RVSKVV, Gwalior	09	09	91.28
GBPUAT, Pantnagar	10	08	51.32
CCSHPKV, Palampur	10	10	73.72
AAU, Jorhat	10	10	110.45
MAU, Parbhani	10	09	47.69
AAU, Anand	10	09	92.77
TNAU, Coimbatore	10	10	54.80
NDUAT, Faizabad	09	09	93.83
V.B., Sriniketan	07	07	25.76
BAU, Ranchi	07	07	47.67
CSAUAT,Kanpur	06	06	34.90
KAU, Thrissur	07	06	64.11
OUAT, Bhubaneshwar	07	06	71.58
ANGRAU, Hyderabad	06	05	77.08
CCSHAU, Hisar	07	07	48.20
RAU, Pusa	07	03	32.50
DBSKKV, Dapoli	05	05	24.08
IGKVV, Raipur	05	05	27.70
UAS, Dharwad	05	04	34.45
RAU, Bikaner	05	03	26.84
Total	**172**	**155**	**1362.73**

*100% ICAR share; including VI Pay Commission arrears: approved R.E. 2011-12

3.0 Research Achievements

WS 1: Weed survey and surveillance

WS 1.1 Weed survey

PAU, Ludhiana

The survey conducted in Punjab to assess the development of cross resistance in *P. minor* to recommended herbicides indicated that the efficacy of two widely used herbicides, viz. clodinafop and sulfosulfuron is decreasing with every passing year and pointed clearly towards the development of cross resistance in *P. minor* to clodinafop to a large extent. Sulfosulfuron is likely to meet the same fate in the near future. Proper monitoring of the existing herbicides is desirable before the situation does out of control on farmers' fields.

RVSKVV, Gwalior

In Bhind, Datia, Shivpuri and Sheopur districts, mustard crop were infested with *Orobanche aegyptiaca*, whereas, Gwalior and Morena were infested with *Asphodelus tenuifolius* during *rabi*. During *kharif* 2011, weed survey was done in rice grown in Gwalior, Bhind, Morena and Datia. In Gwalior, the major weed was *Echinochloa crusgalli,* followed by *Cynotis axillaris*. In Bhind, the major weed was weedy rice*,* followed by *Cynotis axillaris.* In Morena and Datia, major weeds were: *Echinochloa colona and w*eedy rice.

GBPUAT, Pantnagar

In the Almora and Chamoli (1000-1200 msl), the major weed flora during winter season consisted of *Avena ludoviciana, Medicago sativa, R. acetosella, Coronopus species, Chenopodium album* and *Cyperus rotundus*. In Almora and Bageshwar (1220-1800 msl), the weed flora consisted of *Phalaris minor, Avena spp., Stelaria media* and *Vicia hirsuta.*

During rainy season, in the Champawat district and Lohaghat area of Pithoragarh district, the major weed flora consisted of *Elusine indica, Ageratum conizoides, and Cyperus rotundus.* Besides, a number of weed species although at lower density were found which included *Oxalis latifolia, Euphorbia hirta, Cleome viscose, Parthenium hysterophorus* and *Ganinsoga parviflora*.

CSKHPKV, Palampur

Weed survey was conducted during *kharif,* 2011 in district Hamirpur which covers two agro-climatic zones, viz. Zone I (Submontane low hills subtropical having an altitude of 350-650 m amsl) comprising Sujanpur, Khirki, Bara, Nadaun, Amlaher, Dhaneta, and Jangalberi, etc. and Zone II (Mid-hill sub-humid zone having an altitude of 651-1800 m amsl) comprising of Dandru, Jor Ber, Har, Aghar, Ladrour, Bhareri, Jahu, Ukhali, Dhangota, Bijhar, Bhoranj, Awah Devi, Tauni Devi, Uhal, Utpur and Kakkar, etc. The soils of this district are sandy loam to silty clay loam in texture. The important crop rotations of the district are maize-wheat, rice-wheat, sesame/urdbean-wheat, maize-potato, sugarcane, etc. The district was surveyed along following three routes by using GPS and quadrat at every 5-10 km distance.

Route(s) of weed survey: *kharif*, 2011

S. No.	Route	Altitude (msl)	Latitude (N)	Longitude (E)
Route-I	Sujanpur,	601	31° 49' 3.2"	76° 29' 2.7"
	Khirki,	641	31° 47' 6.7"	76° 27' 1.4"
	Bara,	533	31° 46' 2.9"	76° 23' 8.5"
	Nadaun,	492	31° 46' 5.6"	76° 23' 6.5"
	Amlaher,	541	31° 45' 5.5"	76° 19' 8.4"
	Dhaneta,	613	31° 39' 9.6"	76° 22' 4.1"
	Techh,	733	31° 35' 6.6"	76° 25' 5.3"
	Dandru,	759	31° 34' 1.0"	76° 25' 9.5"
	Jor Bar,	785	31° 32' 5.1"	76° 26' 9.2"
	Har,	881	31° 33' 9.3"	76° 30' 1.0"
	Aghar	884	31° 36' 0.4"	76° 35' 0.7"
Route-II	Bhoranj (Behlag),	893	31° 39' 0.7"	76° 39' 2.7"
	Bhareri,	827	31° 38' 1.0"	76° 41' 7.9"
	Jahu,	766	31° 36' 9.7"	76° 42' 7.6"
	Ladrour	982	31° 35' 8.5"	76° 37' 3.6"
	Ukhali,	845	31° 33' 6.6"	76° 36' 3.8"
	Dhangota,	738	31° 31' 0.8"	76° 34' 7.4"
	Bijhar,	878	31° 31' 2.5"	76° 32' 6.2"
	Furnohal,	701	31° 39' 0.8"	76° 30' 2.0"
	Bhoranj,	952	31° 39' 6.5"	76° 38' 4.5"
Route-III	Harnang,	920	31° 42' 51.3"	76° 32' 7.4"
	Awah Devi,	1201	31° 42' 5.7"	76° 40' 8.1"
	Tauni Devi,	1024	31° 43' 07.2"	76° 36' 1.3"
	Uhal,	1015	31° 46' 9.4"	76° 36' 5.3"
	Utpur,	979	31° 47' 09.8"	76° 36' 1.4"
	Kakkar,	916	31° 49' 5.3"	76° 36' 2.6"
	Jangalberi	580	31° 52' 50.0"	76° 33' 1.4"

The major weeds associated with different cropped and non-cropped areas are given below:

Maize: *Echinochloa colona, Digitaria sanguinalis* and *Eleusine indica Commelina benghalensis Ageratum conyzoides*, *Commelina forskalii, Phyllanthus niruri, Brachiaria ramosa* and *Cyperus iria.*

Direct-seeded upland rice: *Echinochloa colona*, *Panicum dichotomiflorum Phyllanthus niruri*, *Cyperus iria*, *Ageratum conyzoides* and *Commelina forskaolii.*

Sugarcane: *Dactyloctenuim aegyptium*, *Eragrostis tennela Echinochloa colona*, *Sorghum halepense* and *Digitaria sanguinalis, Ageratum conyzoides* and *Commelina benghalensis*

Sesame: *Digitaria sanguinalis, Eleusine indica, Eragrostis tennela, Sorghum halepense*, *Ageratum conyzoides, Commelina benghalensis* and *Phyllanthus niruri*

Turmeric: *Commelina benghalensis Ageratum conyzoides, Echinochloa colona* and *Cyperus iria*

Okra: *Digitaria sanguinalis, Eleusine indica and Echinochloa colona, Ageratum conyzoides* and *Oxalis corniculata*

Colocasia: *Echinochloa colona*, *Sorghum halepense*, *Ageratum conyzoides, Commelina benghalensis* and *Cyperus iria*

Ginger: *Commelina benghalensi, Ageratum conyzoides* and *Cyperus iria.*

UAS, Bengaluru

Weed survey was conducted in 2 districts, *viz*. Davanagere and Mandya of Southern Karnataka, major weeds encountered in cropped fields were *Cyperus iria, Echinochloa colona, Fimbristylis miliacea, Marselia quadrifoliata* and *Monochoria vaginalis* (in transplanted rice); *Cyperus rotundus* (sedge), *Cynodon dactylon, Echinochloa colona, Dactyloctenium aegyptium, Digitaria marginata, Chloris barbata* (among grasses); *Amaranthus viridis, Cyanotis axillaris, Commelina benghalensis, Bidens pilosa, Parthenium hysterophorus, Euphorbia hirta, Mimosa pudica* and *Ageratum conyzoides*. *Parthenium hysterophorus is* becoming new major weed in dry areas of cultivated fields in Southern Dry and Southern Transition zones. Alien weed - *Solanum carolinense* is occurring near garbage areas and road sides in 9 districts out of total 17 districts surveyed which indicates the wide adaptability and spread of this new alien weed in Southern Karnataka. A new weed similar to Parthenium has spread over 10 acres in 10 years after introduction through FYM around M. Bevinahally, Tubagere Hobli, Tumkur district.

AAU, Jorhat

Tomato is one of the most popular crops in Assam. Tomato growing areas of Jorhat district were surveyed in 2010-11 in altogether four locations as follows:

Location	Latitude	Longitude
a. AAU Jorhat	26°43'43.6 N	94°12'8.9 E
b. Kuoripukhuri to Kundargaon	26°37'16.3 N	94°9'27.8 E
	26°37'11.2 N	94°8'32.8 E
	26°37'51.7 N	94°9'51.8 E
c. Kakojan to Teok	26°48'40.3 N	94°21'34.4 E
	26°48'42.8 N	94°21'48.2 E
	26°48'59.5 N	94°21'47.3 E
	26°48'56.2 N	94°21'37.0 E
	26°49'5.19 N	94°24'35.7 E
	26°50'40.0 N	94°25'8.05 E

Contd....

Contd....

Location	Latitude	Longitude
d. Deberapar – Mariani & vicinity	26°38'36.8 N	94°17'50.9 E
	26°38'16.1 N	94°17'26.7 E
	26°37'48.1 N	94°20'10.4 E
	26°41'53.7 N	94°22'32.5 E
	26°40'57.5 N	94°24'54.5 E

Amongst the weed species in tomato *Panicum repens*, the rhizomatous perennial grass and the stoloniferous broadleaved perennial species *Alternanthera philoxeroides* were found becoming most problematic in most of the studied areas. Most commonly occurring species during this season were *Ageratum houstonianum, Centella asiatica, Leucas indica, Stellaria media* and *Cynodon dactylon.*

The most dominant species in maize-based cropping system of Karbi Anglong district (Hamren side) was *Borreria articularis* (IVI= 34.07). Next to *Borreria,* other dominant weeds were *Colocasia antiquarum, Mikania micrantha* and *Ageratum houstonianum* amongst the BLWs and *Cynodon dactylon* amongst the grasses. *Chromolaena odorata,* followed by *Borreria articularis* and *Eleusine indica* had appeared as the most dominant weed species in sugarcane fields of Dima Hasao district of Assam.

Weed species recorded in 1992 were extremely reduced or lost their existence in *Jhum* fields after 19 years were *Biophytum reinwardtii* Walp., *Desmodium gangaticum* (L.) DC., *Mollugo pentaphylla* L., *Passiflora foetida* L., *Smilax perfoliata* Lour., *Sonchus asper* (L.) Hill. and *Stephania japonica* (Thunb.) Miers var. *discolor* (Miq.) Forman, besides the grassy weeds *Digitaria setigera* Roth ex R.& S., *Echinochloa colona* (L.) Link. and *Pragmites karka* (Rewtz.) Trin. ex Steud. In *Jhum* or shifting cultivation areas with rice based cropping system, above 600m MSL altitude in Dima Hasao district, prevalence of Asteracean weeds is one of the interesting feature of this situation, which included *Ageratum conyzoides, A. houstonianum, Bidens pilosa, Crassocephalum crepedioides, Elephantopus scaber, Galinsoga parviflora, Gynura* spp., *Mikania micrantha, Siegesbachia orientalis, Spilanthes paniculata, Synedrella nodiflora* and *Tithonia divaricata.*

AAU, Anand

Weed survey carried out in North West Agroclimatic Zone showed that cotton, castor, sorghum, sesamum, groundnut, pearlmillet and clusterbean were major crops and mainly infested with dominant weed species, viz. *Eragrostis major, Dactyloctenium aegyptium, Eleusine indica, Digitaria sanguinalis, Echinochloa crus-galli, Commelina forskalaei, Phyllanthus niruri, Digera arvensis, Euphorbia hirta, Vernonia cinerea, Spermacoce hispida,Amaranthus spinosus, Solanum xanthocarpum, Celosia argentia, Enicostema littorale, Cyperus rotundus, Cyperus iria* and *Cyperus difformis* in *kharif* crops in Kutch district.

Survey on weedy rice

The survey was carried out to monitor the biotypes in rice-wheat cropping system. The biotypes of weedy and wild rice were recorded in middle Gujarat at different locations, viz. Tarapur, Petlad, Matar, Khambhat, Sojitra, Bareja, Nadiad, Anand, Vadodara, Dabhoi and Karjan.

Infestation of weedy rice at different locations

No	Location	Latitude	Longitude	Approx. infestation (%)
1	Dudhipura-1	22^0-31.656N	072^0-44.827E	2-3
2	Dudhipura-2	22^0-31.690N	072^0-44.440 E	1-2
3	Nar-Patiyu	22^0-31.091N	072^0-41.684E	2-3
4	Palol	22^0-30.400N	072^0-40.490 E	2
5	Tarapur-1	22^0-29.910N	072^0-39.345 E	2-3
6	Tarapur-2	22^0-28.366N	072^0-38.842 E	3
7	Isarwada	22^0-26.007N	072^0-37.511 E	2-3
8	Zalapura	22^0-22.068N	072-36.568 E	3
9	Daheda	22^0-23.032N	072^0-32.661E	2-3
10	Golana	22^0-26.913N	072^0-25.858 E	2
11	Varsada	22^0-23.939N	072^0-28.497E	2-3
12	Indranaj-1	22^0-29.632N	072^0-32.138 E	2
13	Indranaj-2	22^0-29.915N	072^0-37.856E	1-2
14	Sinjiwada	22^0-30.831N	072^0-38.129 E	2
15	Sekhupur	22^0-34.638N	072^0-37.419 E	1-2
16	Limbasi	22^0-36.540N	072^0-37.326 E	2
17	Kheda	22^0-42.432N	072-40.608 E	2

TNAU, Coimbatore

Cropped area: The weed flora constituted of mainly broad leaved weeds composed of more than ten species and *Parthenium hysterophorus* registered higher summed dominance value in Salem district and it was followed by Namakkal and Karur. *Cynodon dactylon* recorded higher summed dominance value of grasses in Namakkal District compared to other districts. In sedges, *Cyperus rotundus* and *Cyperus difformis* were the two sedges found in the surveyed area in 12 Districts. Between the two sedges, the summed dominance value of *Cyperus rotundus* was higher in Krishnagiri District and it was followed by Dindigul and Vellore Districts.

Non-cropped area: Among the different weed species broad leaved weeds have recorded higher summed dominance value and it was followed by grasses and sedges in all the Districts. Among the broad leaved weeds, *Parthenium hysterophorus* registered higher summed dominance value in Krishnagiri District and it was followed by Salem and Nilgiris Districts than other broad leaved weeds. In grasses, *Cynodon dactylon* recorded higher summed dominance value in Salem District and it was followed by Erode and Namakkal Districts. In sedges, *Cyperus*

rotundus and *Cyperus difformis* were the two sedges found in the non cropped area at Coimbatore, Namakkal, Krishnagiri, Salem, Erode and Vellore Districts. Between the two sedges, the summed dominance value of *Cyperus rotundus* was higher in Krishnagiri District and it was followed by Dindigul and Vellore Districts.

Infestation of weedy rice in different districts of Tamil Nadu has been surveyed during *kharif* and *rabi*, 2011 in an area of 6.0 ac of Vadakupatty village of Thuraiyur block of Trichy district. Weedy rice has infested at 11.09 per cent during *kharif* season and 19.49 per cent during *rabi* season. Uppliapuram and Kulithalai of Trichy districts, an area of 40.5 ha, 12.0 ha have been surveyed and infested at average of 7.9 and 6.9 per cent during *kharif* and 8.0 and 8.1 per cent *rabi* seasons.

KAU, Thrissur

Infestation of weedy rice (*Oryza spp*.) and the Chinese sprangletop *(Leptochloa chinensis)* are seen spreading in rce fields in large areas. Commonly used herbicides are not effective against these weeds. Till five years back, weedy rice was not at all a serious problem, but now in all the major rice growing tracts of Kerala, viz. Kuttanad, Thrissur kole and Palakad regions, this weed is spreading fast. As it is morphologically and biochemically similar to cultivated rice, control by hand weeding or herbicides are not possible.

Leptochloa chinensis was restricted to the high pH soils of Chittur region in Kerala. However during the last few years, it is seen spreading to other rice regions. Now it has become a major weed problem in the Kole lands and Kuttanad, the major rice bowls of Kerala. Introduction and large scale adoption of the broad spectrum rice herbicide bispyribac-sodium (Nominee gold, Tarak, Adora etc.) has led to a shift in weed flora favouring *Leptochloa* as this herbicide is not effective against *Leptochloa.*

Alligator weed (*Alternanthera philoxeroides)* has been noticed spreading in the lowlands during the last few years. In the Kuttanad and koleland regions, where one crop of rice is taken during the summer season, alligator weed is a problem during the other seasons when the field remains as a water fallow the weed grows luxuriantly in the field and the bunds. It has become an expensive job to remove this weed at the land preparation before sowing the crop.

Weedy rice infestation in a rice field

Leptochloa chinensis infested rice field

NDUAT, Faizabad

Survey and surveillance of weeds under cropped and non-cropped situations during *kharif* and *rabi* seasons of 2011-12 was done in the eastern districts of Uttar Pradesh especially in Ghazipur, Mau and Ballia. The major crops covered were rice and sugarcane during *kharif* season and wheat during *rabi* season. The 5 major weeds recorded in the rice crop were: *Echinochloa colona, E. crusgalli, Eclipta alba, Commelina benghalensis* and *Cyperus* species. Among these, *Echinochloa* species were the most dominant weeds. In the lowlying areas of rice, the weedy rice (*O. nivera, O. sativa f. spontanea* and *O. rufipogon*) were recorded and farmers informed that their severity was enhancing year after year. Sugarcane was surveyed in the Ballia district. Twelve major weeds were noted, among them *Echinochloa colona, Eleusine aegyptium* and *Bracharia reptans* recorded 57.0, 52.0 and 51.5% IVI value while among BLWs, *C. benghalensis* and *Eclipta alba* were found dominated having IVI value of 50.0 in each case. However, *C. rotundus* and *S. spontaneum* were also recorded dominant position (152.4% and 47.5% IVI value). *Phalaris minor* was found most dominant weedy species in all the 3 districts surveyed in the wheat, while, *C. album, Rumex spp.*, *Anagallis arvensis* and *Medicago denticulata* were found pre-dominant weeds among BLWs in wheat. However, *Poa annua* and *Polypogon monospensis* also shown their presence in Mau districts with low IVI value. Studies on herbicidal (butachlor to *Echinochloa colona* and isoproturon to *Phalaris minor*) resistance were done during *rabi* 2010-11 and *kharif* 2011 at Faizabad Centre taking the soil samples from the different locations of Faizabad and Sultanpur districts.

In wheat crop, infestation of new weed species viz. *Poa annua* and *Polypogon monosplensis* in grassy and *Rumex* spp. and *Medicago denticulata* in BLWs have shown their presence from the last 3-4 years. Wild oat (*Avena fatua*) was observed in wheat fields 4-5 years before, now it has completely shifted and not observed. Dominance of BLWs e.g. *C. axillaries and Eclipta alba* in rice; and *Solanum nigrum, Medicago denticulata* and *Rumex spp.* in wheat was noticed. The *Pluchea lanceolata* and *Alhagi camelorum* have completely disappeared from the *rabi* season. Weedy rice is showing its presence especially in the lowlying rice growing areas of eastern U.P.

ANGRAU, Hyderabad

Weed survey conducted in Southern Telangana Zone of Andhra Pradesh in different crops, cropping systems and non-cropped areas revealed that the predominant weeds infesting different crops and cropping system in Rangareddy, Hyderabad, Mahabubnagar, Nalgonda, districts were: *Echinocloa colonum, Echinocloa crusgalli, Cyperus difformis, Cyperus iria* and *Eclipta alba, Cyperus rotundus, Cynodon dactylon, Dactyloctenium aegyptium, Parthenium hysterophorus, Celosia argentia, Digera arvensis, Trianthema portulacastrum, Commelina benghalensis, Alternanthera sessilis* and *Amaranthus viridis.*

CSAUAT, Kanpur

Weed survey was conducted in Central plain and Bundelkhand zone. In Hamirpur district, linseed and chickpea crops were severly infested by *Convolvulus arvensis.* In Jalaun district, in non-cropped area the dominant weed was *Croton sparsiflourus.* In Fatehpur district, in coriander crop the dominat weeds were *Phalaris minor* and *Rumex dentatus.* In Banda district,

linseed crop was severly infested by *Pharthenium hysterophorus.* In Raibareli district, wheat crop was severly infested by *Vicia sativa* in many places. In Hardoi district, *Ocimum canum* was found to be new emerging weed in wheat.

VB, Sriniketan

Survey of weed flora was conducted in Birbhum district under red and lateritic zones during *rabi* 2010-11 in vegetables and *rabi* pulses. Winter vegetables (brinjal, potato, cabbage, cauliflower, tomato and spinach) were pre-dominantly infested by *Ganphalium indicum, Gnaphalium purpureum Polygonum plebeium, Chenopodium album, Anagallis arvensis, Spergula arvensis, Digitaria sanguinalis, Cynodon dactylon* and *Cyperus rotundus*; *rabi* pulses (chickpea and lentil) were infested with *Polygonum plebeium, Gnaphalium purpureum, Cynodon dactylon* and *Cyperus rotundus*. One weed species, *viz. Fumaria indica* was recorded as new in spinach in this area.

BAU, Ranchi

Weed survey of crop fields adjoining to road sides of Ranchi–Gumla, Ranchi Lohardaga, Kuru–Daltonganj and Ranchi–Tatanagar route. Data on weed indices like density/m^2, frequency (%), relative density (%), relative frequency (%) and Importance Value Index based on GPS are presented.

Ranchi–Gumla route: On the basis of weed survey performed on the fields adjoining Ranchi – Gumla road side (GPS points N 23/19'01.7" to E 85/04'56.0") it was found that *Ludvigia parviflora* (IVI= 25.4), followed by *Cyperus iria* (IVI=19.2), *Fimbristlis milliaceae* (18.0), *Panicum repense* (IVI=17.4) and *Digitaria sanguinalis* (IVI= 17.4) were the most dominant species in transplanted rice while in upland situation of redgram + niger/ black gram intercropping system *Dacteloctanium aegipticum* (IVI=19.8) followed by *Panicum repense* (IVI=14.7), *Andrgrophis scropholia* (IVI=16.5), Sphellanthus acmella (IVI=14.4) were the most dominant species of weeds. In Ragi crops *Digitaria sanguinalis (*IVI= 24.7), *Leptochloa chinensis* (IVI=11.9) were the most dominant species.

Ranchi–Lohardaga route: (GPS points N 23/24'53.8" to E 85/13'20.7") *Ludvigia parviflora* (IVI=26.9) followed by *Paspalam distichum* (IVI=17.4), *Sphellanthus acmella* (IVI=15.2) and *Echinocloa colona* were the most dominant species in rice crops. *Digitaria sanguinallis* (IVI=12.5), *Ageratum conzoides* (IVI=9.59) in maize and ragi crops were the dominant weed species.

Kuru-Daltonganj route*:* (GPS points N 23/37'40.1" to E 84/45'10.0") *Cyperus difformis* (IVI= 13.5) *Digitaria sanguinalis* (IVI= 11.8), *Fimbristllis milliaceae* (IVI=22.6), *Ludvigia parviflora* (IVI=7.11) were the most dominant species in rice fields while *Ageratum conzoides* (IVI=43.5*), Panicum repense* (IVI=7.55), were the dominant species in redgram, redgram + maize crops.

Ranchi–Tata route: (GPS points N 23/18'34.5" to E 85/23'35.6") *Ludvigia parviflora* (IVI= 43.4), *Ammania baccifera* (IVI=13.9), *Ericostema axillare* were the dominant species in rice fields.

OUAT, Bhubaneswar

Weed survey has been conducted in the rainfed tracts along the state highway no.1 from Khurda to Nayagarh under East and South Eastern Coastal Plain agro-climatic zone of the state during *rabi*, 2010-11. The covered locations were Baghamari, Pichukuli of Khurda district and Bolagarh of Nayagarh district.

Location 1: Baghamari (Khurda district), 10 km from Khurda town (GPS points: 20^{0}13'03.46"N to 85^{0}30'19.00"E, altitude: 38m from MSL). The weed survey conducted in greengram crop of Baghamari area revealed that *Cynodon dactylon* was the dominant grass with IVI of 23.96 followed by *Echinochloa colona* (22.16) and *Digitaria ciliaris* (18.28). *Ageratum conyzoides* (27.46) and *Amaranthus viridis* (15.19) were the major BLW observed. The only sedge noticed was *Cyperous rotundus* (10.6)

Non-cropped area of Baghamari, Khurda (GPS points: 20^{0}13'15.85"N to 85^{0}29'58.27"E, altitude: 40m from MSL).

Findings: The results of weed survey in non-cropped area at Baghamari revealed the dominance of *Cynodon dactylon* (IVI - 52.80), *Digitaria ciliaris* (20.64) and *Sporobolous diander* (18.42) among grasses. The dominant broad leaf weeds were *Ageratum conyzoides* (36.34), *Amaranthus viridis* (21.80) and *Spaeranthus indicus* (19.21). Major sedge observed was *Cyperus rotundus* (15.55).

Location 2: Pichukuli (Khurda district), 23 km from Khurda town cropped area (blackgram after rice as paira crop GPS points: 20^{0}11'04.86"N to 85^{0}22'57.16"E, altitude: 68m from MSL). Findings: The weed flora in blackgram crop at *Pichukuli, Khurda* was dominated with grasses like *Cynodon dactylon* (IVI-26.34), *Echinochloa colona* (23.58) and *Panicum repens* (19.52). The major BLW observed were *Ageratum conyzoides* (24.73), *Amaranthus viridis* (16.20) and *Achyranthus aspera* (14.26) and *Cyperus rotundus* (13.34) was the only sedge noticed.

Non-cropped area of Pichukuli, Khurda (GPS points: 20^{0}11'05.50"N to 85^{0}22'34.15"E, altitude: 70m from MSL). The floristic composition of the non-cropped area of Pichukuli, Khurda was dominated with grasses like *Cynodon dactylon* (IVI-50.16), *Sporobolou diander* (19.06) and *Digitaria ciliaris* (20.16). The major BLW observed were *Ageratum conyzoides* (33.94), *Spaeranthus indicus* (20.18) and *Achyranthus aspera* (17.51*). Cyperus rotundus* (18.47) was the only sedge found.

Location 3: Bolagarh (Nayagarh district), 36 km from Khurda town, cropped area (horsegram after rice as paira crop, GPS points: 20^{0}10'13.14"N to 85^{0}17'04.77"E, altitude: 86m from MSL). *Cynodon dactylon* (IVI-28.15), *Echinochloa colona* (21.09) and *Digitaria ciliaris* (18.57) were the major grasses observed in horsegram crop at Bolagarh area. Dominant BLW noticed were *Ageratum conyzoides* (27.15), *Amaranthus viridis* (15.91), *Acyranthus aspera* (11.43) and *Cyperus rotundus* (13.42) was the only sedge observed.

Non-cropped area of Bolagarh, Nayagarh (GPS points: 20^{0}10'22.46"N to 85^{0}16'34.90"E, altitude: 97m from MSL). The weed flora in the non-cropped area of Bolagarh area of Nayagarh district was dominated with grasses like *Cynodon dactylon* (IVI-59.75), *Sporobolus diander*

(13.71) and *Eleusine indica* (13.18). The major BLW observed were *Ageratum conyzoides* (39.65), *Spaeranthus indicus* (18.27) and among sedges, only *Cyperus rotundus* (12.49) was found.

The weed survey has been conducted in the irrigated tracts along the national highway no.203 from Bhubaneswar to Puri under East and South Eastern Coastal Plain agro-climatic zone of the state during *kharif*, 2011. The covered locations were Siula of Khurda district and Pipili and Dandamukundapur of Puri district. Location 1: Siula (Khurda district), 14 km from Bhubaneswar, cropped area (transplanted rice GPS points: 20^{0}09'22.41"N to 85^{0}50'32.36"E, altitude: 13 m from MSL). The dominant grasses in transplanted rice at Siula (Khurda district) were *Panicum repens* (IVI-17.19), *Echinochloa crusgalli* (14.97) and *Paspalum scorbiculatum* (13.67). *Ludwigia_parviflora* (17.12), *Alternanthera sessilis* (14.01) and *Ammania bacifera* (13.38) were the major BLW observed. The important sedges were *Cyperus iria* (11.15) and *Cyperus rotundus* (11.15).

Non-cropped area of Siula, Khurda (GPS points: 20^{0}09'21.83"N to 85^{0}50'44.45"E, altitude: 15 m from MSL). *Cynodon dactylon* (IVI-33.13), *Eleusine indica* (20.07) and *Digitaria ciliaris* (19.26) were the major grasses in the non-cropped areas of Siula location. Among the broad leaf weeds, *Ageratum conyzoides* (25.29), *Achyranthus aspera* (17.70) and *Amaranthus viridis* (17.55) were dominant. *Cyperus rotundus* (15.15) was the only sedge observed.

Location 2: Pipili (Puri district), 21 km from Bhubaneswar. cropped area (transplanted rice, GPS points: 20^{0}07'04.18N to 85^{0}50'48.48"E, altitude: 11 m from MSL). The floristic composition in transplanted rice at Pipili area of Puri district were dominated with grasses like *Echinochloa cruss-galli* (IVI-17.61), *Panicum repens* (16.60) and *Leptochloa chinensis* (13.27). The major BLW observed were *Ludwigia parviflora* (17.98), *Ammania bacifera* (13.98) and *Alternanthera sessilis* (13.33). *Cyperus iria* (8.66) and *Fimbristylis miliaceae* (8.40) were the sedge observed.

Non-cropped area of Pipili, Puri (GPS points: 20^{0}07'06.11"N to 85^{0}50'00.55"E, altitude: 13 m from MSL). The weed flora in the non-cropped area of Pipili location were dominated with grasses like *Cynodon dactylon* (IVI-30.67), *Digitaria ciliaris* (19.39), *Eleusine indica* (18.92), BLWs like *Ageratum conyzoides* (22.29), *Spaeranthus indicus* (17.92), *Amaranthus viridis* (16.90) and *Celosia argentea* (15.94). *Cyperus rotundus* (16.25) was the only sedge observed.

Location 3: Dandamukundapur (Puri district), 28 km from Bhubaneswar, cropped area (transplanted rice) GPS points: 20^{0}04'58.33N to 85^{0}50'06.54"E, altitude: 11 m from MSL. The floristic composition of transplanted rice at Dandamukundapur areas of Puri district were dominated with grasses like *Panicum repens* (IVI-18.41), *Echinochloa crusgalli* (18.21) and *Paspalum scrbiculatum* (14.63). *Ludwigia parviflora* (17.80), *Alternanthera sessilis* (14.19) and *Ammania bacifera* (13.81) were the major BLWs noticed. *Fimbristylis miliaceae* (9.78) and *Cyperus iria* (9.53) were the sedge observed.

Non-cropped area of Dandamukundapur, Puri GPS points: 20^{0}04'48.60"N to 85^{0}49'56.39"E, altitude: 14 m from MSL. The dominant grasses in the non-cropped areas of Dandamukundapur were *Cynodon dactylon* (IVI-27.15), *Eleusine indica* (21.74), *Digitaria ciliaris* (20.65) and *Dactloctenium aegyptium* (14.81). The major BLWs were *Ageratum conyzoides* (20.95),

Achyranthus aspera (16.76) and *Spaeranthus indicus* (15.33). The only sedge observed was *Cyperus rotundus* (17.35).

CCSHAU, Hisar

Based on information of 146 farmers, *P.minor* with IVI value of ≥ 70 was one of the major weeds in Karnal, Kaithal, Ambala, Fatehebad and Jind districts of state where as in Bhiwani *Chenopodium album, Asphodelus tenuifolius* and *Chenopodium murale* with IVI values of 62.7, 54.8 and 38.7, respectively were the dominant weeds of wheat crop.

Twenty-two weed species (5 grassy, 3 sedges and 14 broadleaf) were found to be dominant weed species in the phyto-sociological survey of weeds in moong bean crop in Hisar, Sirsa, Bhiwani, Mahender Garh and Fatehbad districts of the state, *Digera arvensis* with a relative density of 50.7% and IVI value of 63.8 was the most dominant weed occurring at 86% of sites surveyed in all districts. Among grassy weeds *Dactyloctenium aegyptium* was most dominant grassy weed with 10.7 % R.D. and IVI value of 24.5. *Cyperus rotundus,Cyperus compressus* and *Bulbostyllis barbata* were the sedges which showed infestation in moong crop with IVI values of 15.8, 3.0 and 2.9, respectively. *A. ludoviciana* was the only grassy weed found to infest fenugreek crop in Bhiwani district with a density of 3.3 plants/m^2 constituting 1.4 % of total weed flora and IVI value of 12.1 occurring at 72% of locations covered. *C. album, A. tenuifolius, C. murale, T. polycerata and Rumex spinosus* were major broadleaf weeds of fenugreek with values of 47, 35.7, 39.9, 22.9 and 14.9, respectively.

Based on information of 199 farmers, 24 weed species (6 grassy, 6 sedges and 12 broadleaf) were found to infest rice fields in Haryana. Grassy weeds *E.colona* and *E. glabrescence* were major weeds found to infest rice fields in all the districts. Similarly *Ammania baccifera* among broadleaf weeds and *Cyperus rotundus, Scirpus tuberosus* among sedges were also present in all the districts. In Karnal a major rice growing district, grassy weeds *E.colona*, *E. glabrescence* and *Leptochloa chinensis* alone constituted 59% of total weed flora. Broadleaf weed *Lindernia* alone constituted 21% of total weed flora in Pinjore area of Panchkula district. *Scirpus supinus* a sedge found in soils with impeded drainage recorded around Cheeka was the second most important weed of rice in Kaithal district with IVI value of 32.7.

SKRAU, Bikaner

Weed survey was undertaken during *rabi* 2010-2011 and *kharif* 2011 in Ajmer district. Major *kharif* crops, viz. bajra, moth, guar and groundnut; and in *rabi* crops, viz. wheat, mustard, barley and gram. Total 14 weed species were found infesting in all the *kharif* crops, *Euphorbia* sp., *Trianthema monogyna, Tribulus terristris, Amaranthus viridis* and *Amaranthus spinosus* were most frequently occurring broad leaf weeds. Their respective average densities were 5.5, 5.5, 6.0, 6.0, and 5.0, plants/m^2. The important grassy weeds of all the *kharif* crops identified were *Cyperus rotundus,* and *Cynodon dactylon.* The average densities of these weeds were in the order of 5.00, and 4.7 plants/m^2. The total weed density ranged between 52-63 plants/m^2.The most common *rabi* weeds infested in the cropped area numbered 13. The broad leaf weeds were, *Chenopodium murale, Chemopodium album, Melilotus indica, Melilotus alba Convolvulus arvensis Asphodelus tenuifolius* and *R. dentatus*. Their respective densities were

in the order of 6.0, 6.0, 5.2, 5.0, 5.0, 5.0 and 6.0 plants/m^2. The grassy weeds *Phalaris minor* and *Avena ludoviciana* were most common and their densities were 5.0, and 4.0 plants/m^2, respectively. Total weed density ranged from 53-62 plants/m^2. The *Orobanche sp.* occurred in mustard crop with 8-10 plants /m^2 in the district.

IGKV, Raipur

A survey of weeds of cropped area mainly wheat, non-cropped and garbage area was done. The dominant weeds of the cropped area surveyed were *Cynodon dactylon, Ameranthus viridis, Blumea lacera,* followed by *Spilanthus calva and Chenopodium album* in cropped area having IVI- 51.4, 15.3, 10.3 and 8.7, 8.6, respectively. In non-cropped area, the dominating weeds were *Amaranthus virdis, Ageratum conyzoides*, *Vicia sativa* followed by *Argimone maxicana* and *Anagallis arvensis* having IVI-23.2, 21.4, 17.1, 16.2 and 12.3, respectively. In garbage area, the dominant weeds were *Cynodon dactylon, Ageratum conyzoides, Parthenium hysterophorus, Astercantha longifolia and Achyranthes aspera* having IVI- 32.1, 25.5, 15.8, 14.8 and 13.3, respectively.

MAU, Parbhani

Rabi 2011

Weed survey was conducted during *rabi* season of 2010-2011 in Jalna, Aurangabad and Jalgaon Districts of Maharashtra state. The crops surveyed were: wheat, gram and sorghum. In Jalna District relative frequency, density of broad leaved weeds i.e. *Euphorbia geniculata* and *Parthenium hysterophorus* was found more as compared to *Cyperus rotundus* and *Cynodon dactylon*. In gram, the dominant broad-leaved weeds were: *Saccharum spontaneum, Chenopodium album* and *Parthenium hysterophorus.* Amongst grassy weeds, only *Cyperus rotundus* and *Cynodon dactylon* were found as dominant weed species. Whereas, in non cropped area, values for all observations were highest for *Parthenium hysterophorus* as compared to other weed species i.e. *Celosia argentia, Xanthium strumarium* and *Cassia tora*. In Aurangabad district highest weed population of the dominant broad leaved weeds were *Portulaca oleracea, Parthenium hysterphorus* and *Chenopodium album,* while in grassy weeds *Cynodon dactylon and Cyperus rotundus* were dominant weeds. In Jalgaon district, the dominant broad leaved weeds were *Parthenium hysterphorus, Euphorbia hirta* and *Digera arvensis* while in grassy weeds *Cynodon dactylon* was the dominant weed.

Kharif 2011

The weed survey was carried out during *kharif* season of 2011 in Parbhani, Jalna and Aurangabad districts of Marathwada region. During *kharif* season of 2011, the fields of sugarcane, cotton, sorghum, soybean, maize, were survayed in above districts. In Jalna district, the dominant broad leaved weeds wwere *Dignera arvensis* and dominant grassy weeds were, *Cyperus rotundus* and *Cynodon dactylon* in sorgum crop. In soybean, the dominant grassy weeds were i.e. *Cynodon dactylon; Cyperus rotundus* as compared to broad leaved weeds i.e. *Euphorbia geniculata. Parthenium hysterophorus* was observed *in* cotton. In Aurangabad district, the dominant broad leaved weeds were *Parthenium hysterophorus, Dignera arvensis* while in grassy weeds *Cynodon dactylon* and *Cyperus rotundus* were dominant weeds in

soybean crop where as in maize crop the dominant broad leaved weeds were *Amaranthus polygamous, Commelina bengalensis* and *Euphorbia genicullata*, where as *Cynodon dactylon* and *Cyperus rotundus* were the dominant grassy weed. In Beed district, the dominant broad leaved weeds were *Euphorbia geniculata & Celocia agrentia in soybean crop and in sorghum,* the dominant broad leaved weeds were *Celosia argentia, Enporbhia geniculata, Commelina communis* and *Parthenium hysterophorus,* while *Cynodon dactylon* in grassy weeds. *Where as, in cotton crop t*he dominant broad leaved weeds were *Celosia argentia* and *Euphorbia geniculata* and the dominant grassy weed *Bracheria eruciformis* was observed.

RAU, Pusa

Rice, wheat, sugarcane and *rabi* maize + potato intercrop were surveyed during *kharif*, 2011 and *rabi* 2010-11 in Sheohar and Muzaffarpur district of Bihar. In rice field nine weed spp. were identified as dominant weeds. There was *Echinocloa colonum, E. crusgalli, Cyperus diformis, Cynodon dactylon, Causullia axillaris, Eleusine indica, Dactyloctenium aegyptium, Eclipta alba,* and *Lippia nodiflora.* During *rabi* season in wheat field dominancy of *Physalis minima, Solanum nigrum, Chenopodium album, Launea pinnatifida, Cersium arvense, Phalaris minor, Cyperus rotundus, Rumex dentatus,* and *Melilotus indica* were observed. In maize + potato inter cropping *Cyperus rotundus, Solanum nigrum, Chenopodium album, Cirsium arvense, Cynodon dactylon, Melilotus alba* and *Melilotus indica* were the most dominant weed flora. In sugarcane the most dominant weed flora were *Cynodon dactylon, Cyperus irria, Cyperus rotundus, Solanum nigrum, Physalasis minima, Abutilon indicum, Euphorbia hirta, Croton bonplandianum, Launea pinnatifida, Melilotus indica* and *Melilotus alba.*

WS 1.1a Weed surveillance

PAU, Ludhiana

In wheat, *P minor* was the most predominant grassy weed of rice-wheat crop rotations while *A. ludoviciana* in non rice- wheat rotations. *Cirsium arvense* and *Convolvulus arvensis* are coming up as important broadleaf weeds and are a future threat for sustained wheat productivity. Wheat field following berseem or potato were free of weeds. Organic farming has led to shift in weed flora in favour of broadleaf weeds especially of *Melilotus* sp. In spring maize, *E. aegyptiacum* and *P. minor* were the major grass sp. *Poa annua* is coming up as a new weed. *A. viridis* was the dominant broadleaf weed *fb* by *C. album.* Spring maize succeeding sugarcane or potato had low weed infestation. Earthling up does not solve weed problem and farmers are interested in having an effective post emergence herbicide which can effectively control weeds in spring maize. *Canabis sativa* and *Cirsium arvense* moving from roadsides into the field areas of wheat and spring maize and may become an important weed of these crops in the near future. In rice, *E. crusgalli* and *E colonum* were dominant grasses, *A. baccifera* and *E. alba* among broad leaf and *C. difformis* and *C. iria* among sedges. Butachlor, pretilachlor and anilophos are commonly used herbicides. Grass weed sp viz. *Eleusine aegyptiacum, Echinochloa crusgalli* and *Leptochloa* are a major problem in dry seeded rice; *Eleusine* and *Leptochloa* escape bispyribac and thus dominate the weed flora. Farmers reported weeds as the major problem/constrain in the adoption of dry seeded rice. In sugarcane, farmers are looking for a post emergence herbicide which can take care of hardy grass weed sp. They are not satisfied with only pre-em

herbicides which lose their efficacy after intercultural operations in the sugarcane field. *Canabis sativa, Achyranthes aspera, Castor sp* was found growing along the road sides.

CCSHAU, Hisar

Weed Surveillance studies conducted in *Kharif* crops revealed that no new weed has appeared. Excellent efficacy of all pre-emergence herbicides used by the farmers was observed in rice crop. However, infestation of *Ammania baccifera* increased in the previous season due to high moisture conditions. In weed surveillance studies, *Avena ludoviciana* was observed as wheat weed in sand dunal areas of Dighawa, Jui, Loharu, Badhra, Siwani and Tosham of Bhiwani distict which was not observed earlier in these areas. None of the mustard genotype grown in the region is tolerant to infestation of *Orobanche.* Tomato crop in Nuh, Punahana and Ferozepur Jhirka areas of Mewat is severely infested with parasitic weed *Oroabache aegyptiaca* causing 15-70 % decrese in fruit yield of tomato. Sporadic infestation of parasitic weed *Cuscutta chinensis* was observed in barseem crop in Karnal, Kaithal, Tohana, Kurukshetra Ambala, Cheeka and Panipat areas of state. *Coronopus didymus* has become a major weed in barseem crop. Infestation of *Euphorbia dracanculoides* is increasing in gram crop planted under rainfed conditions.

CSKHPKV, Palampur

In Hamirpur district increasing dominance of *Ageratum conyzoides, Commelina benghalensis a*nd *Brachiaria ramosa* was observed in maize crop since last survey. *Parthenium hysterophorus* also started invading the upland Kharif crops. About 68 per cent of the farmers are using herbicides to control weeds in maize and rice. But some of the farmers were not using herbicides at proper time, dose and method of application.

Spread of *Cassia tora* and *Zygogramma* beetle on large scale was observed in some pockets of the district.

UAS, Bengaluru

New weeds namely similar to *Solanum carolinense* L. (Solanaceae) (taluks of Maddur in Mandya district and spreading more areas in Mysore city (12º N, 17.548" N, 76º 39.039" E) and near HD Kote (12º 03.818" N, 76 º 21.465" E) during 2011), *Verbesina encelioides* Cav. (occurring in tank bed area on road sides, is slowly spreading all along roadsides around Chikkamagalur (1016m, 13º 31.446" N, 75º 77.133" E) during *Kharif* 2009 – 11), *Tithonia diversifolia* (Hemsl.) A. Gray (Asteraceae) (occurring in tank bed area on road sides, is slowly spreading all along roadsides around Chikkamagalur (1016m, 13º 31.446" N, 75º 77.133" E) during *Kharif* 2009 – 11), *Ipomoea triloba* L. (Convolvulaceae) (weed is severe in Mandya district (682m, 12º 58.539" N, 76º 82.312" E), a new weed similar to *Parthenium* with underground roots propagation were noticed on cropped fields and road sides in Southern Karnataka.

ANGRAU, Hyderabad

In rainfed cotton, C*ynotis cucullata infestation was observed.* In non cropped areas infestation of *Trianthema portulacastrum* and *Alternanthera sessilis* was more. Infestation of parasitic

weed *Orobanche* was observed in tomato, brinjal and *Parthenium.*

OUAT, Bhubaneswar

East and Southestern Coastal Plain Zone

- *Mikania micrantha*, previously confined to the road side plantations was observed in the interior areas of Jagatsinghpur, Kendrapara, Cuttack, Puri, Khurda and Nayagarh districts.
- *Parthenium hysterophorus*, previously confined to the roadside areas, are now observed in all major canal embankments and bunds of crop fields in the coastal command areas
- *Alternanthera philoxeroides* is becoming a problem in low lying swampy areas of Coastal districts.

Mid Central Table land Zone

- Large scale of invasion of *Celosia argentea* was reported in groundnut and pulses under rainfed upland situation of Dhenkanal and Anugul districts.

IGKV, Raipur

Weed surveillance study revealed that *Alternanthra triandra* in cropped fields especially direct seeded rice which occupies around 70% area in state, has emerged as a new havoc. Also the road sides, bunds etc is getting heavily infested with this weed especially in Raipur district. The control of this weed after 4-5 leaf stage becomes difficult with prevalent herbicides like Chlorimurom+Metsulfuron (Almix) , however, 2,4-D is still an effective solution for this weed.

Another weed invading the non-cropped are is Malwa *pusila.* The intensity of this weed is multiplying rapidly. However, the good side of its invasion is that it is replacing *Parthenium hysterophorus.* If the multiplication is continued, undoubtedly it is going to invade cropped area within a short period.

WS 1.2: Studies on herbicidal resistance in different weed flora

PAU, Ludhiana

Biology and management of herbicide resistant biotypes- *P. minor*

The long term study on management of isoproturon resistant populations of *P. minor* revealed that during twelfth year pinoxaden and clodinafop were the most effective herbicides and on an average reduced *P. minor* population by above 87 and 95%, respectively, which was significantly higher than all other herbicides except mesosulfuron + iodosulfuron which also reduced population by 85%. This was followed by sulfosulfuron (25%), fenoxaprop (21%) and isoproturon (18%). The higher mortality with clodinafop this season could be due to lower temperature and frosty days. The per cent mortality of *P minor* with isoproturon and fenoxaprop was at par with control indicating complete inefficiency of isoproturon and fenoxaprop against *P. minor.* The non significant differences in dry matter accumulation by *P.minor* survivors, 55 days after spray strongly indicate that surviving plants had developed resistance against respective herbicides including pinoxaden and meso+iodosulfuron also.

Table 1: Effect of different herbicides on P*. minor* populations.

Herbicides dose (kg ha^{-1})	*P minor* population (No/0.5 m^2)		% decline at 40 DAS
	Initial	40 DAS	
Pinoxaden 0.05	49.4	5.86	71.9* (87)
Clodinafop 0.06	55.5	1.77	82.3 (95)
Sulfosulfuron 0.025	42.7	33.90	25.0(25)
Meso+ Iodo 0.0144	42.9	12.67	54.0 (65)
Fenoxaprop 0.1	73.2	63.80	21.4 (21)
IPU 1.0	44.6	35.90	22.0 (18)
Control	61.6	66.70	10.9(9)
CD at 5%	12.7	14.45	16.3
P. minor population			
P_1	55.0	30.42	42.0 (45)
P_2	57.8	33.67	39.1(43)
P_3	52.1	31.00	39.2(44)
P_4	60.0	36.28	38.0(43)
P_5	45.8	38.81	33.4 (37)
P_6	48.6	25.19	45.4 (49)
P_7	53.8	26.48	46.7 (51)
P_8	50.0	27.09	45.3 (52)
P_9	49.3	28.52	42.2 (47)
P_{10}	56.2	37.67	39.3 (44)
CD at 5%	NS	NS	NS
Interaction CD	NS	NS	NS

* Arc sign transformed values; parentheses are original values

Another study on development of cross/multiple resistance in *P. minor* clearly showed that there are strong indication that at farmers fields the *P minor* is fast developing resistance against recently recommended herbicides viz. pinoxaden and meso + iodosulfuron along with commonly used herbicides clodinafop and sulfosulfuron.

Table 2: Growth response of *P. minor* populations to the doses of clodinafop.

Treatment (g/ha)	Dry weight of 5 plants (mg)	
	20 DAS	50 DAS
Clodinafop		
Control 0	155.9	1622.4
½ x	232.3	981.5
x	165.4	535.4
2 x	152.1	814.1
CD at 5%	35.6	139.7
P. minor populations		
P_1	261.3	1484.4
P_2	217.0	960.4
P_3	189.2	979.2
P_4	204.5	1040.7
P_5	188.6	1141.2
P_6	148.0	920.6
P_7	176.4	1231.7
P_8	113.3	626.5
P_9	105.8	507.1
P_{10}	160.1	991.7
CD at 5%	42.3	293.5

x=Recommended dose of clodinafop = 60.0 g/ha

Another field study indicated that trifluralin and pendimethalin as the best possible options for control of resistant *P minor* in wheat. Both the herbicides induced complete mortality in all the resistant populations of *P minor* and no plant could establish and produce seed in the treated plots as evident from the picture of the experimental plots. Chances of development of multiple resistances involving these herbicides will be less as observed in case of other herbicides.

Showing complete control of resistant *P minor* biotypes with pre-emergence herbicides

Pendimethalin 0.75 kg/ha

Trifluralin 1.0 kg/ha

Unsprayed check

Experimental field - Full view

CCSHAU, Hisar

To find out reasons of poor efficacy of herbicides especially clodinafop against *P.minor* in wheat crop, a systemic study of 163 farmers was conducted in wheat growing districts of Haryana. In Kaithal, Karnal, Kurukshetra (Pehowa), Ambala (Naggal and Barara), Fatehbad (Tohana), Jind districts of state, only 4% farmers used recommended dose of clodinafop with 22% control of *P.minor* where as 25 % farmers used double to recommended dose of clodinafop with only 35.7 % control of *P.*minor, indicating development of cross resistance against clodinafop herbicide only in pockets of Tohana, Kaithal, Pehowa, Safidon, Karnal areas where wheat is continuously grown after rice since last 40 years.

In Yamuna Nagar, parts of Ambala and Kurukshetra, where wheat is grown in sugarcane and potato based crop sequences, situation is comfortable. In these areas, 46 % farmers used recommended dose of clodinafop with 81.6% control of *P.minor* where as only 26% farmers who are not following crop rotation, have to go for sequential application or double dose of clodinafop with only 41 – 7.5 % control.

At Sagga (Karnal), clodinafop 60 g/ha and sulfosulfuron 25-30 g/ha did not provide satisfactory control of *P. minor* in wheat (60-70%). Mesosulfuron+ iodosulfuron provided about 80% control. Clodinafop+ metribuzin 60+105 g/ha, trifluralin/ pendimethalin *fb* clodinafop 1000 *fb* 60 g/ha provided the >90% control of *P. minor* resulting in similar grain yields (49-51.5 q/ha) with highest yield under clodinafop+ metribuzin. Lowest grain yields were obtained with clodinafop 60 g/ha (38.5 q/ha) and sulfosulfuron 25 g/ha (39.5 q/ha). Fenoxaprop + metribuzin (R.M.) also provided effective control of *P. minor* but showed some phyto-toxicity on the crop (Variety HD 2851) 10-15% at 15 DAA which recovered to some extent with time.

Increased doses of clodinafop (75 g/ha), sulfosulfuron (30 g/ha), pinoxaden 50-60 g/ha and recommended doses of mesosulfuron + iodosulfuron (14.4 g/ha) and pinoxaden (50 g/ha) provided effective control of *P. minor* in wheat. The new herbicide fenoxaprop+ metribuzin (ready-mix) 22%EC 275 g/ha also provided its effective control. Tank-mix combination of metribuzin 105 g/ha with clodinafop 60 g or sulfosulfuron 25 g/ha improved the control of *P. minor.* Pre-emergence application of pendimethalin or trifluralin 1000 g/ha *fb* clodinafop provided effective control of *P. minor.*

GBPUAT, Pantnagar

Resistance of *P. minor* to isoproturon

Resistance was again observed in the seed lots collected from farmers' fields in Nainital and U.S. Nagar districts. Plants from 12 out of 16 locations exhibited resistance to isoproturon at recommended and double doses.

V.B., Sriniketan

Butachlor resistance in *Echinochloa sp.*: Emergence of 75 and 80% were recorded where seeds were collected from butachlor treated and untreated fields respectively. In 0.5, 1.0 and 2.0 kg dose, emergence was 25, 5, 0% as well as 30, 15, 0% in seeds from butachlor treated and untreated fields, respectively. At recommended dose of butachlor 90% and 85% inhibition were recorded, so it is expected that no resistance has developed in *Echinochloa colona* under Red and Lateritic Zone where butachlor has been used since last five years.

OUAT, Bhubaneswar

Study on biology and management of *Echinochloa*

The germination of *Echinochloa* species is around 60% and the emergence of both the species was at 3 days. *Echinochloa colona* (0.20 g) recorded 9.1 % less dry weight than *Echinochloa crusgalli* (0.22 g) at 25 days after emergence. The number of seeds/plant in *Echinochloa colona* (540) was 8.4% less than *Echinochloa crusgalli* (590).

WS 1.2a: Biology & management of isoproturon resistant *P. minor*

Cooperating centres: PAU, CCSHAU, GBPUAT

Not reported

WS 1.2b: Effect of dates of sowing on efficacy of clodinafop for controlling isoproturon resistant P. minor in wheat

Cooperating centres: PAU, CCSHAU, GBPUAT

Not reported

WS 1.2c: Inheritance of resistance to sulfosulfuron in P. minor

Cooperating centres: PAU, CCSHAU, GBPUAT

Not reported

WS 1.2d: Validation of isoproturon resistance

Cooperating centres: PAU, CCSHAU, GBPUAT centres will supply seeds of isoproturon resistant P. minor and isoproturon herbicide to UAS (B) and KAU centres for validation.

Not reported

WS 1.3: Effect of glyphosate on propagation potential of perennial weeds - *Cyperus rotundus* (3 years permanent plot)

Cooperating centres: PAU, GBPUAT, KAU, UAS (B), AAU (J), AAU(A), TNAU

Herbicides:

1. Glyphosate 1.5 kg/ha
2. Glyphosate 1.0 kg/ha
3. Glyphosate 0.5 kg/ha
4. Glyphosate 0.75 kg/ha
5. Treat-1 + Jaggery (2%)
6. Treat-2+ Jaggery (2%)
7. Treat-3 + Jaggery (2%)
8. Treat-4 + Jaggery (2%)
9. Control (untreated)

AAU, Anand

Post emergence application of glyphosate 0.75 to 1.50 kg/ha alone as well as along with jaggery reflected their effect in terms of toxicity on *Cyperus rotundus*. There was consistent increase in the efficacy of each concentration with corresponding increasing in their doses against the *Cyperus rotundus.* All the concentrations of glyphosate alone and with jaggery showed 38 to 96 % control of *Cyperus rotundus* but higher dose (1.5 kg/ha) is effective on *Cyperus rotundus.*

PAU, Ludhiana

The field study to evaluate efficacy of glyphosate alone and mixed with 2% jaggery revealed that glyphosate had good suppressing potential against *Cyperus* shoots and reduced tuber population and addition of jaggery had no advantage on either shoot mortality or in reducing the tuber population over glyphosate alone.

Table 3: Effect of glyphosate application mixed with jaggery on propagation potential of *Cyperus rotundus.*

Treatment (dose kg/ha)	*Cyperus* shoots m^{-2}			Regenerated shoots m^{-2} 20 DAS	Tubers m^{-2} up to 30 cm depth
	Initial	20 days after spray	% mortality		
T_1 Glyphosate 1.5	233.0	6.06 (39)	65.68 (82)	33.0	247.2
T_2 Glyphosate 1.0	178.0	4.57 (23)	70.03 (88)	26.0	130.6
T_3 Glyphosate 0.75	210.0	6.19 (39)	64.44 (81)	22.0	244.4
T_4 Glyphosate 0.5	207.0	5.56 (32)	66.54 (83)	29.0	286.1
T_5 Treat 1 + 2 % Jaggery	155.0	4.61 (24)	70.68 (84)	22.0	225.0
T_6 Treat 2 + 2 % Jaggery	119.0	4.07 (16)	68.33 (86)	20.0	133.5
T_7 Treat 3 + 2 % Jaggery	191.0	5.44 (30)	67.33 (85)	22.0	175.0
T_8 Treat 4 + 2 % Jaggery	151.0	6.18 (38)	59.21 (73)	28.0	213.9
Control	252.0	15.1 (240)	8.61 (3)	80.0	194.4
LSD(P=0.05)	NS	2.23	12.57	NS	NS

Parentheses are original values. Data subjected to $\sqrt{x+1}$ transformation

GBPUAT, Pantnagar

Cyperus rotundus plants were killed by Glyphosate application at various doses. However, tuber viability was 60 to 86 % at different doses of the herbicide.

Table 4: Mortality (%) of *Cyperus rotundus* at different doses of glyphosate.

Treatments	Dose (kg/ha)	Mortality (%)
T1	Glyphosate (0.5)	50.5
T2	Glyphosate (0.75)	76.8
T3	Glyphosate (1.0)	75.0
T4	Glyphosate (1.5)	82.5
T5	T1 + Jaggery (2%)	55.6
T6	T2 + Jaggery (2%)	73.5
T7	T3 + Jaggery (2%)	86.0
T8	T4+ Jaggery (2%)	75.6

UAS, Bengaluru

Spraying glyphosate at 1.5 kg/ha with 2 % jaggery significantly reduced the tuber biomass of perennial weed C*yperus rotundus.* Addition of 2% dry fruit extract of soapnut powder (*Sapindus laurifolia*) along with glyphosate was equivalent as that of triton X surfactant with regard to control of purple nutsedge. In maize-sunflower cropping system, population of *C. rotundus*

significantly increased, whereas population of *D. aegyptium* decreased compared to finger millet – groundnut cropping system.

TNAU, Coimbatore

Application of glyphosate 1.5 kg/ha was found to be effective in reducing density, lower shoot dry weight, tuber dry weight and higher weed control efficiency of *Cyperus rotundus*.

KAU, Thrissur

Two sprayings of glyphosate 0.75 kg/ha within an interval of 48 hours gave very good control of *Cyperus rotundus*.

WS 1.4: Weed Seed longevity of weeds associated with major cropping systems under arable conditions.

Cooperating centres: PAU, GBPUAT, UAS(B), KAU, AAU(J)

AAU, Jorhat

Weed seed longevity studies showed that the total weed density in soil was 1310 m^{-2} in rice –rice sequence and 9343 m^{-2} had emerged in rice-wheat sequence.

GBPUAT, Pantnagar

In cropping systems such as Rice-Wheat and Soybean-Wheat, weed seeds that continued to dominate include *P. minor, C. album, R. acetosella, A. arvensis, Melilotus spp during winter season* and *E. colona, Elusine indica, Eclipta alba, Euphorbia hirta* during rainy season. The *C. rotundus* continued to dominate the soybean-wheat cropping system.

KAU, Thrissur

The effect of continuous weeding at monthly intervals has resulted in a drastic decline in the weed floral count and the species diversity of the location. In the first year 36 species were recorded from the location which has come down to 22 species, a shift in the floral composition has also been observed.

Dominant species

- Ist Year- *Axonopus compressus*, *Hyptis suaveolens*, *Borreria articularis* and *Ischaemum indicum*
- II Year - *Hemidesmus indicus*, *Biophytum sensitivum* and *Curculigo orchioides*
- III Year - *Borreria articularis* , *Phyllanthus amarus , Curculigo orchioides, Cyperus iria, Desmodium triflorum* and *Stachytarpheta indica*
- New species - *Linternia crustacea* and *Melochia corchorifolia*

Monthly removal of weeds from the area has also brought out the seasonal influence on weed germination and also the effect of weather parameters on the weed germination. Hence correlation study with weather parameters was undertaken with some major weed species that were found during all the three seasons of the year. The weed for which significant influence was observed is given below.

Table 5 : Correlation of weather parameters on weed germination.

Species	MaxT	MinT	Avg T	RH	Sun Shine hrs	Rains
Phyllanthu amarus	-		-	+	-	
Sida acuta					-	+
Desmodium triflorum	-		-		-	+
Axonopus compressus						+

The result of a 3 year month wise estimation of germination of *Phyllanthus amarus* in the coconut garden revealed that weed germination starts in June with the advent of monsoon and continues till November. The peak germination has been observed in July and September Weather parameters like Relative humidity were found to have a positive influence on weed growth. It is not a summer weed and maximum temperature and high sunshine hours were found to have a negative influence on the weed germination and growth.

A similar analysis with *Desmodium trifolium* clearly brings out the influence of rainfall, low temperature and lower sunshine hours on the germination and growth of the weed. Weed proliferation is observed from July to December.

The weed *Mimosa pudica* does not seem to be influenced by any of the weather parameters studied. The weed germination was observed throughout the year and was found to be affected only by the availability of water. The water requirement also seems to be meager.

WS 1.5 : Crop weed toxicity of herbicide & recovery time

Cooperating centres: PAU, UAS(B) & GBPUAT

UAS, Bengaluru

Crop-weed toxicity of herbicide and recovery time in cropping system indicated that senescence period of 48 hr with glyphosate at 1312 g/ha fb spraying of glyphosate at 1312 g ai/ha after 45 days enhanced the mortality of *C. rotundus*. Even though bio-mass of maize was low in zero tillage, RGR and CGR showed higher values during 62-90 DAS than atrazine and hand weeded plots. However during initial stages, these values were less due to weed competition and poor growth.

GBPUAT, Pantnagar

Toxicity symptoms of glyphosate in grassy weeds is indicated by anthocyanin accumulation. In *cyperus* leaves, the toxicity symptoms are leaf chlorosis and necrosis.

Toxicity symptoms of the herbicide glyphosate in grassy weeds: The symptoms indicate anthocyanin accumulation in leaves

Glyphosate toxicity symptom in Cyperus leaves

WS 1.6: Physiological studies in long term net work trials

Cooperating centres: PAU, UAS(B), GBPUAT, KAU, AAU(J), V.B.

PAU, Ludhiana

In rice- wheat system, in wheat field, the weed seed bank of *P. minor* had further declined because of replacement of isoproturon with trifluralin in 2007-08 season. All weed control treatments had significantly lower weed seed bank of *P. minor* than control. Surprisingly no seedling of *P.minor* was observed in clodinafop + metsulfuron treatment. This indicated toward possibility of strong interaction between environment particularly low temperature and frosty conditions with efficacy of the herbicide. Under field conditions the *P. annua* had established as predicted earlier. *Rumex dentatus* had the highest weed seed bank and has become a major weed. Use of trifluralin or 2,4-D helped in reducing seed bank of *R. dentatus.* The results clearly indicated that seed bank of *P. minor* considerably declined due to use of trifluralin which was introduced during 2007-08 in the system.

In rice, seed bank of *E. crusgalli* and *C. axillaries* increased in all treatments as compared to previous season. The seed bank of *I rugosum* had declined from previous year. While seedlings of *C iria* were not observed but two new seeds in the system observed were *Eclipta alba* and *L chinensis* which established in the field also.

GBPUAT, Pantnagar

In the maize-pea cropping system, weedy plots among the sub-plot treatments recorded highest number of weed seeds in seed bank. In the DSR-chickpea system, the main plot treatments weedy and Anilophos application fb hand weeding recorded highest number of weed seeds in seed bank.

V.B., Sriniketan

Emergence of seedlings in PHT in rice-mustard cropping system during *rabi* 2010-2011 in the soil collected after harvest of *kharif* rice 2010 were recorded. Among the *kharif* treatments,

lowest emergence (2 numbers/2 kg soil) was recorded under butachlor (repeated) followed by 2, 4-D + fertilizer where as the highest emergence (9 numbers/2 kg soil) was recorded in FP. The two treatments pretilachlor / butachlor (rotation) followed by 2, 4-D coupled with fertilizer or organic matter showed equal number of emergence (7 numbers/2 kg soil). Higher emergence was recorded in BL followed by sedges and grasses. Farmers practice recorded the highest emergence. The treatments of *rabi* combined with fertilizer always showed less number of emergence than that of combined with FYM.

KAU, Thrissur

The study using different organic sources revealed that monocot weeds were maximum in treatment where NPK alone was applied. Farmers practice encouraged dicot weeds. However total weed count was more where organic manures from vermicompost, neem etc was applied. Minimum weed seed accumulation in the soil seed bank was seen in POP recommendation and application of NPK alone. This indicates a need to standardize the organic matter and the source of the organic matter since the organic matter can itself prove to be a major seed bank for weed seeds. People going after organic cultivation should be aware of the threat from weeds.

WS 1.7: Effect of CO_2 enrichment on growth and development of weed species.

Cooperating centres: UAS(B), KAU

UAS, Bengaluru

Weeds like *Parthenium hysterophorus* and *Ageratum conyzoides* had higher ED_{50} in elevated CO_2 condition than normal CO_2 concentration; *Cyperus rotundus* had lower ED_{50} at elevated Co_2 condition. *Echinochloa colona* and *Euphorbia geniculata* showed no response for CO_2 concentration.

KAU, Thrissur

In C3 plants like *Ludwigia* the study brings out the positive effect of CO_2 enrichment on all the growth parameters. The plant attains maturity faster comes to flowering earlier however the fruit and seed production is not so positively influenced as the other growth parameters. However in the case of a C4 plant like *Echinochloa* the effect is not so evident. CO_2 enrichment does not have a positive impact on any of the growth parameters. The performance of the plant outside the chamber is better in all the growth parameters.

The chlorophyll a, b and total chlorophyll of all the three weeds studied was higher inside the chamber as compared to outside the chamber. However the chlorophyll a/b ratio indicated a 20 to 50% increase outside the chamber as compared to inside the chamber this may be due to increased light intensity outside than inside the chamber

WS 1.8: Study on biology and management of *Echinochloa* and wild rice

Cooperating centres : Echinochloa - AAU(J), VB
Wild rice - CSKHPKV, RVSKVV, VB, AAU (J), NDUAT, BAU, OUAT, KAU, IGKV.

IGKV, Raipur

Oryza nivara and *Oryza sativa* (fatua) are the two major species of weedy rice in the region.

KAU, Thrissur

Germination studies revealed the presence of staggered dormancy. The initial germination (just after harvest) ranged from 8-12%. Above 50% of the seeds germinated after 5 months of storage, 5-10% seeds germinated during the intervening period. The chaff percentage was very high (up to 70%) in all the variants collected.

Wild Rice	Initial Germination	Staggered Germination	After 5 Months
General Observation	8-16%	5-15%	40-50%

A study was initiated at the centre for plant biotechnology and molecular biology, college of horticulture, Vellanikkara to characterize the five different ecotypes of wild rice collected from the rice tracks of Palghat district in Kerala and the popular cultivated rice var. Jyothi, with respect to morphological characters and molecular markers. Morphological observations were recorded for number of grains per panicle, panicle length, grain length, grain breadth and awn length. Among the five genotypes number of grains per panicle (65 – 103) and awn length (2.5cm – 6.5cm) showed high variability whereas the size of the grains was uniform as indicated by the length and breadth of the grains. Panicle length varied from 16.5cm to 20cm. The reduction in awn length and increase in number of grains per panicle may be due to intercrossing with the cultivated rice.

Molecular studies

Method

DNA was isolated from all the six genotypes by CTAB method (Rogers and Benedich, 1994). RAPD analysis was carried out on all the 6 samples using five primers (RN05, RN07, RY08, RY09, S10) selected after a preliminary screening of 15 primers.

Table 6: Morphological characters of weedy rice collected by Palakkad.

Ecotype	No. of grains /panicle	Panicle length	Grain length	Grain breadth	Awn length
EP - 05	103	18.0	0.7	0.3	2.5
EP - 09	75	16.5	0.7	0.3	4.5
EP - 10	103	18.8	0.7	0.3	3.3
EP - 11	65	19.0	0.8	0.2	4.0
EP - 12	92	20.0	0.8	0.3	6.5

A total of 24 amplicons were produced (size ranging from 300bp-1500bp) with an average of 4 – 5 amplicons per primer. All the primers distinguished Jyothi from other ecotypes. Maximum numbers of polymorphic bands were obtained with RN07. Amplification pattern of EP10 was found to be distinct from the other ecotypes and it showed the highest number of grains and shorter awns. Diversity analysis (DARwin5) showed a very close relationship of this ecotype with var. Jyothi indicating a possibility that this may be a natural hybrid.

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 Ghazipur, Mau and Ballia districts of eastern Uttar Pradesh. Among the three weed species of weedy rice, Oryza sativa f. spontanea was the most dominant species in all the districts with a weed density of 25.6-42.3 plants per m^2 with a relative density of 44.8-57.8% with IVI values ranging from 94.8-115.5%. In all the districts, the second important species was O. rufipogon, while density of O. nivara was lowest. The O. nivara and O. rufipogon species of weedy rice were also found in non-crop land low lying areas also. Farmers also explained the severity of this weed species and told that O. rufipogon and O. spontanea are being observed in the crop fields only from last within 3-4 years as an invasive form.

CSKHPKV, Palampur

The infestation of weedy rice varied from 10-50 % in direct-seeded rice in different districts.

V.B., Sriniketan

On the basis of morphological characters of the plants collected from different area, as well as, grown in earthen pots, three species of Echinochloa have been identified, namely, Echinochloa colonum, Echinochloa crusgalli and Echinochloa glabrescens. Similarly, phyto-geographical distribution, identifying keys, morphological details, germination behaviour and other growth parameters of four species of weedy rice were studied. Four species of weedy rice, namely, Oryza rufipogon, O. barthii, O. minuta and O. nivara were identified during the reporting period.

WS 1.9: Weed seedling identification method

AAU, Jorhat

For identification of the weeds to larger groups, one or a few characters might be sufficient, however, for identification to the lowest possible rank, viz genus and species, combination of a number of stable characters is very much essential.

WS 2 : Weed management in crops and cropping systems

WS- 2.1 : Effect of time of sowing and weed control methods in direct seeded rice

Cooperating centres: BAU, NDUAT, GBPUAT, IGKVV, AAU(J), MAU, KAU, CSAUAT, VB, OUAT, TNAU, DBSKKV, ANGRAU, UAS(B), RAU (P), UAS(D), CSKHPKV

Treatments :

Main plot : Time of sowing

1. Before onset of monsoon
2. After onset of monsoon

Sub-plot: Weed control

1. Pretilachlor-S 0.5 kg/ha Pre-em

2. Butachlor 1.5 kg/ha Pre-em + 1 hand weeding
3. Post em fenoxaprop 60 g/ha or Almix 4 g/ha or Tank mix of both
4. Sesbania (broadcast) + 2,4-D 0.5 kg/ha at 30 DAS
5. Weedy
6. Weed free

Note:

i. AAU(J), VB, OUAT, UAS(D) will continue the same treatments for one more year.

ii. All other cooperating centres will include the following treatments in sub plots

Sub-plot : Weed control

1. Pretilachlor-S 0.5 kg/ha Pre-em
2. Azimsulfuron 35 g/ha
3. Post em fenoxaprop 60 g/ha or chlorimuron + metsulfuron 4 g/ha or Tank mix of both
4. Cyhalofop-p butyl 90 g/ha + 2,4-D 0.5 kg/ha 30 DAS
5. Butachlor 1.5 kg/ha Pre-em + 1 hand weeding
6. Weedy
7. Weed free

IGKV, Raipur

Echinochloa colona, Ischaemum rugosum, *Alternathera triandra, Cynotis axillaries, Croton banplandianum* were the predominant weed species observed in the experimental field. At all the stages, dry matter of weeds was significantly lower in post-monsoon sowing than pre-monsoon sowing time. Among the different weed control measures, treatment of two hand weeding registered significantly lowest dry matter than rest of the treatments at all the stages fb treatment of butachlor 1.5 kg/ha *fb* one hand weeding. Time of sowing did not influence grain yield significantly. Among various weed control measures, significantly higher grain yield was recorded from two hand weedings and butachlor 1.5 kg/ha *fb* one hand weeding than other treatments during both the years.

CSAUAT, Kanpur

The significantly minimum weed population and dry weight/m^2 at 30, 60 DAS and at harvest were obtained when rice was sown after onset of monsoon. Among the weed control practices, the minimum weed population and dry weight were achieved with the application of butachlor (1.5 kg/ha) + one hand weeding fb with the application of cyhalofop-p butyl (90 g/ha) + 2,4-D (0.50 kg/ha). The significantly higher grain yield (32.89 q/ha) was obtained from treatment sown after onset of monsoon than before onset of monsoon (26.60 q/ha). The higher grain yield of rice (37.52 q/ha) was obtained with the application of butachlor (1.5 kg /ha) + one hand weeding

followed by the application of cyhalofop-p butyl (90 g/ha) + 2,4-D (0.50 kg/ha) (35.65 q/ha). The higher net return (Rs 19,673/ha) was obtained from sowing after onset of monsoon followed by, before onset of monsoon (Rs 12,237/ha). The higher net return (Rs 23,841/ha) was obtained with the application of cyhalofop-p butyl + almix (90 g/ha+ 4g /ha) followed by butachlor (1.5 kg/ha)+one hand weeding application (Rs 22,893/ha).

OUAT, Bhubaneswar

Sowing before onset of monsoon produced higher grain yield of 2987 kg/ha as compared to sowing after onset of monsoon (2592 kg/ha). Weed free treatment recorded significantly highest yield of 3432 kg/ha. Pre-emergence application of butachlor-S 1.5 kg/ha with one HW at 30 DAS recorded lowest weed index 4.14 % followed by pretilachlor S 0.5 kg/ha (12.40%). The highest value of 66.3% was obtained from weedy treatment. Highest net return of Rs.12,478/ha was obtained from sowing before onset of monsoon with higher B:C ratio of 1.99. Among different chemical weed control practices followed, highest net return of Rs.15,255/ha and B:C ratio of 2.13 was obtained from the treatment of pre-emergence application of butachlor-S 1.5 kg/ha with one HW at 30 DAS.

AAU, Jorhat

Weed free treatment produced highest grain yield. Among the weed management treatments, application of butachlor 1.5 kg/ha along with one hand weeding 30 DAS resulted in highest grain yield which was followed by pretilachlor 0.5 kg/ha + safener + hand weeding 30 DAS. Among the four weed control treatments, butachlor 1.5 kg/ha + hand weeding 30 DAS was relatively better followed by pretilachlor + safener 0.5 kg/ha + hand weeding 30 DAS in respect of lowering weed density and dry weight.

GBPUAT, Pantnagar

Significantly lower weed density and dry weight was recorded with post monsoon sown crop as compared to pre monsoon crop. Among the herbicidal treatments, pre emergence spray of butachlor 1500 g/ha supplemented with one hand weeding gave the highest grain yield (2813 kg/ha) followed by the application of cyhalofop butyl 90 g/ha the application of 2, 4-D 500 g/ha as post-emergence.

UAS, Bengaluru

In direct-seeded rice (over four seasons) under upland condition, sowing time had no influence on weed emergence. Pre-emergence application of butachlor 1.5 kg/ha fb hand weeding (4423 kg/ha) and pretilachlor – S 0.5 kg/ha (4164 kg/ha) gave fairly good control of weeds and yielded slightly lower than hand weeding (4682 kg/ha) besides being economical in saving weeding cost by Rs. 3350 to 5300/ha over hand weeding twice (20 & 45 DAS, Rs. 6500/ha).

NDUAT, Faizabad

The treatment, sowing after the onset of monsoon recorded significantly lower values of density and dry weight of weeds and highest WCE, yield and economic return over the other treatment e.g. before the onset of monsoon. Among the weed control treatments, lower density and dry

weight of weeds were recorded with pre-emergence application of cyhalofop-p-butyl 90 g/ha + 2,4-D 0.5 kg/ha as post-emergence. The weed control efficiency, yield parameters, yield and economic returns were higher in the same treatment. It can be concluded that cyhalofop-p-butyl 90 g/ha PE + 2,4-D 500 g/ha as POE along with sowing after the onset of monsoon recorded higher yield.

V.B., Sriniketan

The number and dry matter of different categories of weeds were found less in rice crop sown after onset of monsoon than that of before onset of monsoon. Pretilachlor-s and butachlor controlled all categories of weeds but fenoxaprop only controlled grasses and 2,4-D only controlled broad leaved weeds. The grain yield of rice was the highest in weed free check when rice crop was sown after onset of monsoon and it was followed by butachlor + one hand weeding. Early post emergence application of fenoxaprop showed phyto-toxicity in rice crop but it recovered within a short period of time. The highest net return and B:C ratio was recorded where crop was sown after onset of monsoon integrated with butachlor + HW.

TNAU, Coimbatore

Lower density and dry weight of weeds with higher WCE, yield and economic returns were recorded in after onset of monsoon than before onset of monsoon sowing. Similarly lower density and dry weight of weeds were recorded in pre-emergence application of butachlor 1.5 kg/ha + one hand weeding with higher weed control efficiency, yield parameters, yield and economic returns.

BAU, Ranchi

Time of sowing i.e. pre or post monsoon sowing did not influence yield attributing as well as grain and straw yield of rice. Among weed control methods, application of Almix 4g/ha as post emergence recorded maximum 1000 grain (23.49 g), grain/panicle (65), reduced unfilled grain/panicle (35), and higher number of effective tillers/m^2(322), thereby producing 17.1% higher grain (2397 kg/ha) and 20.4% higher straw (3181 kg/ha) yield compared to mean grain (2047 kg/ha) and straw yield (2642 kg/ha) produced by rest of the treatments. Rice sown as post monsoon recorded significantly higher net return (Rs 16357) and B:C ratio (1.4) while among weed control methods application of Almix 4g/ha recorded maximum net return (Rs 19132/-) and B:C ratio (1.71).

DBSKKV, Dapoli

The grasses and sedges were more competitive than BLWs. However, sowing before onset of monsoon significantly reduced the weed growth of BLWs at 60 DAS. Weed free check and use of butachlor 1.5 kg/ha pre-em + one hand weeding at 40 DAS significantly reduced weed growth, grasses and sedges at 60 & 90 DAS. All weed control measures produced significantly higher grain yield of rice than weedy check. Sowing before onset of monsoon and weed free check recorded significantly higher grain yield.

MAU, Parbhani

The paddy crop sown before onset of monsoon recorded significantly more grain yield than paddy crop sown after onset of monsoon. While the paddy crop grown in weed fee situation resulted in highest grain yield which was found at par with PE- butachlor 1.5 kg/ha followed by one hand weeding and found significantly superior over rest of the weed control treatments.

CSKHPKV, Palampur

The major weeds of the experimental field were *Echinochloa colona, Ageratum conyzoides, Panicum dichotomiflorum, Cyperus iria* and *Commelina benghalensis. Digitaria sanguinalis, Setaria glauca, Polygonum alatum, Eleusine indica, Aeschynomene indica* were also recorded in small numbers. Results revealed that except for the population of *Panicum* at harvest and the total weed population and dry matter of weeds at 60 DAS and at harvest none of the sowing dates influenced these parameters significantly. Both, the population and weed dry weight were significantly higher under pre monsoon sowing at both stages of observation. However, the population of *Panicum* at harvest was significantly higher when sowing was done after the onset of monsoon.Comparison of weed control treatments at 60 DAS revealed that all herbicides were at par among themselves and with weed free all of which were significantly superior to weedy check in controlling *Echinochloa* and total weed population. At harvest, azimsulfuron was as effective as the most effective weed free in controlling *Echinochloa.* Azimsulfuron, chlorimuron and cyhalofop butyl also proved as effective as weed free in respect of total weed population. In respect of weed dry weight weedy check registered the maximum accumulation and weeds free the minimum at both stages of observation. At 60 DAS, weed free was most effective and among herbicides, only cyhalofop butyl was superior to weedy check in controlling *Echinochloa*. At harvest, all herbicides were equally effective as weed free in reducing total weed dry weight. All the weed control treatments including weed free remaining at par resulted in significantly higher paddy grain yield over weedy check

ANGRAU, Hyderabad

In direct-seeded rice, irrespective of time of sowing (before onset or after onset of monsoon), either pre-emergence application of butachlor at 1.5 kg/ha followed by one hand weeding at 30 DAS or post-emergence application of fenoxaprop-p-ethyl (60 g/ha) + metsulfuron methyl + chlorimuron ethyl (4g/ha) or cyhalofop-p-butyl (100 g/ha) + 2,4 D (0.5 kg/ha) were effective in realizing higher grain yield and efficient weed control and these treatments were comparable to hand weeding (20 & 40 DAS).

KAU, Thrissur

Weed problems are more severe in dry seeded rice, (sown before the onset of monsoon). Water management (standing water) in the rice field results in lesser weed emergence. Herbicide treatments are effective in controlling the weeds and can be used as substitute for the hand weeding.

RAU, Pusa

The results revealed that under main plot treatment, the lowest weed population and weed dry

weight were recorded in rice crop sown before monsoon. There was significant effect of time of sowing before or after monsoon on grain yield of rice where pre monsoon sown crop registered significantly higher grain yield. Under sub-plot treatments of the weed management methods, the lowest weed count and weed dry weight were recorded in weed free condition followed by sesbania (broad cast + 2,4-D 0.5 kg/ha at 30 DAS) and butachlor + one hand weeding. The highest grain yield (42.27 q/ha) was recorded under weed free condition which was at par with butachlor 1.5 kg/ha pre-emergence + 1hand weeding (38.9 q/ha) and followed by sesbania (broadcast) + 2,4-D 0.5 kg/ha at 30 DAS (38.5 q/ha). The highest net return (Rs. 22945/ha) was obtained under treatment of butachlor 1.5 kg/ha pre-emergence + 1 hand weeding which was followed by sesbania (broad cast) + 2,4-D 0.5 kg/ha at 30 DAS. Significantly higher net return (Rs. 21208/ha) was recorded under before onset monsoon sown crop over post monsoon sown crop. The highest weed control efficiency (79.9%) was recorded by weed free treatment followed by sesbania (broadcast) + 2,4-D 0.5 kg/ha at 30 DAS.

Table 7: Effect of time of sowing and weed management practices on weed density.

Treatments	Weed density No./m^2 (60 DAS)						
	Palampur	Jorhat	Faizabad	Kanpur	Bhubaneswar	Pusa	Dapoli
Before onset of monsoon	6.3 (46.9)	7.0	7.1 (50.6)	57.1	30.7	5.7	90.2
After onset of monsoon	5.6 (32.0)	7.0	6.1 (37.2)	37.47	33.1	6.8	58.1
LSD(P=0.05)	**1.6**	**NS**	**1.3**	**-**	**1.5**	**0.3**	**-**
Pretilachlor-S 0.5 kg/ha Pre-em	5.6 (32.7)	6.8	6.5 (42.3)	41.47	14.7	7.6	86.8
Butachlor 1.5 kg/ha Pre-em + 1 hand weeding	6.8 (46.0)	6.9	6.2 (39.0)	20.61	10.3	5.3	22.8
Azimsulfuron 35 g/ha	5.6 (30.7)	-	4.4 (19.6)	53.69	-	-	51.6
Post em fenoxaprop 60 g/ha or Almix 4 g/ha or Tank mix of both	6.5 (44.0)	7.9	7.42 (54.5)	49.5	25.3	7.3	61.3
Sesbania (broadcast) + 2,4-D 0.5 kg/ha at 30 DAS	-	7.5	-	-	22.7	5.2	-
Cyhalofop-p butyl 90 g/ha +2,4-D 0.5 kg/ha 30 DAS	6.5 (41.7)	-	5.33 (27.9)	37.81	-	-	96.0
Weedy	9.9 (100.7)	10.2	11.1 (123.8)	63.66	98.7	9.7	200.8
Weed free	1.0 (0.0)	2.9	0.7 (00)	0.0	3.7	2.48	2.2
LSD (P=0.05)	**1.6**	**0.6**	**2.1**	**-**	**2.2**	**0.6**	

#Square root transformed data, Figures in parenthesis are original values

Table 8: Effect of time of sowing and weed control on weed dry biomass at 60 DAS.

Treatments	Weed dry biomass (g/m^2)									
	Pantnagar	Palampur	Parbhani	Jorhat	Faizabad	Kanpur	Bhubaneswar	Pusa	Ranchi	Raipur
Before onset of monsoon	278.4	3.6 (13.5)	24.1	4.63	14.4 (208.4)	179.7	8.2	5.05	505.6	104.9
After onset of monsoon	65.5	3.0 (8.8)	28.2	4.62	13.0 (168.6)	119.0	11.2	6.51	693.9	98.5
LSD(P=0.05)	**164.0**	**0.8**	**-**	**NS**	**1.2**	**-**	**5.30**	**0.44**	**NS**	**0.5**
Pretilachlor-S 0.5 kg/ha Pre-em	249.8	3.4 (10.6)	30.9	4.5	11.4 (129.6)	124.9	5.8	6.83	516	115.6
Butachlor 1.5 kg/ha Pre-em + 1 hand weeding	31.9	3.7 (13.2)	18.5	4.4	5.2 (26.4)	72.1	3.8	5.20		73.8
Azimsulfuron 35 g/ha	222.7	3.1 (9.2)	-	-	9.2 (83.7)	222.5	-	-	460	113.6
Post em fenoxaprop 60 g/ha or Almix 4 g/ha or Tank mix of both	131.1	3.6 (13.2)	26.8	5.4	13.7 (188.3)	154.4	8.6	6.66	533.7	95.2
Sesbania (broadcast) + 2,4-D 0.5 kg/ha at 30 DAS	-	-	23.4	5.0	-	-	6.9	5.28		-
Cyhalofop-p butyl 90 g/ha +2,4-D 0.5 kg/ha 30 DAS	280.0	3.3 (10.1)	-	-	5.7 (32.3)	99.8	-	-	463.4	101.4
Weedy	288.0	5.5 (28.9)	38.5	6.7	18.5 (342.6)	239.6	20.8	8.91	519	145.4
Weed free	0.0	1.0 (0.0)	13.4	1.7	0.7 (00)	0.0	1.9	1.79	567.7	67.0
LSD (P=0.05)	**156.7**	**0.6**	**-**	**0.33**	**2.8**	**-**	**2.60**	**0.67**	**NS**	**21.2**

Square root transformed data; Figures in parenthesis are original values

Table 9: Effect of time of sowing and weed control on grain yield of direct seeded rice.

Treatments	Grain yield (kg/ha)											
	Pantnagar	Palampur	Parbhani	Jorhat	Faizabad	Kanpur	Bhubaneswar	Ranchi	Pusa	Dapoli	Raipur	Sriniketan
Before onset of monsoon	1211	2015	1889	1720	3640	2666	2987	3520	3821	2359	2580	3441
After onset of monsoon	2859	2291	1785	1740	4370	3289	2592	3562	3384	2216	3050	3567
LSD(P=0.05)	**1261**	**228.3**	**92.8**	**NS**	**380**	**-**	**NS**	**NS**	**368**	**NS**	**340**	**NS**
Pretilachlor-S 0.5 kg/ha Pre-em	1400	2183	1983	2000	3840	3344	3007	3010	3569	2218	1680	3930
Butachlor 1.5 kg/ha Pre-em + 1 hand weeding	2813	2254	2358	2040	4320	3752	3290	3019	3893	3328	4750	4062
Azimsulfuron 35 g/ha	1371	2303	-	-	4030	2851	-	2990	-	1827	2970	-
Post em fenoxaprop 60 g/ha or Almix 4 g/ha or Tank mix of both	1479	2036	1560	1600	3660	3045	2896	3070	3714	2287	4230	3551
Sesbania (broadcast) + 2,4-D 0.5 kg/ha at 30 DAS	-	-	1134	1850	-	-	2695	-	3847	-	-	3496
Cyhalofop-p butyl 90 g/ha +2,4-D 0.5 kg/ha 30 DAS	1563	2205	-	-	4480	3565	-	3065	-	2308	3880	-
Weedy	1220	1078	1094	510	2990	1712	1157	2994	2365	527	1240	2211
Weed free	3397	2303	2535	2370	4540	2812	3432	3097	4227	3515	4790	4080
LSD (P=0.05)	**625**	**348**	**458**	**200**	**510**	**-**	**159**	**NS**	**461**	**139**	**560**	**117**

Table 10: Effect of time of sowing and different weed control methods and economics of direct seeded rice.

Treatments	Net return (Rs/ha)						B:C ratio			
	Kanpur	Bhubaneswar	pusa	Faizabad	Ranchi	Sriniketan	Bhubaneswar	Faizabad	Sriniketan	Ranchi
Before onset of monsoon	12237	12478	21208	23362	8048	17325	1.9	1.5	0.9	0.6
After onset of monsoon	19673	8925	17842	31596	15625	18578	1.7	2.0	1.0	1.3
Pretilachlor-S 0.5 kg/ha Pre-em	21651	13156	21048	26262	14134	21943	2.1	8.0	1.2	1.2
Butachlor 1.5 kg/ha Pre-em + 1 hand weeding	22893	15255	22945	29756	9983	23290	2.1	1.8	1.2	0.7
Azimsulfuron 35 g/ha	15898	-	-	28064	13032	-	-	1.8	-	1.2
Post em fenoxaprop 60 g/ha or Almix 4 g/ha or Tank mix of both	18276	11790	20151	24618	14930	18410	1.9	1.6	1.0	1.3
Sesbania (broadcast) + 2,4-D 0.5 kg/ha at 30 DAS	-	10780	22694	-		18221	1.8	-	1.0	-
Cyhalofop-p butyl 90 g/ha +2,4-D 0.5 kg/ha 30 DAS	23841	-	-	32484	12734	-	-	2.0	-	1.2
Weedy	5323	-620	12014	18792	6810	4468	0.9	1.4	0.3	0.6
Weed free	21848	13458	18297	31732	11270	21380	2.1	1.8	1.0	0.6

WS 2.2 : Effect of rice establishment techniques under different weed management practices

Cooperating centres : BAU, AAU(J), MAU, KAU, CSAUAT, VB, OUAT, TNAU, DBSKKV, ANGRAU, UAS(B), RAU (P), GBPUAT

Treatments:

Main plot: (Establishment method)

1. System of rice intensification (SRI)
2. Transplanted rice
3. Direct-seeded rice (sprouted & broadcast)/ direct-dry seeded rice
4. Drum seeded rice (sprouted)

Sub-plot: (Weed control)

1. Pyrazosulfuron + mechanical weeding
2. Cono weeder/ mechanical weeding
3. 2 hand weeding
4. Weedy

AAU, Jorhat

The transplanted method significantly reduced the weed intensity as compared to other three methods. Among the weed control practices, application of pretilachlor 0.75 kg/ha along with mechanical weeding resulted significantly lowest values of weed density and dry matter production at all the growth stages followed by use of 'cono weeder'. Transplanted method resulted significantly higher grains per panicle as well as grain yield (28.0 q/ha) followed by SRI method. Among weed control practices, application of pretilachlor 0.75 kg/ha along with mechanical weeding recorded significantly higher grain yield (27.5) which was at par with 'cono weeder' (25.7). The reduction in yield due to weed competition was 5.8 quintal per hectare.

UAS, Bengaluru

In systems of rice establishment (averaged over five seasons), normal transplanting (4664 kg/ha) and SRI (4367 kg/ha) were superior to drum seeding (3902 kg/ha) and broadcasting of rice (3279 kg/ha). Pre-emergence application of pyrazosulfuron ethyl 25 g ai/ha fb mechanical weeding (45 DAS/P) was very effective in lowering weeds of all types and gave higher yield (4947 kg/ha) as that of hand weeding (4800 kg/ha), apart from saving weeding cost by Rs. 3800/ha over hand weeding (Rs. 6200/ha).

OUAT, Bhubaneswar

At harvest, SRI method recorded significantly lowest weed biomass of 27.7 g/m^2 followed by transplanting method (30.3 g/m^2). Among various rice establishment methods, SRI method recorded significantly the highest grain yield of 4620 kg/ha which was attributed to the higher yield attributes like effective tillers/m^2 (395.7), number of grains/panicle (124.6) and 1000 grain weight (23.8g). The highest yield of 4690 kg/ha was recorded with the treatment of Pyrazosulfuron 60g/ha + mechanical weeding followed by practice of two hand weeding (4460 kg/ha) among various weed control methods. Highest net return (Rs.24120 per ha) and B:C ratio (2.46) was obtained with SRI method followed by transplanted rice (Rs.19450 per ha and 2.06).

CSAUAT, Kanpur

The transplated rice by conventional method with pyrazosulfuron (25 g/ha) along with conoweeder is recommended for its higher yield and income.

GBPUAT, Pantnagar

The highest grain yield of rice was obtained with SRI technique with weed management through twice conoweeding (20 & 40 DAT) among all the establishment methods and weed control treatments. Among different weed control treatments, hand weeding twice (20 & 40 DAT) recorded maximum weed control efficiency.

V.B., Sriniketan

Transplanting method was the most effective in controlling all categories of weeds throughout the growth period followed by SRI system. Among the sub plot treatments pyrazosulfuron-ethyl + mechanical weeding was found to be the most effective. SRI system produced the highest

grain yield and it was followed by transplanting method. The interaction effect was significant. The highest grain yield of rice was obtained in SRI system with pyrazosulfuron ethyl + mechanical weeding. The highest net return and B:C ratio was recorded in SRI system coupled with pyrazosulfuron + mechanical weeding.

TNAU, Coimbatore

Pre-emergence application of pyrazosulfuron-ethyl 30 g/ha at 3 DAT + weeding with finger type double row rotary weeder at 40 DAT recorded higher weed control efficiency, grain yield and straw yield with better economic returns in system of rice intensification.

BAU, Ranchi

Drum-seeded rice recorded significantly higher effective tillers (257/m^2) as compared to transplant, SRI and direct seeded rice. However, this beneficial effect was nullified by 30.6 and 27.5% reduced filled grain, 7.9 and 1.6% reduced 1000 grain weight resulting 24.1 and 16.6% reduced grain yield as compared to transplant (3120 kg/ha) and SRI (2838 kg/ha). Transplant method of establishment recorded maximum mean net return (Rs 30682) while drum seeded rice recorded maximum mean B:C ratio compared to rest of the establishment method. Among weed control methods, application of pyrazosulfuron + mechanical weeding, recorded maximum net return (Rs 30026) and B:C ratio (3.01)

ANGRAU, Hyderabad

Transplanting of paddy or System of Rice Intensification with pyrazosulfuron ethyl fb mechanical weeding was better for efficient weed control and higher grain yield of rice. When there is no time for nursery raising drum seeding of sprouted seeds and Pyrazosulfuron ethyl+ mechanical weeding is also a viable option for the farmers.

KAU, Thrissur

Among the different rice establishment techniques, the least weed problems were seen in transplanted rice, followed by SRI. Higher weed problems are noticed in wet seeding and drum seeding techniques. Grass weeds were more in seeded rice whereas broad leaf weeds and sedges were more in the transplanted rice. Hand weeding was the most efficient weed control, but it was costly. Chemical weeding was economical and equally effective.

RAU, Pusa

The results revealed that the lowest weed count (6.1/m^2) and weed biomass (6.0 g/m^2) were observed by transplanted rice followed system of rice intensification and drum seeded rice under establishment methods. Among different weed control methods, the lowest weed count (4.6/m^2) and weed biomass (4.2 g/m^2) were recorded 2 hand weeding which was at par with pyrazosulfuron + mechanical weeding. The highest grain yield (47.00 q/ha) was recorded by system of rice intensification (SRI) which was followed by transplanted rice (45.4 q/ha). Among different weed control methods, the highest grain yield of rice (53.45 q/ha) was recorded under 2 hand weeding which was at par with the yield (50.6 q/ha) obtained under Pyrazosulfuron + Mechanical weeding. The highest weed control efficiency 71.3%) was recorded by 2 hand weeding followed by pyrazosulfuron + mechanical weeding (66.3%).

TNAU, Madurai

Among the establishment methods, SRI performed better than other methods of establishement followed by transplanted rice. Cono weeding was found to be effective in management of weeds. It was followed by pre-emergence application of pyrazosulfuron-ethyl fb mechanical weeding.

Table 11: Effect of rice establishment methods and weed control on weed density.

Treatments	Weed density No. /m^2 (60 DAS)		
	Jorhat	Bhubaneswar	Pusa
System of rice intensification (SRI)	30.1	35.3	7.7
Transplanted rice	26.8	41.2	6.1
Direct-seeded rice (sprouted & broadcast)	31.3	42.7	9.2
Drum-seeded rice (sprouted)	37.9	46.8	7.1
LSD(P=0.05)	**2.2**	**1.8**	**0.2**
*Pyrazosulfuron 60 g/ha + mechanical weeding	21.3	19.4	5.4
Cono weeder	29.4	23.1	6.1
2 hand weeding	29.9	15.3	4.6
Weedy	45.3	111.1	14.2
LSD(P=0.05)	**6.0**	**1.9**	**0.2**

Jorhat centre used pretilachlor 0.75 kg/ha, Figures in parenthesis are original values

Table 12: Effect of rice establishment and weed control on weed biomass.

Treatments	Weed dry biomass at 60 DAS (g/m^2)				
	Ranchi	Pantnagar	Jorhat	Pusa	Bhubanesar
System of rice intensification (SRI)	3.23(9.97)	4.16(17.74)	23.8	7.8	20.3
Transplanted rice	3.24(10.1)	4.31(20.26)	21.8	6.0	22.5
Direct-seeded rice (sprouted & broadcast)	3.23(10.1)	7.57(61.01)	24.2	8.2	24.3
Drum seeded rice (sprouted)	3.21(9.94)	6.19(40.11)	24.1	7.6	26.4
LSD(P=0.05)	**-**	**0.17(4.75)**	**NS**	**0.2**	**0.9**
*Pyrazosulfuron 60 g/ha + mechanical weeding	3.28(10.4)	5.02(24.96)	14.5	4.9	12.7
Cono weeder	3.17(9.66)	6.03(36.50)	21.1	5.8	13.5
2 hand weeding	3.16(9.5)	2.98(8.31)	21.6	4.2	11.3
Weedy	3.30(10.50)	8.20(69.34)	36.7	14.6	57.7
LSD (P=0.05)	**NS**	**0.3(10.10)**	**5.0**	**0.2**	**1.9**

Figures in the parentheses indicates original values; * Jorhat centre has used pretilachlor 0.75 kg/ha

Table 13: Effect of rice establishment methods and weed control on grain yield of rice.

Treatments	Grain yield (kg/ha)								
	Pantnagar	Jorhat	Sriniketan	Ranchi	Kanpur	Bhubaneswar	Pusa	Coimbatore	
								Rabi	*Kharif*
System of rice intensification (SRI)	4675	2610	3919	2334	5017	4620	4700	5568	5521
Transplanted rice	3949	2800	3672	2532	5727	4008	4539	5412	5183
Direct-seeded rice (sprouted & broadcast)	3039	2300	3757	2273	3061	3402	4135	5238	4942
Drum seeded rice (sprouted)	3669	2280	2283	2042	3485	3505	4265	5188	4913
LSD(P=0.05)	**218.01**	**180**	**33.8**	**NS**	**1.36**	**206.3**	**380**	**409**	**329**
*Pyrazosulfuron 60 g/ha + mechanical weeding	4381	2750	3747	2333	5140	4690	5064	5571	5671
Cono weeder	4105	2570	3454	2562	4022	4200	4815	5537	5375
2 hand weeding	4671	2500	3294	2288	4820	4460	5345	5517	5488
Weedy	2175	2170	3136	1998	3309	2120	2415	4780	4025
LSD (P=0.05)	**244.04**	**210**	**100.4**	**124**	**371**	**155.3**	**392**	**224**	**412**

WS- 2.3: Efficacy of herbicides for controlling weeds in direct-seeded rice

Cooperating centres : BAU, AAU(J), MAU, KAU, CSAUAT, VB, OUAT, TNAU, DBSKKV, ANGRAU, UAS(B), RAU (P), GBPUAT and rice growing volunteer centres also.

Treatments:

	Herbicides	Time of Application	Dose(g/ha)
1	Pyrazosulfuron	3-7 DAS	25
2	Pretilachlor –S	0-5 DAS	750
3	Cyhalofop butyl	25 DAS	90
4	Fenoxaprop	30 DAS	60
5	Cyhalofop butyl + (chlorimuron + metsulfuron)	25-30 DAS	90+20
6	Fenoxaprop+ (chlorimuron + metsulfuron)	25-30 DAS	60+20
7	Azimsulfuron	20 DAS	35
8	Bispyribac sodium	20 DAS	25
9	Fenoxaprop + Ethoxysulfuron	25-30 DAS	60+ 15
10	Oxyfluorfen + 2,4-D	PE + 30 DAS	300 + 0.5
11	2 hand weeding		
12	Weedy		

AAU, Jorhat

Among various weed control practices, pretilachlor 750 g/ha, hand weeding at 20 and 40 DAS, pyrazosulfuron 25 g/ha and oxyfluorfen 300 g/ha +2,4-D 500 g/ha resulted lowest weed density and dry weight at different growth stages. Hand weeding at 20 and 40 DAS resulted highest grain followed by oxyfluorfen 300 g/ha + 2,4-D 500 g/ha, pretilachlor 750 g/ha and pyrazosulfuron 25 g/ha.

GBPUAT, Pantnagar

The combined application of fenoxaprop along with (chlorimuron 60 + metsulfuron 20 g/ha) gave the highest grain yield in direct dry seeded rice and its also found superior at all the stages (30, 60 and 90 DAS) of crop and effectively reducing the density and dry weight of weeds compared to other herbicidal treatment.

CSAUAT, Kanpur

The weed population/m^2 and dry weight was found minimum with application of cyhalofop butyl (90 g/ha) + almix (4 g/ha) fb with the application of bisbyribac (25 g/ha) and significant maximum in weedy plot. The significantly higher yield (37.11q/ha) was recorded with the application of cyhalofop butyl (90 g/ha) + almix (4 g/ha) followed by application of bisbyribac (25 g/ha), (35.42 q/ha).

OUAT, Bhubaneswar

Hand weeding plots recorded significantly highest yield of 3560 kg/ha where as weedy treatment recorded the lowest yield (1490 kg/ha). Among different chemical methods of weed control, significantly higher yield of 3350 kg/ha was obtained from application of fenoxaprop + (chororimuron + metsulfuron), which was at par with cyhalofop butyl +(chlorimuron + metsulfuron). Application of fenoxaprop + (chlorimuron + metsulfuron) recorded lowest weed index 6.30% followed by cyhalofop butyl +(chlorimuron + metsulfuron) of 7.45 %. The highest value of 57.3% was obtained from weedy treatment. Highest net return of Rs.16120/ha was obtained from application of fenoxaprop + (chlorimuron + metsulfuron) followed by cyhalofop butyl +(chlorimuron + metsulfuron) Rs16080/ha but the highest B:C ratio of 2.37 was observed with cyhalofop butyl +(chlorimuron + metsulfuron).

TNAU, Coimbatore

Pre-emergence application of pyrazosulfuron-ethyl at 25 g/ha recorded lesser weed density, dry weight and higher grain yield followed by pretilachlor (sofit) 750 g/ha. The crop phytotoxicity was observed in pre-emergence application of oxyfluorfen 300 g/ha.

UAS, Bengaluru

Pyrazosulfuron-ethyl 10 WP 25 g/ha – 3 DAS (2198 kg/ha), pretilachlor – S 0.75 kg/ha – 3 DAS (2310 kg/ha), cyhalofop butyl 10 EC 90 g/ha + chlorimuron ethyl + metsulfuron methyl 20 WP 4 g/ha – 25 DAS (2490 kg/ha), fenoxaprop-p-ethyl 9 EC 60 g/ha + chlorimuron ethyl + metsulfuron methyl 20 WP at 4 g/ha – 25 DAS (2616 kg/ha), bispyribac sodium 10 SC 25 g/ha – 20 DAS (2398 kg/ha) and fenoxaprop-p-ethyl 9 EC 60 g/ha + ethoxysulfuron 15 WG 15 g/ha (2416

kg/ha) gave similar yields, but lower than hand weeding (3122 kg/ha). Usage of herbicides saved weeding cost by Rs. 4030 to 5300/ha as compared to hand weeding (Rs. 6500/ha).

BAU, Ranchi

Application of pyrazosulfuron 25g/ha 3-7DAS being at par with pretilachlor-S 50% 750 g/ha 0-5DAS, cyhalofopbutyl 10% 90 g/ha 25-30 DAS, fenoxaprop 9.3% 30 DAS 60 g/ha, azimsulfuron 50DF 35 g/ha 35 DAS, fenoxaprop 60 g + ethoxysulfuron 15 g/ha 25-30 DAS, oxyfluorfen 23.5 EC 300 g + 2,4-D 80% 500 g/ha and two hand weeding at 20 and 40 days after sowing recorded 7.6, 15.7, 19.0 and 93.2% significantly higher grain yield as compared to cyhalofopbutyl 10% 90 g/ha 25-30 DAS + Almix 25-30 DAS 20 g/ha, fenoxaprop 9.3% 60 g/ha + Almix 20 g/ha 25-30DAS, bispyribac-sodium 10% 25 g/ha 25DAS, and weedy check respectively. Application of pyrazosulfuron 25g/ha 3-7 DAS and pretilachlor-S 50% 750 g/ha 0-5DAS recorded maximum net return (Rs32156) and B: C ratio (3.7) compared to rest of the treatments.

MAU, Parbhani

Highest grain yield was recorded in 2 HW which was found at par with fenoxaprop + (chlorimuron+metsulfuron) and POE spray of azimsulfuron and oxyfluorfen + 2,4-D and significantly superior over rest of all the treatments. The highest weed control efficiency for grassy and broad leaved weeds at 30 DAS (72% & 70%) and 60 DAS (74% & 78%) was observed with 2 HW which was followed by fenoxaprop + (chlorimuron + metsulfuron) in and azimsulfuron.

ANGRAU, Hyderabad

In direct-seeded rice, post emergence application of either cyhalofop-p-butyl (100 g/ha) + (chlorimuron ethyl + metsulfuron methyl (4.0 g/ha) or fenoxaprop-p-ethyl (60 g/ha) + (chlorimuron ethyl + metsulfuron methyl) (4.0 g/ha) resulted in efficient weed control and higher grain yield comparable to hand weeding (25 & 50 DAS). Combination of herbicides is found to be superior to single application of either pre-emergence or post-emergence herbicides.

V.B., Sriniketan

The herbicides and herbicide mixtures *viz.* azimsulfuron, bispyribac sodium, ethoxysulfuron, oxyfluorfen + 2, 4-D, cyhalofop butyl, fenoxaprop either alone or in combination with Almix showed toxicity on crop and it was recovered within a short period of time. Cyhalofop butyl and fenoxaprop either alone or in combination with Almix / ethoxysulfuron and bispyribac sodium were found to be the most effective in controlling grassy weeds. Post- emergence application of azimsulfuron controlled broad leave and sedge weeds. *Melochia corchorifolia* was the most predominant weeds in the present experimental field. Azimsulfuron as post emergence was found to be the most effective in controlling this problematic weed. The highest grain yield was recorded under 2 HW and this was statistically at par with pyrazosulfuron as PE and azimsulfuron, bispyribac sodium, cyhalofop butyl + Almix as POE. The highest net return and B:C ratio was recorded in pyrazosulfuron ethyl in both current *kharif* season and average of two years.

RAU, Pusa

The weed count and weed dry weight were recorded minimum under 2 hand weeding which was statistically at par with azimsulfuron, bispyribac sodium and fenoxaprop + ethoxysulfuron while significantly superior over rest of the treatments. The grain yield was also registered maximum under treatment 2 hand weeding which was statistically at par with treatment azimsulfuron, bispyribac sodium, fenoxaprop + ethoxysulfuron and fenoxaprop + (chlorimuron + metsulfuron) was significantly superior over rest of the treatments.

DBSKKV, Dapoli

In general, growth of grasses and sedges was more than BLWs. The weed density and weed growth of BLWs at 60 DAS was not influenced by various treatments. At 90 DAS, hand weeding twice, oxyfluorfen + 2,4-D, fenoxaprop (chlorimuron+metsulfuron) reduced weed growth, exhibiting weed control efficiency of 98.2%, 79.1%, and 75.5%, respectively, showing significant increase in rice yield over weedy check. Hand weeding twice recorded significantly higher number of filled grain and weight of filled grains panicles. Thus hand weeding twice produced significantly higher grain yield (3452 kg/ha) followed by use of fenoxaprop + ethoxysulfuron (3251 kg/ha). As compared to best treatment of hand weeding twice, the per cent reduction of grain yield was found in use of fenoxaprop + ethoxysulfuron (5.8%) followed by oxyfluorfen + 2,4-D (17.2%). The phyto-toxicity effect on crop at 10, 20 DAS and at harvest was not observed.

TNAU, Madurai

The investigation conclusively proved that post-emergence mixture of fenoxaprop + ethoxysulfuron on 30 DAS in aerobic rice is the appropriate weed management practice to control broad spectrum of weeds and to achieve higher productivity in aerobic rice.

SVPUAT, Meerut

The major weeds of the experimental field were *Echinochloa colona, Echinochloa crusgalli, Commelina benghalensis, Eclipta alba, Phylanthus niruri and Cyperus spp.* All the weed control treatments were found superior than weedy check. Among the weed control treatments, the lowest weed density (9.0/m^2 and 14.0/m^2) was recorded in treatment bispyribac-sodium 25 g/ha as post emergence followed by treatment of azimsulfuron 35 g/ha as post emergence. Similarly the lowest weed dry weight was also recorded in the same treatment. As far as grain yield is concerned, all the weed control treatments maintained its superiority over weedy check. Post-emergence application of bispyribac-sodium 25 g/ha gave significantly higher grain yield (3470 and 3182 kg/ha) closely followed by azimsulfuron 35 g/ha as post emergence (3225 and 3046 kg/ha) during both the years. Treatment, fenoxaprop + (chlorimuron + metsulfuron) 60+20 g/ha, pyrazosulfuron 25 g/ha, fenoxaprop 60 g/ha and hand weeding twice also recorded higher grain yield than remaining treatments. Fenoxaprop alone showed some phytotoxic effects on the crops 10-15 days after spraying. After some time crop recovered the growth.

Table 14: Effect of herbicides on weed density at 60 DAS in direct-seeded rice

Treatment	Weed density No. /m^2					
	Jorhat	Dapoli	Bhubaneswar	Pusa	*Meerut	*Madurai
Pyrazosulfuron 25g/ha	6.7	139.6	27.5	22.14	22	9.4 (87.2)
Pretilachlor-S 750 g/ha	6.7	123.6	30.8	23.93	33	9.9 (97.6)
Cyhalofop butyl 90 g/ha	8.2	153.0	26.7	25.66	41	8.8 (77.6)
Fenoxaprop 60 g/ha	7.6	48.3	23.5	26.14	24	8.4 (70.6)
Cyhalofop butyl 90 g/ha +(chlorimuron+metsulfuron) 20 g/ha	8.6	104.0	12.5	24.11	39	8.2 (67.0)
Fenoxaprop 60 g/ha+Almix 20 g/ha	7.6	76.0	11.8	23.46	26	5.7 (32.5)
Azimsulfuron 35g/ha	8.3	154.0	21.7	19.60	22	6.6 (43.7)
Bispyribac sodium 25 g/ha	9.3	158.7	15.5	21.88	14	6.2 (38.1)
Fenoxaprop 60 g/ha +Ethoxysulfuron 15 g/ha	8.3	40.7	18.3	22.01	45	6.1 (37.5)
Oxyfluorfen 300 g/ha +2,4-D 750 g/ha	7.7	61.3	25.8	26.64	42	6.0 (35.8)
2 hand weeding	7.0	6.7	3.6	18.21	49	7.5 (56.3)
Weedy	11.0	182.3	104.7	73.03	102	17.8 (316.8)
LSD (P=0.05)	**0.7**	**-**	**4.6**	**3.9**	**4.9**	**0.2**

Figures in parenthesis are original values; * volunteer centres; # 45 DAS

Table 15: Effect of herbicides on weed dry biomass at 60 DAS in direct seeded rice.

Treatment	Weed dry biomass (g/ m^2)						
	Jorhat	Pantnagar	Bhubaneswar	Pusa	Ranchi	*Meerut	*Madurai
Pyrazosulfuron 25g/ha	5.3	350.7	23.5	12.0	19.0 (430)	21.1	15.8 (250)
Pretilachlor-S 750 g/ha	5.4	359.9	24.7	15.8	22.4 (600)	29.7	16.9 (286)
Cyhalofop butyl 90 g/ha	5.7	339.9	23.4	19.2	20.1 (483)	34.6	14.9 (224)
Fenoxaprop 60 g/ha	6.2	134.1	18.5	20.1	22.0 (577)	35.7	12.5 (155)
Cyhalofop butyl 90 g/ha +(chlorimuron+metsulfuron) 20 g/ha	6.1	276.4	7.8	16.2	23.6 (662)	46.9	11.9 (141)
Fenoxaprop 60 g/ha+Almix 20 g/ha	5.9	54.9	5.7	14.9	23.4 (651)	22.6	8.5 (72)
Azimsulfuron 35g/ha	7.0	216.0	16.5	9.9	20.3 (490)	20.1	10.5 (110)
Bispyribac sodium 25 g/ha	6.9	112.7	9.8	11.8	22.4 (600)	13.9	10.2 (103)
Fenoxaprop 60 g/ha +Ethoxysulfuron 15 g/ha	5.9	67.5	12.7	12.0	21.5 (552)	49.2	10.1 (102)
Oxyfluorfen 300 g/ha +2,4-D 750 g/ha	4.9	331.1	21.3	21.1	22.9 (626)	61.6	9.7 (94)
2 hand weeding	4.6	75.1	4.5	8.3	15.4 (283)	39.7	11.3 (128)
Weedy	7.6	532.3	33.5	45.2	33.7 (1396)	86.4	32.6 (1062)
LSD (P=0.05)	**4.9**	**121.9**	**2.7**	**3.9**	**3.3**	**4.3**	**0.4**

Figures in parenthesis are original values; # 45 DAS; * Volunteer centre dry biomass kg/ha

Table 16: Effect of herbicides on grain yield of direct-seeded rice

Treatment	Grain Yield (Kg/ ha)										
	Jorhat	Coimbatore	Bhubaneswar	Sriniketan	Dapoli	Kanpur	Pusa	Pantnagar	Ranchi	*Meerut	*Madhurai
Pyrazosulfuron 25g/ha	1500	4575	2725	4217	2171	2430	4397	744	3900	2725	3615
Pretilachlor-S 750 g/ha	1560	4209	2460	4096	1841	2752	4320	630	3900	2272	3734
Cyhalofop butyl 90 g/ha	870	3209	2640	3821	1460	2924	4154	1331	3867	2250	3780
Fenoxaprop 60 g/ha	1450	3309	2920	3769	2100	2216	4088	2142	3367	2755	3970
Cyhalofop butyl 90 g/ha +(chlorimuron+metsulfuron) 20 g/ha	1020	3476	3230	4194	2047	3711	4395	1420	2833	2527	4073
Fenoxaprop 60 g/ha+Almix 20 g/ha	1470	3376	3270	4009	2336	3130	4401	3559	2967	2877	4253
Azimsulfuron 35g/ha	1150	3442	3000	4201	2416	1920	4675	2086	3233	3046	5106
Bispyribac sodium 25 g/ha	990	3876	3075	4162	1992	3542	4453	2831	2900	3182	5710
Fenoxaprop 60 g/ha +Ethoxysulfuron 15 g/ha	1580	4085	3070	3419	3251	3318	4429	3183	3233	2516	6051
Oxyfluorfen 300 g/ha +2,4-D 750 g/ha	1670	2823	2875	4079	2859	2511	4028	820	2233	1591	4016
2 hand weeding	2250	4309	3490	4243	3452	3812	4671	3005	4000	2741	4321
Weedy	410	1209	1490	2152	837	1830	3361	288	1867	1115	2232
LSD (P=0.05)	**140**	**219**	**139**	**231**	**154**	**486**	**291**	**730**	**270**	**198**	**303**

*Volunteer centre

WS-2.4: Evaluation of metribuzin in combination with clodinafop, sulfosulfuron and pinoxaden for weed control in wheat

Cooperating centres: PAU, CCSHAU, CSKHPKV, GBPUAT, RAU(B), CSAUAT, RVSKVV, RAU(P), IGKV, NDUAT, SVBPUAT (Meerut), RBSCA, (Agra).

Treatments:

Treatment	Dose (g/ha)
Clodinafop	60
Sulfosulfuron	25
Metribuzin	175
Pinoxaden	50
Clodinafop + metribuzin	60+105
Clodinafop + metribuzin	60+122.5
Sulfosulfuron + metribuzin	25+105
Sulfosulfuron + Pinoxaden	25 + 40
Weed free	
Weedy check	

PAU, Ludhiana

In wheat, clodinafop, pinoxaden alone provided effective control of *P minor*. Tank mixing of these herbicides with metribuzin helped in controlling *Rumex dentatus* and *Chenopodium album*. Sulfosulfuron alone provided effective control of *P minor, Medicago denticulata and C album*; tank mixing with metribuzin helped control *Rumex*. Tank mixing of sulfosulfuron + pinoxaden showed antagonism. Tank mixing of metribuzin with either of clodinafop, sulfosulfuron and pinoxaden did not reflect in any yield advantage over application of these herbicides alone.

CCSHAU, Hisar

Tank-mix application of metribuzin 105-122.5 g/ha with clodinafop 60 g/ha or sulfosulfuron 25 g/ha improved the control of *P. minor* and *BLW* with no phyto-toxicity on the crop, indicating the importance of tank-mix application of these herbicides in management of the cross resistance in *P. minor.*

CSKHPKV, Palampur

Weeds in unweeded check reduced the grain yield of wheat by 65 per cent over clodinafop + metribuzin 60+105 g/ha. However, clodinafop + metribuzin 60+105 g/ha behaved statistically alike with all the weed control treatments and resulted in significantly higher grain yield by effective control of weeds.

GBPUAT, Pantnagar

Tank mix application of pinoxaden 50 + metribuzin 122.5 g/ha or clodinofop – propargyl 60 + metribuzin 122.5 g/ha were found most effective against grassy as well as broad leaved weeds in wheat and these treatments produced wheat grain yield similar to weed – free condition.

Table 17: Effect of different treatments on weed density and dry weight in wheat.

Treatment	Dose (g/ha)	Weed density (No./m^2)						Weed dry biomass (g/m^2)						
		Pantnagar	Gwalior	Pusa	Raipur	Faizabad	#Meerut	Pantnagar	Gwalior	Pusa	Raipur	Faizabad	#Agra	#Meerut
Clodinafop	60	5.5 (261)	9.1	25.7	40.31	11.0 (120.2)	57	3.8 (43.6)	11.6	11.3	6.1	8.6 (74.4)	15.4	35.2
Sulfosulfuron	25	4.4 (80)	6.9	27.8	17.99	8.6 (73.8)	29	3.0 (20.3)	9.6	13.7	4.1	5.5 (29.5)	13.7	26.1
Metribuzin	175	3.4 (30)	9.4	30.7	20.32	8.2 (67.6)	15	2.4 (10.3)	14.4	17.4	4.7	6.0 (36.3)	12.4	11.2
Pinoxaden	50	5.6 (269)	4.6	36.9	28.17	11.0 (122.1)	49	3.7 (41.0)	13.0	20.2	6.0	8.0 (64.5)	11.1	29.7
Clodinafop + metribuzin	60+105	2.3 (9.1)	6.0	24.5	16.65	8.7 (75.3)	09	2.3 (9.1)	6.0	9.4	5.5	6.0 (36.1)	10.7	7.8
Clodinafop + metribuzin	60+122.5	1.8 (5.4)	2.7	20.3	16.31	7.4 (56.0)	05	1.8 (5.4)	5.5	7.1	3.9	3.8 (13.6)	10.0	4.1
Sulfosulfuron + metribuzin	25+105	2.3 (9.5)	11.0	21.8	13.98	7.6 (56.9)	08	2.3 (9.5)	7.1	8.6	3.4	4.5 (19.5)	07.1	7.9
Sulfosulfuron + Pinoxaden	25 + 40	1.9 (6.8)	8.3	32.0	22.31	8.1 (66.0)	10	-	5.5	18.2	5.5	5.9 (33.8)	08.3	9.2
Pinoxaden+metribuzin	40+105	-	7.5	-	-	-	-	-	15.2	-	-	-	-	-
Pinoxaden+metribuzin	40+122.5	-	7.9	-	-	-	-	-	10.2	-	-	-	-	-
2,4-D Na salt	500 g/ha	-	12.7	-	-	-	-	-	15.9	-	-	-	-	-
2,4-D Na salt	1000 g/ha	-	9.8	-	-	-	-	-	13.6	-	-	-	-	-
Weed free		0.0 (0.0)	4.4	7.4	16.66	1.0 (0.0)	00	0.0 (0.0)	3.6	3.0	3.3	1.0 (0.0)	0.0	00
Weedy check		6.0 (410)	24.3	52.2	44.65	13.2 (174.6)	108	4.9 (130.4)	42.4	36.0	14.4	11.9 (141.9)	26.6	86.2
LSD(P=0.05)		**-**		**3.7**	**-**	**2.5**	**8.1**	**-**	**-**	**2.2**	**2.6**	**0.8**	**3.6**	**6.4**

volunteer centre

Table 18: Effect of different treatments on grain yield of wheat.

Treatment	Dose (g/ha)	Grain yield (kg/ka)								
		Pantnagar	Palampur	Gwalior	Pusa	Hisar	Raipur	Faizabad	#Agra	# Meerut
Clodinafop	60	4320	3180	3639	3740	4758	2420	3390	4071	4222
Sulfosulfuron	25	5244	3165	4287	3860	4764	2490	3620	4115	4666
Metribuzin	175	4612	3260	3510	3610	4337	2490	3520	4160	4700
Pinoxaden	50	4362	3120	3305	3360	4645	2440	3290	4180	3981*
Clodinafop + metribuzin	60+105	5525	3480	4176	3950	4730	2670	3620	4231	5000
Clodinafop + metribuzin	60+122.5	5300	3478	4055	4100	4756	2590	3920	4272	4889
Sulfosulfuron + metribuzin	25+105	5024	3365	4583	4050	4593	2720	3880	4393	5111
Sulfosulfuron + Pinoxaden	25 + 40	-	3318	4648	3553	4817	2490	3550	4244	4889*
Pinoxaden+metribuzin	40+105	5560	-	4143	-	-	-	-	-	-
Pinoxaden+metribuzin	40+122.5	5340	-	4176	-	-	-	-	-	-
2,4-D Na salt	500 g/ha	-	-	3665	-	-	-	-	-	-
2,4-D Na salt	1000 g/ha	-	-	3694	-	-	-	-	-	-
Weed free		5588	3460	5028	4190	4801	2670	4650	4411	5222
Weedy check		2885	1218	2222	2620	3470	1390	3020	3485	3577
LSD(P=0.05)		**-**	**380**	**411**	**461**	**-**	**360**	**260**	**273**	**415**

 # Volunteer centre; * Pinoxaden= Carfentrazone ethyl

RVSKVV, Gwalior

Application of sulfosulfuron + pinoxaden (25 +40 g/ha) in wheat recorded highest yield and net return after weed free treatment. It was followed by sulfosulfuron + metribuzin (25 +105 g/ha). Among the alone applications, sulfosulfuron 25 g/ha was also found more effective than other alone herbicide application.

RAU, Pusa

All the treatments significantly reduced the weed population and dry weight of weed over check. However the maximum reduction in weed count and dry weight were observed under weed free condition while under chemicals used, application of clodinafop +metribuzin 60+122.5 g/ha) had registered minimum weed count and dry weight which was statistically at par with sulfosulfuron + metribuzin 25 + 105 which were significantly superior to rest of the treatments. Grain yield was recorded highest under weed free plot which was statistically at par with treatment clodinafop +metribuzin 60+122.5, Sulfosulfuron + metribuzin 25 + 105, clodinafop +

metribuzin 60+105, sulfosulfuron 25 and clodinafop 60. All the treatments significantly reduced the weed population and dry weight of weed over check. However the maximum reduction in weed count and dry weight were observed under weed free condition while under chemicals used, application of clodinafop +metribuzin 60+122.5 g/ha had registered minimum weed count and dry weight which was statistically at par with sulfosulfuron + metribuzin 25 + 105 which were significantly superior to rest of the treatments. Grain yield was recorded highest under weed free plot which was statistically at par with treatment clodinafop +metribuzin 60+122.5 Sulfosulfuron + metribuzin 25 + 105, clodinafop + metribuzin 60+105, sulfosulfuron 25 and clodinafop 60.

IGKV, Raipur

Medicago denticulata, Chenopodium album, Anagalis arvensis and Alternanthera triandera were the predominant weed species in the experimental field. Among the herbicide treatments, sulfosulfuron + metribuzin 25 + 105 g/ha produced significantly higher grain yield of wheat than weedy check due to lowest weed dry matter production and weed control efficiency and higher yield attributes as well. However, treatment of hand weeding twice and clodinafop + metribuzin 60 + 105 g/ha were next to highest, in order.

NDUAT, Faizabad

Metribuzin 122.5 g + clodinafop 60 g/ha (PoE) being at par with metribuzin 105 g + sulfosulfuron 25 g/ha (PoE) recorded significantly higher values of WCE, yield attributes and yield as well as the economic returns in wheat over rest of the weed control treatments.

SVPUAT, Meerut

The major weeds of the experimental field were *Phalaris minor, Anagallis arvensis, Chenopodium album, Rumex spinosus, Polygonum plebejum, Poa annua, Fumaria parviflora*. The lowest weed population and their dry weight were recorded in weed free treatment. Among the herbicide treatments, the lowest weed population was recorded in the treatment clodinafop + metribuzin (60 + 122.5 g/ha) followed by sulfosulfuron + metribuzin (25+105 g/ha), clodinafop + metribuzin (60+105 g/ha) and weedy check. Similarly the lowest weed dry weight was also recorded in the same treatment. As far as grain yield is concerned, all the weed control treatments maintained theirs uperiority over weedy check. Post-emergence application of sulfosulfuron + metribuzine (25+105 g/ha) gave significantly higher grain yield (5111 kg/ha) closely followed by clodinafop + metribuzine (60+ 1 05 g/ha), clodinafop + metribuzin (60+105 g/ha) and sulfosulfuron + carfentrazone ethyl.

RBSCA, Agra

Thr significantly lower population of grassy and non-grassy weeds was found in sulfosulfuron + metribuzin (25+105 g/ha) as compared to all other treatments except sulfosulfuron + metribuzin (25+40 g/ha). The lowest dry matter of total weeds was obtained with sulfosulfuron + metribuzin (25+105 g/ha) and this was found significantly superior over all other treatments except sulfosulfuron + metribuzin (25+40 g/ha) and clodinafop + metribuzin (60 + 122.5 g/ha). The highest biological yield was obtained with weed free but this was found statiscally at par with clodinafop + metribuzin (60+105 g/ha), sulfosulfuron + metribuzin (25+105 g/ha) and sulfosulfuron + metribuzin (25+40 g/ha).

WS-2.5: Bioefficacy of pinoxaden 5 EC in combination with broadleaf herbicides against complex weed flora in wheat.

Cooperating centres: PAU, CCSHAU, CSKHPKV, GBPUAT, RAU(B), CSAUAT, RVSKVV, RAU(P), IGKV

Treatments:

Treatments	Dose (g/ha)	Time of application
Pinoxaden	50	28 DAS
Metsulfuron-methyl	4	28 DAS
Pinoxaden + carfentrazone-ethyl	50+20	28 DAS
Pinoxaden + metsulfuron-methyl	50 + 4	28 DAS
Pinoxaden +2,4-D	50+500	28 DAS
Pinoxaden *fb* carfentrazone-ethyl	50 & 20	28 & 35 DAS
Pinoxaden *fb* metsulfuron-ethyl	50&4	28 & 35 DAS
Pinoxaden *fb* 2,4-D	50 & 500	28 & 35 DAS
Carfentrazone-ethyl	20	28 DAS
Idosulfuron + Mesosulfuron	400	25-30 DAS
2,4-D	500	28 DAS
Weedy Check	-	
Weed Free	-	

PAU, Ludhiana

In wheat, metsulfuron provided effective control of all the broadleaf weeds. Carfentrazone and 2,4-D were poor against *Rumex dentatus* and *Medicago denticulata*. Tank mixing of pinoxaden with broadleaf herbicides did not influence the efficacy of pinoxaden; efficacy of metsulfuron and 2,4-D was not affected while the efficacy of carfentrazone was reduced against *Rumex*. The wheat grain yield under tank mixing or sequential application of pinoxaden with metsulfuron, carfentrazone and 2,4-D were at par to weed free check. The results indicated that pinoxaden can be applied as tank mix with metsulfuron and 2,4-D, however, in case of carfentrazone sequential application should be preferred.

CSKHPKV, Palampur

Weeds in unweeded check reduced the grain yield of wheat by 52.2 per cent over the best treatment i.e. pinoxaden + metsulfuron methyl 50 + 4 g/ha. However, pinoxaden + metsulfuron methyl 50 + 4 g/ha behaved statistically alike with pinoxaden 50 g/ha, pinoxaden + carfentrazone 50 + 20 g/ha, pinoxaden + 2,4-D 50 + 500 g/ha, pinoxaden *fb* carfentrazone-ethyl 50 *fb* 20 g/ha, pinoxaden *fb* metsulfuron methyl 50 *fb* 4 g/ha, pinoxaden *fb* 2,4-D 50 *fb* 500 g/ha and weed free treatments and resulted in significantly higher grain yield by effective control of weeds.

GBPUAT, Pantnagar

At 60 days stage of crop the lower weed population was recorded with combined application of pinoxaden 50 g + metsulfuron-methyl 4.0 g , which was found significantly lower over rest of the herbicidal treatments applied either alone on in combination except than Pinoxadan 50 g followed by metsulfuron-methyl 4.0 g. The highest weed population was obtained with application of 2,4-D 500 g as compared to application of pinoxaden 50 g/ha applied as alone, total weed population was significantly reduced and the combination of 2, 4–D 500 g and carfentrazone-ethyl 20 g applied as tank mix with pinoxaden applied at 30 days stage. Dry matter accumulation at 60 days stage was decreased over 30 days in treatments like, pinoxaden 50 g. + MSM 4 g pinoxaden 50 g. + carfentrazone-ethyl 20 g followed by MSM 4 g pinoxaden 50 g followed by carfentrazone- ethyl 20 g., pinoxaden 50 g followed by 2,4-D 500 g/ ha respectively and was significantly lower over rest of the herbicidal treatments and weedy check plot. Pinoxaden 50 g + MSM 4 g have lowest total weed dry matter accumulation. Highest grain yield (4167 kg/ha) was recorded in weed free plot which was at par with rest of the treatments except alone pinoxaden 50 g/ha applied alone, MSM, carfentrazone-ethyl 20 g and 2,4-D 500 g/ha. The reduction (41.9 %) in grain yield was recorded in weedy check plot due to heavy infestation of weeds. Lowest yield reduction due to weeds only 0.95 percentage was found with application of pinoxaden 50 g/ha + MSM 4 g/ha. The grain yield was comparable in the treatment of isoproturon, pinoxaden followed by MSM, pinoxaden+ 2, 4-D and pinoxaden+ MSM. Lower yield were obtained from carfentrazone-ethyl and 2,4-D treated plots.

CSAUAT, Kanpur

The minimum density of weeds and dry weight of grassy weeds was recored with application of idosulfuron + misosulfuron at 60 DAS and harvest. The minimum density and dry weight of broad leaf weeds were recorded with application of pinoxaden fb metsulfuron-ethyl (50+4 g/ha).

The maximum yield (5527 kg/ha) and net income (Rs 44094/ha) obtained with application of idosulfuron + mesosulfuron (12+2.4 g/ha).

RVSKVV, Gwalior

For effective control of grassy and broad leaf weeds, lowest weed index, higher yield, net return and benefit cost ratio was observed with application of idosulfuron + mesosulfuron 400 g/ha followed by pinoxaden + 2,4-D (50 +500 g/ha), pinoxaden + metsulfuron (50 + 4 g/ha) as POE after weed free (2, hand weedings at 28 & 45 DAS) treatment.

RAU, Pusa

Weed free treatment recorded significantly lowest weed count and weed dry weight over all other treatments, while in terms of grain yield it remain statistically at par with pinoxaden + carfentrazone-ethyl (50 + 20 g/ha) (T_3) and significantly superior over rest of the treatments. Amongst weed control methods T_3 had recorded significantly lowest weed count and weed dry weight over all other treatments except pinoxaden + 2, 4-D (50 + 500 g/ha) (T_5), pinoxaden *fb* carfentrazone-ethyl(50 & 20 g/ha) (T_6), carfentrazone-ethyl (20 g/ha) (T_9) and idosulfuron + mesosulfuron (400 g/ha) T_{10}. Amongst all weed control methods, grain yield was also recorded

maximum under T_3 which was significantly superior to all other treatments except T_5, T_6, T_9 and $T_{10,}$ which remain statistically at par with it.

IGKV, Raipur

Medicago denticulata, Chenopodium album, Anagalis arvensis were the predominant weed species in experimental field. Other than hand weeding twice, the herbicide treatments, pinoxaden + carfentrazone p 50 + 20 g/ha and pinoxaden + metsulfuron 50 + 4 g/ha also produced significantly higher grain yield of wheat than weedy check due to lowest weed dry matter production and high weed control efficiency and higher yield attributes.

Table 19: Effect of treatment of bioefficacy of pinoxaden 5 EC in combination with broadleaf herbicides against complex weed flora in wheat.

Treatment	Weed density (No./m^2)			Weed dry biomass (g/m^2)			
	Pantnagar	Raipur	Pusa	Pantnaagar	Raipur	Pusa	Gwalior
Pinoxaden	4.7 (247)	20.7	29.4	1.6 (4.53)	6.5	21.3	4.1
Metsulfuron-methyl	5.8 (374)	14.6	37.2	4.4 (78.53)	2.0	25.9	142.7
Pinoxaden + carfentrazone –ethyl	4.5 (92)	10.0	18.9	1.3 (3.06)	1.4	13.7	3.8
Pinoxaden + Metsulfuron-methyl	3.0 (19)	10.0	21.8	0.5 (0.73)	1.6	16.7	3.3
Pinoxaden + 2, 4-D	4.1 (73)	15.3	19.7	0.8 (1.33)	3.5	14.6	3.1
Pinoxaden *fb* Carfentrazone-ethyl	4.1 (65)	13.3	20.2	1.1 (2.26)	3.1	15.4	4.2
Pinoxaden *fb* metsulfuron-methyl	3.7 (51)	14.6	23.9	0.8 (1.33)	2.6	18.0	8.3
Pinoxaden *fb* 2, 4-D	4.5 (96)	15.3	21.4	1.4 (1.33)	3.4	15.2	6.8
Carfentrazone-ethyl	5.7 (311)	14.3	19.3	4.2 (69.86)	3.5	14.2	149.1
Idosulfuron + Mesosufuron	5.1 (177)	18.3	20.9	2.6 (15.60)	4.9	14.9	3.1
2, 4-D	6.1 (439)	15.0	23.7	4.5 (98.73)	3.1	17.6	147.9
Isoproturon	4.3 (80)			2.3 (10.93)			-
Weed free	0.0	9.3	6.7	0.0 (0.0)	1.5	2.9	2.8
Weedy check	6.1 (511)	50.6	46.2	4.5 (100.93)	15.5	32.1	300.2
LSD (P=0.05)	**0.9**	**-**	**2.2**	**4.5**	**2.2**	**1.9**	**-**

*Volunteer centre

Table 20: Effect of treatment of Bioefficacy of pinoxaden 5 EC in combination with broadleaf herbicides against complex weed flora in wheat.

Treatment	Grain yield (kg/ha)					
	Palampur	Pantnagar	Kanpur	Pusa	Raipur	Gwalior
Pinoxaden	3684	3492	4799	3599	2180	3148
Metsulfuron-methyl	3066	3174	4442	3395	2350	3333
Pinoxaden + carfentrazone –ethyl	3704	3809	5377	4250	2650	4352
Pinoxaden + Metsulfuron-methyl	3880	4127	4920	3715	2620	4537
Pinoxaden + 2, 4-D	3669	3849	5120	4002	2420	4630
Pinoxaden *fb* Carfentrazone-ethyl	3586	3968	5421	3868	2340	4222
Pinoxaden *fb* metsulfuron-ethyl	3739	3809	5291	3675	2340	4370
Pinoxaden *fb* 2, 4-D	3519	3968	5312	3815	2510	4450
Carfentrazone-ethyl	3157	2619	4512	4095	2530	3197
Idosulfuron + Mesosufuron	3386	3928	5527	4056	2210	4676
2, 4-D	3046	2619	4731	3575	2500	3426
Isoproturon	-	3889	-	-	-	-
Weed free	3757	4167	5585	4341	2710	4713
Weedy check	1852	2421	4312	2918	1750	2509
LSD (P=0.05)	**457**	**547**	**683**	**391**	**410**	**568**

WS 2.6: Integrated weed management in Maize

Cooperating centres: TNAU, MAU, UAS(B), CSKHPKV, PAU, UAS(D), ANGRAU, DPDKV (Akola) (Long term trial to be continued for 5 years on fixed site)

Treatments

1. Oxyfluorfen 0.2 kg/ha PE on 3 DAS
2. Atrazine 1.0 kg/ha PE on 3 DAS
3. Pendimethalin 0.75 kg/ha PE on 3 DAS
4. Ametryn 1.0 kg/ha PE on 3 DAS
5. Oxyfluorfen 0.2 kg/ha PE on 3 DAS + mechanical weeding 30 DAS
6. Atrazine 1.0 kg/ha PE on 3 DAS + mechanical weeding 30 DAS
7. Pendimethalin 0.75 kg/ha PE on 3 DAS + mechanical weeding 30 DAS
8. Ametryn 1.0 kg/ha PE on 3 DAS + mechanical weeding 30 DAS
9. Hand weeding twice on 20 & 40 DAS
10. Weedy check

PAU, Ludhiana

Oxyfluorfen gave effective control of *D. ciliaris, C. benghalensis, A. racemose, E. aegyptiacum;* atrazine was poor against *A. racemose*; pendimethalin gave effective control of *A. racemose, Digitaria and E. aegyptiacum*. Integration of all the herbicides with one hoeing reduced the population of grasses as compared to use of respective herbicide alone. Oxyfluorfen 0.2 kg/ha alone recorded the highest maize grain yield and it was at par to oxyfluorfen/atrazine both fb one hoeing and two hoeing treatments.

UAS, Bengaluru

Integrated weed management in maize revealed that maize kernel yield obtained in hand weeding (7254 kg/ha) was similar to use of herbicides pendimethalin, oxyfluorfen or atrazine as pre-emergence at 3 DAS fb mechanical weeding at 30 DAS (6858 to 6968 kg/ha) and oxyfluorfen fb 2,4-D Na salt at 30 DAS (6817 kg/ha). Further use of herbicides saved weeding cost to an extent of Rs. 3485 to 4050/ha as compared to hand weeding (Rs. 6000/ha).

MAU, Parbhani

Highest grain yield was recorded in 2 HW which was at par with oxyfluorfen 0.2 kg/ha + mechanical weeding 30 DAS, atrazine 1.0 kg/ha+ mechanical weeding 30 DAS and pendimethalin 0.75 kg/ha + mechanical weeding 30DAS and was significantly higher than rest of the treatments. The highest WCE for grassy as well as broad leaved weeds at 30 DAS and 60 DAS was observed in 2 HW treatment followed by oxyfluorfen 0.2 kg/ha on 3 DAS + mechanical weeding at 30 DAS and atrazine 1.0 kg/ha + mechamical weeding at 30 DAS.

CSKHPKV, Palampur

In an experiment on integrated weed management studies in maize, atrazine 1.0 kg/ha on 3 DAS + mechanical weeding at 30 DAS behaved statistically alike with all the weed control treatments in which one mechanical weeding at 30 DAS was executed and hand weeding twice treatment and resulted in significantly higher grain yield of maize by effective control of weeds. Weeds in unweeded check reduced the grain yield of maize by 46.5 per cent over the best treatment.

UAS, Dharwad

Application of oxyfluorfen 0.2kg/ha PE or atrazine 1.0 kg/ha PE or pendimethalin 0.75 kg/ha PE or atrazine 1.0 kg/ha EPOE when used alone did not differ significantly with respect to yield levels. The yield levels were significantly higher when one mechanical weeding was added to these herbicides than applying them alone. However, the application of these herbicides with one mechanical weeding were on par with each other (3208, 3047, 3115 and 3047 kg/ha respectively). Further these treatments were statistically on par with hand weeding twice. (3269 kg/ha). Weed dry matter /m^2 was significantly lower with herbicides when combined with one mechanical weeding compared to when they are used alone.

ANGRAU, Hyderabad

Pre-emergence application of either atrazine 1.0 kg/ha fb intercultivation at 30 DAS or oxyflourfen 0.3 kg/ha fb IC at 30 DAS was very effective for efficient weed control and achieving higher grain yield in maize.

PDKV, Akola

Atrazine 1.0 kg/ha PE followed by mechanical /hand weeding at 30 DAS proved better in controlling weed, dry matter accumulation, weed control efficiency , weed index, grain yield and NMR but hand weeding twice at 20 & 40 DAS proved superior over in all aspects except B:C ratio.

Table 21: Effect of treatments on weed density and dry biomass at 60 DAS in Maize.

Treatment	Weed density (No./m^2)		Weed dry biomass (g/m^2)		
	Palampur#	*Akola	Palampur	Hyderabad	*Akola
Oxyfluorfen 0.2 kg/ha PE on 3 DAS	8.8 (77.3)	68.7	6.8 (45.3)	53.5	83.2
Atrazine 1.0 kg/ha PE on 3 DAS	7.0 (52.0)	54.5	6.1 (36.0)	49.5	65.5
Pendimethalin 0.75 kg/ha PE on 3 DAS	7.6 (58.7)	60.5	5.9 (34.0)	57.5	69.6
Ametryn 1.0 kg/ha PE on 3 DAS	9.5# (93.3)	-	7.1# (49.6)	-	-
Oxyfluorfen 0.2 kg/ha PE on 3 DAS + mechanical weeding 30 DAS	1.0 (0.0)	43.2	1.0 (0.0)	20.8	52.3
Atrazine 1.0 kg/ha PE on 3 DAS + mechanical weeding 30 DAS	1.0 (0.0)	28.7	1.0 (0.0)	16.5	33.6
Pendimethalin 0.75 kg/ha PE on 3 DAS + mechanical weeding 30 DAS	1.0 (0.0)	34.2	1.0 (0.0)	24.7	44.9
Ametryn 1.0 kg/ha PE on 3 DAS+ mechanical weeding 30 DAS	1.0# (0.0)	-	1.0# (0.0)	-	-
Hand weeding twice on 20 & 40 DAS	1.0 (0.0)	22.7	1.0 (0.0)	13.5	29.1
Weedy check	10.4 (110.7)	105.7	8.9 (80.1)	132.0	127.9
LSD (P=0.05)	**2.5**	**7.8**	**1.4**	**3.2**	**9.3**

*Volunteer centre; # Atrazine

Table 22: Effect of treatments on grain yield in Maize.

Treatment	Grain Yield (Kg/ ha)				
	Parbhani	Palampur	Ludhiana	Hyderabad	#Akola
Oxyfluorfen 0.2 kg/ha PE on 3 DAS	7284	3490	7284	6020	2724
Atrazine 1.0 kg/ha PE on 3 DAS	6914	4500	6914	6570	3051
Pendimethalin 0.75 kg/ha PE on 3 DAS	6420	4390	6420	5350	2857
Ametryn 1.0 kg/ha PE on 3 DAS	6296*	4520[a]	6296[a]	-	-
Oxyfluorfen 0.2 kg/ha PE on 3 DAS + mechanical weeding 30 DAS	6673	4660	6673	6970	3110
Atrazine 1.0 kg/ha PE on 3 DAS + mechanical weeding 30 DAS	6913	5330	6913	7310	3348
Pendimethalin 0.75 kg/ha PE on 3 DAS + mechanical weeding 30 DAS	6620	4990	6620	6770	3148
Ametryn 1.0 kg/ha PE on 3 DAS + mechanical weeding 30 DAS	-	4950[b]	-	-	-
Hand weeding twice on 20 & 40 DAS	6667**	4740	6667	7450	3351
Weedy check	5803	2850	5803	3190	1764
LSD (P=0.05)	**632**	**690**	**632**	**710**	**550**

WS 2.6a: Effect of maize based cropping systems on weed dynamics, soil health and crop productivity

Cooperating centres: CSKHPKV, MAU, RAU(P), RBSCA, (Agra), DPDKV (Akola)

Treatments:

Main plot : (Cropping system)

1. Maize-wheat
2. Maize-chickpea
3. Maize-pea
4. Maize-mustard
5. Maize-potato-green gram/ black gram

Sub-plot: (Weed control)

1. Recommended practice
2. Weedy

MAU, Parbhani

Significantly highest grain yield was recorded in the cropping system of maize-chickpea, which was significantly superior over rest of the treatments. As regards weed control treatments recommended practice of weed control recorded significantly highest grain yield (equivalent yield of the system) over the control i.e. weedy check. Interaction effect of cropping system and weed control treatments was found to be non significant.

CSKHPKV, Palampur

Maize-potato crop produced significantly highest wheat equivalent yield. Maize-pea crop was the next best in increasing the wheat equivalent yield. Recommended herbicides resulted in significantly higher maize grain yield over farmer's practice of weed control.

RBSCA, Agra

Significantly lower weed population was noted in maize-wheat cropping system at later stages as compared to all other cropping systems except maize-checkpea and maize-mustard in case of non-grassy weeds. The differences in dry matter of total weeds at later stages due to different cropping systems could not reach the level of significance. Recommended practice significantly reduced the weed population as well as their dry matter as compared to weedy check. Significantly higher wheat equivalent yield was obtained in maize-potao as compared to all other cropping systems. Maize-wheat also gave significantly higher wheat equivalent yeld over maize-pea and maize-mustsrd. However, highest net return (Rs. 37833.75/ha) and B:C ratio were obtained with maize-wheat cropping system, closely followed by maize-potato cropping system in respect of net return. Significantly higher wheat equivalent yied was obtained with recommended practice as compared to weedy check. Recommended practice gave near about Rs. 9200/ha additional net return than weedy check.

WS 2.7: Weed management in sugarcane ratoon.

Cooperating centres: GBPUAT, RAU (P), OUAT, CCSHAU, PAU, UAS(D)

Treatments

1. Atrazine 1.5 kg/ha PE on 3 DAP
2. 2,4-D (Amine salt) 0.75 kg/ha as POE on 75-90 DAP
3. Atrazine 1.5 kg/ha PE on 3 DAP + 2,4-D (Amine salt) 0.75 kg/ha as POE on 75-90 DAP
4. Metribuzin 0.88 kg/ha (pre-em) fb one hoeing at 45 DAS fb 2,4-D (Amine salt 0.75 kg/ha) at 90 DAS
5. Ethoxysulfuron 37.5 g/ha at 2-4 leaf stage of weed
6. (Chlorimuron+Metsulfuron) 8 g ai/ha at 2-4 leaf stage of weed
7. Hand weeding thrice on 30, 60 & 90 DAP
8. Weedy check

OUAT, Bhubaneswar

Pre-emergence application of metribuzine 0.88 kg/ha with one HW at 45 DAP and application of 2,4-D Na salt 0.5 kg/ha at 90 DAP recorded significantly the lowest weed density both at 120 DAS (23.6/m2) and at harvest (52.3/m2). Broadleaf weeds (52.9%) were dominant at 120 DAS (Table 2) flowed by grasses (30.8%) and sedges (16.3%). However a shift from broadleaf weeds (48.3%) to sedges (20.8%) was observed in weed densities at harvest. Integration of metribuzine (2 DAP) with HW (45 DAP) and 2,4-D (90 DAP) recorded the highest yield (89.8 t/ha), number of millable canes (90.500/ha) and WCE (62.5%). Integration of metribuzine with hoing and POE application of 2,4-D recorded the highest net return of Rs. 75800/ha.

GBPUAT, Pantnagar

In sugarcane ratoon, hand weeding at 30, 60 and 90 days after ratooning (DAR) caused maximum reduction in the density and dry weight of total weeds being at par with application of metribuzin 0.88 kg ha-1 at 3 DAR fb hoeing at 45 fb application of 2,4-D (amine salt) 0.75 kg/ha at 2-4 leaf stage of broad leaved weeds.

CCSHAU, Hisar

The best treatment combinations against complex weed flora in sugarcane ratoon were found to be atrazine 1500 g/ha fb 2,4-D amine 750 g/ha, or metribuzin 880 g/ha fb hoeing fb 2,4-D amine 750 g/ha. Atrazine alone was the next best treatment. In the situations of dominance of sedges, 2,4-D amine 750 g/ha or ethoxysulfuron 37.5 g/ha were the best options. In case of dominance of BLW, chlorimuron+ metsulfuron (RM) 8 g/ha was the best option.

PAU, Ludhiana

In sugarcane ratoon, atrazine was effective against Digitaria ciliaris, Eleusine aegyptiacum and broadleaf weeds upto two months only; after that these grasses produced huge dry matter at par to weedy check plot. Follow up application of 2,4-D amine was effective only against Cyperus rotundus and broadleaf weeds only. Metribuzin effectively controlled above grasses including Acrachne racemose, broadleaf weeds and also had suppressing effect on Cyperus. The sequential application of metribuzin, hoeing and 2,4-D amine provided long term control of majority of the weeds and turned out to be best treatment in sugarcane ratoon crop.

Table 24: Effect of weed management treatments on weed dry matter and cane yeild in sugarcane ratoon.

Treatment	Weedry matter (g/m^2) 120 DAS			Cane yield (t/ha)			
	Ludhiana	Bubaneswar	Pantnagar	Ludhiana	Hisar	Bhubaneswar	Pantnagar
Atrazine 1.5 kg/ha PE on 3 DAP	420	72.1	142.9	59.4	76.7	80.6	67.9
2,4-D (Amine salt) 0.75 kg/ha as POE on 75-90 DAP	485	57.3	169.1	54.3	71.2	71.5	57.9
Atrazine 1.5 kg/ha PE on 3 DAP + 2,4-D (Amine salt) 0.75 kg/ha as POE on 75-90 DAP	322	71.3	88.4	63.5	81.9	86.3	78.3
Metribuzin 0.88 kg/ha (pre-em) fb one hoeing at 45 DAS fb 2,4-D (Amine salt 0.75 kg/ha) at 90 DAS	162	26.2	42.4	75.1	79.7	89.8	82.4
Ethoxysulfuron 37.5 g/ha at 2-4 leaf stage of weed	458	-	150.0	50.2	71.3	-	60.5
(Chlorimuron+Metsulfuron) 8 g ai/ha at 2-4 leaf stage of weed	425	-	155.9	52.3	70.4	-	59.4
Hand weeding thrice on 30, 60 & 90 DAP	128	28.5	18.7	76.2	85.1	88.2	84.9
Weedy check	468	162.8	305.5	50.1	63.5	55.2	37.5
LSD(P=0.05)	**88.0**	**6.0**	**26.3**	**10.1**	**5.4**	**5.8**	**36.0**

WS- 2.8: IWM in autumn planted sugarcane intercropping system

Cooperating centres: NDUAT & CSAUAT

NDUAT, Faizabad

A field experiment conducted to study the effect of weed management practices (pendimethalin 1.0 kg/ha PE, trifluralin 1.25 kg/ha ppi, FP and WC) and intercropping system (wheat, mustard, sugarcane) in autumn planted sugarcane. The farmers practice treatment of weed control (3 manual weeding) in sugarcane + wheat fb sugarcane + mustard intercropping found most promising combination to reduce the weed density and dry weight and recorded highest cane equivalent yield (CEY), net return (Rs. 147602.0 and 146944/ha) also fb sugarcane + wheat / mustard combined with trifluralin 1.25 kg/ha as ppi. However, maximum BCR (Rs. 2.04) recorded with sugarcane + mustard combined with trifluralin 1.25 kg/ha.

CSAUAT, Kanpur

The maximum grassy weed population and dry matter was observed when sugarcane was intercropped with wheat. The maximum broad leaf weeds population and its dry matter was observed under sugarcane-mustard intercropping. The maximum sugarcane equivalent yield

(852.2 q/ha) was achieved when sugarcane intercrop with wheat. Among the weed control practices the minimum weed density and its dry weight was recorded with application of farmers' practice (two manual weeding + one hand hoeing) followed by the application of trifluralin (1.25 kg/ha). The higher net income (Rs. 123443/ha) and B:C ratios (2.44) were obtained with sugarcane-wheat intercropping. The highest income (Rs 127819/ha) and B:C ratios (2.59) were obtained with application trifluralin in sugarcane (1.25 kg/ha).

WS- 2.9: Long term trial on tillage in different cropping systems

Cooperating centres: Centres who have not completed 5 years study will continue

Cropping system: Dominant system of the region

Treatments :

Tillage:	**Ist Crop**	**2nd Crop**
(Main plot)		
	Zero tillage	Zero tillage
	Zero tillage	Conventional
	Conventional	Zero tillage
	Conventional	Conventional
	Ist Crop	**2nd Crop**
Weed Control		
(Sub plot)		
	Hand Weeding	Hand Weeding
	Recommended herbicide	Recommended herbicide
	Weedy Check	Weedy Check

Rice-wheat cropping system

GBPUAT, Pantnagar

The tillage and weed management practices in both the crop did not influence the grain and straw yield, wheat sown with zero till methods gave significantly higher grain and straw yield over conventional methods and sowing. The highest grain yield of wheat was obtained with hand weeding twice and at par with application of isoproturon 1.0 kg + metsulfuron methyl 4 g/ha. In transplanted rice application of butachlor 1.5 kg/ha fb 2,4–D 0.5 kg/ha recorded at par grain yield over the hand weeding twice.

NDUAT, Faizabad

Long term trial on tillage in rice-wheat cropping system is being conducted since *kharif* 2007. Rice is being grown conventionally but CT and ZT along with weed control treatments executed in wheat. Wheat crop was showing the effect as in ZT treatments, the density of BLWs eg. *Rumex* spp., *Solanum nigrum* and *C. arvensis* are becoming dominant. In ZT along with HW (30 & 50 DAS) or isoproturon 1.0 kg/ha recorded significantly superior grain yield over other treatment combinations.

Microbial studies

Among various tillage systems, maximum physico-chemical and microbial properties were observed under zero tillage as compared to wheat sown through conventional tillage. In case of different weed management practices at 50 DAS, microbial parameters did show the significant effect between the treatments, while at harvest stage the effect was non significant.

BAU, Ranchi

On the basis of two years experimentation it can be concluded that conventional - conventional method of tillage being similar to conventional – zero tillage and recommended herbicides butachlor 1.5 kg/ha pre-emergence + 2,4-D 0.5 kg/ha post- emergence in rice and isoproturon 0.75 kg/ha + 2,4-D 0.5 kg/ha post-emergence in wheat produced significantly higher grain and straw yield compared to any tillage and weed control methods tested in the experiment. However, conventional – zero method of tillage and recommended herbicide in rice and wheat respectively was the most profitable in terms of net return and B:C ratio.

Microbial studies

Maximum soil microbial biomass carbon was observed in both wheat (226.5 ppm) and rice (224.5 ppm). In the zero-zero tillage, pH, oganic carbon, potential mineralizable ntrogen, total bacteria, total fungi were not affected significantly.

CSAUAT, Kanpur

In rice, conventional tillage recorded significantly minimum weed population and their dry weight in comparison to zero tillage practices. Hand weeding twice and herbicidal treatment (pendimethalin followed by almix) were comparable to each other and showed superiorty over weedy check in regarding to weed population and dry weight reduction. Maximum yield (3357 kg/ha) was obtained under conventional tillage and minimum under zero tillage conditions. The application of herbicide pendimethalin (1.0 kg/ha) followed by Almix (4 g/ha) recorded maxium yield (3125 kg/ha) and net income (Rs18626/ha) obtained over weedy check. Conventional tillage and application of pendimethalin (1.0 kg/ha) followed by almix (4 g/ha) recommended for rice signficatnly reduced the weed density, their dry weight and enhanced the net income.

RAU, Pusa

In rice, both the treatments had significant effect on all the parameters. The lowest weed count (27.90 /m^2) and weed dry weight (7.59 g/m^2) and highest grain yield (3595 kg/ha) was recorded under CT-ZT treatment. The weed count in CT-ZT treatment was significantly lower than ZT-CT and CT-CT and it was at statistically at par with ZT-ZT. The tillage did not show its impact on weed dry weight. The highest grain yield was recorded with CT-ZT treatment which was significantly superior over rest of the treatments. Amongst weed management treatments the lowest yield and highest weed count and weed dry weight was recorded under weedy check. The recommended herbicide and hand weeding was statistically at par in terms of weed count, weed dry weight and grain yield.

In wheat, the lowest weed count was observed under CT-ZT treatment which was statistically at par with all other treatments except CT-CT, same trend was followed in terms of weed dry weight

also. The highest grain yield was recorded under CT-ZT treatment which was significantly superior to rest of the treatments and was followed by ZT-CT. Among the weed management practices, weedy check had highest weed count and weed dry weight along with lowest grain yield. The recommended herbicide had highest grain yield and was significantly superior over rest of the treatments.

On the basis of five year experimentation, in rice-wheat cropping system the highest gross return, net return and B:C ratio was registered under CT-ZT treatment, which were significantly superior to rest of the treatments. Amongst weed management practices highest gross return, net return and B: C ratio was recorded under recommended herbicide and it was significantly superior to rest of the treatments.

Table 25: Long term trial on tillage in rice-wheat cropping system.

Treatments	Weed cont (No/m^2)	Weed dry wt. (g/m^2)	Grain yield (kg/ha)	Weed cont (No/m^2)	Weed dry wt. (g/m^2)	Grain yield (kg/ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B: C ratio
Tillage		**Rice**			**Wheat**			**System**	
ZT-ZT	26.19	7.20	3110	11.12	7.99	3603	74336	39336	1.12
ZT-CT	30.60	7.96	2902	14.71	8.28	3391	69712	33512	0.93
CT-ZT	27.90	7.59	3545	12.23	7.45	4170	85499	48899	1.34
CT-CT	31.11	8.24	3398	16.40	8.81	3790	79461	41661	1.10
LSD (P=0.05)	9.15	2.09	190	6.01	3.14	210	5781	3254	0.12
Weed management									
Weedy check	55.79	13.33	2562	22.26	10.81	2800	59220	26020	0.78
Recommended herbicide (Butachlor 1.5 kg/ha)	15.36	4.50	3667	7.13	4.61	4338	88726	52006	1.42
HW	16.09	5.64	3490	8.32	6.59	4075	83800	44500	1.13
LSD (P=0.05)	7.12	1.27	214	4.19	1.95	185	5607	2613	0.09

lowest grain yield. The recommended herbicide had highest grain yield and was significantly superior over rest of the treatments.

On the basis of five year experimentation, in rice-wheat cropping system the highest gross return, net return and B:C ratio was registered under CT-ZT treatment, which were significantly superior to rest of the treatments. Amongst weed management practices highest gross return, net return and B: C ratio was recorded under recommended herbicide and it was significantly superior to rest of the treatments.

Table 25: Long term trial on tillage in rice-wheat cropping system.

Rice-rice cropping system

OUAT, Bhubaneswar

Inclusion of CT in the tillage system reduces the weed densities by 18.3% to 26.4% during different stages of crop growth in the rice-rice system. During the initial stages (25 DAP),

application butachlor (1.5 kg ha^{-1}) reduced the weed density by 62% over unweedy check. The yield reduction in ZT-ZT method was in the tune of 24.7% as compared to CT-CT method. Integration of ZT-ZT method and use of butachlor 1.5 kg ha^{-1} obtained the maximum B: C ratio of 1.85 in the rice-rice system. The composition of weed seed bank in ZT was dominated with grasses (63%) followed by broad leaf weeds (24%) and sedges (13%) and the corresponding values in CT were 65%, 23% and 12%.

Soil microbial studies

The combination of CT-ZT and CT-CT lowered the BD significantly in comparison with ZT-ZT methods. Porosity and infiltration rate increased significantly with the imposition of CT as tillage method. However CT in combination with ZT and CT-CT alone increased the available N, P, K of the soils over ZT- ZT methods. The population of bacteria, fungi and actinomycetes were the lowest in ZT-ZT method and increased significantly in treatments of ZT-CT, CT-ZT and CT-CT which indicated the positive effect of CT on soil microbial population. Imposition of various weed management practices however did not have any effect on these properties.

Sunflower-maize cropping system

TNAU, Coimbatore

Dominant weed flora was *Cynodon dactylon, Panicum repens, Digera arvensis* and *Chloris barbata* in grasses, *Cyperus rotundus* in sedges and *Trianthema portulacastrum, Parthenium hysterophorous, Digera arvensis* and *Datura metal* in broad leaved weeds. Maize grown in black soils with predominance of broad leaved weeds - zero tillage + atrazine 0.5 kg/ha + hand weeding at 45 DAS and maize grown in black soils with predominance of perennial/annual grassy weeds and sedges - conventional tillage (one disc plough + one cultivator + one rotavator) + hand weeding on 45 DAS resulted in higher weed control efficiency and yield. Sunflower grown in black soils with predominance of broad leaved weeds – zero tillage + pendimethalin 1 kg/ha + hand weeding on 45 DAS and sunflower grown in black soils with predominance of perennial/annual grassy weeds and sedges – conventional tillage (one disc plough + one cultivator + one rotavator) + hand weeding on 45 DAS resulted in higher weed control efficiency and yield.

Table : Effect of tillage and weed management practices on weed density, dry biomass, economics and yield of sunflower and maize. (Mean over 6 years).

Treatment Tillage	Weed density (No./m^2)		Weed dry biomass (kg/ha)		Yield (kg/ha)		B:C ratio	
	Sunflower	Maize	Sunflower	Maize	Sunflower	Maize	Sunflower	Maize
Zero – Zero	5.4 (63.9)	4.7 (63.4)	5.2 (478.8)	5.3 (479.3)	1181	4182	1.8	3.5
Zero –conventional	4.7 (48.4)	4.3 (53.5)	5.2 (417.4)	5.2 (423.9)	1584	4041	2.4	3.2
Conventional –zero	5.1 (60.6)	4.4 (52.3)	4.9 (457.5)	4.9 (375.5)	1167	4720	1.5	3.7
Conventional - conventional	4.2 (37.0)	3.8 (36.5)	4.4 (286.5)	4.5 (280.4)	1449	5015	1.8	3.8
LSD (P=0.05)	**0.2**	**6.6**	**0.1**	**0.04**	**168.3**	**538.7**	-	-
Hand weeding twice	4.3 (36.4)	3.7 (29.5)	4.3 (244)	4.3 (215.3)	1527	5027	1.9	3.7
Recommended herbicide	4.2 (31.9)	3.9 (37.9)	4.2 (180.6)	4.5 (272.4)	1603	5153	2.1	3.9
Weedy check	5.8 (83.5)	5.7 (112.3)	6.1 (771.5)	6.1 (866.5)	725	2991	1.2	3.0
LSD (P=0.05)	**0.2**	**0.17**	**0.2**	**8.3**	**154.2**	**526.8**	-	-

Figures in parethesis are original values

UAS, Bengaluru

Adopting zero tillage continuously for sunflower in summer and maize in *kharif* gave lower yields by 300 kg/ha in sunflower and 1500 kg/ha in maize than conventional tillage (1151 kg/ha and 4867 kg/ha, respectively). Zero tillage favoured the development of perennial weeds *C. rotundus* and *C. dactylon*, while conventional tillage favoured emergence of annual grasses and broad leaved weeds. However, there was a saving of tillage cost of Rs. 850 and 700/ha in sunflower and maize respectively by following zero tillage. Use of herbicides saved weeding cost by Rs. 4800/ha in maize or sunflower crops over hand weeding (Rs. 5800 to 6000/ha).

Kharif Rice-*Rabi* Lablab bean cropping system

DBSKKV, Dapoli

During *rabi* season, compared to monocots, BLWs were more competitive weeds. Amongst them *L. aspera, A. conyzoides, C. argentea, A. sessilis, C. viscosa, C. helicacabum* were most competitive weeds followed by *E. hirta*. Amongst monocots *E. colona* was most competitive followed by *E. indica*. During *rabi* season *L. aspera* was found to be the most dominant weed species followed by *C. helicacabum*. In various tillage systems the weed density & weed growth did not differ significantly at 60 & 90 DAS. Hand weeding at 20 and 40 DAS significantly reduced the weed growth of monocots & BLWs at 60 DAS compared to use of oxadiargyl and weedy check, exihibiting weed control efficiency of 98.5% and 92.2% respectively as against 59.2% and 25.2 respectively with the use of oxadiargyl alone. The CT-CT tillage system produced significantly higher grain yield of *Rabi* Lablab bean followed by CT-ZT tillage system. The grain yield of lablab bean in CT-ZT and CT-CT were at par. Hand weeding at 20 and 40 DAS and use of oxadiargyl 0.120 kg/ha significantly reduced weed density and weed growth at 60 and 90 DAS and thus significantly increased the grain yield of lablab bean.

During *kharif* season at 60 DAS and 90 DAS, compared to monocots, BLWs were competitive. Amongst monocots *I. globossa* was most competitive followed by C. *iria* and *L. chinensis*. Various tillage systems weed growth of BLWs at 60 & 90 DAS did not influence significantly. But Z-C tillage system showed significantly increase in weed growth of monocot than Z-Z systems. As a result all tillage systems were identical in grain yield of rice. Hand weeding twice at 20 and 40 DAS recorded significantly higher number of panicles per running meter length and grain yield than use of oxadiargyl & weedy check. Hand weeding & use of oxadiargyl 0.120 kg/ha significantly reduced weed growth of monocot and BLWs at 60 DAS & increased grain yield of rice over weedy check.

Weed seed bank studies

Shallower soil layer of 0-5 cm depth recorded emergence of more number of BLWs as compared to monocot than 5-10 and 10-15 cm soil layers. ZT-ZT tillage system recorded highest weed emergence of BLWs than monocot followed by CT-ZT tillage system from 05cm, 5-10cm & 10-15cm soil layers.

Of the two major weeds of *Rabi* field bean, *L. aspera* was having higher seed rain than *C. argentea* by 34.19 %. Seed rain of *L. aspera* m^2 was highest in case of ZT-ZT tillage system

(33157 m^2) which was reduced by 3.93% (31855 m^2) in case Z-C tillage system followed by C-C & CT-ZT tillage system. However, in case of *C. argentea* seed production potential m^2 was highest in case ZT-ZT tillage system (16124 m^2) compared to ZT-CT tillage system. Weed control measures viz. hand weeding twice at 20 and 40 DAS and use of oxadiargyl reduced seed rain of *L. aspera* by 94.0% and 60.6% respectively. Such reduction in case of *C. argentea* was of the order of 94.2% and 80.0% respectively.

Microbiological studies

In a long term trial started in 2003 on effect of tillage system on soil microflora in *kharif* rice-*rabi* Lablab bean cropping system. Even after nine years, the estimated microbial population namely Bacteria, Fungi, nitrogen fixers and phosphate solubilisers were not influenced by all tillage systems at the three stages (30DAS, 50DAS and at harvesting stage) of plant growth. However C-C tillage system slightly dominates all microbial population as compared to rest of the tillage system. The all micro flora including fungi at harvest during *rabi* season were significantly influenced by weed control measures. Two hand weeding at 20 & 40 DAS significantly influenced total bacterial population, total fungal population (influenced only at harvesting stage during *rabi* season) nitrogen fixers, phosphate solubilisers as compared to the application of weedicide oxadiargyl 0.12 kg/ha and weedy check. The microbes such as nitrogen fixers and phosphate solubilisers in weedy check were at par with oxadiargyl treatment which indicates that there is not much significant decrease in the beneficial microbial population by the use of oxadiargyl. 0.12 kg/ha.

However in another long term permanent experiment started year (2011) to see the combined effects of green manuring and different weed control measures on soil microflora and their associated parameters in a rice groundnut cropping system.In the 1st year, soil microflora such as bacteria, fungi(except harvest),nitrogen fixers and phosphate solubilisers and rest parameters such as microbial biomass carbon and basal soil respiration were significantly influenced by green manuring treatment then the non-green manuring treatment.The treatment free weeding significantly influenced total bacterial population, total fungal population (only at 30 DAT) nitrogen fixers, phosphate solubilisers, microbial biomass carbon and basal soil respiration as compared to the fixed herbicide , rotational herbicide and weedy check .However there is a need to study the longer effect of these herbicides on the beneficial micro flora.

Pearlmillet- wheat cropping system

AAU, Anand

Pearl millet: Tillage treatment had no significant effect on grain and straw yield of wheat. Significantly the higher grain and straw yield were recorded under hand weeding treatment which was at par with pre emergence application of atrazine 0.5 kg/ha. Maximum grain yield reduction was 40.5 %, reported in weedy check treatment.

Wheat: The tillage treatments failed to manifest any effect on weed dry bio-mass in wheat. Among weed management practices, the treatment hand weeding done at 30 DAS showed significantly the lower dry weed weight which was at par with pre emergence application of

pendimethalin 0.5 kg/ha. The maximum WCE (82.6%) was obtained under HW followed by pre emergence application of pendimethalin 0.5 kg/ha (79.1 %) in wheat crop. Tillage had no significant effect on grain and straw yield of wheat. Significantly higher grain and straw yield were recorded under hand weeding done at 30 DAS which was at par with pre-emergence application of pendimethalin 0.5 kg/ha.

Weed seed bank studies

Predominant weed species of grasses were *Eragrostis major, Eleusine indica, Digitaria sanguinalis, Dactyloctenium aegyptium, Commelina benghalensis* and *Chloris barbata.* The major species of weeds as dicot were *Euphorbia hirta, Boerhavia diffusa, Mollugo nudicaulis, Digera arvensis,Oldenlandia umbellate, Phyllanthus niruri, Trianthema monogyna,,Tridex procumbeans* and *Amaranthus spinosus,* whereas *Cyperus rotundus* and *Cyperus iria* were recorded as sedges.

Table 27: Effect of treatments on weed biomass and yield of crops.

Treatment Tillage	Weed dry biomass (kg/ha) at Harvest		Yield (kg/ha)	
	Pearlmillet	Wheat	Pearlmillet	Wheat
Zero – Zero	703	658	2052	3584
Zero –conventional	679	642	2045	3696
Conventional –zero	697	687	2041	3631
Conventional - conventional	716	672	2031	3733
LSD (P=0.05)	**NS**	**NS**	**NS**	**NS**
Hand weeding twice	252	250	2385	4243
Recommended herbicide	335	302	2322	4007
Weedy check	1510	1443	1419	2733
LSD (P=0.05)	**56**	**67**	**169**	**475**

Moth bean-wheat cropping system

SKRAU, Bikaner

In the *kharif,* moth bean crop was taken for nine consecutive years (2003-2011). Results revealed that recommended herbicide, pre-planting incorporation of fluchloralin at 0.75 kg/ha produced significantly higher seed yield (960 kg/ha) than weedy check (640 kg/ha). The increase in seed yield with this treatment over weedy check was 320 kg/ha. None of the tillage operation were found significant with regard to the seed yield of moth bean.

In case of *rabi* wheat crop, recommended herbicide, post emergence metsulfuron methyl at 4 g/ha produced significantly higher pooled seed (3190 kg/ha) than weedy check (2220 kg/ha), the increase over weedy check was 970 kg/ha. There was no significant difference in grain yield of wheat due to tillage operations.

There was no change in bulk density of soil layers with various tillage operations in moth bean-wheat cropping system. Maximum number of weeds /m^2 was recorded in weedy check plots and

that minimum weeds /m^2 were recorded in case of recommended herbicide in both the *rabi* and *kharif* crop.

Maize-chickpea cropping system

UAS, Dharwad

Maize yields did not differ significantly due to main plot treatments (Tillage), since only conventional tillage was followed for *kharif* maize. In sub plots, among different weed control treatments, there was no significant difference between hand weeding (4313 kg/ha) and recommended herbicide (3832 kg/ha), while the yields were significantly lower in weedy check (2275 kg/ha).

In chickpea during *rabi* 2010, yields were significantly higher with conventional tillage over zero tillage. Among sub plot treatments, hand weeding (947 kg/ha) resulted in significantly higher yield over recommended herbicide-alachlor (825 kg/ha). Chickpea yield was significantly lower (714 kg/ha) compared to hand weeding and recommended herbicide.

Microbiological studies

Chickpea (*rabi*-2010)

The population of free living nitrogen fixers and mineral phosphate solubilising microorganisms on 30 DAS were found to be higher with hand weeding and application of alachlor 1. 5 kg/ha recorded lowest microbial load. However on 90^{th} day the results obtained with hand weeding and alachlor 1. 5 kg/ha were found to be statistically on par with each other. On 30^{th} and 60^{th} DAS highest amount of CO_2 was released in the treatment received ZT+HW (28.6 and 48.3 mg CO_2 per 100 g soil). The observations on 90th day was found to be maximum with ZT+RH (32.8 mg CO_2 per 100 g soil), which is significantly higher to the treatment received ZT+HW (30.5 mg CO_2 per 100 g soil). Highest dehydrogenase phosphatase activity was recorded in the treatment received ZT+HW. However, on 90^{th} day highest dehydrogenase and phosphatase activity was recorded with ZT+RH which is on par with ZT+HW

Maize *(kharif*- 2011)

At 30 and 60 DAS, highest population of free living nitrogen fixing bacteria was recorded with CT+HW (50.00 and 28.37 X 10^4 CFU g^{-1}), which is significantly higher than the other treatments. On 90 DAS the population of free living nitrogen fixers were highest in CT+RH (35.33 X 10^4 CFU g^{-1}), which is found to be on par with CT+HW (29.67 X 10^4 CFU g^{-1}).similar results were recorded with respect to MPS microorganisms at30,60 and 90 DAS. The observations recorded on the soil respiratory and dehydrogenase activity at 30 DAS revealed that highest amount of CO_2 was released with CT+HW. On 90^{th} day CT+RH recorded increased CO_2 release followed by CT+HW. Phosphatase activity was highest in the treatment CT+HW and lowest phosphatase activity was noticed in ZT+RH on 30^{th} 60^{th} and 90 DAS.

Maize-wheat cropping system

SKUAT, Jammu

In wheat, *Avena fatua, Chenopodium album, Vicia sativa, Fumeria parviflora, Phalaris minor, Medicago denticulata* and *Anagallis arvensis* were recorded as the major associated weeds during the crop growth season. It was observed that weed population and dry weight of weeds remained significantly higher where zero-tillage was practised to the current crop for its establishment and the magnitude of weed population and dry matter decreased with conventional tillage either in the current crop or when practised in the previous crop establishment. The wheat crop yield however, did not differ significantly due to different tillage systems as conventional and zero tillage produced almost similar grain yield values of wheat crop. However, weed population, weed dry matter and grain yield of wheat were significantly influenced by weed control treatments. Highest grain yield (3798 kg/ha) was recorded under treatment of metribuzin 200 g/ha and was found at par with two hand weedings at 30 and 60 DAS. Wheat grain yield with metribuzin 200 g/ha recorded 85.6 percent increase over the un-weeded control plots. Almost a similar trend was observed with respect to weed population and weed dry matter production at 30 and 60 DAS of wheat crop.

In Maize crop, *Poa annua, Cyperus iria, Eichnochloa crusgalli, Setaria glauca, Amaranthus virdis and Cyanodon dactylon* were the dominant weeds species. Weed population was not influenced significantly due to different tillage systems for crop establishment but dry matter and grain yield of maize showed significant differences with zero tilled plots recording relatively higher weed dry matter and correspondingly lower grain yields of maize. Weed control treatments shows significant variations in weed population, weed dry matter and grain yield of maize. Significantly highest grain yield to the tune of 409 kg/ha was recorded with two hand weedings which was followed by application of atrazine 1.0 kg/ha whereas the lowest maize grain yield was observed (254 kg/ha) in weedy check treatment. Almost a similar trend was noticed with respect to weed population and dry matter of weeds in maize.

WS- 2.10: Long term herbicide trial in different cropping systems

Cooperating centres : All centres

Cropping system: Dominant system of the region

Rice-rice cropping system

TNAU, Coimbatore

Transplanted lowland rice-rice cropping system

Chemical method of weed control reduced the weed density and weed dry weight. The effect was more under rotational use of herbicides (butachlor in *kharif* and pretilachlor in *rabi*). Shift in weed species from *Echinochloa colona* to *Panicum distachyon* and absence of *Eclipta alba* was observed. Broad leaved weeds density was higher in hand weeding treatments of XXII and XXIII crops when compared to I crop. Integration of weed control by butachlor + 2,4-DEE with 100% inorganic nitrogen recorded maximum yield during *Rabi,* 2010-11 and *kharif,* 2011 and it was on

par with butachlor + 2,4-DEE followed by pretilachlor 0.75 + 2,4-DEE 0.4 kg/ha during both the seasons.

Increase in organic carbon and available nitrogen in the post harvest soils of *rabi,* 2010 and *kharif,* 2011 was observed for combined application of inorganic and organic source of N. There was build up in nutrient status over initial level.

Continuous application of butachlor + 2,4-DEE herbicide mixtures in every season or rotational application of butachlor + 2,4-DEE during *kharif* and pretilachlor + 2,4-DEE during *rabi* did not show build up of these herbicides in the post harvest soil or grain and straw of the 22nd and 23rd crops. Degradation of herbicides is faster under 75% inorganic N source + 25% organic source treatment than in 100 % inorganic source alone treatment.

UAS, Bengaluru

In summer rice- *kharif* transplanted rice-cropping system, results indicated that use of pretilachlor during summer (4931 kg/ha) and hand weeding (4978 kg/ha) resulted in higher paddy yield than the use of butachlor + 2,4 – D EE (4733 kg/ha) both during *Kharif* and summer due to poor control of sedges during summer.

Rice-wheat cropping system

PAU, Ludhiana

In wheat, all the herbicides effectively controlled *P. Minor;* trifluralin was poor against *Medicago denticulata* and *Coronopus didymus;* 2,4-D against *Coronopus* and *Rumex dentatus*; sulfosulfuron against *Rumex dentatus.* Metsulfuron effectively controlled all the broadleaf weeds. Rotational herbicidal treatment recorded the highest grain yield and was significantly better than trifluralin and sulfosulfuron applied alone and at par with rest of the herbicidal treatments.

In rice, anilofos gave good control of *Ischaemum rugosum* and was relatively more effective than butachlor and pretilachlor against grassy weeds, however, performed poorly against *Cyperus iria* and *Caesulia axillaries;* pretilachlor was ineffective against *Ischaemum*; metsulfuron effectively controlled broadleaf weeds and sedges. Anilophos alone gave maximum rice grain yield and was at par to its own application when followed by metsulfuron; both these treatments were significantly better than all the other herbicidal treatments. Rice grain yield under pretilachlor alone was at par to weedy check. Microbial population showed a decreasing pattern with herbicidal treatments over control.

NDUAT, Faizabad

A long term trial (since 1991) is being conducted in rice-wheat system (PHT) to observe the change in weed shift and to note the development of resistant biotypes of *Echinochloa colona* against butachlor at 1.5 kg/ha in rice and of *Phalaris minor* against isoproturon 1.0 kg/ha + 2,4-D 500 g/ha in wheat as these herbicides are being used continuously. It is clear from the data recorded on weeds, crop yield and resistance to rice-wheat system that (i) No considerable variation in grain yield of rice as well as of wheat due to *kharif* and *rabi* season treatments and their interaction were observed (ii) there was no definite trend in change of weed shift in both the

crops and (iii) herbicide treatments executed in rice and wheat did not cause the development of resistant biotypes in *E. colona* and *P. minor*, against the butachlor and isoproturon, respectively.

Microbiological studies

During *rabi* and *kharif* season, microbial properties at 30 DAS showed significant impact of the treatments. Maximum microbial population was found in hand weeding plot at various growth stages. Butachlor and isoproturon applied in rice and wheat field did not show any residual harmful effect on physico-chemical and microbial properties of soil.

GBPUAT, Pantnagar

Long term weed management in rice-wheat system the highest grain yield (3683 kg/ha) of rice was found with application of Bispyribac sodium 25 g/ha while in wheat with application of sulfusulfuron 25 g/ha (4567 kg/ha). The yield of both rice and wheat was increased as compared to the base years (i.e. 1999-2010).

CSKHPKV, Palampur

In transplanted rice, *Echinochloa crusgalli, Panicum dichotomiflorum, Cyperus iria, Ammania baccifera* and *Ageratum conyzoides* were the dominating weeds during *kharif* 1999 when experiment was started. The population of all these weeds decreased considerably during *kharif* 2000 and only *Echinochloa* and *Panicum* were the dominating weeds. These weed species continued to dominate during *kharif* 2002 but during *kharif* 2003, *Echinochloa, Cyperus, Panicum, Ammania* and *Digitaria* were dominating. However, *Ischaemum rugosum* and *Aeschynomene indica* were the new weeds. During 2006, *Echinochloa crusgalli, Ischaemum rugosum, Cyperus iria* and *Aeschynomene indica* were the dominating weeds. However, during 2007 *Echinochloa crusgalli, Cyperus iria* and *Panicum dichotomiflourum* were the dominating weeds. During initial years there was no significant difference between weed management and fertility treatments in influencing the grain yield of rice. During *Kharif* 2009,2010 and 2011, *Echinochloa crusgalli, Ammania baccifera* and *Aeschynomene indica* were the dominating weeds. Irrespective of continuous or rotational use of herbicides in rice and wheat, use of 75% N through fertilizer + 25% N through *Lantana* in rice resulted in significantly higher grain yield of rice over remaining treatment combinations.

In wheat, *Phalaris minor, Avena ludoviciana, Lolium temulentum* and *Ranunculus arvensis* were the dominating weeds during 1999-2000. During *rabi* 2002-2003 rotational use of clodinafop 60 g/ha fb 2,4-D 1.0 kg/ha resulted in significantly lower population and dry matter of *Phalaris minor, Lolium temulentum* and *Avena ludoviciana* over farmer's practice and continuous use of IPU + 2,4-D. During 2007, *Phalaris minor, Avena ludoviciana, Lolium temulentum, Vicia sativa, Anagallis arvensis* and *Poa annua* were the dominating weeds. *Poa annua* and *Alopecurus myosuriodes* were the new weeds. Whereas, during *rabi* 2008-09, Stellaria*, Coronopus* and *Trifolium* were the new weeds.There was not much change in weed flora during *rabi* 2010-11 Irrespective of continuous or rotational use of herbicides in rice or wheat, use of 75% N through fertilizer and 25% N through *Lantana* in rice resulted in significantly higher grain yield of wheat.

Weed seed bank studies

In Long term experiment of continuous use of herbicides in rice-wheat, the rotational use of herbicides in both the crops (cyhalofop butyl/butachlor to rice and clodinafop fb 2,4 D/isoproturon + 2,4 D to wheat) coupled with 75% N through fertilizer and remaining 25% N through lantana or entire N through fertilizer to rice recorded minimum emergence of broad leaved weeds (33-50/m^2) after rice. Farmers' practice (in both the crops) recorded maximum number of broad leaved weeds (117/m^2) but lowest number of grassy weeds (67/m^2) after rice. On overall basis, rotational use of herbicides in both the crops in combination with whole N applied through fertilizer to rice recorded minimum (0.66) total number of weeds /100 g soil.

Nutrient uptake studies

After the harvest of each crop, numerically higher organic carbon was recorded in treatments where partial N (25%) was supplied through *Lantana* as compared to all N supplied through fertilizer.

CCSHAU, Hisar

Studies on long term effect of continuous or rotational use of herbicides with or without green manuring in rice-wheat sequence

In the long-term trial on effect of green manuring and use of herbicides continued since 1999, all type of weeds in rice was less under green manured plots. In wheat, broadleaf weeds were more and *Phalaris minor* was less under non-green manured plots. Grain yield of rice and wheat was more under green manuring. The performance of continuously used herbicide clodinafop in wheat and butachlor in rice provided effective control of weeds.

The weed seed bank studies indicated that emergence of *P. minor* (22 plants/m^2 under weedy check) and broadleaf weeds (6.7 plants/m^2) was less in pots filled with soil from green manured plots than non-green manured plots (33 & 10.3 plants/m^2, respectively). Among BLW, emergence of *Coronopus* was more from soil obtained from green manured plots. Emergence of weeds was more in weedy check plots' soil than the treated plots.

BAU, Ranchi

Results revealed that application of Almix 4g/ha PoE alone or in combination with butachlor 1.5 kg/ha PE in rice and isoproturon 1.5 kg/ha + 2,4-D 0.5 kg/ha in wheat can be practiced for higher productivity and profitability of rice – wheat cropping sstem

Microbiological studies

In the long term effect of herbicides the pH, E.C organic carbon potential mineralizable Nitrogen, total bacteria and total fungi were not influenced significantly while application of butachlor 1.5 kg/ha + Almix 20 g/ha – isoproturon 0.75 kg/ha + 2,4-D 0.5 kg/ha recorded significantly higher soil microbial biomass carbon.

Rice-maize

ANGRAU, Hyderabad

In rice-fallow-maize system, (*rabi*, 2010-11), atrazine applied as pre-emergence or early post-emergence or along with paraquat resulted in similar influence on weed control and yield of maize. Among various weed control treatments applied to rice (*kharif*, 2011) highest grain yield was obtained with hand weeding done at 20 and 40 DAP which was on par with pre-emergence application of butachlor 1.0 kg/ha and significantly superior to post-emergence application of cyhalofop-p-butyl at 100g/ha.

Rice-groundnut

OUAT, Bhubaneswar

In gruondnut, the floristic composition in *rabi* groundnut was dominated with grasses (51.8%) followed by broad leaf (35.9%) and sedges (12.3%) at initial stages (25 DAS). Application of butachlor + 2, 4-DEE rotated with pretilachlor without OM in rice along with use of alachlor in groundnut recorded significantly the lowest weed density (53.0 /m^2) in groundnut during initial stages of crop growth (25 DAS). A shift of *Celosia argentea* from alachlor treatment to hand weeding and butachlor treated plots was observed in *rabi* groundnut. Incorporation of organic matter to rice though increases the weed population marginally (21.2%), is effective in increasing pod yield of groundnut in the tune of 8.2%. Though of hand weeding and earthing in groundnut produced the highest yield (2033 kg/ha), application of alachlor 1.0 kg/ha to groundnut was found to be superior in terms of yield (1951 kg ha^{-1}) and weed control (initial weed biomass of (7.6 g/m^2).

In rice, At the initial stages of crop growth (25 DAS), use of herbicides reduced the weed density by 70 % over hand weeding and the treatment of butachlor 0.75 kg/ha + 2,4-DEE 0.4 kg/ha without OM recorded the lowest weed density of 43.0/m^2. The increase in weed biomass due to organic matter was in tune of 13.3 % at 25 DAS, 10.9 % at 60 DAS and by 8.0 % at harvest. Inclusion of OM over the years increased the grain yield in the tune of 3.4 % over the treatments without OM and the grain yield of herbicidal treatments was at par.

REY and economics of rice-groundnut system

Two Hand Weeding along with OM to rice and hand weeding with earthing up in groundnut produced the highest REY of 11.35 t/ha. But application of butachlor + 2,4D EE without OM to rice and alachlor to groundnut recorded the highest B:C ratio of 1.85

Soil microbial studies

Application of herbicides to rice significantly reduced some of the microbial attributes like fungal and bacterial population by 9.0 % to 7.3 % and 4 % to 8 %, respectively. Addition of organic matter (*Sesbania aculeata* incorporation) enhanced the bacterial and fungal population by 18.18 % and 8.2 %, respectively. The microbial population of treatments were in order: Hand weeding (twice) > butachlor 0.75 kg/ha + 2,4-D EE 0.40 kg/ha > butachlor + 2,4-D EE in rotation with pretilacholor 0.75 kg / ha. Use of alachlor to groundnut however, enhanced the bacterial population by 0.6 % though fungal population remained unchanged. In general, an increasing

trend in microbial population and enzyme activities were observed since the initial year of study (2002-03), particularly in the treatments with the incorporation of *Sesbania aculeata*, thereby indicating the stabilizing effects of organic matter on soil microbes. Addition of organic matter could not significantly influence the BD, pH, OC and nutrients like available N, available K and available S. However, the available nutrients status of the soils shows an increasing trend over the years in treatments with organic matter, which justifies the role of organic amendments in stabilizing soil properties. Use of herbicides in conjunction with FYM improved soil fertility through better microbial activity.

DBSKKV, Dapoli

During experimental period, as compared to BLWs, grasses and sedges were more competitive. Green manuring reduced weed density of monocot at 30 DAT and BLWs at 50 DAT and weed growth of BLWs at harvest than without green manuring. The weed density and weed growth under fixed herbicide (pretilachlor) and rotational herbicide (pyrazosulfuron) was at par. The grain yield of *kharif* rice in use of herbicides and weed free check was at par with each other and produced significantly higher grain yield over weedy check. Thus, as compared to best treatment of weed free check percent reduction in grain yield (WCI) was found to be least in use of rotational herbicide (6.2%) followed by use of same herbicide (13.7%).

Soil microbial studies

in rice groundnut cropping system, in the 1st year, soil microflora such as bacteria, fungi(except harvest), nitrogen fixers and phosphate solubilisers and rest parameters such as microbial biomass carbon and basal soil respiration were significantly influenced by green manuring treatment then the non-green manuring treatment.The treatment free weeding significantly influenced total bacterial population, total fungal population (only at 30 DAT) nitrogen fixers, phosphate solubilisers, microbial biomass carbon and basal soil respiration as compared to the fixed herbicide , rotational herbicide and weedy check .However there is a need to study the longer effect of these herbicides on the beneficial micro flora.

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Maize-wheat cropping system

AAU, Anand

In maize, significantly lower dry weed weight was recorded in IC + HW carried out at 20 & 40 DAS treatment which was at par with pre emergence application of tank mix of pendimethalin (0.25 kg/ha) with atrazine (0.50 kg/ha) at 30 DAS. Significantly the higher grain yield was recorded in IC + HW carried out at 20 & 40 DAS treatment which was at par with tank mix

application of pendimethalin (0.25 kg/ha) with atrazine (0.50 kg/ha) as pre emergence and application of atrazine at both the rates of 1.00 and 2.00 kg/ha. Same trend was noticed for straw yield except low dose of atrazine.

In wheat, grain yield in hand weeding carried out at 30 DAS was at par with pre-emergence application of pendimethalin 0.50 kg/ha and post-emergence application of MSM 4.0 g/ha. Same tend was noticed in the yield of straw of wheat.

Weed seed bank study

During the course of seed bank studies, the predominant weed species of grasses were *Eragrostis major, Eleusine indica, Digitaria sanguinalis* and *Commelina benghalensis.* The major species of weeds as dicot were *Phyllanthus niruri, Digera arvensis, Oldenlandia umbellata and Amaranthus spinosus*. *Cyperus rotundus* and *Cyperus iria* were recorded as sedges.

Pearlmillet-wheat cropping system

RVSKVV, Gwalior

In pearlmillet, under pearl millet-wheat cropping system, weed free treatments recorded the highest grain yield followed by atrazine 0.5 kg/ha PE + one hand weeding at 30 DAS. However, application of atrazine 0.5 kg/ha PE proved profitable because of BCR was higher than other treatments.

Table 28: Weed dry biomass, yield and economics of pearlmillet as affected by different treatments under pearl millet – wheat cropping system.

Treatments	Weed dry biomass (g/m^2) (60 DAS)	Grain yield (kg/ha)	Gross return (₹/ha)	Net returns (₹/ha)	B:C ratio
Atrazine 0.5 kg/ha PE	97.8	3546	20938	10248	2.2
Atrazine 0.5 kg/ha PE + FYM 10 t/ha	100.9	3556	22018	10728	2.0
Atrazine 0.5 kg/ha PE + 1 HW 30DAS	50.2	3898	22089	11284	2.0
Two hand weeding at 30 & 45 DAS	12.9	4019	24440	11650	1.9
Weedy check	280.9	1241	13195	4205	1.5
LSD(P=0.05)	28.7	685	-	-	-

In wheat, it was noted that hand weeding twice at 30 and 60 DAS (weed free) treatment gave maximum grain yield 4314 kg/ha, net return of Rs. 30820/ha and benefit cost ratio of 2.92 as compared to remaining treatments. Consequently application of isoproturon 0.75 kg/ha + hand weeding at 60 DAS and isoproturon 0.75 kg/ha + 2,4-D 0.5 kg/ha were more effective weed management practices for control of mixed weed flora in wheat.

Table 29: Effect of different weed control measures on yield, weed population, weed biomass and economics of wheat.

Treatments	Weed density(No./m^2) (60 DAS)	Weed biomass (kg/ha)	Grain yield (kg/ha)	Net return (₹ ha)	B: C
Isoproturon 0.75 kg/ha	2.9	5.9	3484	26510	2.3
Isoproturon 0.75 + 2,4-D 0.5 kg/ha	2.3	7.6	3889	28602	2.7
Isoproturon 0.75 + 1, HW	2.1	9.8	4072	30124	2.8
Weed free (2, HW)	2.3	9.4	4314	30820	2.9
Weedy check	**2.3**	**41.6**	**2219**	**20600**	**1.5**

Weed seed bank study after harvest of pearl millet (2009-10)

In all, five weed species, one belonging to grasses - *Phalaris minor* and three broad leaved viz. *Chenopodium album, Anagallis arvensis* and *Spergula arvensis* and one sedge - *Cyperus rotundus* were recorded to imerge in post harvest soil of pearlmillet. *Phalaris minor* and *Chenopodium album* were the major weeds in the soil weed bank.

Weed seed bank study in post harvest soil (*kharif* 2010)

In all 6 weed species were recorded, out of which two belonged to grasses viz *Commelina benghalensis* and *Echinocloa crusgalli,* three were broad leaved weeds; *Digera arvensis, Phylanthus niruri* and *Trianthema monogyna* and one sedge *Cyperus rotundus*. Similarly highest number of total weeds, broad leaved weeds, grasses and sedges were found in atrazine 0.5 kg/ha + FYM 10 ton/ha (in bajra) treated soil.

Rice- yellow sarson cropping system

V.B., Sriniketan

In rice, complete disappearance of *Hydrolea,* decreasing tendency of *Fimbristylis, Cynodon* and *Digitaria and* new appearance of *Paspalum* both in repeated and alternate use of butachlor / pretilachlor. In yellow sarson, decreasing tendency of *Digitaria* and new appearance of *Polygonum* and *Solanum* was noticed both in repeated and alternate use of pendimethalin and pendimethalin / isoproturon. In rice, highest average grain yield was recorded in alternate use of butachlor / pretilachlor + OM + 2, 4-D but the highest net return and B:C ratio were noticed in repeated use of butachlor + 2, 4-D + fertilizer. In yellow sarson, the highest average seed yield, net return and B:C ratio were observed in alternate use of isoproturon / pendimethalin + FYM.

Rice- chickpea cropping system

IGKV, Raipur

In rice, *Echinochloa colona, Ischaemum rugosum, Aeschenomene indica* among grasses, *Alternathera triandra, Cynotis axillaries, Commelina benghalensis, Croton banplandianum*

among broad leaf weeds and Cyperus iria among sedges were the predominant weed species observed in the experimental field. Dry matter recorded at 60 DAS and at harvest significantly influenced by weed control measures. At both the stages, dry matter of weeds was significantly lower in the treatment of two hand weeding than unweeded control. It was followed by pre-emergence application of oxadiargyl 80 g fb post emergence application of Bisyribac 10% Na 25 g/ha at 23 DAS and fenoxaprop 60 g + chlorimuron + metsulfuron 4 g/ha, in order, at both the stages and was significantly inferior to weedy check. Significantly higher seed yield was recorded from the treatment of two hand weedings and were at par with oxadiargyl 80 g fb post emergence application of Bisyribac 10% Na 25 g/ha at 23 DAS and fenoxaprop 60 g + chlorimuron + metsulfuron 4 g/ha and significantly superior over weedy check.

In chickpea*, Medicago denticulata, Chenopodium album, Melilotus indica* were the predominant weeds in the experimental field. The effect of treatments applied to direct seeded rice during *kharif* was significant. Seed yield of chickpea was significantly higher where hand weeding twice was done in rice despite of non significant effect of *kharif* treatments on weed dry matter production in *rabi*. Tillage had no significant effect on weed dry matter as well as seed yield. Weed control methods significantly affected the production of weed dry matter as well as seed yield of chickpea. Pre-emergence application of pendimethalin 1.0 kg/ha^{1} produced significantly higher seed yield as compared to weedy check and farmers' practice, respectively.

Microbiological studies

Effect on basal soil respiration rate & dehydrogenase activity: The BSR, DHA, AP, MBC, rhizobial and PSB population were most affected by Fenoxaprop 60 g ha^{-1} + chlorimuron (CME) + metsulfuron (MSM) 4 gha^{-1}which were applied at post emergence stage. However, at 30 DAS in the study of AP, MBC and in microbial population their effect was found at par with application of Pyrazosulfuron (EPE). In microbial biomass and acid phosphatase study at 50DAS all the herbicidal treatments were found at par with hand weeding practice. The hand weeding practice and weedy check had positive effect to enhance the microbial activities and their population in soil in the entire growth period of crop. At harvest stage of the crop all the treatments were found at par in their effect.

No residual effect of *kharif* treatments was observed on soil properties during *rabi* experimentation. The conventional and zero tillage systems of *kharif* experiment did not impose any effect on microbial, biochemical properties of soil and nodulation of chickpea crop. The application of pendimethalin at recommended dose inhibited the microbial activities and their population in crop rhizosphere up to 30DAS but the effect was normalized at 50DAS where the values related to the above parameters found at par with hand weeded plots. Hand weeding practice found best to increase number and dry weight of nodules at 50DAS, followed by control treatment. However, the nodulation parameters in herbicide treated plots were found at par with control. At harvest stage of the crop all the treatments were found non effective.

Groundnut - transplanted finger millet cropping system

UAS, Bengaluru

Results indicated that use of 2,4-D EE 0.75 kg/ha at 15 DAS in finger millet (2719 kg/ha) and alachlor 1.0 kg/ha at 3 DAS (1808 kg/ha) in groundnut paved way for dominance of grasses and lowered the yield than the use of butachlor 0.75 kg/ha at 3 DAP (3389 kg/ha) in finger millet and pendimethalin 1.0 kg/ha at 3 DAS (2081 kg/ha) in groundnut. Use of fertilizers + FYM gave similar mean yield of groundnut and finger millet over a period of 12 seasons as compared to the use of fertilizers alone. Use of herbicides saved weeding cost by Rs. 3500 to 7000/ha in the system.

Groundnut-wheat cropping system

UAS, Dharwad

The wheat grain yields were significantly higher in weed free check but were at par with metsulfuron (2458 kg/ha). The grain yield obtained with trisulfuron (2217 kg/ha) was on at par with that of metsulfuron (2458 kg/ha). The weed dry matter at 60 DAS was significantly lower with application of metsulfuron (3.19 g/m^2) and it was on par with 2,4-D (3.36 g/m^2) and trisulfuron (3.54 g/m^2).

Microbiological studies

The total number of free living nitrogen fixers and MPS microorganisms were found to be more in numbers in weed free check at 30 DAS (99.00 x 10^4 CFU g^{-1} and 44.33 x10^4 CFU g^{-1} respectively). Among the herbicides, application of metsulfuron methyl 4 g/ha drastically reduced the population of both free living N_2 fixers and MPS microorganisms on 30, 60 and 90 DAS). In general soil respiration, dehydrogenase and phosphatase activity at 30, 60 and 90 DAS was highest with weed free check. Application of metasulfuron methyl 4 g/ha reduced the soil biological activity. However, on 90th DAS the results obtained with weed free check and Isoguard plus1kg/ha did not differ significantly.

Cluster bean-wheat

SKRAU, Bikaner

In cluster bean, results revealed that all the weed control treatments produced significantly higher seed yield than weedy check. As regard the herbicidal treatment, pre-plant incorporation of imazethapyr at 75 g/ha followed by a mechanical weeding at 30 days after sowing gave significantly higher seed yield (1580 kg/ha) than weedy check (653 kg/ha). The increase in yield with this treatment over weedy check was (927 kg/ha). This treatment was able to reduce maximum dry weight of weeds where the dry weight was 51 kg/ha. However, the seed yield recorded with this treatment was at par with that recorded with pre-plant incorporation of imazethapyr at 75 g/ha alone. In wheat, post-emergence application of metsulfuron methyl at 4.0 g/ha followed by one mechanical weeding treatment produced 335 kg/ha grain yield of wheat which was significantly higher than weedy check (182 kg/ha), the increase in grain yield with this

treatment over control was 153 kg/ha. This treatment suppressed maximum *rabi* seasonal weeds where the dry weight of weeds was 41kg/ha than weedy check (274 kg/ha).

The major weeds found infesting in cluster bean crop were *A. virdis*, *Gynopsis gynedra, T monogyna, T. terristris and Euphorbia sp.* The maximum weed bio-mass (30 g/m^2) recorded in weedy check and minimum weed bio-mass (2 g/m^2) recorded in pre-plant incorporation of imazethapyr at 75 g/ha followed by a mechanical weeding at 30 days after sowing. In wheat crop major weeds found infesting were *Chenopodiam sp. Millilotus sp. Asphodelus tennuifolius, Rumax dentatus and Heliotropium* sp. Maximum weed biomass (19 g/m^2) was observed in weedy check plot and minimum weed biomass (3.2 g/ha) was recorded in post emergence application of metsulfuron methyl at 4 g/ha followed by one mechanical weeding treatment.

WS 2.11 : Long term trial (minimum 5 years duration)

Rice-chickpea cropping system

Cooperating centres: NDUAT, RAU (P), GBPUAT

Treatments in DSR

- Weedy check
- Mechanical weeding (2)
- Butachlor 1.5 kg/ha +1 HW
- Anilophos 0.5 kg/ha +1 HW

Treatments in chickpea

- Weedy check
- Mechanical weeding (2)
- Pendimethalin 0.75 kg/ha +1 HW
- Pendimethalin 1.0 kg/ha

GBPUAT, Pantnagar

During *rabi*, the experimental area was mainly infested with *Phalaris minor* (56.9%) among the grasses, *Chenopodium album* (15.5%), *Melilotus indica* (1.9%), *Medicago denticulata* (13.8%), *Fumaria parviflora* (8.1%), *Vicia sativa* (2.9%) and *Polygonum plebejum* (0.5%) among the broad leaf weeds and *Cyperus rotundus* (0.4%) was the only weed among the sedges at 60 DAS. Among the weed management practices adopted in rice the density of all the weeds except *Polygonum plebejum* and *Cyperus rotundus* were influenced significantly at 30 DAS. Application of butachlor fb one hand weeding was found effective against the weeds in chickpea. In chickpea crop, the density of all the weeds species except *Medicago denticulata* were influenced significantly due to different weed management practices. The plots treated with the alone application of pendimethalin 1.0 kg as pre emergence was found effective in reducing the density of all the weeds as compared to other treatments.

In chickpea crop at 60 DAS, alone application of pendimethalin 1.0 kg was found effective against all the sedges and broad leaf weed except *Medicago denticulata* and *Fumaria Parviflora* where pendimethalin 0.75 kg supplemented with one hand weeding also recorded the lowest density in treated plots. The dry weight of all the grasses, broad leaf weeds and sedges were effectively controlled by the alone application of pendimethalin 1.0 kg followed by the twice mechanical weeding. Among different weed management practices adopted in rice crop, application of butachlor supplemented with one hand weeding was found effective against weeds in chickpea crop, which followed by anilofos+ one hand weeding. In chickpea crop, alone application of pendimethalin 1.0 kg was found most effective in respect to reducing the density of weeds. Herbicidal treatments applied to rice crop and chickpea had non-significant effect on the number of nodule per plant and its dry weight . Grain yield was affected significantly due to the herbicidal treatment. Among the weed management practices applied to rice, application of butachlor fb one hand weeding recorded the highest (635.5 kg ha^{-1}) grain yield of chickpea which was at par with weedy check. Within the chickpea treated plots the highest yield (963.8 kg) was found with pendimethalin 0.75 kg supplemented with one hand weeding. Weedy plot recoded 28.4% lower yield of chickpea as compared to application of pendimethalin 0.75 kg supplemented with one hand weeding that produced highest yield of chickpea.

Among the different weed management practices adopted in rice-chickpea cropping system. The highest grain yield of chickpea (963.8 kg/ha) was obtained with the application of pendimethalin 0.75 kg/ha supplemented with one hand weeding which was significantly superior over the other weed control treatment.

NDUAT, Faizabad

A long term trial on the management of weeds in rice-chickpea cropping system is being conducted since 2006-07 to find out the weed shift, weed seed bank and microbial effect in rice-chickpea system due to the different herbicides applied. Due to the continuous use of anilophos 0.4 kg/ha in rice, dominance of BLWs e.g. *Lindernia spp., Caesulia axillaries* and *Eclipta alba* was observed,while application of pendimethalin 1.0 kg/ha in chickpea showed the dominance of *Solanum nigrum, Rumex* spp. and *E. hirta* etc. However, application of anilophos 0.4 kg/ha in rice during *kharif* along with pendimethalin 0.75 kg/ha fb HW 30 DAS recorded significantly higher grain yield of chickpea (16.8 q/ha).

Microbiological studies

The observation related to microbial studies (free living bacteria 'P' solubilizers, acid-P, alkaline P, soil biomass carbon and dehydrogenase activity) significant effect were observed between the treatment. Maximum population was found under two hand weeding plot at various growth stages. However, at harvest stage the variation were found non-significant.

RAU, Pusa

During *kharif* season in rice crop, mechanical weeding (T_2) had recorded significantly lowest weed count and weed dry weight over anilophos + 1 HW (T3) and weedy check (T_4). Under sub plot treatments all weed control treatments proved its superiority over weedy check while remaining statistically at par amongst them.

During *rabi* season in chickpea crop under the main plot treatment, the lowest weed count and weed dry weight were recorded under treatment T_2 which was statistically at par with T_3 and T_4, similarly grain yield was also recorded highest under T_2 which was at par with T_3 and T_4 all T_2, T_3 and T_4 were significantly superior over weedy check. Under subplot treatments T_2 had proved its superiority over others in terms of weed count, weed dry weight and grain yield except T_3 which remained statistically at par with it.

Weed seed bank studies

The lower weed seed bank 111, 173 and 176 were found under the treatment combination manual weeding twice in both crop season, application of butachlor 1.5 kg/ha + 1 HW in rice and Pendimethalin 0.75 kg + 1HW in chickpea and application of Butachlor 1.5 kg + 1 HW in rice and two manual weeding the chickpea, respectively. In case of grassy weed the lowest weed seed were observed under the treatments manual weeding twice in both the crop; application of Butachlor 1.5 kg/ha in rice + 1 HW and two manual weeding in chickpea and Anilophos 0.5 kg + 1 HW rice and Pendimethalin 0.75 + 1 HW in chickpea, respectively. The maximum weed seed accumulation 820/m^2 was found under check plot in both season. The same trends were also observed in case of BLWs where two manual weeding in both crops reduced the weed seed of all type of weed constantly.

WS 2.12: Rice-wheat cropping system

Cooperating centres: GBPUAT, CSAUAT, AAU (J), RAU (P)

Treatments in Transplanted rice

- Weedy check
- Mechanical weeding (2)
- Butachlor 1.5 kg/ha
- Anilophos 0.5 kg/ha

Treatments in wheat

- Weedy check
- Mechanical weeding
- Isoproturon 1.0 kg/ha
- Isoproturon 0.75 kg/ha tank mix 1% urea
- Isoproturon 0.75 kg/ha tank mix 0.1% surfactant/ adjuvant

CSAUAT, Kanpur

In wheat, the manual weeding twice applied in preceding rice crop significantly reduced the weed population and its dry weight at all the stages of crop. Among the weed control practices in wheat, hand weeding twice minimized the weed population and its dry weight at all the stages of crop. Among the weed control practices in wheat, hand weeding twice minimized the weed population and its dry weight followed by isoproturon (0.75 kg/ha) + (0.1% tank mix surfactant)

application at 30 DAS. Signficatnly maximum wheat straw and grain yield was recroded under hand weeding twice in both the crops. Isoproturon (0.75 kg/ ha + 0.1% tank mix surfactant) application in wheat produced maximum grain yield (4960q/ha) which is comparable with hand weeding twice and signficatnly superior over weedy check (4268 kg/ha).

In rice, pre-emegence application of anilophos (0.50 kg a.i./ha) in signficatnly reduced the weed population and its dry weight at all the stages of crop. Due to much reduction of weeds, the maximum rice grain yield (5114 kg/ha) and net income (Rs. 27627/ha) was achieved under this treatment. Hence it is recommended for farmers' of Central U.P.

AAU, Jorhat

Application of pretilachlor 0.75 kg/ha or butachlor 1.5 kg/ha which finally resulted significantly higher grain yield of rice than mechanical weeding 25 DAS. Highest grain yield of wheat crop was obtained from the treatment with isoproturon 0.75 kg/ha + 1% urea and isoproturon + surfactant. The treatments applied to rice did not have any residual effect on the performance of wheat crop.

Application of pretilachlor 0.75 kg/ha or butachlor 1.5 kg/ha in rice brought about lowest number of weeds and weed dry weight at all the stages of rice. Application of isoproturon 0.75 kg/ha + adjuvant and isoproturon 0.75 kg/ha + 1% urea resulted lowest values of the density and dry weight of weed. Treatment with pretilachlor 0.75 kg/ha in rice resulted lowest values of weed density and dry weight in wheat.

The soil borne seeds of broad-leaved weeds were found to be highest than the sedges and grasses in all the treatments. Dormant weeds were comparatively higher in the treatments that received pretilachlor during the rice cropping.

Soil Microbial population

Representative surface (0-15 cm) soil samples were collected after harvest of crops from respective treatments. Collected soils were subjected to serial dilution in specific media for total microbial count and total microbial count was recorded at 10^{-6} dilution and the results were expressed in terms of colony forming unit (cfu) per gram of oven dry soil. The total population for *Azotobacter, Azospirillum* and PSB decreased due to application of herbicide in either crop (table 2.11.6 and 2.11.7) after harvest of crops.

The trend in microbial population over five years showed an initial decrease during first three years in herbicide treated soil in both the crops. Nevertheless, the microbial population of *Azotobacter*, *Azospirillum* and PSB remained smaller than the untreated weedy or mechanical weeding plots.

GBPUAT, Pantnagar

The major weeds at 60 DAS in weedy plots were *Phalaris minor* (20.8%), *Meliotus alba* (0.63%), *Medicago denticulata* (71.5%), *Polygonum plebejum* (2.23%), *Chenopodium album* (2.23 %), *Coronopus didymus* (0.20%), *Vicia sativa* (0.35%), *Rumex acestocella* (4.79%). At 60 DAS, none of the weed control treatments applied to rice crop significantly affected the density

of different weed species except *Polygonum plebejum* and total dry matter of weeds. The density of *Polygonum plebejum* was highest in the plot treated with anilofos 0.5 kg/ha followed by the weedy plot as well as the plot treated with butachlor 1.5 kg. Weed control treatments applied to wheat significantly influenced the density of all the weeds except *Corornopus didymus* and *Vicia sativa*. The lowest weed density and dry matter of weeds at 60 DAS was recorded with the application of isoproturon applied at 0.75 kg/ha along with surfactant (0.1%). The dry mattes accumulation was influenced significantly due to subplot treatments applied to wheat. The lowest dry matter was recorded with isoproturon 1.0 kg/ha at 30 DAS followed by isoproturon 0.75 kg/ha along with Urea (1%) tank mix. Among the weed control treatments applied to wheat, the highest grain yield (4756 kg) was recorded with the plots treated with isoproturon (0.75 kg at 30 DAS) along with urea (1%) tank mix followed by the combination of isoproturon 0.75 kg surfactant (0.1%).

RAU, Pusa

In rice, the lowest weed count, weed dry wt. and highest grain and straw yields were recorded under the treatment mechanical weeding (T_2) and butachlor 1.5 kg/ha (T_3) which were significantly superior over treatments weedy check and application of anilophos 0.5 kg/ha and both were at par between themselves. However, application of anilophos 0.5 kg/ha was also effective for minimizing weed density and increasing grain and straw yield over weedy check.

In wheat, all the weed control treatments showed their effect to minimize weed population and increase the grain and straw yield over weedy check in main plot treatment. Minimum weed population and weed dry wt. and maximum grain yield were recorded under mechanical weeding which was significantly superior over weedy check (T_1) and isoproturon 0.75 kg/ha (tank mix 1% urea) (T_4) while at par with isoproturon 1.0 kg/ha (T_3). Under sub plot treatments, weed count and weed dry weight was recorded lowest in mechanical weeding treatment which were significantly lower as compared to other treatments except isoproturon 0.75 kg/ha (tank mix 0.1% surfactant) which remained statistically at par with it. Grain yield was recorded highest under mechanical weeding treatment which was at par with isoproturon 1 kg/ha and isoproturon 0.75 kg/ha tank mix 0.1% surfactant.

SKUAST, Jammu

In wheat, during *rabi* 2010-2011, weed population, dry weight of weeds and grain yield of wheat were not significantly influenced by weed control measures taken up in previous year rice crop. However, weed control measures in wheat showed significant variations in weed population, dry weed weight and grain yield of wheat. Significantly highest grain yield of 3779 kg/ha was recorded in the treatment with Isoproturon1kg/ha and was at par with the treatments where 0.75 kg Isoproturon +1% tank mix urea applied. However, lowest grain yield of wheat was recorded in case of weedy check treatment. Application of isoproturon 1kg/ha in wheat also proved itself superior to all other weed management treatments with respect to suppression of weed population recording significantly lowest weed count at 30 and 60 days after sowing. Almost a similar trend was observed with respect to dry matter production of weeds in wheat at 30 and 60 DAS. The weed flora recorded in wheat crop comprised of *Avena fatua ,Chenopodium album, Vicia sativa, Fumeria parviflora, Phalaris minor, Medicago denticulata* and *Anagallis arvensis.*

During the rice growth period the predominant weed species found were *Eichnochloa crusgalli, Eichnochloa colonum, Cyperus iria, Cyperus difformis and Cyanodon dactylon.* Amongst the weed control treatments in rice, the lowest weed population of 5.67 and 29.00 was recorded at 30 and 60 days after transplanting, respectively where application of butachlor 1.5 kg/ha was made (which was previously treated with isoproturon 1 kg/ha in wheat crop) followed by two mechanical weeding (MW-30 and 60 DAT). Almost a similar trend was also observed with respect to weed dry matter accumulation in rice. Highest rice grain yield was observed to the tune of 33.90 q/ha with herbicidal application of Butachlor 1.5 kg/ha followed by two mechanical weeding (MW-30 and 60 DAS) recording 66 and 48 per cent higher grain yields, respectively over weedy check treatment.

WS 2.13: Maize/ Pearl millet-chickpea/ lentil/ pea

Cooperating centres : CSKHPKV, AAU(A), RAU(P), GBPUAT, PAU, UAS(D), CCSHAU MAU & RAU(B)

Treatments in maize

- Weedy check
- Mechanical weeding (2)
- Atrazine 0.75 kg/ha PE
- Atrazine 1.0-1.50 kg/ha PE
- Atrazine 0.75 kg/ha fb. 2,4-D 0.5 kg/ha

Treatments in chickpea / lentil / pea

- Weedy check
- Mechanical weeding (2)
- Pendimethalin 1.0/1.25 kg/ha PE
- Pendimethalin 0.75 kg/ha fb Mechanical weeding

PAU, Ludhiana

Weed control treatments applied to maize previous crop did not influence the infestation of weeds in succeeding crops. Pendimethalin 0.75 kg/ha fb hoeing significantly reduced dry matter of *P minor*, *Rumex and Coronopus* and recorded the highest field pea and chickpea seed yield and was significantly better than all other treatments. The microbial population in soil showed downward trend upon herbicidal treatments as compared to unsprayed control plot. Hand hoeing helped enhance the microbial population in herbicidal treatments.

AAU, Anand

In maize, significantly the highest grain yield was recorded in mechanical weeding carried out at 20 and 40 DAS. Significantly the lowest grain and straw yield of maize were recorded in weedy check. Weed control efficiency varied between 42 to 69 percent. In chickpea, significantly the

highest seed and straw yield were recorded in pre emergence application of pendimethalin (0.75 kg/ha) with post emergence application of 2, 4-D. Significantly the lowest seed yield of chickpea was recorded in weedy check. Presence of weeds through out the season resulted in 62.5 per cent decrease in seed yield of chickpea.

Weed seed bank study

During the course of seed bank studies, the predominant weed species of grasses were *Eleusine indica, Eragrostis major, Dactyloctenium aegyptium, Digitaria sanguinalis, Echinochloa crus galli, and Commelina benghalensis.* The major species of weeds as dicot were *Digera arvensis, Phyllanthus niruri, Oldenlandia umbellata, Euphorbia hirta, Boerhavia diffusa* and *Trianthema monogyna. Cyperus rotundus, Cyperus iria, Fimbristylis woodrowii* and *Cyperus deformis* were recorded as sedges.

MAU, Parbhani

Under cropping system of maize – chickpea, maize crop recorded (on the basis of equivalent yield of the cropping system) significantly highest grain yield in plots weeded by mechanical weedings (2HW) which was found at par with PE- atrazine 1.5 kg/ha and PE- atrazine 0.75 kg/ha *fb* 2,4-D 0.5 kg/ha and significantly superior over rest of the treatments.

In chickpea, the highest pod yield (equivalent yield) was recorded under PE- pendimethalin 0.75 kg/ha *fb* 1 HW which was found at par with mechanical weedings (2HW) and found significantly superior over rest of the treatments.

Microbiological studies

Herbicide in the present investigation had only temporary effect on soil health parameter. The herbicide used i.e. atrazin, pendimethalin 2,4-D, in maize-chickpea cropping system did not lower the basal soil respiration and microbial biomass production of microbes at the harvest time of the crop. Similar results regarding beneficial microflora were found. Increasing trend in number of colonies was found from initial to harvest. Application of herbicide did not restrict the microbial growth in both the crops .There is non significant effect of herbicide on number of root nodules and nodule dry matter.Total number of 'N'fixer were observed more than that of 'P'solubilizer.s

CCSHAU, Hisar

In long term trial in pearl millet –chickpea cropping system, seed yield of chickpea was maximum (2089 kg/ha) in two mechanical weeding treatment which was at par with pre-emergence application of pendimethalin *fb* one hoeing (2009 kg/ha). Presence of weeds through out the season and use of pendimethalin alone caused 55 and 53.6 % decrease in grain yield of chickpea as compared to mechanical weeding twice. Weed dynamics studied after 4 years of experimentation indicate that maximum no. of weed were present in 0-5 cms soil layer as compared to 5-10 cms layer. Weed flora mainly consisted of broadleaf weeds viz. *C.album, Fumaria, Medicago denticulata* and *Lathyrua aphaca* constituting 88.3 % of weed flora in weedy check.

In chickpea rhizosphere, at 3 DAT bacterial populations in pendimethalin treated plot was very low (11.5.0 x10^6/ g dry soil) as compared to mechanical weeding (35.6 x 10^6/ g dry soil). Same is the case with actinomycetes population. Later on at 10 DAT, 30 DAT and at harvest it was almost same. There was no change on fungal and free living diazotrophs population at all the stages.

SKRAU, Bikaner

In pearl millet, results revealed that all the treatments produced significantly higher grain yield than weedy check. Among the herbicidal treatments higher pooled seed yield recorded with pre-emergence application of atrazine at 0.75 kg/ha where the yield was 2460 kg/ha. The increase in pearl millet yield over weedy check was 1350 kg/ha. This herbicide was also able to control maximum seasonal weeds where the dry weight of weed was 61 kg/ha. In gram, all weed control treatments produced significantly higher seed yield than weedy check plot. Pre-emergence pendimethalin 0.75 kg/ha followed by a mechanical weeding treatment gave higher pooled seed yield of gram 1420 kg/ha than weedy check (570 kg/ha), the increase in seed yield with this treatment over weedy check was 850 kg/ha.

Weed flora in pearl-millet most common weeds were *Chorcorus sp, Digera muricata, T. Monogyna*, *E. hirta* and *A. viridis* recorded at 60 days after sowing along with weed biomass. In gram, major weeds found infesting were *Cenopodium sp. Melilotus alba, Rumax dentatus, Asphodelus tenuifolius* and *Heliotropium sp.* Data indicate that in pearl millet crop significantly higher (344 kg/ha) weed biomass recorded in weedy check plot than all other treatments and minimum weed biomass (0.33) was recorded in application of pre emergence atrazine 0.75 kg/ha followed by post emergence 2,4-D at 0.5 kg/ha treatment. In gram, all the weed control treatments were able to reduce maximum weeds when compared to weedy check (188 kg/ha). Minimum weed biomass (32 kg/ha) was recorded with application of pre- emergence pendimethalin at 0.75 kg/ha followed by a mechanical weeding.

GBPUAT, Pantnagar

Weeds control treatments in maize crop had significant effect on grain yield of pea and was highest (891.8 kg/ha) with application of atrazine+2,4-D (0.75 + 0.5 kg/ha) treated plots. Significantly highest yield of pea (1039.8 kg/ha) was recorded with pendimethalin 0.75 kg + one HW followed by mechanical weeding (30 and 60 DAS).

CSKHPKV, Palampur

Weeds in unweeded check reduced the grain yield of maize by 45.1 per cent over atrazine 1.5 kg/ha. Atrazine 1.5 kg/ha behaving statistically similar with all the weed control treatments resulted in significantly higher grain yield of maize by effective control of weeds. Among the treatments applied in pea, pendimethalin 1.2 kg/ha being statistically at par with pendimethalin 0.75 kg/ha *fb* mechanical weeding and two mechanical weedings resulted in significantly higher grain yield of maize.

Whereas, in case of pea, residues of atrazine 1.5 kg/ha being statistically at par with mechanical weeding twice resulted in significantly higher pod yield of peas over unweeded check. Weeds in unweeded check reduced the pod yield of pea by 47.9 per cent over the best

treatment pendimethalin 0.75 kg/ha *fb* mechanical weeding. Among the treatments applied in peas, pendimethalin 0.75 kg/ha *fb* mechanical weeding being statistically at par with mechanical weeding twice resulted in significantly higher pod yield of pea by effective control of the weeds and improved yield attributes of pea.

Weed seed bank study

In weed management in maize-pea experiment, weedy check in maize and pendimethalin 0.75 kg/ha fb mechanical weeding in pea recorded minimum emergence of broad leaved weeds (33 m^{-2}), grasses (50/m^2) and total weed emergence/100g soil (0.36) after the harvest of pea crop. After the harvest of maize, atrazine 1.5 kg/ha in maize and pendimethalin 0.75 kg fb mechanical weeding in pea recorded minimum emergence of broad leaved weeds (133/m^2) and total weed emergence/100g soil (0.96).

UAS, Dharwad

In main plots, the grain yield in maize was signficantly higher with mechanical weeding which was on par with atrazine 0.75 kg/ha PE fb 2,4-D POE. The weed dry matter at harvest also followed the same trend. In subplots, the maize and weed dry matter were not influenced by treatments imposed on preceding chickpea.

Microbiological studies

Chickpea *rabi* -2010

At 30 and 60 DAS, highest population of free living nitrogen fixers and MPS microorganisms were recorded with hand weeding.However, on 90th DAS, highest plate count was recorded in the treatment received pendimethalin 1.25 kg/ha. At 30 DAS, reduced soil respiration was recorded with pendimethalin 1.25 kg/ha. Whereas, mechanical weeding significantly influenced the soil respiration over other treatments. The observations recorded on 60 and 90 DAS revealed that highest soil respiration was observed with pendimethalin 0.75 kg/ha. Highest dehydrogenase activity was observed on 30 DAS (0.07 µg TPF formed g^{-1} soil day^{-1}), followed with weedy check (0.05 µg TPF formed g^{-1} soil day^{-1}), whereas lowest dehydrogenase activity was recorded in the treatment received pendimethalin 1.25 kg/ha as pre emergent spray (0.02 µg TPF formed g-1 soil day-1). At 60 and 90 DAS, highest dehydrogenase activity was recorded in the treatment received pendimethalin 1.25 kg $h^{-1.}$ (9.07 and 0.85 µg TPF formed g^{-1} soil day^{-1} respectively). At 30DAS, highest phosphatase activity was observed in treatment with hand weeding (37.14 µg TPF formed g^{-1} soil day^{-1}), followed with weedy check (33.97 µg PNP g^{-1} soil h^{-1}). At 60 DAS, increased phosphatase activity was recorded with mechanical weeding (20.72 µg PNP g^{-1} soil h^{-1}), while application of pendimethalin 1.25 kg/ha did not affect the soil phosphatase activity, which significantly more than the remaining treatments on 90th day.

Maize *kharif* 2011

Highest free living nitrogen fixers were recorded in the plot receiving two mechanical hand weeding at 30 and 60DAS (45.33 X 10^4 CFU g^{-1}),while lowest population was observed with atrazine 1.00 kg/ha as pre emergent spray(33 X 10^4 CFU g^{-1}). Similar results were also recorded

on the 60th day. However, on 90th day the population of free living nitrogen fixers improved in the treatment with atrazine 1.0 kg/ha (16.67 X 10^4 CFU g^{-1}) which was statistically on par with mechanical weeding (15.67 X 10^4 CFU g^{-1})(Table 13). Significantly higher MPS microbial load was observed with mechanical weeding (82.67 X 10^4 CFU g^{-1}) compared to the treatments received pendimethalin at both the levels on all the three intervals. The dehydrogenase activity was maximum with the plots received mechanical hand weeding on 30 ,60 and 90 DAS (11.67,16.85 and 8.43 µg TPF formed g-1 soil day-1respetively). Similar trend was noticed with respect to phosphatase and soil respiration. However, the present investigation on the above mentioned parameters on 90th day have revealed that the results obtained with recommended dose herbicides were found to be on par with the treatment received mechanical weeding.

RAU. Pusa

In maize, application of atrazine 0.75 kg/ha *fb* 2,4-D Na salt 0.5 kg/ha was effective for maximum reduction in weed count and weed dry weight which was significantly superior over all other treatments, while these were recorded minimum under mechanical weeding twice. Similarly maximum grain yield was observed under treatment of mechanical weeding twice, which was significantly superior over all other treatments except atrazine 0.75 kg/ha *fb* 2,4-D 0.5 kg/ha. Under sub plot treatments all weed control treatments remained statistically at par amongst themselves in terms of weed count, weed dry weight and grain yield but were significantly superior over weedy check.

In lentil, under main plot treatment mechanical weeding (T_2) had recorded significant lowest weed count and weed dry weight over all other treatments while in terms of grain yield T_2 had recorded highest grain yield which was significantly superior to all other treatments except atrazine 0.75 kg/ha *fb* 2,4-D 0.5 kg/ha (T_5). Under sub plot treatments, all the weed management treatments were effective to minimize the weed control weed dry weight and maximize the grain yield of lentil. The application of pendimethalin 0.75 kg/ha *fb* manual weeding was most effective amongst chemicals for reducing weed count and weed dry weight which was significantly superior over alone application of pendimethalin and weedy check while statistically at par with T_2 (mechanical weeding twice) which had registered lowest weed count and weed dry weight. Similarly, maximum grain yield was recorded under mechanical weeding twice which was significantly superior to all other treatments except T_4 (pendimethalin 0.75 kg/ha *fb* 1 MW).

PDKV, Akola

The major weed flora during *kharif* season in maize crop in the selected area composed of *Xanthium strumarium, Celosia argentea, Tridax procumbens, Phyllanthus niruri, Portulaca oleracae, Euphorbia hirta, Parthenium hysterophorus, Digera arvensis, Cynodon dactylon, Cyperus rotundus, Amaranthis viridis, Dinebra arabica, Panicum spp etc.,* both broad and narrow leaved weeds are observed but dominance of broad leaved weeds was observed in entire field.

Application of atrazine 0.75 kg/ha as PE fb 2,4-D as PoE (30 DAS) significantly reduced weed population, weed dry matter accumulation, highest weed control efficiency and resulted in maximum grain yield of maize. In chickpea, application of pendimethalin 0.75 kg/ha fb hand weeding (30 DAS) significantly reduced weed population, weed dry matter accumulation and resulted in maximum grain yield.

WS 3: Management of parasitic/ invasive/ problematic/ aquatic weeds

WS 3.1 : Management of *Cuscuta*

Crops: Lucerne, niger, onion, field bean, rice fallow

Cooperating centres : TNAU, OUAT, MAU, UAS(B), RAU(B), ANGRAU, UAS(D), DBSKKV

Treatments:

Main plot : (Summer ploughing)

1. Summer deep ploughing
2. No summer ploughing

Sub-plot : (Weed control)

1. Pendimethalin 1.0 kg/ha PE as sand mix
2. Pendimethalin 1.0 kg/ha at 15 DAS
3. Imazethapyr 75-100 g/ha as PPI
4. Imazethapyr 75-100 g/ha as Post em
5. Early post-emergence (10-12 DAS) of pendimethalin 0.5 kg/ha in Lucerne
6. Stale seedbed (chemical- paraquat 0.5 kg/ha)
7. Stale seedbed fb pendimethalin 0.5 kg/ha (PE)
8. Farmers' practice

Management of *Cuscuta* in Lucerne

SKRAU, Bikaner

A field experiment was conducted for five years on weed control in Lucerne crop with special reference to dodder (*Cuscuta*), a stem parasitic weed. Results revealed that deep summer ploughing produced significantly higher green fodder yield (229 q/ha) than no summer ploughing. The increase in green fodder yield with this treatment over no summer ploughing was 23 q/ha. None of the ploughing treatments were found significant in case of seed yield. As regard the weed control practices, results revealed that all the weed control treatments produced significantly higher pooled green fodder and seed yield of Lucerne than farmers practice. Among the weed control practices, both pre-planting incorporation and post emergence application of imazethapyr at 75 g/ha produced significantly higher pooled green fodder yield 235 and 228 q/ha than farmers practice (186 q/ha), where the increase in green fodder yield with these treatments over farmers practice were 49 and 42 q/ha, respectively. However, the green fodder yield recorded with pre-plant incorporation of imazethapyr treatment was at par with that of yield recorded with pre-emergence pendimethalin at 1.0 kg/ha applied as sand mix. Imazethapyr controlled almost all seasonal weeds along with dodder.

OUAT, Bhubaneswar

Management of *Cuscuta* in niger

The germination of *Cuscuta* was 11.1% less in summer deep ploughing and significantly less in pendimethalin 1.0 kg/ha PE as sand mix (0.5 no m^{-2}). The method of summer deep ploughing in niger was effective in reducing the density of *Cuscuta* by 8.0% at 30 DAS and 6.6% at 60 DAS. The *Cuscuta* control efficiency was highest in stale seed bed fb pendimethalin 0.5 kg/ha PE and pendimethalin 1.0 kg/ha PE as sand mix (52.2%). The practice of summer deep ploughing increased the grain yield of niger by 2.5% over no summer ploughing and the treatment of stale seed bed fb pendimethalin 0.5 kg/ha PE recorded significantly the highest grain yield of 805.3 kg/ha. The treatment of pendimethalin 1.0 kg/ha PE as sand mix produced the highest B:C ratio (1.78) followed by imazethapyr 75 g/ha as PPI (1.71).

Table 30.: Effect of summer ploughing and weed management on germination, density of *Cuscuta* and yield niger

Treatments	Density of *Cuscuta* (/m^2)		*Cuscuta* control efficiency (%)	Yield of niger	B:C ratio
	30 DAS	60 DAS	(60 DAS)	kg/ha	
Summer ploughing					
Summer deep ploughing	7.6	14.1	5.4	667.4	1.6
No summer ploughing	7.9	14.9	-	652.1	1.7
LSD (P=0.05)	**0.1**	**0.5**		**8.1**	
Weed control					
Pendimethalin 1.0 kg/ha PE as sand mix	2.5	9.6	52.2	797.2	1.8
Pendimethalin 1.0 kg/ha at 15 DAS	8.7	17.0	15.4	538.7	1.4
Imazethapyr 75 g/ha as PPI	3.1	11.7	41.8	772.7	1.7
Imazethapyr 75 g/ha as Post em	8.6	17.6	12.4	503.8	1.4
Stale seed bed (prarquat 0.5 kg/ha)	11.8	20.1	-	441.3	1.1
Stale seed bed fb pendimethalin 0.5 kg/ha PE	2.1	9.6	52.2	805.3	1.6
Farmers' Practice (HW at 20 & 40 DAS)	1.4	10.8	46.3	759.2	1.3
LSD (P=0.05)	**0.2**	**0.5**		**9.1**	
M x S (Interaction – S within M)					
LSD (P=0.05)	**NS**	**NS**		**NS**	

DBSKKV, Dapoli

Management of *Cuscuta* on *Lablab purpureus* sown during *rabi* 2010-11

For effective control of *cuscuta* in *rabi* lablab bean crop the field should be ploughed before sowing and pendimethalin 1.0 kg/ha be applied as pre- emergence with sand mix for obtaining higher yield and net returns.

WS 3.2 - Management of *Orobanche* in tomato, potato, tobacco and brinjal-based system

Crops	Cooperating Centres
Tobacco	RAU (P), TNAU
Tomato	UAS(B), OUAT, UAS(D)
Brinjal	UAS(B), OUAT, UAS(D)
Potato	UAS(B),

Treatments:

Main plot:

1. Solarized
2. Non-Solarized

Sub-plot : (Weed control)

1. Oxyfluorfen 0.1 kg/ha (3DAP)
2. Pendimethalin 1.0 kg/ha (3 DAP)
3. Metribuzin 0.5 kg/ha
4. Neem Cake 200 kg/ha
5. HW 30-35 DAP
6. HW twice at 30-35 and 50-55 DAP
7. Control

OUAT, Bhubaneswar

The emergence of the *Orobanche* shoot took around 49 days and it went up to a height of 14.3cm and produced 4500 seeds/floret. Soil solarization reduced the density of *Orobanche* by 30% and dry weight by 39%. Application of pendimethalin 1.0 kg/ha recorded the lowest density per brinjal plant (9.2) at 30 DAP followed by neem cake 200 kg/ha (10.2). Soil solarization resulted 6.7% more yield over non-solarization. Among weed management practices, hand weeding twice recoded the highest yield (32.6 t/ha) which was at par with the yield from the plots applied with pendimethalin 1.0 kg/ha (32.3 t/ha).

UAS, Bengaluru

Use of herbicides – metribuzin 0.5 kg/ha, pendimethalin 1.0 kg /ha and oxyfluorfen 0.1 kg /ha – all at 3 DAP lowered the emergence of *Orobanche* and delayed by 10 – 15 days than usual emergence of 50–60 days after planting in tomato. In this crop, use of neem cake at 200 kg/ha at planting along with pre-emergence herbicides improved the yield by 12 to 17% over neem cake application alone. Two hand weeding (25-30 and 50-60 DAP) fb hand picking of *Orobanche* (at 70 and 90 days after planting) was very effective in reducing the menace of *Orobanche* in addition to producing higher tomato (35.0 t/ha) yields but proved to be very expensive in view of escalating labour wages and labour constraints.

ANGRAU, Hyderabad

Recently infestation of parasitic weed *Orobanche* was reported on tomato and brinjal in farmers fields in *Chevella* agricultural division in Rangareddy district of southern telangana zone of Andhra Pradesh. Spot application of herbicides could not control *Orobanche* and hence it has been decided to go for soil solarization using black and white polythene sheets as an on farm research.

WS 3.3 - Management of *Striga* in maize, sorghum, pearlmillet and sugarcane-based system

Cooperating centres: TNAU, UAS (B), UAS(D), ANGRAU, RVSKVV

Treatments:

1. Atrazine 0.5 kg/ha (for other crops) or 1.0 kg/ha (for sugarcane)
2. 2,4-D Na salt 1.0 kg/ha + urea 1% + soap solution 1% as post-em. (50-55 DAS in other crops; 70-75 DAS in sugarcane)
3. Directed spray of 20% urea on Striga plants
4. Directed spray of 5% ammonium sulphate on Striga plants
5. 125% recommended fertilizer
6. Directed spray of paraquat 0.5% (50-55 DAS in other crops; 70-75 DAS in sugarcane)
7. Atrazine 0.5 kg/ha (in other crops) or 1.0 kg/ha (sugarcane) as pre-em. followed by mulching with crop residue after final inter cultivation (around 35-45 DAS in sorghum/maize/pearl millet) and 120 days (in sugarcane)
8. Unsprayed control

TNAU, Coimbatore

Management of *Striga asiatica* in early-planted sugarcane

Reduction in density and dry weight of *Striga asiatica* with better control efficiency could be achieved with post-emergence spraying of 2,4-D Na salt 1.0 kg/ha + urea 1% + soap solution 1% on 70 - 75 DAP. Productivity and profitability of sugarcane infested with *Striga asiatica* could be increased by post emergence spraying of 2,4-D Na salt 1.0 kg/ha + urea 1% + soap solution 1% on 70 - 75 DAP and pre-emergence application of atrazine 1.0 kg/ha +2,4-D Na salt 1.0 kg/ha + urea 1% + soap solution 1% as POE on 75 DAP followed by mulching with cane trash

after final inter-culitvation on 120 DAP. Pre-emergence application of atrazine 1.0 kg/ha +2,4-D Na salt 1.0 kg/ha + urea 1% + soap solution 1% as POE on 75 DAP followed by mulching with cane trash after final inter-culitvation on 120 DAP could be recommended for effective control of *Striga asiatica* in sugarcane and for higher productivity and profitability in sugarcane cultivation.

WS: 3.4 Survey on occurrence of *Dendropthae* in trees and its management

Cooperating centres: UAS (B), KAU, TNAU, ANGRAU, UAS(D), CSAUAT, NDUAT, RAU (P), AAU (J), VB, BAU, CSHPKV, DBSKVV, MAU, AAU (A)

a. Documentation of occurrence of Dendropthoe spp. on trees-timber/fruit trees in different agro-climatic zones.

b. Percent infestation of Dendropthoe spp (each spp.) on trees in different agro-climatic zones.

Note: Use GPS data on altitude, latitude and longitude to demarcate the distribution of these species in different agro-climatic zones.

Management practices (Treatments)

1. Padding of 2,4-D, Na salt (5%)
2. Padding of common salt (1g/ml of water) on scrapped stem of Loranthus and
3. Spraying of ethrel (4000 ppm) on the parasitic leaves.
4. Others

Observations:

i. Percent drying of leaves/shoots

ii. Regrowth of *Dendropthae* needs to be monitored.

AAU, Anand

Loranthus (*Dendrophthae falcate* L.) is a genus of parasitic plants that grow on the branches of trees. Loranthus grows strongly on ageing trees particularly the middle of old branches. In Anand area, loranthus was observed on mango, sapota, silver oak, guava and bottle brush. The infestation depends on ageing of trees and climatic conditions. No infestation was recorded in dry region of Saurashtra area particularly on *Kesar* mango plantation whereas it was recorded 22 to70 percent in South Gujarat agro-climatic zones.

AAU, Jorhat

In Dima Hasao and Karbi Anglong districts (Hamren side) the rate of infestation by *D. falcata* was very meagre (less than 10%). The parasite was discovered infecting the trees like *Butea monosperma* (Lamk) Taub. (fabaceae), *Mangifera indica* L. (Anacardiaceae) (mango tree), *Premna latifolia* Roxb. (verbanaceae) and *Dillenia indica* L. (dilleniaceae). The ripen fruits of *D. falcata* is found edible.

TNAU, Coimbatore

Loranthus infestation survey on sapota was conducted at Sangagiri block of Salem district of the

45 sapota trees surveyed 11 trees have found to be infested with loranthus and the percentage of infestation is 24 percent. Infestation survey on mango tree at Katpadi block of Vellore District of the 5 mango trees surveyed 17 trees have been found to be infested with loranthus and the percentage of infestation is 49 percent and surveyed various places of Tamil Nadu.

Loranthus infestation on neem trees was surveyed at Puliampatti block of Erode district, Annur block of Coimbatore district, Arcot block of Vellore district and Thuraiyur block of Trichy district of the 45 sapota trees surveyed none of them found to be infested with loranthus and Thuraiyur block of Trichy district of the 3 neem trees surveyed one tree has infested and the percentage of infestation is 33 percent.

V.B., Sriniketan

On the basis of survey in mango orchards and other trees in Birbhum and Burdwan districts under Red and Lateritic Zone, two species and one variety of *Dendriophthoe* namely, *Dendrophthoe glabrascens* and *D. falcata* var. *coccinia* were identified. In mango orchard 65 – 71 % trees were infested. The host plants other than mango tree were identified as, *Nerium indicum, Lagerstroemia speciosa, Holarrhena antidysenterica, Terminalia arjuna.*

CSAUAT, Kanpur

Survey on occurrence of Dendropthae on Mahua, mango, peepal and Seshame trees were conducted in Kanpur ciry, Fatehpur, Raibarelli and Unnao districts. The frequency of occurrence of Dendropthae on Mahua in Fatehpur and Kanpur city district ranged from 2-7 location and in Fatehpur and Unnao 1-6 spot lacoated on mango. In Unnao district the occurrence of Dendropthae on Peepal and Seshame were seen at 1-2 locations.

CSKHPKV, Palampur

This weed was found as a semi-parasite on trunk of Mango in zone 1 of Himachal Pradesh.

NDUAT, Faizabad

Infestation of Dendropthoe was surveyed in Ghazipur, Mau and Ballia districts in fruit trees (Guava, Mango, *Ber*, Citrus and *Imli*). It was reported that except *imli* (Tamarind), all the fruit trees found infested with *Loranthus* in all the districts. However, extent of infestation varied from species to species with the maximum infestation was found in guava and *ber* (5.3% plants) followed by mango (4.6% plants) and others.

ANGRAU, Hyderabad

Survey was conducted in Southern and Central Telangana Zone of Andhra Pradesh for documentation of occurrence of *Dendropthoe* spp on trees like timber / fruit trees from the survey. Infestation of *Dendropthoe* was not observed in trees – fruit trees in the zone.

DBSKKV, Dapoli

Survey about occurrence Parasitic Weeds on fruit trees and timber trees

Following tree species were found to be infested with partial stem parasites viz. *Macrosolen capitellatus (L. capitellatus), Dendrophthoe falcate (L. longi florus)* and *Visccum articulatum*.

Parasite / Region	*Macrosolen capitellatus*		*Dendrophthoe falcata*		*Visccum articulatum*
	Fruit trees	**Other tree spp.**	**Fruit trees**	**Other tree spp.**	
1) South Konkan Coastal Zone **(Very to Very high Rainfall with Lateritic soils)**	*Anona reticulata (Ramphal)*	*Acacia catechu (Khair)*	*Artocarpus heterophyllus (Jack fruit)*	*Ficus benghalensis (wad)*	*Acacia catechu (Khair)*
	Emblica officinalis Gaerth (Awala)	*Ficus benghalensis L. (Wad)*		*Pongamia pinnata L.(Karanj)*	
	Mangifera indica L.(Mango)	*Gmelina arborea L.(Shiwan)*	*Mangifera indica L. (Mango)*	*Ficus glomerata Roxb (Umbar)*	*Grewia tiliaefolia Vahl. (Dhaman)*
		Casurina equisetifolia (Suru)			
	Manilkara achras Miill (Sapota)	*Grewia tiliaefolia Vahl.(Dhaman)*		*Gmelina arborea L.(Shiwan)*	
	Psidium guajava L.(Pomogranate)	*Moringa oleifera Lamk (Drumstic)*		*Grewia tiliaefolia Vahl.(Dhaman)*	
	Syzygium cumini L.(Jamun)	*Acacia auriculiformis*			
		Tectona grandis L. F. *(Teak)*			
2) North Konkan Coastal Zone (Very to Very high Rainfall with Medium black soils)	*Artocarpus heterophyllus (Phanas)*	*Ficus glomerata Roxb (Umbar)*	*Mangifera indica* L. *(Amba)*	*Ficus benghalensis* L. *(Wad)*	*Acacia catechu (Khair)*
	Mangifera indica L. *(Amba)*	*Gmelina arborea L.(Shiwan)*		*Terminalia panciculata* Roth *(Kinjal)*	
	Manilkara achras Miill (Chickoo)	*Grewia tiliaefolia Vahl.(Dhaman)*			
	Anona reticulata (Ramphal)	*Acacia catechu (Khair)*	*Artocarpus heterophyllus (Phanas)*	*Ficus riligiosa (Pimpal)*	*Grewia tiliaefolia Vahl.(Dhaman)*
	Emblica officinalis Gaerth. (Awala)	*Ficus benghalensis L.(Wad)*			
	Syzygium cumini L.(Jambhool)	*Acacia auriculiformis*			
	Psidium guajava L. (Peru)	*Moringa oleifera* Lamk *(Shewaga)*			
		Tectona grandis L. F.(Sagwan)			

MAU, Parbhani

Dendropthoe was not noticed at Marathwada Agricultural University Campus at Parbhani location as well as on farmers' field, hence trial was not further conducted during *kharif* 2011-2012.

KAU, Thrissur

Loranthus control using ethrel (8000 ppm) spray and 2.4 D (0.8 g / 25 ml) padding was done in mango trees in farmers field at Edappal.

WS 4.0: Herbicide residues, persistence, leaching behaviour and toxicity

WS 4.1: Studies on herbicide residue in food chain, soil and ground water

Herbicide doses: Recommended (1X) and 2X

Note: The recommended doses of pre and post-emergence herbicides be carried out in major crops of the region. Herbicides to be applied at recommended (1X) and double the recommended (2X) dose. The standard method of application to be observed with necessary calibrations.

Crop	Herbicide	Centre
Wheat	Isoproturon	PAU
	Trifluralin	PAU
	2-4D	PAU, GBPUAT, CSKHPKV, RVSKVV
	Sulfosulfuron	NDUAT, CSAUAT
	Pendimethalin	AAU(A)
Rice	Cyhalofop-butyl	KAU
	Almix	NDUAT, CSAUAT
	Pyrazosulfuron	UAS (B)
	Oxyfluorfen	GBPUAT, TNAU
	Butachlor	AAU(J)
	Pretilachlor	AAU(J), OUAT
	Bispyribac-sodium	PAU
	2-4D	ANGRAU
Maize	Atrazine	TNAU, ANGRAU, PAU, MAU
	Pendimethalin	ANGRAU, MAU
Sunflower	Pendimethalin	TNAU,
	Alachlor	TNAU
Soyabean	Alachlor	MAU
	Quizalofop	MAU
	Chlorimuron	RVSKVV
	Pendimethalin	RVSKVV
Chickpea	Quizalofop	AAU(A)
Groundnut	Oxyfluorfen	OUAT,
Potato	Atrazine	CSKHPKV
Tea	Glyphosate	CSKHPKV
	Paraquat	TNAU
	Oxyfluorfen	TNAU
Brinjal	Pendimethalin	AAU (J)
Carrot	Oxyfluorfen	PAU

RVSKVV, Gwalior

Persistence of herbicides in soil applied to wheat

2,4-D sodium salt applied to wheat at double the recommended dose (1.0 kg/ha) and sulfosulfuron 25 g/ha persisted in soil up to 45 days after application. 2,4-D 0.5 kg/ha, Clodinafop (60 g/ha), metribuzine (175 g/ha) and pinoxadin (50 g/ha) persisted in soil up to 30 DAA. No residues of all the herbicides used, left after harvest of crop as per bioassay method using black gram as test crop.

Persistence of herbicides in soil applied to soybean

Pendimethalin applied to soybean 1.0 and chlorimuron-ethyl 9 g/ha persisted in soil up to 45 days. Similarly, pendimethalin and chlorimuron ethyl at double the recommended doses (2.0 kg/ha and 18 g/ha) persisted up to 60 days. No residues of all the herbicides used were left after harvest of crop as per bioassay method using maize as test crop.

Persistence of atrazine in soil applied to pearl millet under Pearl millet-wheat cropping system (2010)

Atrazine applied to pearlmillet 0.5 kg/ha either alone or along with 1.0 t/ha FYM to pearlmillet persisted in soil for 45 days. No residues of atrazine were left after harvest of crop as per bioassay method using barley as test crop.

OUAT, Bhubaneswar

- Residues of pretilachlor in direct-seeded rice soils when applied at recommended dose of 1.0 kg/ha were recorded up to 45 days and at 2. 0 kg/ha were observed up to 60 days. In post harvest soil, grain and straw samples, the residues were below detectable limit of 0.001ppm.
- The residue of oxyfluorfen in soils of *kharif* groundnut could be detected up to 30 days after application when applied at recommended dose (0.05 kg/ha) and up to 45 days when applied at double the recommended dose (0.1 kg/ha).

AAU, Jorhat

Herbicide residue in winter rice

The highest concentration of herbicide residue was detected in soil with application of double recommended doses on the day of spray for both the herbicides. Irrespective of herbicides and doses, residues decreased with time and were not detected at 45 days after spray. Butachlor residues of 0.04 ppm in double dose and 0.025 ppm in recommended dose were detected in soil up to 30 days after spray, while in pretilachor the same (0.018 ppm) at that interval was detected with double dose.

Herbicide residue in rice grain, straw and groundwater

Residues of butachlor and pretilachlor in rice grain and straw and in groundwater after harvest of the crop were below detectable level (10 ppb).

Herbicide residue in chilli after winter rice

Highest concentration of 0.35 ppm metribuzin residue was detected on the day of the spray with metribuzin 1.0 kg/ha. The lowest concentration is detected at 30 days after spray with metribuzin 0.5 kg/ha.

GBPUAT, Pantnagar

Residues of isoproturon in wheat and butachlor in transplanted rice at harvest were not detectable in soil, straw and grain after continuous use of 21 years showing no residue build-up in the environment. No residues of isoproturon and butachlor were detected in ground water.

PAU, Ludhiana

Effect of continuous/rotational use of herbicides

Continuous use of clodinafop (60 g/ha) and sulfosulfuron (25 g/ha) for 10 years, isoproturon (0.94 kg/ha) for 18 years, and trifluralin (1.2 kg/ha) for five years to wheat and butachlor (1.5 kg/ha) and anilofos (0.375 kg/ha) to rice crop for 17 years in the rice-wheat cropping sequence was studied for herbicide persistence. HPLC was used for the quantification of butachlor, anilofos, sulfosulfuron and clodinafop residues. The study revealed that butachlor, anilofos, clodinafop, sulfosulfuron and isoproturon and trifluralin over the years in rice-wheat cropping systems did not leave any residues in soil, grain and straw.

Herbicide residue at recommended and double the recommended dose.

Herbicides namely butachlor in rice and IPU, 2,4-D, sulfosulfuron and trifluralin in wheat, were applied at recommended and double the recommended doses and studies for their persistence. The residue of all these herbicides was below the detectable limit.

Herbicide residues under weed control in maize-based cropping systems

No residue of atrazine, pendimethalin was detected in maize-chickpea and field pea cropping systems.

Herbicide residues under weed control in canola *gobhi sarson* (*Brassica napus*)

Residues of trifluralin, oxyfluorfen and clodinafop in leaves of canola *gobhi sarson* (cv GSC 5), collected at 60 days after sowing, were analysed by HPLC. In none of the herbicidal levels, the peak was obtained at the respective retention time and each sample recorded “below detectable limit” of these herbicides. It indicated that all herbicides used in the present trial are safe for use in canola *gobhi sarson*.

Herbicide residues under weed control in *Brassica* sp intercropped autumn sugarcane

Residues of pendimethalin 0.562 and 0.75 kg/ha applied to raya (*Brassica juncea*) and *gobhi sarson* (*B napus*) as pre emergence were analysed by High Pressure Liquid Chromatography (HPLC). Leaf samples of *raya* and *gobhi* sarson were collected at 90 days stage from each plot and analysed for pendimethalin residues. Raya and *gobhi sarson* upon analysis on HPLC for

residue detection showed that for none of the herbicidal levels, the peak was obtained at the respective retention time and each sample recorded below detectable limit for pendimethalin. The present finding will allow the people make best use of these crops as vegetables as this also help in enhancing the farmer's income as they get premium price in the market.

Herbicide residues under weed control in vegetables intercropped autumn sugarcane

Residues of pendimethalin and oxyfluorfen applied to cabbage (*B oleracea* var capitata) transplants, peas (*Pisum sativum*) and garlic (*Allium sativum*) were analysed by High Pressure Liquid Chromatography (HPLC). Residues in cabbage, garlic and peas, the residues were analysed in the leaves (75 days after transplanting), bulb (175 days after sowing) and seed (100 days after sowing), respectively, at harvest. All the crops upon analysis on HPLC for residue detection showed that for none of the herbicidal levels, the peak was obtained at the respective retention time and each sample recorded "below detectable limit" of these herbicides. It indicated that all herbicides used in the present trial are safe for use in these vegetable crops.

UAS, Bengaluru

Use of herbicides namely pyrazosulfuron-ethyl 25-50 g/ha in rice did not show herbicide residues in soil, grain, straw and under ground water at the time of harvest of crops, i.e. 120 days of herbicide application. Similarly the residue of butachlor were below detectable level in soil, grain and straw samples in long-term herbicide trial on rice-rice system over 12 years.

Pendimethalin and butachlor residues were also found below detectable limit of 0.001 ppm in groundnut kernels, finger millet grains and soil samples in long term herbicide trial of finger millet-groundnut sequence over 12 years.

Pendimethalin and butachlor residues were also found below detectable limit of 0.001 ppm in groundnut kernels, finger millet grains and soil samples in long term herbicide trial of finger miller-groundnut sequence over 12 years.

NDUAT, Faizabad

Butachlor residue studies in post harvested soil of rice in rice-wheat cropping system (long-term trial)

Butachlor 1.5 kg/ha PE and isoproturon 1.0 kg + 2,4-D Na salt 0.5 kg/ha applied in rice and wheat cropping system did not observe its harmful toxic level of residue in soil.

Herbicide residue studies in soil applied in rice under rice-wheat cropping system

Almix applied 4, 6 and 8 g/ha as pre-emergence persisted up to 30, 45 and 60 DAS in soil of rice, respectively.

CSAUAT, Kanpur

Studies on herbicide residue in soil through bio-assay technique

Results revealed that herbicide application improved all yield attributing characters than control. Double dose of herbicide did not give significantly superior result, sometimes it depressed the

vegetative growth. There was no residual effect of herbicides in soil after harvest of crop studied by bioassay technique.

KAU, Thrissur

When oxyfluorfen was applied 150, 200, 240 and 480 g/ha as pre-emergence, residues in the soil at the time of harvest were 0.004, 0.018, 0.025 and 0.038 ppm, respectively.

AAU, Anand

Pendimethalin and quizalofop-p-ethyl residues in sandy loam soil under wheat and chick pea crops

Pendimethalin and quizalofop-p-ethyl residues at different soil depth decreased as the stage of sampling advanced in both the doses. Pendimethalin and quizalofop-p-ethyl residues were lower at all the intervals in near surface soil under the application of pendimethalin applied 0.50 kg/ha as compared to applied 1.0 kg/ha. Same trend was also observed in case of quizalofop-p-ethyl application 50 and 100 g/ha. Pendimethalin residues were detected at the time of harvest in sandy loam soil under wheat.

TNAU, Coimbatore

Residue of atrazine in maize soil and crop produce

Application of atrazine at 1 kg/ha persisted in soil up to harvest while up to 90 days at 0.5 kg/ha application rate. However fifty per cent of applied herbicide was degraded from the soil before 30 days after application. The residue of atrazine was below detectable limit in maize grain and straw at both the levels of application within 3 hrs of application.8 to 15 per cent of the atrazine dissipated from the soil. 90 per cent of the applied atrazine degraded from the soil before 60 days of its application under 0.5 kg ai/ha application, while it took 90 days under double dose of atrazine application (1.0 kg/ha).

Residue of pendimethalin and alachlor in sunflower grown soil and crop produce

Application of pendimethalin 1 kg/ha persisted in soil up to 60 days while up to 90 days at 2 kg/ha application rate. However fifty per cent of applied herbicide was degraded from the soil before 30 days after application. The residue of pendimethalin was below detectable limit in sunflower parts (grain & straw) at both the levels of application within 60 days of application more than 90 per cent of the pendimethalin dissipated from the soil. For complete degradation from the soil, pendimethalin took 60-90 days. The residues of alachlor persisted in soil upto 30 and 45 days after application under x and 2x applied plots. The mean half life for the pendimethalin is 14.1 days while it is 9.8 days for alachlor.

Residue of oxyfluorfen and paraquat in tea grown soils and crops

Oxyfluorfen: Application of oxyfluorfen at 200 g/ha persisted in soil up to 25 days while up to 50 days at 400 g/ha application rate. However fifty per cent of applied herbicide was degraded from the soil before 10 days after application. Dissipation of oxyfluorfen followed first order kinetics and the half life of oxyfluorfen increased with increased dose of application (5.1 and 9.2 days, respectively) at 200 and 400 g/ha application rate.

Paraquat : Application of paraquat in acid soil persisted in soil up to 75 days irrespective of application rate. However fifty per cent of applied herbicide was degraded from the soil before 25 days after application. More than 80 per cent of the applied paraquat degraded from the soil before 75 days of its application. Dissipation of paraquat followed first order kinetics and the half life of paraquat increased with increased dose of application (20 and 23 days respectively at 2 and 4 kg/ha application rate.

ANGRAU, Hyderabad

Residues of 2,4-D in rice

The residues of 2,4-D persisted up to 30 days in soil after herbicide application at recommended doses of application. In the surface layers of the soil (0-10 cm) the residues could be detected upto 30 DAA. In the 10-20 cm layer, the residues could be detected from 10 days after application and upto 30 DAA. When double the recommended dose was applied the residues persisted up to 60 days after application in the surface layers (0-10 cm) and upto 30 DAA in 10-20 cm depth. The retention time under the present experimental conditions was found to be 6.19 minute for 2,4-D. The limit of detection was 0.05 mg/kg. The residues of 2,4-D in post-harvest soil samples, rice grain and plant samples collected at harvest time were BDL.

Atrazine and pendimethalin residues in maize

At 0-10 cm depth in soil atrazine residues persisted up to 60 days at both the levels of herbicide application. Beyond which no detectable residues could be noticed. Leaching of the residues could be observed in 10-20 cm layer as indicated by the detectable residues of 0.082 ppm (Xdose) and 0.102 ppm (2X dose). However, in layers below 20 cm no residues could be recorded. No detectable residues of atrazine were present in the samples of grain and soil collected from the field experiment with maize at both doses of atrazine tried i.e. 1.0 and 2.0 kg/ha. The residues of atrazine were not detected either in the soil or in the grain at the time of harvest.

Application of pendimethalin at 2 kg/ha persisted in soil up to 90 days after application while up to 60 days at 1 $kgha^{-1}$ application rate in the surface layer of the soil sample (0-10 cm). In 10-20 cm layer leaching of Pendimethalin was observed. Residues in this layer persisted up to 30 days after application. However, more than fifty per cent of applied herbicide degraded from the soil at 30 days after application. At the time of harvest, the residue of pendimethalin was below detectable limit in maize grain and straw at both the levels of application.

CSKHPKV, Palampur

- Atrazine at four levels of application *i.e.* 0. 5 kg/ha (pre-em.), 1.0 kg/ha (pre-em.), 1.5 kg/ha (pre-em.) and 2.0 kg/ha (pre-em.) did not leave detectable levels of residues in soil and potato tubers at the time of crop harvest.
- 2,4-D in soil at three levels of application i.e. 0.5 kg/ha, 1.0 kg/ha and 2.0 kg/ha (35 DAS) persisted in soil up to 30, 60 and 90 days, respectively. The dissipation of 2,4-D in soil at three levels of application i.e. 0.5 kg/ha, 1.0 kg/ha and 2.0 kg/ha (35 DAS) followed first

order kinetics with half lives varying from 4.12 to 17.7 days. Residues of 2,4-D were below detectable level in wheat grain and straw .

- Glyphosate at three rates of application *i.e.* 0.5 kg/ha, 1.0 kg/ha and 2.0 kg/ha persisted in soil upto 30, 45 and 60 days, respectively. More than 85% of applied glyphosate in soil dissipated within 45 days of herbicide application.
- Studies on glyphosate residues in tea plant indicated that more than 75 per cent of glyphosate was lost in 15 days after herbicide application. Half life in tea leaves varied from 5.8 to 7.9 days.
- In permanent herbicide trial on transplanted rice-wheat sequence, non detectable levels of isoproturon and 2,4-D residues were recorded by using bioassay and spectro-photometric techniques.

WS 4.2: Studies on herbicide persistence in water

Water hyacinth	Paraquat	KAU, UAS(B), AAU(A), ANGRAU
	2,4-D	GBPUAT, TNAU
	Glyphosate	TNAU,
Alternanthera	Paraquat	KAU

AAU, Anand

Paraquat residues in water were decreased as the stage of sampling advanced in both the doses. Paraquat residues were lower at all the intervals in water under the application of Paraquat applied 0.50 kg/ha as compared to applied at 1.0 kg/ha. Paraquat residues were detected up to the fifteen days from the application of herbicide. pH and EC(dSm^{-1}) of water at various intervals were influenced by application of Paraquat in water for management of water hyacinth.

TNAU, Coimbatore

Dissipation of 2,4-D was relatively rapid and followed similar trends at both concentrations. Within 10 days, more than 90 per cent of the applied amount was degraded from the aquatic system and only 2 per cent of the applied 2,4-D was recovered in the water at 10 days after its application in only at double dose which received water hyacinth. Half life for the applied 2,4-D is less than 10 days irrespective of the presence of water hyacinth. Presence of water hyacinth increased the half life of 2,4-D (9.8 days) when compared to absence of water hyacinth (2.3 days).

No fish mortality was observed both at recommended and double the recommended dose of 2,4-D during the study period. pH of the water samples showed a decreasing trend up to 10 days. After 15 days the pH showed increasing trend. Similar results were observed with respect to EC also.

ANGRAU, Hyderabad

Residues of paraquat in the water samples collected at 0, 1, 2, 5, 10, 15 and 30 days of application as estimated by spectrophotometer revealed that residues were detected up to 20 days after application and were below detectable limit by 30 days of application.

GBPUAT, Pantnagar

- 2,4-D applied at 0.5 and 1.0 kg/ha in soil persisted till 30th and 60th days respectively. No detectable residue (<0.001 g/g soil) was observed after 60th day of application at doses. At harvest no residues was detected in wheat grain, soil and straw.
- Oxyfluorfen herbicide in rice applied at 240 and 480 g/ha dissipated up till 60th d after application. However, no detectable residue (<0.005 g/g) was found on 90th d of application. At harvest no residues was detected in soil, grain and straw.

KAU, Thrissur

Persistence of paraquat residues in the aquatic system covered with *Alternanthera philoxeroids* was less than two weeks. At 14 DAS, residues of paraquat in the treatments 0.5 and 1.0 kg/ha were below the detectable level of 0.05 µg/ml. However, both the levels of application were not sufficient to control the weed. The stem remained green and started producing new shoots at 180 DAS, which is due to the hardy nature of plant. No significant difference in pH was noticed due to herbicide application at both the levels, viz. 0.5 and 1.0 kg/ha.

WS 4.3 : Characterization of leaching behaviour of herbicide in soil

Pretilachlor	NDUAT, KAU, AAU(J)
Atrazine	AAU (A)
Pinoxaden/Azimsulfuron	PAU
Oxyfluorfen	RVSKVV, TNAU
2,4-D	CSHPKV, UAS(B)
Pendimethalin	MAU, GBPUAT
Isoproturon	CSAUAT
Butachlor	OUAT, AAU(J)
Cyhalofop	ANGRAU

RVSKKV, Gwalior

Characterization of leaching behaviour of Oxyfluorfen in soil

Oxyfluorfen leaches in soil up to 30 to 40 cm in alluvial soil and the leaching decreases to 20 to 35 cm by amendment of FYM as per bioassay technique using maize as test crop.

AAU, Jorhat

Leaching behaviour of butachlor in sandy clay soil with different organic carbon content

Highest residue was detected in the 0-5 cm layer of soil irrespective of herbicide and doses

applied, which decreased with depth. The leaching of herbicide at recommended and twice the recommended dose was observed up to 25 cm in case of butachlor and 20 cm with pretilachlor, irrespective of organic matter content. The herbicide residue content in surface soil (0-15 cm) was higher in soil with high organic carbon content for both the herbicides.

AAU, Anand

Germination of sensitive cucumber was influenced by both the levels of atrazine applied at 1.0 and 2.0 kg/ha in sandy loam and clayey soils at 0 to 5 cm depth. Movement of atrazine herbicide was not observed and germination was not restricted in cucumber in both the soils in 10 to 60 cm depth at 7 DAS. Overall it was observed that atrazine movement in sandy loam soil showed more as compared to clayey soil.

GBPUAT, Pantnagar

- Oxyfluorfen at recommended dose did not moved beyond 10 cm soil column while at double recommended doses it moved upto 15 cm soil depth indicating low mobility of oxyfluorfen in soil column.
- Pendimethalin residue concentrations were maximum at the upper soil layer mainly at the depth from 0 to 5 cm of column at both doses. Pendimethalin did not moved beyond 10 cm soil column showing little leachability of herbicide.
- In water 2,4-D applied at 0.5 and 1.0 kg/ha persisted up till 30th and 45th d respectively. No detectable residue (<0.001 g/g soil) was observed after 45th d of application at both doses.

OUAT, Bhubaneswar

The residues of oxyfluorfen decrease significantly with increase in soil depth. Residues could be detected up to 15 cm depth (0.01ppm) irrespective of concentrations and no residues could be detected in the leachate collected at 60 cm depth.

TNAU, Coimbatore

The oxyfluorfen residue decreased with increase in soil depth and residue was detected upto 60 com depth under both the levels of application (200 and 400 g/ha) irrespective of soil types After 7 DAA, only 7-10 and 17-64 per cent of the applied quantity of oxyfluorfen remained in the soil across different depths respectively in silty clay loam and clayey soils and the per cent retention is more in double the recommended dose (2x) applied column.

CSKHPKV, Palampur

In experiment on leaching and movement behaviour of herbicides in silty clay loam soil, it was observed that at two levels of application of 2,4-D (0.75 kg and 1.5 kg/ha), most of the herbicide remained only up to 15 cm but the movement of herbicide was up to 25 cm at higher dose (1.5 kg/ha).

KAU, Thrissur

Recovery of the herbicide by GC method was very low. Due to the low application rate (0.1 kg/ha), the herbicide content in the soil was less than 1 ppm even in the top 0-2cm layer. No residue was detected in the leachate.

WS 4.4: Persistence of herbicides may be tested in the farmers field (soil and crop produce)

Cooperating Centres: All Centres

AAU, Anand

Pearl millet and sorghum crop produce were collected where herbicide were sprayed. Atrazine residues were below detection limit in pearl millet and sorghum seed and straw samples.

RVSKVV, Gwalior

Herbicides isoproturon 1.0 kg/ha and 2,4-D applied to wheat in farmers' fields do not persist in post harvest soil as per bioassay study using maize as test plant.

TNAU, Coimbatore

The data revealed that pendimethalin residue level in the soils collected from different farmer's field. Increase in the time decrease the pendimethalin concentration. After harvest of the cotton, the pendimethalin was becomes below detectable limit in sandy clay and sandy clay loam soils. In clay loam and clayey soils it persists even after harvest.

Among the different metabolites of metamifop, *N*-(2-fluorophenyl)-2-hydroxy-*N*-methylpropionamide (HPFMA) alone was determined as it is known to be the first degradation product of this herbicide and also formed in higher quantities when compared to other metabolites. HPFMA was not detected in any of the substrates at the lower rates of metamifop application of 75 to 100 g/ha. At higher dose of 125 and 200 g/ha, HPFMA was detected in soil and grain. Time of application have significant influence that the HPFMA concentration was higher in soil and grain when the metamifop was applied at 5-6 leaf stage than 2-3 leaf stage of the weed seedlings.

GBPUAT,Pantnagar

Isoproturon residues in grain, straw and soil in wheat at farmers' fields

At farmers fields at harvest in wheat isoproturon and clodinafop-propargyl and in rice butachlor and pretilachlor herbicide residues was below detectable limits in soil, grain and straw.

OUAT, Bhubaneswar

Persistence of butachlor in soils under transplanted rice: Soil samples collected from transplanted rice fields in Nimapara block of Puri district under deltaic alluvial soils show residue up to 60 days after application of butachlor 1.0 kg/ha. However the residues in post harvest soils, grain and straw were below detectable level.

Persistence of pendimethalin in soils under *kharif* groundnut: Soil samples collected from groundnut fields in Gajamara of Dhenkanal district under Mid Central Table land zone show residue up to 45 days after application of pendimethalin 1.0 kg/ha. The residues in post harvest soils, pod and stover were below detectable level.

CSKHPKV, Palampur

- Isoproturon residues were below detectable limits in soil and wheat grain samples collected from the fields of 4 farmers of the Kangra district who were using isoproturon in wheat crop for more than 10 years.
- Soil and wheat grain samples from the 2,4-D treated fields of farmers of Kangra district at the harvest of the crop recorded below detectable levels of herbicide residues.

AAU, Jorhat

Persistence of herbicide in farmers' field in direct-seeded upland rice

Butachlor and pretilachlor residues were below detectable level (<10 ppb) in soil after harvest of rice crop.

ANGRAU, Hyderabad

Twelve tomato samples from the farmers fields were collected and analyzed for residues of Pendimethalin. Residues were not found in the tomato samples tested at the time of harvest. This indicates that the residues were below detectable limit in tomato samples and were free of residues and pendimethalin degraded completely by harvest time.

KAU, Thrissur

When butachlor and pretilachlor were applied at the rate of 1.0 kg/ha and 0.45 kg/ha, residues in the soil at 3 weeks after spraying were 0.18 and 0.10 ppm respectively. The results showed that the chances for residue accumulation in soil are quite less for these herbicides, when applied at the recommended levels.

WS 4.5: Studies on secondary metabolites of herbicides

Cooperating Centres: TNAU, AAU(A)

WS 4.6: Adsorption and desorption behaviour of herbicides

Cooperating centres: KAU, AAU(A), GBPUAT, TNAU, AAU(J), OUAT, CSHPKV, PAU

Pretilachlor	KAU
Atrazine	AAU(A), GBPUAT
Oxyfluorfen	TNAU
Metametron	TNAU
Butachlor	AAU(J)
2,4-D	OUAT, CSHPKV
Methabenzthiazuron	PAU

AAU, Anand

Preliminary kinetic studies revealed that maximum adsorption took place within first 42 hrs. Therefore, 42 hr equilibration time was used in adsorption technique. After equilibration, the amount of atrazine left in the solution phase was determined by GLC. The results revealed that total amount of atrazine adsorbed increased with increasing initial concentration from 2.5 to 25 µg/ml of equilibrium solution (25 µg to 250/µg/g soil). The amount of atrazine adsorbed varied from 18.0 to 141.2 µg/g.

TNAU, Coimbatore

Adsorption of oxyfluorfen in different soil types was evaluated. Increase in the concentration of oxyfluorfen increased the adsorption of oxyfluorfen. Amount of adsorbed oxyfluorfen desorbed from soil is in the range of 0.38 to 35.2 per cent across different concentration of oxyfluorfen applied to the organic soil.

GBPUAT, Pantnagar

Adsorption concentration of atrazine increases as the adsorption time increases after that rate becomes slow and then almost constant. Also, the adsorption concentration of atrazine increases as applied atrazine concentration increases. Desorption of atrazine was slow and increases as the concentration increases. Higher desorption was observed where higher concentration of atrazine was applied. Herbicide was highly correlated with organic carbon content of soil.

CSKHPKV, Palampur

2,4-D adsorption ranged from 31.0-44.7% for soil I, 34.4-45.2% for soil II and 32.3-45.2% for soil III, respectively. The adsorption isotherms obtained fitted well with freundlich equation when plotted on a log-log scale.

KAU, Thrissur

Adsorption of chloroacetanilide herbicides, butachlor and pretilachlor in laterite soil

The results showed that butachlor and pretilachlor are strongly adsorbed on laterite soil and their adsorption onto soils is enhanced by the presence of organic matter. On comparing the two organic matter sources, it was found that FYM retained more quantity of herbicides than vermicompost. Moisture levels did not have significant effect on the adsorption, mainly because of water insoluble nature of the herbicides under study. It was also indicated that persistence is determined by total organic carbon where as initial adsorption is mainly influenced by dissolved organic carbon.

WS 5.0: Transfer of Technology

WS 5.1: Parthenium management by *Zygogramma* beetles

IGKV, Raipur

Release of bio-agent *Zygogramma bicolorata* for management of *Parthenium hysterophorus* at infested site damaged the *Parthenium* plants by 41.2%.

BAU, Ranchi

Zygogramma beetles were spread on the *Parthenium* plants in the premises of university. The beetles were alive for some days but suddenly their population started reducing. It appeared that they were destroyed either by birds or frog or they could not sustain extreme cold climate of Ranchi.

GBPUAT, Pantnagar

The larvae, eggs and adults of *Zygogramma* beetles were highest in the month of Aug to September. Maximum 75-80% damage of *Parthenium* was observed during the early September when the *Zygogramma* population was also higher than rest of the months. The extent of damage varied from 0-60%. The maximum damage was found when the weather was humid and during the hottest periods.

AAU, Anand

The grubs of *Zygogramma bicolorata* hatched out from eggs were found to survive on *Parthenium* plants and caused 5-10% defoliation. The full developed grubs entered into the soil for pupation but the beetles did not emerge from dia-pause stage. Similar observation has also been recorded during 2010. This may probably be due to the un-favourable environmental conditions to break the diapause conditions.

V.B., Sriniketan

Large scale establishment of the bio control agent (Mexican beetle) under natural condition and considerable damage on *Parthenium* have been observed in 2011. Again many local competitive plants have been found effective in suppressing the weed. But to combat the rapid spread of *Parthenium* no single method/approach will be sufficient/effective. Chemical method using herbicides alone is not effective because of sufficient seed bank in soil and appearance of the weed in different flushes. An integrated approach involving chemical and biological using both insect and competitive plants was initiated for effective management of *Parthenium*. The suppression of *Parthenium* to the tune of 78-82% was noticed after two months of growth. But it was interesting to note that in the subsequent periods the remaining *Parthenium* was attacked and defoliated by *Zygogramma bicolorata* beetle from adjacent areas where it has already been established. Thus, more than 98% suppression in the initial year has been noticed with the integrated approach of *Parthenium* management.

TNAU, Coimbatore

Zygogramma biocolorata beetles were released on July month in three heavily parthenium

infested areas of Thondamuthur, Vadavalli, and Arasur blocks (Large scale demonstration project areas). Adult beetles were released at 500, 480 and 450/m^2 per site in about 200 m^2 areas in blocks under non-crop situation. Enhanced *Parthenium* damage was observed at 3rd month of observation with a damage range of 73.9-89.9% with an average damage of 82.0% based on biomass reduction in comparison with *Parthenium* from beetle free areas.

UAS, Bengaluru

The release of *Zygogramma bicolorata* for management of *Parthenium* caused 45-80% and 30-70% damage in Hadonahally and Tubagere villages, respectively. But there was 5-15% regrowth of *Parthenium*.

CSKHPKV, Palampur

The activity of beetles increased from July beginning to September. Maximum population of larvae was seen during July and August, The beetle population per *Parthenium* plant was more during July to September, which caused a damage of 20-58%.

CSAUAT, Kanpur

The maximum population of Mexican beetle were found on 21.9.2011 and thereafter population of Mexican beetles declined with the passage of time. The population of beetles disappeared in last week of November. It is calculated that after releasing beetles in heavily affected areas of parthenium, 60-70% damage occurred by the mexican beetles.

CCSHAU, Hisar

Natural population of *Zygogramma* appeared through out state due to rains received in March to May with high multiplication rate and up to 80% defoliation in some pockets. During *kharif*, 2011 beetles appeared during September survived up to November and defoliated *Parthenium* plants.

AAU, Jorhat

The insect did not establish at the site where it was released. One week after release it totally disappeared. Moreover, the number of live beetles received from DWSR were very less so it could not be released in other sites.

RVSKVV, Gwalior

Zygogramma beetles released for *Parthenium* management at Gwalior could not survive and not observed in any next season.

MAU, Parbhani

After one month of release of 10 pairs of beetle in 10 square meter area the damage to the *Parthenium* plant was to the extent of 87.7% and average 2.4 larvae and 4.6 adult were recorded on each plant.

NDUAT, Faizabad

Use of bioagent *Zygogramma bicolorata* for management of *Parthenium hysterophorus* at

Parthenium infested site at Kumarganj, Faizabad damaged the *Parthenium* plants by 65.2%. The natural population of beetle was observed in few pockets in Faizabad and Barabanki districts in the month of August-September.

ANGRAU, Hyderabad

Zygogramma bicolorata released for management of *Parthenium hysterophorus* resulted in over all damage of the *Parthenium* plants by 67%.

Parthenium management by *Zygogramma* beetles

S. No	Site -1			Site- 2			Site – 3			
	Egg	Larva	Adult	Egg	Larva	Adult	Egg	Larva	Adult	% damage
1	0	3	4	0	4	5	0	4	7	80
2	1	8	5	0	5	8	0	6	8	78
3	0	3	8	0	10	7	3	7	13	75
4	3	4	8	0	12	13	0	7	14	68
5	0	5	8	0	0	10	0	5	12	70
6	2	6	12	0	8	11	0	6	4	65
7	0	4	10	0	7	7	2	4	7	63
8	0	5	8	0	6	10	0	10	6	60
9	1	8	6	0	3	8	0	10	12	51
10	0	4	8	0	2	7	0	4	9	60
Average	0.7	5	7.7	0	5.7	8.6	0.5	6.3	9.2	
Overall damage	67 %									

WS 5.2: Management of water hyacinth by *Neochetina bruchi / eichhorniae*

Cooperating centres: UAS (B), KAU, TNAU, ANGRAU, AAU (J), VB, BAU, NDUAT, RAU (P), CCSHAU, OUAT

UAS, Bengaluru

The new aquatic weed, *Salvinia molesta* has been noticed around Thekkatte and Kota villages, Udupi district in coastal zone (400 km from Bangalore) since 3-4 years. Initially, the weed was confined to ponds around these villages. However, floods, which occurred during 2010, caused the spread of *Salvinia* to adjoining paddy fields and posing problems in rice cultivation. The farmers of these areas are requesting Zonal Agricultural Research Station, Brahmavara to find solution to this weed. This problem has been referred to Weed Control Project by the University to take steps in the management of *Salvinia molesta*. After confirming the aquatic weed in Udupi area, the project made two trips (one in March 2011 and the other in October 2011) to Thrissur to bring bio-control agent *Cyrtobagus salviniae* and release to *Salvinia* infested ponds in Udupi District. The weevils of the bio-control agent, about three thousand were released during March 2011 in five ponds in Thekkatte and Kota villages and in one pond at Barkur during October 2011.

TNAU, Coimbatore

Management of *Rottboellia cochinchinensis* in rainfed vertisols

Before herbicide spray, the incidence of *Rottboellia cochinchinensis* was 48.5% of the total weed vegetation in the field. At 15 and 30 days after spraying of herbicide, glyphosate (Mera 71) 10 ml + ammonium sulphate 20 g + 2 ml surfactant/litre of water recorded lower density and dry weight of all the weeds and this was followed by, glyphosate (Round up 41 % SL) 20 ml + ammonium sulphate 20 g + 2 ml surfactant observed with good control of weeds predominantly *Rottboellia cochinchinensis*.

CCSHAU, Hisar

Two demonstrations on the efficacy of *Neochetina bruchi* weevils on control of water hyacinth were conducted in the areas heavily infested with water hyacinth during October, 2011. Weevils could not multiply at both locations perhaps due to low temperature and humidity.

WS 5.3: Yield loss estimation

OUAT, Bhubaneswar

- About 60% of the farmers in East and South-eastern Coastal zone are practicing beushaning at 20-25 DAS + one hand weeding at 45 DAS as weed management in direct seeded rainfed rice. Only 20% of farmers are using herbicides and that too in lower doses (400-500 ml butachlor / ha).
- The extent of yield loss due to weeds observed were 50% in direct seeded rice, 15% in transplanted rice and 55% in pulses. The practice of beushaning + hand weeding costs Rs 2600 / ha with average wages of Rs 100 / day. About 45% of the farmers growing rainfed rice are not satisfied with the current weed management practices

GBPUAT, Pantnagar

The mean potential yield loss due to uncontrolled weeds was 27.8% in wheat 31.1% in rice, 40% in barnyard millet and 28.9% in finger-millet in hills under farmers practices as compared to recommended practices, Whereas, in plains of Uttarakhand, mean potential yield was recorded 12.1% in wheat and 9.3% in rice under farmers practices on compared to recommended practices.

UAS, Bengaluru

In Mandya district, the major occupation of the farmers is agriculture with sheep rearing, maintenance of dairy animals and poultry birds as the subsidiary occupation. Majority of land holding come under command area and farmers can take up cultivation of crops during both the seasons. Although farmers are well aware about the yield losses caused by weeds in different crops and are aware regarding the use of herbicides for effective weed control, but their adoption of the technology varied depending on the economical, technical, psychological and resource constraints. Nowadays majority of farmers are very much interested in integrated approach for management of weeds in maize, sugarcane, maize and coconut gardens. Severe shortage of labour during important field operations in these crops has resulted in use of pre-

emergence herbicides followed by intercultural operations for management of weeds. Farmers are gaining knowledge on the use of both pre and post emergent herbicides. The misconceptions about the loss of soil fertility and death of beneficial soil micro organisms due to use of herbicides in the farmers minds is vanishing slowly and they are showing inclination towards use of herbicides for management of weeds.

V.B., Sriniketan

Yield losses of crops in farmers' practice and recommended practice against weed free condition were estimated to be 7.32–12.9% and 0.5–1.5% in transplanted rice; 26.7% and 2.3% in direct-seeded puddled rice; 16.3–17.4% and 1.4–1.6% in yellow sarson and 6.7% and 1.2% in potato.

TNAU, Coimbatore

Yield loss assessment of tomato in western zone of Tamil Nadu

Farmers using herbicide for the control of weeds are using 0.5 liters of herbicide per ha while the recommended practice was 2.5 liter per ha. This has shown that those farmers who are using herbicides are much aware of the herbicide application and its resultant benefits about the chemical means of controlling the weeds. The ultimate benefit of controlling the weeds in the initial stages of the crop cultivation is the increased yield levels. The present study has found out that there was an increased productivity of about 6.25 t/ha of the crop which could increase the revenue by about Rs. 50000 per ha of the crop under study. The yield loss due to the non adoption of chemical method of weed control was found to be 17.2%. It could be inferred that the yield loss is significant.

Hence, extensional activities of SAU and Agricultural Department should be strengthened to increase the adoption levels as the farmers are well aware of different cost effective implements and modern weed management practices.

RVSKVV, Gwalior

Weeds are the major problem in pearl-millet causing 10-30% yield loss. The main constraint in crop production was uncertainty or rainfall/ electric power supply. Labour scarcity was the third constraints during peak season and farmer bring labourers from other places and pay higher labour wages. In study area 35% of the farmers were using atrazine 0.5 kg/ha in pearl-millet costing Rs. 1350/ha. The main reasons for not adopting the chemical herbicides were lack of technical know-how than economical and resource constraints. Where as some of the farmers were afraid of applying chemical herbicides in to the soil.

BAU, Ranchi

The mean yield loss in rice due to weeds with farmers practice compared to weed free condition was observed to be 36.4%.

CSKHPKV, Palampur

Estimation of yield losses due to weeds in rice at farmers' fields was made in different localities of Kangra district during *Kharif* 2011. Five farmers were selected for the purpose. The estimation

was based on yields of respective crops obtained with farmer's practice, recommended package of weed management and weed free conditions. In rice crop butachlor 1.5 kg/ha was used. The mean potential yield loss in Farmer's practice was 15.1% and 5.7% in recommended package of weed management as compared to weed free conditions respectively.

Survey on adoption and awareness of weed control technology in maize

Maize is an important crop of Himachal Pradesh. Survey on adoption and awareness of weed control technology in maize was undertaken in three villages of district Hamirpur located about 90-120 km away from CSK HPKV Palampur. In all twenty farmers belonging to different categories were surveyed. The educational level of farmers varied from uneducated to graduation.

About 35% farmers were found to have direct linkage with the university. Another 35 per cent used to consult University KVK and 10% to officers of state agricultural department. About 20 per cent farmers depend on pesticide dealers and their relatives to know about the technology. Average yield loss in maize crop varied from 20-48%. About 100% farmers go for earthing up in maize and about 60% use chemicals for the control of weeds. Many farmers were using recommended dose of atrazine for the control of weeds.

NDUAT, Faizabad

Mean potential yield loss due weeds in wheat and rice with farmers practice was estimated to be 12.9% and 17.8% over weed free treatments, while 3.7 and 6.7% yield losses reported in recommended practices over weed free in wheat and rice, respectively.

CCSHAU, Hisar

Yield loss in wheat with farmer's practice is 8.6% as compared to weed free treatment in Tosham and Loharu area of Bhiwani. In wheat yield losses due to weeds at farmer's level are 11.3% after herbicide adoption. It shows high adoption level and excellent efficacy of recommended herbicides.

WS 5.4: On Farm trial (OFT)

RVSKVV, Gwalior

All treated chemical herbicides gave higher yield due to control of weeds as compared to farmer practice / weedy check. In pearl-millet imazethapyr 100 g/ha PoE yielded 43.9% (Rs. 8072/ha net return) higher over weedy check plot. Similarly in pigeon pea crop atrazine 0.5 kg/ha PE was more effective for controlling weeds and resulted 42.1% higher yield over weedy check (Net income Rs. 36380/ha). Whereas, under sesamum crop, trifluralin 1.0 kg/ha PPI gave 45% higher yield over weedy check and net return of Rs. 10310/ha with 2.30 BCR.

PAU, Ludhiana

OFT on barley, transplanted basmati rice and transplanted rice were conducted at 31, 4 and 4 locations, respectively. Post-emergence application of 2,4-D (sodium salt) 625 g/ha and metsulfuron 20 g/ha were used in barley and in rice pyrazosulfuron 150 g/ha, oxadiargyl 112.5 g/ha and pendimethalin 2.5 l/ha all at 3 DAT were tested with weedy check.

OUAT, Bhubaneswar

***Rabi* 2010-11**

- On Farm trials conducted on transplanted rice during *rabi* 2010-11 in Hatipada villages of Ganjam districts revealed that maximum yield of 3.88 t/ha was recorded in the plot applied with oxadiargyl 0.065 kg/ha followed by pyrazosulfuron 0.02 kg/ha (3.73 t/ha). A net saving of Rs 170/- to 1850/- ha was obtained in the plots treated with herbicides
- On Farm trials conducted on groundnut in Mangalpur, Pipili, Puri district during 2010-11 *Rabi* revealed that highest yield was obtained in the plots applied with oxyfluorfen 0.05 kg /ha (2.57 t/ha) followed by pendimethalin 0.5 kg/ha (2.40 kg/ha). The saving in weeding cost over farmers practice was to the tune of Rs 1950 to Rs 2100/ha.

***Kharif* 2011**

- On Farm trials conducted on transplanted rice during *kharif* 2011 in Bhangamal (Dhenkanal), Pubasasan (Puri), Manapur (Khurda), Bhagabanpur Sasan(Khurda), Khamar/ Nuagaon (Dhenkanal) and Ankula(Angul) revealed maximum yield of 3.98 t/ha in the plot applied with oxadiargyl 0.6 kg/ha with a net saving of Rs 1650/- to 1880/-/ ha. over farmers' methods
- On Farm trials conducted on *Kharif* groundnut in Katakmada Khamar and Sankhua village of Dhenkanal district during 2011 revealed highest average yield was in the plots applied with oxyfluorfen 0.05 kg/ha (1.75 t/ha) with a net saving in weeding cost of Rs 1900 to Rs 2025/ ha.

GBPUAT, Pantnagar

On farmer's field, application of clodinafop (60 g/ha) + metsulfuron-methyl (msm) (4 g/ha) in transplanted rice, atrazine (500 g/ha) in barnyard millet and finger millets in hills, whereas, application of vesta 15 WP (clodinafop 15% + metsulfuron-methyl 1%) (60 g/ha) in wheat and Bispyribac–Sodium (20 g/ha) in transplanted rice recorded higher yield in plains as compared to farmers practices.

AAU, Jorhat

Weed management in upland direct-seeded rice was conducted in 8 locations during 2011 in two districts, *viz.*, Golaghat and Jorhat of the state with the treatments pretilachlor 0.75 kg/ha + grubber 35 DAS, butachlor 1.0 kg/ha + grubber 35 DAS and farmers' practice. The weed density and dry weight in herbicide treated plots were lower than the farmer's practice of mechanical weeding at early stage, the lowest being recorded with pretilachlor 0.75 kg/ha + grubber at 35 DAS. The highest mean grain yield of 3230 kg/ha was observed with pretilachlor 0.75 kg/ha + grubber at 35 DAS.

On farm trial on weed management ion tuberose was conducted in seven locations during 2011 in two districts, *viz.*, Nagaon and Jorhat of the state. The yield of tuberose as flower weight (q/ha) was comparable in both metribuzin and oxadiargyl treated plots. However, metribuzin 500 g/ha + garden hoeing 30, 60, 90 and 120 DAP resulted slightly higher spike numbers/plant compared to the oxadiargyl 150 g/ha + garden hoeing 30, 60, 90 and 120 DAP.

NDUAT, Faizabad

- Butachlor 1.5 kg/ha applied in rice recorded maximum yield (5.42 t/ha) and net return of Rs. 41270/- /ha followed by pretilachlor 0.5 kg/ha (Rs. 40665/-) and oxadiargyl 100 g/ha (Rs. 39090/-). However, anilophos 0.4 kg/ha proved inferior to control the weeds effectively and resulted in low yield and net return (Rs. 35770/- /ha). In case of farmers practice treatment, lowest level of net return (Rs. 32710/- /ha) and BCR (Rs. 2.07) were recorded among the different treatments.
- On farm trials conducted on weed control in wheat resulted that sulfosulfuron 25 g/ha proved its superiority in controlling the weeds effectively and gave highest grain yield (4.26 t/ha), net return (Rs. 37290 /ha) and BCR (3.19) followed by metribuzin 175 g/ha (40.0 q/ha, Rs. 3567.0 and 3.11) and isoproturon 1.0 kg/ha (3.95 t/ha, Rs. 33325 and 2.75). Though among these herbicides, much difference with respect to grain yield, net return and BCR were not observed.

AAU, Anand

Weed Management in potato at Farmer's field

Metribuzin applied 0.35 kg/ha at 10 days after transplanting or post-emergence application of paraquat 0.5 kg/ha before emergence of crops showed higher potato yield at farmer's fields in potato crop.

Weed management in groundnut at farmers' field

Application of pendimethalin 1.0 kg/ha as pre emergence was found effective to control weeds with higher kernel yield at farmer's fields in groundnut.

Integrated weed management in maize at farmers' field

Grain yield of maize increased as compared to farmer's practices with monitory benefit by tank mix pre-emergence application of pendimethalin 0.25 kg/ha with atrazine 0.5 kg/ha to the maize crop grown in *kharif.*

CCSHAU, Hisar

Based on results of 7 On-Farm trials, Taarak at 250 g/ha provided 80% control of *Echinochloa spp* where as Nominee Gold at 250 g/ha, which is preferential choice of farmers gave 82% control of grassy weeds. Maximum grain yield 7.00 t/ha was obtained with the use of Nominee Gold which was 2.94% higher than Taarak. Maximum net returns (Rs.63000/ha) were obtained with the use of Nominee Gold.

Based on 17 locations at farmer's fields, Columbus a new brand of clodinafop provided is as good as Topik, Moolah, Topple brands and provided 88.5% control of *P. minor* as against 87.6% by Topik, Moolah and Topple with a grain yield of 4.61 t/ha.

V.B., Sriniketan

A total of 14 On-Farm Trials in rice, yellow sarson and potato under rice-based cropping system were conducted in Birbhum and Burdwan Districts of West Bengal. Ten on farm trials in rice, two

in yellow sarson and two in potato were conducted to demonstrate the effect of improved weed management practices on weed management and yield as compared to farmer's practice. Pyrazosufuron ethyl + HW, reduced tillage (paraquat / glyphosate 1.0 kg/ha before puddling + one puddling) + HW, pretilachlor + HW, Almix + HW in rice; isoproturon, fenoxaprop-p-ethyl in yellow sarson and metribuzin, pendimethalin + EU effectively controlled weeds and gave more yield economic returns.

TNAU, Coimbatore

Integrated weed management in green gram and black gram was conducted in three locations during 2010-11. Pre-emergence application of pendimethalin 0.75 kg + imazethapyr 60 g/ha on 15 DAS + quizalofop ethyl 50 g/ha for broad-spectrum weed control and higher seed yield and economic returns in both the crops.

UAS, Bengaluru

On-farm trials in transplanted rice, in southern dry zone, use of bensulfuron methyl 0.6% G at 60 g/ha + pretilachlor 6% G at 600 g/ha - 3 DAP and pyrazosulfuron ethyl 25 g/ha – 3 DAS gave 12-17% higher yield than hand weeding (15-20 and 35-40 DAS, 5.10-5.35 t/ha), besides saving weeding cost by Rs. 4700 to 6150/ha over hand weeding and gave additional returns of Rs. 8590 to 12,930/ha over farmers' practice.

CSKHPKV, Palampur

During the year under report 14 On-Farm trials to demonstrate weed management technology to make yield loss assessment due to the weeds in rice and to control problematic weeds like *Ageratum conyzoides, Ageratum houstonianum, Parthenium hysterophorus, Lantana camara* in orchards and grasslands were conducted in different panchayats. The results indicated that chemical weed control in farmers' field could increase the grain yield of transplanted and direct seeded puddled rice by 15.2 and 25.2%, respectively over the farmers' practice. Whereas, weed free treatment recorded an increase in yield of 28.6 and 34.8% over farmers' practice in transplanted and direct-seeded rice, respectively.

SKRAU, Bikaner

With a view to disseminate the technology for controlling *Orobanche* a parasitic weed in mustard crop, On-Farm trials were conducted at farmers field at village Shekhasar, Tehshil Lunkaransar, Distt., Bikaner. Maximum seed yield of mustard was recorded with neem cake 200 kg/ha + PM 0.5 kg/ha fb HW 60 DAS V(17.0 q/ha) where the net returns was Rs. 39000 /- per hectare. In farmers' practice seed yield and net income was in the order of 1.0 t/ha and Rs 23400/- per hectare.

MAU, Parbhani

Farm trials on integrated weed management technology on sorghum, soybean and cotton were conducted on 20 farmers' field in *kharif* 2011. The demonstrations on farmer's fields were conducted at different locations by providing recommended weed management technology with free of cost herbicide to each farmer. An increase of 26.0, 39.2 and 25.5% in grain yield of

soybean, cotton and sorghum yield was observed respectively due to adoption of integrated weed management practices over farmers practice.

ANGRAU, Hyderabad

In castor, pre-emergence application of pendimethalin *fb* post-emergence application of propaquizafop resulted in effective weed control and ultimately resulted in higher yields compared to farmers method and resulted in savings from Rs. 75-275. But, the net profit due to adoption of chemical weed management was in a range of Rs 1925 to Rs 7525/ha.

In rice, application of Londax power i.e, bensulfuron methyl + pretilachlor at 5 DAT resulted in timely and effective weed control with a saving of around Rs 1200-2200/ha on cost of weed management and with a net profit of Rs. 2900-6200/ha.

In groundnut post-emergence application of imazethapyr coupled with pre-emergence application of pendimethalin resulted in a net profit of around Rs. 3014 to 11590/ha compared to farmers practice.

In tomato, pre-emergence application of pendimethalin at 1.0. kg/ha fb hand weeding resulted in effective and timely weed control and resulted in a saving of Rs. 2000-2700/ha against farmers method.

BAU, Ranchi

In transplanted rice, application of recommended herbicide reduced cost of weeding by 82.5% thereby recorded 57.2% higher returns over farmers' practice of weeding twice (20 labour per weeding).

WS 5.5 Impact analysis of weed management

RVSKVV, Gwalior

***Rabi* 2010-11:** About 90% farmers are using inter-cultivation operation for control of weeds. 67% farmers are aware of chemical method of weed management whereas as only 5% farmers were using mechanical weed control method (Hand hoe).

***Kharif* 2011:** In rice crop, weeds caused 15-30% yield loss. Cultural weed management practices are commonly done by farmers. The main constraints in crop production was labour scarcity during peak season. In paddy crop, butachlor 1.0 kg/ha was commonly used for weed management which was costing Rs. 1350/ha. While one hand weeding cost was Rs. 4000/ha (saving in weeding cost Rs. 2650/ha). Agricultural retail shops are the source of information to disseminating technical knowledge to the farmers. The adoption of chemical herbicides is exposed through training and demonstration on farmers field.

OUAT, Bhubaneswar

- The dominant cropping system practiced in East and South-eastern Coastal Plain zone are rice - pulses / groundnut, rice-vegetables and rice-rice (irrigated patch - 15%).
- The major production constraints are lack of exposures, unavailability of inputs in time, weed menace and uncertainty of monsoon.

- The yield of the crops are low in 50-70% of the areas and the farmers are spending Rs 1500 - 2250 /ha more in manual weeding. Most of the farmers are not satisfied with the traditional method of weed management.

PAU, Ludhiana

Level of satisfaction

Crop	Satisfactory	Partially	Not satisfied
Rice	70	10	20
Wheat	60	20	20
Cotton	50	30	20

GBPUAT, Pantnagar

During *rabi* season of 2010-11 and *kharif* 2011 Thirty-two farmers were interacted to know the various component of weed management and losses caused by the weeds in the nearby areas of distt- Chamoli–Gwaldom, Tehri Garhwal, KarnPrayag, Almora, Bageshwar, Pithoragarh ,Champawat, U.S. Nagar and Dwarahat. On the basis of collection of data from the farmers it was noticed that application of residue mainly in distt. U.S. Nagar was confirmed up to large farmers in wheat (42%), rice (46%), in sugarcane (48%), soybean (32%), and in pulses (23%) along with manual weeding. Mechanical weeding, hoeing and inter-cultivation tillage operations were more prominent in sugarcane. Small and marginal farmers are still using the mechanical and mannual weeding in wheat, rice, pulses and vegetables. Use of herbicides was higher in *Tarai* and Bhabar areas compared to *Bhabar* and hilly areas of Uttarakhand, particularly in wheat and rice crop.

CSAUAT, Kanpur

Information was collected from 20 farmers of twenty villages of Ramabainagar, Jalaun, Jhansi, Mahoba, Hardoi and Banda districts. Among the farmers, many were illiterate, 25-30% high school passed and few had higher level of education. The illiterate farmer usually adopted traditional method of weed management practices. They lack knowledge about weed management practices. KVK of the agricultural university located 15-50 km distance from the farmers' field. However, most of the farmers depend on the agricultural officers for information. Twenty percent information is obtained from private sources (mostly of the pesticide dealers). The farmers were well aware of the importance of tillage and crop rotation as cultural method of weed control. They do not have much awareness about the importance of cultivation techniques like, stale seedbed technique and inter-cultivation on weed management. The awareness about mechanical implements for weed control is very poor. But the farmers are well aware of the usefulness of herbicides for weed control. Among the methods adopted for weed control, use of tillage and herbicides are most popular. Among the herbicides, isoproturon, atrazine, 2,4-D, butachlor, metribuzine, sulfosulfuron, pendimethalin and anilophos are popular. Some farmers use lower doses of herbicide, especially isoproturon in wheat, metribuzine in potato and atrazine in maize.

AAU, Anand

Farmers of Middle Gujarat are adopting hand weeding and inter-culture in major crops for weed management. Out of the twenty farmers selected, the major occupation was agriculture with dairy as a supplementary occupation with small patch of land set a side for growing lucerne. Farmer has knowledge about crop weed competition to manage weeds during 30 to 45 days after sowing in most of the crops. Farmers of Middle Gujarat are adopting tobacco–pearlmillet cropping system (65%). More than 35% farmers are also adopting cotton-wheat cropping system. Weed problem is also serious in all crops. Yield losses in different cropping system ranging from 20-55%. Majority of the farmers are adopting mechanical and chemical weed control methods.

CCSHAU, Hisar

Impact analysis of weed management technology was conducted in Tohana, Jakhal and Ratia blocks of Fatehbad district revealed lack of timely supply of electricity was the number one constraint of crop production followed by non availability of labour at peak times. Extent of yield gain due to adoption of weed management technology was 0.8-1.0 t/ha where as in rice crop it was 1.2-1.5 t/ha. Sixty eight percent (68%) farmers are satisfied with weed management technology adopted by them in wheat crop where in rice 100% are satisfied by adopting weed management technology in rice crop.

Survey on awareness and adoption of weed management technology in wheat conducted in Fatehbad, Jind, Kaithal, Ambala, Karnal and Kurukshetra districts reveal that all the farmers (100%) are well aware of weed management options in wheat and adopt chemical means to control weeds in wheat crop because severe infestation of *P. minor* in rice-wheat cropping system. For control of grassy weeds 17% farmers preferred sulfosulfuron and 100% used only recommended dose of this herbicide while only 44% farmers adopted clodinafop with 78 % using 1.5-2 packets of this herbicide. R. Mix formulation of sulfosulfuron +metsulfuron was also the choice of 25% farmers due to its good efficacy against complex weed flora the second preference of farmers. Atlantis was the choice of only 14% farmers due to comparatively its suppression effect on crop. None of farmer used fenoxaprop because of its poor efficacy against *P. minor*.

TNAU, Coimbatore

Impact of integrated weed management on onion in western zone of Tamil Nadu

The farmers are practicing chemical methods to control the weeds in an extensive manner as the income from the crop was high. The results of the study revealed that adopters of integrated weed management has obtained an increased crop yield to the level of 3.88 t/ha. The difference in the farm income was Rs.59957/ha between the adopters and the non adopters. It has clearly indicated the importance of IWM in controlling the weed flora in onion. The major constraint for non adoption of herbicidal method was due to the fact that the farmers though aware of the usage of herbicides, but reasons only known to them as they were not practicing the same. This was followed by maximization of the expenditure because the weeding operations have required more labour and the prevalence of high wage rates in the study area. The functional

analysis has revealed that the herbicide quantity, plant protection chemical and labour (excluding manual weeding) were positive and significantly contributing to the productivity of onion crop.

CSKHPKV, Palampur

Level of satisfaction

Crop	Satisfactory	Partially satisfied	Not satisfied
Maize	88	12	0
Wheat	64	36	0

Awareness about important weed management

Mechanical : 80%

Chemical : 55%

Cultural : 80%

Adoption	25%	50%	75%	100
Mechanical			√	
Chemical		√		
Cultural			√	

SKRAU, Bikaner

Impact assessment and adoption study was conducted at farmers field from selected cultivators to find out the major tools and their adoption, major methods of weed control, anticipated yield loss, and technology adoption particularly in wheat crop. Among the tools, farmers are using *Kassi* (hoe) 55%, *khurpi* 25 %, spades 9% and 10% cycle-hoe weeder. All the three methods, cultural, mechanical and chemical are in practice, their respective values were in the order of 48, 35 and 16%. Anticipated estimation of yield loss ranged between 15-35% for various crops. Average value of adoption of technology was 38%.

AAU, Jorhat

Impact analysis on weed management in upland direct seeded rice

Golaghat district:

The level of satisfaction on weed management technology was satisfactory in upland direct seeded rice and vegetable crops. Anticipation yield loss by weeds if not controlled was in the range of 60-70% and 25-30% farmers had adopted manual and cultural methods of weed control.

Jorhat district:

The level of satisfaction on weed management technology was satisfactory in summer rice and vegetable crops. Anticipation yield loss by weeds if not controlled was in the range of 60-70%. About 25-30% farmers had adopted manual and cultural methods of weed control.

BAU, Ranchi

Farmers have adopted herbicide butachlor 1.5 kg/ha PE in rice for weed control. The farmers were of the opinion that by using chemical weed control there is saving in expenditure.

UAS, Bengaluru

Cost of weed management in rice

Type of weed management	Cost in Rs./ha	% Adoption
Chemical (herbicide plus hand weeding)		
Pre-emergence application of pyrazosulfuron ethyl 10 WP at 25 g/ha + one hand weeding (20 women labour/ha)	3100	30
Pre-emergence application of butachlor 50 EC at 1.0 kg/ha + one hand weeding (20 women labour/ha)	2700	50
Pre-emergence application of pretilachlor 50 EC at 0.75 kg/ha + one hand weeding (20 women labour/ha)	2800	10
Pre-emergence application of bensulfuron methyl (0.6 % G) 60g +pretilachlor (6% G) 600 g/ha as pre-emergent spray + one hand weeding (10 women labour/ha)	2800	10
Mechanical (Hand weeding alone) – 60 Women labour	6000	

Impact of IWM on crop yield and farm income

Particulars	Yield (t/ha)	Farm income (Rs/ha)
Adopters	4.5	49,500
Non Adopters	2.6	28,600
Difference	1.9	20,900

- **Selling price of rice: Rs. 11,000 per t**

Cost of weed management in groundnut

Type of weed management	Cost (Rs/ha)	Adoption (%)
Chemical (herbicide plus hand weeding)		
Pre-emergence application of pendimethalin 30 EC at 1.0 kg/ha + one hand weeding (15 women labour/ha)	3500	50
Pre-emergence application of alachlor 50 EC at 1.0 kg/ha + one hand weeding (20 women labour/ha)	3050	50
Mechanical (Hand weeding alone) – 70 Women labour	7000	

Impact of IWM on crop yield and farm income

Particulars	Yield (t/ha)	Farm income (Rs/ha)
Adopters	1.4	30,380
Non adopters	0.9	19,530
Difference	0.5	10,850

- **Selling price of groundnut pods : Rs. 21700/t**

IGKV, Raipur

Impact analysis, adoption and awareness of weed control technologies in paddy was done with farmers from village Nagargaon block Dharsinwa, district Raipur. Hand weeding is the major method of weed control. Farmers are also using mechanical method as well as chemical. But, due to economic, resource and technical problems, use of chemical control is limited, however, continuous demonstrations, contacts, labour problems and their cost, availability of effective herbicides attracting the farmers for use of herbicides in paddy rather than manual weeding.

DBSKKV, Dapoli

Weed management:

Crop (a)		Number	Cost
Monoculture of rice	Intercultivation	--	--
	pedimethalin 1.0 kg/ha	-	-
	Manual	80	Rs. 9,600/-
	(Wages/ day)	120	
Crop (b)			
Lablab bean	Intercultivation	--	--
	pedimethalin 1.0 kg/ha	10	Rs2000.00
	Manual	50	Rs6000.00
	(Wages/ day)	120	

Level of Satisfaction:

Crop	Satisfactory	Partially satisfied	Not satisfied
Lablab bean	√	--	--

Adoption	25%	50%	75%	100%
Mechanical	--	--	--	--
Chemical	√	--	--	--
Cultural	--	--	√	--

MAU, Parbhani

Level of satisfaction:

Crops	Satisfactory	Partially satisfied	Not satisfied
Soybean	90%	10%	-
Sorghum	90%	10%	-

Adoption level	25%	50%	75%	100%
Mechanical	10%	-	-	-
Chemical	-	25%		
Cultural	-	-	10%	90%

Awareness about important weed management:

Mechanical : - 0 -

Chemical : 50-60%

Cultural : 100%

Adoption	25%	50%	75%	100%
Mechanical	15%	00	00	00
Chemical	-	35%	-	-
Cultural	-	-	20%	80%

NDUAT, Faizabad

Level of satisfaction

Crop	Satisfactory	Partially satisfied	Not satisfied
Wheat	68	32	0
Rice	89	11	0

Anticipated yield loss by weeds if not controlled	:	Rice - 30-40% in puddled transplanted Wheat - 20-30%
Major methods of control	:	Cultural : 20-30% Mechanical : 20-25% Manual : 30-40% Chemical : Rice - 40-60% Wheat- 15-20%
Awareness about weed management practices		100%
Mechanical (weeders) Chemical (herbicide) Cultural (State seed-bed, rotation)	:	10-20% 20-30% 40-50%

Adoption level

Adoption	25%	50%	75%	100%
Mechanical	-	40%	-	-
Chemical	-	-	38% in wheat 48% in rice	-
Cultural	-	-	-	100%

ANGRAU, Hyderabad

Impact analysis was done on weed management in Kulakacherla mandal of Rangareddy district in Southern Telangana Zone of Andhra Pradesh. The crop selected for the study was cotton and methodology adopted was survey using proforma covering all aspects of weed management. Altogether 15 farmers from the selected mandal were surveyed and the average farm income was around Rs. 50,000-Rs 80,000 and other farm activities include dairy farming. 75 % of cultivated area is rain-fed and 25% under bore wells. Major cropping system followed is cotton- fallow (65 %), maize+ redgram (25 %) Rice-vegetables (10%). Rice based cropping systems are adopted in tank command areas. Predominant weed flora was *Cyperus rotundus* among sedges, *Cynodon dactylon, Dactyloctenium aegyptium* and *Panicum species* under grasses, and *Celosia argentia*, *Digera arvensis*, *Euphorbia genicultata, Parthenium hysterophorus, Commelina benghalensis, Amaranthus* among broad leaved weeds. 60% of farmers opined that broad leaved weeds are causing yield reduction and 40% opined that it is grasses and sedges which cause yield reduction.

10% of the farmers are adopting integrated weed management involving Pyrithiobac sodium at 625 ml/ha + quizalofop-p-ethyl (1000 ml/ha) which cost of Rs.3,500/ha with a saving of Rs.1000 /ha compared to farmers method. Major weed management practice include mechanical weeding i.e., inter cultivation twice (90% adoption). Adopters of chemical weed management are getting 15 q /ha of cotton with farm income of Rs.49,500/ha where as non adopters are getting only 11.5 q/ha (Rs. 37,950). 35 % of the farmers are not satisfied with the current weed management practices as timely control of weeds is not being done due to non-availability of labour in time. Few farmers who are adopting chemical weed management are fully satisfied. Major constraint in crop production was non–availability of labour in time due to migration of labour to cities and involved in construction work and other non agricultural activities.

Awareness/adoption

The main source of information about weed management practices was private input dealers followed by print/mass media, progressive farmers and extension department. 80% of the farmers felt weeds as pest and 20% of farmers opined weeds as fodder. Farmers opined that 60-70% of yield loss was anticipated when weeds are not controlled. Major method of weed control was inter-cultivation using local blade harrow. 100% of farmers are aware of mechanical weed management, and 30% of farmers are aware of chemical method of weed management. 100% of farmers are adopting mechanical weed management and 10% are adopting chemical methods and cultural methods are adopted by 50% of farmers for weed management. Main reason for not adopting IWM is due to lack of technical knowledge (50%), non-availability of resources (30 %) followed by economical reasons (20%).

V.B., Sriniketan

Awareness of different weed management practices

Method of weed management	Awareness
Chemical	Butachlor, Pyrazosulfuron, Pretilachlor, Almix, Bispyribac-sodium, 2,4 -D, Metribuzin, Glyphosate, Oxyfluorfen, Pendimethal in, Fenoxaprop
Mechanical	Hand hoe, Spade, Khurpi
Cultural	Summer ploughing, Crop rotation

Adoption Level of different Weed management Practices

Adoption	25%	50%	75%	100%
Mechanical	√			
Chemical		√		
Cultural	√			

Reasons for not adopting

Economical	Poor economic condition of the farmers, small land holding size
Resource	Good quality seed, fertilizer, financial assistance, plant protection chemicals are rarely available
Technical	Lack of technical know how about modern weed management practices among the farmers

RAU, Pusa

Ten farmers were selected from Muzaffarpur district for front line demonstration during *rabi* maize 2010-11. The treatments were metribuzine 500 g/ha, farmer practice and no weeding (weedy check). Total area for this demonstration was 10 ha. The results revealed that highest grain yield was application of metribuzin 500 g/ha, which was 64.7% higher than weedy check and 13.4% farmer practice.

Front line demonstrations on carfentrazone and sulfosulfuron in wheat were done in Muzaffarpur and Sheohar districts with involvement of 55 farmers. In case of carfentrazone demonstration, the percent of increase in grain yield of wheat over farmer practice was 27.9% and over weedy check was 49.8%.In sulfosulfuron, the grain yield of wheat was 45.2% and 27.1% higher over weedy check and farmers practice, respectively.

For FLD on moong, 12 farmers of Sheohar district were selected for 2 ha area and demonstration was conducted with following treatments, pendimethalin 1 kg/ha, farmers practices and weedy check. The results revealed that pendimethalin 1 kg/ha recorded the highest grain yield and percent increase in yield over farmers' practice and weedy check was 45.1% and 19.4%, respectively.

4.0 Station Trials

Weed management in individual crops

Rice nursery

AAU, Jorhat

Rice nursery treated with oxadiargyl 90 g/ha or pretilachlor 600 g/ha resulted in the lowest weed dry weight. Among the treatments applied to the main field, the lowest weed dry weight was obtained with pretilachlor 750 g/ha. Application of oxadiargyl 90 g/ha to nursery and pretilachlor 700g/ha in main field resulted in highest grain yield of the crop.

Direct-seeded upland rice

GBPUAT, Pantnagar

Bio-efficacy of penoxulam (1.02% w/w) + cyhalofop-butyl (5.1% w/w) for weed control in direct dry-seeded rice

Post–emergence application of ready mixture of penoxsulam + cyhalofop–butyl in transplanted as well as direct dry-seeded rice applied at 150 g/ha at 21 DAT / DAS was found to be most effective against the density and dry matter accumulation of weeds as compared to its lower doses. The highest yield of the direct dry-seeded rice was found with higher dose of penoxsulam + cyhalofop–butyl 400 g/ha, while in transplanted rice it was with application of bispyribac sodium 20 g/ha.

AAU, Jorhat

Time of sowing did not affect the grain yield. The highest grain yield was recorded under weed-free treatment followed by application of butachlor 1.5 kg/ ha + hand weeding 30 DAS (22.4) and pretilachlor + safener 0.5 kg/ha. Weed-free treatment followed by butachlor 1.5 kg/ha + hand weeding 30 DAS and pretilachlor + safener 0.5 kg/ha resulted in the lowest density and weed dry matter production.

Transplanted rice

GBPUAT, Pantnagar

Studies on bio-efficacy, phytotoxicity, carry-over and residual effect of butachlor 50 EC (Machete) in transplanted rice

In transplanted rice, application of butachlor sponsor sample doses 1250, 2000 and 4000 g/ha were found more effective in reducing the density and dry weight of all the weeds as compared to market samples and almix. The application of butachlor 2000 g/ha as pre-emergence produced the highest grain yield, followed by butachlor at higher dose 4000 g/ha.

To evaluate the bio-efficacy, phytotoxicity, varietal, compatibility and residual of penoxsulam 2.67%w/w (2.5%w/v) OD for weed control in transplanted rice and their residual effect on succeeding crop

The lowest weed density and dry weight of transplanted rice was recorded with the application of bispyribac sodium 20 g/ha at 15 DAT and penoxsulam at higher dose 25 g applied 18 DAT. The application of penoxsulam 25 g/ha recorded the highest grain and straw yield, followed by penoxsulam 22.5 g/ha.

Evaluation of bio-efficacy of triasulfuron 20 WG against weeds in transplanted rice

In transplanted rice, tank-mix application of pretilachlor 625 g/ha + triasulfufon 10 g/ha at 3 DAT was found most effective against mixed weed flora, and yielded similar grain yield of rice over the hand weeding twice at 20 and 40DAT.

Wheat

GBPUAT, Pantnagar

Application of UPH–110 in wheat 500 g/ha was found most effective against mixed weed flora in wheat, and this treatment yielded almost similar grain yield of wheat than the of weed–free situation.

CCSHAU, Hisar

Screening of wheat cultivars for sensitivity to new herbicide fenoxaprop+ metribuzin (ready-mix)

There was no phyto-toxicity of fenoxaprop+ metribuzin (RM) 22 EC at X dose on DBW 17, PBW 343 and WH 711. These cultivars tolerated the herbicide even up to 2X level. Durum wheat cultivars WH 896 and WH 912 showed some phyto-toxicity at X dose at 30 DAT which recovered with time (Table 52). WH 542 and PBW 550 were highly sensitive to this herbicide, resulting in significant reduction in grain yields as compared to untreated checks. WH 283 was moderate in sensitivity which showed some recovery but not to desired level.

Evaluation of metribuzin in combination with clodinafop, sulfosulfuron and pinoxaden for weed control in wheat

Weed flora of the field was dominated by *Phalaris minor* along with broad-leaved weeds (BLW), like *Coronopus didymus, Melilotus indica, Medicago denticulate, Anagallis arvensis, Rumex dentatus* etc. Pinoxaden alone provided complete control of *P. minor,* whereas clodinafop resulted in satisfactory control of *P. minor* but not at par with weed free check. These herbicides did not provide any control of BLW. Sulfosulfuron alone resulted in the lowest control of *P. minor* among these herbicides, but it provided good control of BLW. Addition of metribuzin 105-122.5 g/ha to sulfosulfuron and clodinafop increased the control of *P. minor* and BLW as well as compared to their alone applications. The best combination was found to be sulfosulfuron 25 g/ha or clodinafop 60 g/ha + metribuzin 105 g/ha with improvement in grain yields. Addition of

metribuzin to pinoxaden did not increase the control of *P. minor* rather there was slightly lower control under the combination; however the differences w.r.t. dry weight were non-significant. This was inevitable as pinoxaden alone performed very well against *P. minor*. Addition of metribuzin to pinoxaden increased the control of BLW. There was no phytotoxicity of any of the herbicidal treatments on the wheat. It indicates that tank-mix of metribuzin can be done with these herbicides in order to increase the control of *P. minor* for management of cross resistance development.

Soybean

GBPUAT, Pantnagar

Studies on the bio-efficacy and phytotoxicity carry over and residual effect of imazethapyr 10% SL in soybean

Application of imazethapyr at 400 g/ha was found more effective against grassy as well as broad-leaved weeds and yielded higher grain yield of soybean.

Studies on bio-efficacy, phytoxicity carry over residual effect of quizalafop–p-ethyl in soybean

All the doses of quizalofop 5% EC (elegant) and market sample applied in soybean were found more effective against the grassy weeds than BLW. The lowest weed density and dry weight of weeds were recorded with twice hand weeding, which was at par with higher dose of quizalofop (elegant) 200 g/ha. The application of quizalofop 200 g/ha gave the highest (2479 kg/ha) grain yield of soybean, which was at par with other doses of herbicidal treatment.

Tuberose

AAU, Jorhat

Application of metribuzin 500 g/ha + hand weeding 30, 60, 90, 120DAP resulted in the highest value of flower yield, followed by oxadiargyl 1.5 kg/ha + HW 30, 60, 90, 120 DAP (5.71 t/ha) . In general, metribuzin 500 g/ha + HW 30, 60, 90, 120 DAP recorded significantly lowest weed density and dry matter production.

Mentha

GBPUAT, Pantnagar

Application of oxyflurofen in mentha at 412 g/ha was found most effective against the density and dry weight of weeds as compared to its lower dose 176 g/ha.

Cotton

AAU, Anand

Weed management in Bt cotton

Significantly maximum seed cotton yield was recorded in IC + HW carried out at 15, 30 and 45DAS, which was at par with pendimethalin 900 g/ha *fb* IC + HW at 30 and 60 DAS, quizalofop

50 g/ha as POE *fb* IC + HW at 30 DAS, quizalofop 100 g/ha as POE *fb* IC + HW at 30 DAS, fenoxaprop 50 g/ha as POE *fb* IC + HW at 30 DAS and fenoxaprop 100 g/ha as POE *fb* IC + HW at 30 DAS. Stalk yield of cotton was higher in same treatment but was at par with all the treatments, except weedy check. Weed control efficiency varied between 79 and 91% in these treatments. Germination count recorded at 10 DAS and plant height as well as plant dry matter accumulation recorded at 30 DAS of succeeding crops viz., chickpea, wheat and mustard were not significantly influenced by residual effect of herbicides applied in cotton as pre- or post-emergence.

Okra

RVSKKV, Gwalior

Two hand weedings at 30 and 50 DAS and mulching (after seed germination) fetched maximum yield and net returns as well as BCR, followed by pendimethalin @ 1.0 kg/ha + 1 HW at 30 DAS but the B.C. ratio was higher (2.20) in mulching plot.

Cowpea

RVSKKV, Gwalior

Weed-free treatment recorded higher seed yield, net returns and B.C. ratio, followed by 1 hoeing + HW at 20 and 40 DAS. Among the herbicides, the application imazethapyr 75 g/ha with one hand weeding at 40 DAS and pendimethalin + 1 HW at 40 DAS recorded higher yield, net returns and BC ratio.

Weed management in cropping systems

Rice-rice

VB, Sriniketan

A preliminary attempt was made with three early post-emergence herbicides to control *Echinochloa* in plastic trays as well as in micro-plot. Bispyribac sodium 25 g/ha, azimsulfuron 35 g/ha, and fenoxaprop-p-ethyl 50 g/ha applied at 12 DAS (2–3 leaf stage of *Echinochloa spp.*) selectively controlled the *E. crusgalli, E. glabrescens* without hampering the rice seedling.

Organic potato-soybean

CSKHPKV, Palampur

Studies on weed management in organic potato-soybean cropping system revealed that integration of FYM 25 t/ha and FYM 37.5 t/ha with *Chromolaena* mulch resulted in significantly higher potato tuber yield. Weeds in unweeded check reduced the potato tuber yield by 20.4% over weed management with black polythene sheet. Among different organic manures, FYM 35 t/ha resulted in significantly higher potato tuber yield Vermicompost prepared from *Lantana* and *Chromolaena* were the next best treatments in this regard. Among different weed control methods, black polythene sheet mulch *fb* earthing-up resulted in the highest potato tuber yield. White polythene sheet mulch *fb* earthing-up was the next best treatment.

Herbicide Testing

Rice

TNAU, Coimbatore

Bio-efficacy, residue, phytotoxicity and carryover of glyphosate on transgenic corn

Post-emergence application of round-up at 900, 1800 and 3600 g/ha registered higher weed control efficiency and grain yield in transgenic Hishell and 900 M Gold maize hybrids. Grain yield was significantly higher in transgenic stacked 900 M Gold and Hishell maize hybrid with post-emergence application of glyphosate at 1800 and 3600 g/ha than all other treatments.

Herbicide and insect resistance in transgenic maize hybrids

Post-emergence application of glyphosate (round-up) at 1800 g/ha recorded lower weed density, dry weight and lower weed control efficiency in transgenic stacked hybrids in 30V92 and 30B11. Grain yield was significantly higher in transgenic stacked 30V92 and 30B11 maize hybrids with post-emergence application of round-up at 1800 and 900 g/ha

Bio-efficacy, residue and phytotoxicity of glyphosate on cotton hybrids

Higher weed control efficiency was observed with glyphosate at 3600 g/ha, followed by glyphosate at 2700 and 5400 g/ha, which resulted in more than 98% WCE. Among the treatments, glyphosate at 2700 g/ha recorded the higher seed cotton yield of 3.09-3.20 t/ha during winter season. No phytotoxic symptoms were observed in succeeding crops.

Pre-emergence mixed herbicide for transplanted rice

Pre-emergence application of UPH 309 at 20 kg/ha recorded lesser weed density and dry weight. The maximum grain and straw yield was observed in pre-emergence application of UPH 309 at 10 kg/ha and on par with UPH 309 at 12.5 kg/ha. In the residual crop, the higher seed yield was recorded in UPH 309 at 12.5 kg/ha.

Bio-efficacy of pyrazosulfuron-ethyl in transplanted rice

Higher weed control efficiency of 84.20 and 79.60% was recorded with PE pyrazosulfuron-ethyl at 30 g/ha + HW and PE pyrazosulfuron ethyl at 20 g/ha + HW. Pre-emergence application of pyrazosulfuron ethyl at 20 g/ha + HW recorded significantly higher grain and straw yield and it was on par with PE pyrazosulfuron-ethylat 30 g/ha+ HW.

Bio-efficacy of post-emergence herbicides in transplanted rice

Post-emergence application of RIL 029/F1 (10% SC) at 200 g/ha recorded lesser density and dry weight of grasses, sedges and broad-leaved weeds, followed by RIL 029/F1 (10% SC) 100 g/ha. Post-emergence application of RIL 029/F1 (10% SC) at 50 g/ha recorded higher grain yield, followed by pretilachlor at 1.0 kg/ha + HW at 40 DAT, RIL-029/F1 at 20 g/ha, and pre-emergence application of butachlor at 1.0 kg/ha + rotary weeder at 40 DAT.

Bio-efficacy of Metamifop 10% EC on grassy weeds in direct-seeded rice

Application of metamifop 10 EC at 100 and 125 g/ha at 2-3 leaf stages and metamifop 10 EC at 125 g/ha at 5-6 leaf stages gave comparable results with respect to grass weed control and yield of rice. Between stages of application, use of metamifop 10 EC at 2-3 leaf stages was found to be better than spraying at 5-6 leaf stages. Hence, application of metamifop 10 EC at 100 g/ha at 2-3 leaf stage was found to be better in controlling grass weeds in direct seeded rice. Metamifop 10 EC did not cause any phytotoxicity or any significant effect on germination, plant height and yield of the following blackgram.

Effect of pre-emergence application of oxyfluorfen on rice

Pre-emergence application of oxfluorfen 23.5% EC at 400 g/ha recorded lower weed density, dry weight and higher WCE at 20 and 40 DAS in rice. The grain yield of rice was higher under pre-emergence application oxyfluorfen 23.5% EC at 250 g/ha. Bioassay revealed that the germination, plant height and dry matter production and yield attributes of residue crops, viz. sunflower and blackgram were not affected by the pre application of oxyfluorfen (23.5%) at different dose of herbicides. The herbicides applied at a higher dose did not leave any toxic residue in the field at the end of the cropping period.

Effect of early post-emergence application of imazethapyr and its phytotoxicity in groundnut

Early post-emergence application of imazethapyr 10% SL at 100 g/ha 15 DAS + earthing-up on 45 DAS controlled the weeds effectively throughout the crop period, resulting in better pod and haulm yield. It effectively controlled the broad-leaved weeds compared with grasses and sedges. Higher dose of imazethapyr at 200 g/ha recorded higher weed control efficiency but it caused phytotoxicty in groundnut. There was no carry-over toxicity of imazethapyr on the succeeding pearlmillet and sunflower.

Effect of pre-emergence application of oxyfluorfen on groundnut

Pre-emergence of oxyfluorfen (23.5% EC) at 400 g/ha recorded lesser weed density and dry weight of grasses, sedges and broad-leaved weeds and it was on par with oxyfluorfen at 300 g/ha. The maximum pod yield was observed in pre-emergence of oxyfluorfen at 250 g/ha. Bioassay revealed that germination, plant height and dry matter production and yield attributes of residual crops, viz., sunflower and pearlmillet were not affected by the pre-emergence application of oxyfluorfen (23.5%). The herbicides applied at a higher dose did not leave any toxic residue in the field at the end of the cropping period.

Effect of early post-emergence application of imazethapyr and its phytotoxicity in soybean

Early post-emergence application of imazethapyr 10% SL at 100 g/ha 15 DAS + earthing-up on 45 DAS controlled weeds effectively throughout the crop period, resulting in better grain yield. It effectively controlled the broad-leaved weeds compared with grasses and sedges. Higher dose of imazethapyr at 200 g/ha recorded higher weed control efficiency but it caused phytotoxicty in

soybean. There was no carry-over toxicity of imazethapyr on the succeeding pearlmillet and sunflower. Yield of these succeeding crops were not significantly influenced by preceding early post-emergence application of imazethapyr.

Effect of early post-emergence halosulfuron-methyl (NC-319 75%WDG) on weeds in sugarcane

Halosulfuron-methyl 75 WG at three doses 90, 100 and 200 g/ha gave good control of *Cyperus rotundus* and also recorded significantly more yield over control. Higher yield attributes were obtained with PE atrazine 1.0 kg/ha + hand weeding and earthing-up on 60 DAP, followed by hand weeding on 30 DAP and earthing-up on 60 DAP.

Bio-efficacy of Sulfentrazone for weed control in sugarcane

Application of sulfentrazone @ 1200 g/ha as pre-plant incorporation recorded lower weed density, weed dry weight and higher weed control efficiency. Plant characters like germination and tiller production were higher with application of sulfentrazone @ 1200 g/ha as pre-plant incorporation.

Effect of pre-emergence application of oxyfluorfen on weed control in onion

Pre-emergence of oxyfluorfen (23.5% EC) at 400 g/ha recorded lesser weed density and dry weight of grasses, sedges and broad-leaved weeds, and it is on par with pre-emergence application of oxyfluorfen at 300 g/ha. The maximum bulb yield was observed in pre-emergence application of oxyfluorfen at 200 g/ha. Bioassay revealed that the germination, plant height and dry matter production and yield attributes of residual crops, viz. sunflower and pearlmillet were not affected by the pre-application of oxyfluorfen at different doses. The herbicides applied at a higher dose did not leave any toxic residue in the field at the end of the cropping period.

Effect of pre-emergence application of oxyfluorfen in potato

Lower weed density, weed dry weight and higher weed control efficiency was recorded in hand weeding twice at 15 and 30 DAP at the early stages of crop growth. Pre-emergence application of oxyfluorfen 23.5% EC at 200 g/ha was control the weeds effectively throughout the crop period and also increasing the number of tubers/ha, single tuber weight and yield. There was no carry-over toxicity of oxyfluorfen on the succeeding beans. Germination of beans succeeding crop were not significantly influenced by preceding application of oxyfluorfen at higher doses (400 g/ha).

Effect of pre-emergence application of oxyfluorfen on weed control in tea

Herbicide oxyfluorfen (23.5% EC) (new molecules) at 400 g/ha as a pre-emergence spray was found effective and superior to others by reducing the total weed density. Pre-emergence application of oxyfluorfen at 250 g/ha reduced the weed density and dry weight conspicuously below the economic threshold level, increased the green leaf yield and net returns distinctly in tea plantation. Bioassay studies to find out the effect of herbicide residues on the succeeding crop sunflower indicated that dose, method and time of application of oxyfluorfen herbicide did not affect the germination of succeeding crops.

Gram

SKRAU, Bikaner

Post-emergence application of imazethapyr 50 g/ha produced significantly higher seed yield (1.55 t/ha) over weedy check (0.67 t/ha). Further, this herbicide was also responsible to suppress weed growth and recorded weed dry weight of 0.035 t/ha.

Cumin

SKRAU, Bikaner

Post-emergence application of imazethapyr at 50 g/ha produced significantly higher seed yield (353 kg/ha) over weedy check. The increase in yield with this treatment over weedy check was 226 kg/ha. Further, this herbicide was also responsible to suppress weeds and recorded weed dry weight of 36 kg/ha.

Seed production potential

AAU, Anand

In cotton, six major weeds, viz. *Digera arvensis, Phyllanthus niruri, Trianthema monogyna* and *Celosia argentia* as dicot weeds and *Eragrostis major, Dactyloctenium aegyptium, Echinochloa crusgalli* and *Digitaria sanguinalis* as monocot weeds were observed. Maximum seed production (44,980 /plant) was recorded in *Eragrostis major* among monocot weeds, whereas maximum seed production (19,350/plant) was recorded in *Celosia argentia* among dicot weeds.

5.0 Recommendations

ANGRAU, Hyderabad

- In direct-seeded rice, either pre-emergence application of butachlor at 1.5 kg/ha followed by one hand weeding at 30 DAS or post-emergence application of fenoxaprop-p-ethyl (60 g/ha) + metsulfuron methyl + chlorimuron ethyl (4g/ha) were effective in realizing higher grain yield and efficient weed control.
- In rice nursery, bispyribac sodium 10% at 20 g/ha at 12-15 DAS for efficient weed control.
- In transplanted rice or SRI, transplanting of paddy or system of rice intensification with pyrazosulfuron ethyl fb mechanical weeding is better for efficient weed control and higher grain yield of rice. When there is no time for nursery raising drum-seeding of sprouted seeds and pyrazosulfuron-ethyl + mechanical weeding is also a viable option for the farmers.
- In rice, bensulfuron-methyl + pretilachlor can be applied at 5 DAT for timely and effective weed control.
- In maize, pre-emergence application of either atrazine 1.0 kg/ha fb intercultivation at 30 DAS or oxyflourfen 0.3 kg/ha fb IC at 30 DAS was very effective for efficient weed control and achieving higher grain yield in maize.
- In rice-fallow-maize system, atrazine applied as pre-emergence or early post-emergence or along with paraquat are equally effective for better weed control and higher yield of maize.
- In groundnut, pre-emergence application of pendimethalin coupled with post-emergence application of imazethapyr is very effective in controlling broad spectrum of weeds and realizing higher yields.
- In castor, pre-emergence application of pendimethalin fb post-emergence application of propaquizafop resulted in effective weed control and higher yields.
- In tomato, pre-emergence application of metribuzin 0.5 kg/ha + hand weeding at 30 DAT is effective for efficient control of weeds in addition to realizing higher yield and net returns in tomato.
- In onion, application of oxadiargyl 90 g/ ha (PE) + quizalofop ethyl 50 g /ha (POE) at 2-3 leaf stage of weed was very effective in control of broad spectrum weeds fb pendimethalin C.S 0.75 kg / ha (PE) + quizalofop ethyl 50 g/ha (POE).
- In carrot, application of metribuzin (Pre-emergence) 0.3 kg/ha followed by hand weeding at 30 DAS will result in efficient weed control and higher root yield.
- In cabbage, oxyfluorfen 0.25 kg/ha as pre-emergence +black polythene mulch

significantly reduced the grasses and broad leaved weeds and resulted in the highest cabbage yield and net profit.

PAU, Ludhiana

- Control of broad-leaved weeds in barley (*Hordeum vulgare*) can be achieved with post-emergence (30 days after sowing) application of metsulfuron-methyl 4 g/ha applied by dissolving in 375 liters of water.
- Control of climbing weed (*Ipomoea* sp.) in sugarcane can be achieved with post-emergence application of 2,4-D sodium salt 1.6 kg/ha or 2,4,D amine salt 0.58 kg/ha applied by dissolving in 375 liters of water when the *Ipomoea* plants are in 3-5 leaf stages.
- Control of mixed weed flora in wheat can be achieved with post-emergence (35 days after sowing) application of fenoxaprop + metribuzin 275 g/ha by dissolving in 375 litres of water.

TNAU, Coimbatore

- Pre-emergence application of butachlor 1.5 kg/ha + one hand weeding after onset of monsoon or pyrazosulfuron ethyl at 25 g/ha at 3 DAS or oxyfluorfen at 250 g/ha or EPOE metamifop 10 EC at 100 g/ha at 2-3 leaf stages for direct wet-seeded rice is recommended.
- Post-emergence oxyfluorfen 23.5% EC at 250 g/ha + HW on 45 DAS or EPOE imazethapyr at 100 g/ha 15 DAS + earthing-up on 45 DAS for irrigated groundnut is recommended.

RAU, Pusa

- In direct-seeded rice, butachlor 1.5 kg/ha at 0-3 DAS or pyrazosulfuron 25 g/ha at 3-7 DAS or pretilachlor 0.75 kg/ha as 0-7 DAS.
- In transplanted rice, butachlor 1.5 kg/ha or butachlor 1.5 kg/ha super-imposed with 2,4–D 0.8 kg/ha as post-emergence or pyrazosulfuron 30 g/ha as post-emergence.
- In maize, atrazine 1.5 kg/ha as pre-emergence + 2,4–D 0.8 kg/ha as post-emergence or pendimethalin 1.0 kg/ha, followed by 2,4 –D 0.8 kg/ha as post-emergence.
- In wheat, 2,4–D 0.8 kg/ha as post-emergence (where *Phalaris minor* is not a problem) or pendimethalin 1.0 kg/ha as pre-emergence. Where *Phalaris minor* and wild oat are problematic, isoproturon 0.75-1.0 kg/ha as post-emergence or sulfosulfuron 25 g/ha as POE. Where *Physalis minima, Cirsium arvense and Solanum nigrum* are problematic, carfentrazone 25 g/ha as post-emergence.
- In sugarcane, atrazine 1.5 kg/ha as pre-emergence + 2,4–D 0.8 kg/ha as post-emergence.

- In potato, metribuzin 0.5 kg/ha as pre-emergence + 1 earthing-up or alachlor 1.5 kg/ha as pre-emergence and 1 earthing-up or pendimethalin 1.0 kg/ha as pre-emergence.
- In pulses (pigeonpea, gram, lentil, moong, urd, rajmash), alachlor 1.5 kg/ha or pretilachlor 0.75 kg/ha as pre-emergence or pendimethalin 1 kg/ha as PE or fluchloralin 1.0 kg/ha or oxadiazon 0.5 kg/ha as pre-emergence in lentil or pendimethalin 1.0 kg/ha or pretilachlor 0.75 kg/ha or dichlorophop 0.75 kg/ha as pre-emergence in rajmash.
- In maize-potato intercropping system, metribuzin 0.5 kg/ha followed by one earthing-up.
- For *Orobanche* management in tobacco, soil solarization should be done followed by oxyfluorfen 0.1 kg/ha (3 DAP) or pendimethalin 1.0 kg/ha (3 DAP) or metribuzin 0.5 kg/ha were found effective to delay the germination of *Orobanche*.

6.0 Extension Activities

Centre	Popular articles	Radio talks	TV Programmes	Kisan Melas	Handouts/ Folders	Bulletins/ Booklet	Training Programmes	Demonstrations	*Parthenium* Awareness Week
PAU, Ludhiana	-	-	-	-	-	-	-	-	✓
UAS, Bangalore	-	-	2	1	-	-	9	-	✓
RVSKVV, Gwalior	-	-	-	4	-	-	-	-	✓
GBPUAT, Pantnagar	3	-	-	1	-	1	1	10	✓
CSKHPKV, Palampur	-	-	2	-	-	-	14	-	✓
AAU, Jorhat	-	-	3	-	-	2	19	-	✓
MAU, Parbhani	5	4	6	4	-	-	-	4	✓
AAU, Anand	3	1	2	1	-	-	10	-	✓
TNAU, Coimbatore	4	1	3	-	-	-	4	-	✓
NDUAT, Faizabad	6	6	-	2	-	-	-	-	✓
VB, Sriniketan	-	1	1	-	-	3	3	-	✓
BAU, Ranchi	-	-	-	-	-	-	-	-	✓
CSAUAT, Kanpur	2	-	-	2	-	-	-	1	✓
KAU, Thrissur	-	-	-	-	-	-	-	-	-
OUAT, Bhubaneswar	2	1	3	-	-	4	3	-	✓
ANGRAU, Hyderabad	-	-	-	-	-	-	-	-	✓
CCSHAU, Hisar	2	1	-	2	6	2	16	-	✓
RAU, Pusa	-	-	-	-	-	-	-	-	-
DBSKKV, Dapoli	2	1	-	-	-	-	-	-	✓
IGKVV, Raipur	1	1	-	-	2	2	4	-	✓
UAS, Dharwad	-	-	-	-	-	4	-	-	✓
RAU, Bikaner	-	-	-	-	-	-	-	-	✓

Parthenium Awareness Week

AAU, Anand

Parthenium awareness week was organized by AICRP on Weed Control, B.A. College of Agriculture, Anand Agricultural University, Anand during second and third week of August, 2011 with great success and grandeur in collaboration with Directorate of Weed Science Research, ICAR, Jabalpur. The main objective of the celebration was to create awareness among the public, students and authorities about the parthenium to manage in eco system. This year centre covered both urban and rural areas as the events were held in Vadodra and Anand districts.

PAU, Ludhiana

Parthenium awareness week was observed by the DWSR Ludhiana centre. Awareness camps were organized and literature was distributed to the people for creating awareness regarding the ill effects of *Parthenium* and its control measures. '*Parthenium* Awareness Day' was organized in collaboration with Farm Advisory Service Scheme (FASS), Jalandhar at village Bhatija, Jalandhar district on 7 September, 2011.

GBPUAT, Pantnagar

Parthenium Awareness Week was organized during August 16-23, 2011 at Pantnagar centre in collaboration with DWSR (ICAR), Jabalpur. Staff, students and residents of the University as well as local residents, farmers and students of various schools and colleges actively participated in the awareness campaign organized at various places.

OUAT, Bhubaneswar

'*Parthenium* awareness campaign' was conducted in two different places: (i) Katarajhari UGME school, Nayagarh district and (ii) Gadataras village, Gop, Puri. The programmes were highly successful with excellent response from representatives of all sectors. AICRP in weed control, Bhubaneswar center also received very good feed back of the programme by securing queries on *Parthenium* over telephone, letters and personal visits to the project office. Thus the observation of “Parthenium Awareness Week, 2011” was a great success at Bhubaneswar Centre.

UAS, Bengaluru

During August 16-22, 2011, scroller and posters containing information about parthenium, its ill-effect and management were displayed in the premises of Directorate of Weed Science Research Centre, University of Agricultural Sciences, Main Research Station, Hebbal, Bangalore. Also live specimens of the botanicals suppressing parthenium like *Cassia sericea, Cassia tora, Hyptis suaveolens, Amaranthus spinosus, Cassia occidentalis, Mirabilis jalapa, Tephrosia purpurea, Tagetes erecta and Stylozanthus hamata*, seeds of the botanicals and boxes containing Mexican beetle, *Zygogramma bicolorata* were displayed. The beetles, hand

outs brought out by DWSR Centre, UAS, Bengaluru and the seeds of *Cassia uniflora* were put for sale. Video documentary film on 'Parthenium – a National Weed, Ill Effects and its Management Strategies" prepared jointly by DWSR Centre, UAS, Bengaluru and DWSR, ICAR, Jabalpur was screened to the viewers both in vernacular language, Kannada and English.

CCSHAU, Hisar

Department of Agronomy, CCS HAU Hisar in collaboration with various KGK's of state celebrated 'Parthenium Awareness Week' from August 16-22, 2011 with good success and grandeur. This year Parthenium week celebration covered both rural and urban areas.

IGKV, Raipur

"Parthenium Awareness Week" was observed from 16-22 August, 2009 by Directorate of Weed Science Research-IGKV center at Indira Gandhi krishi Vishwavidyaylaya, Raipur with great enthusiasm, as a part of national programme. The main objective of the programme was to create awareness amongst the general public, farmers, school and college students and policy planners about the impact of this noxious weed and available strategies to manage/utilize the Parthenium on eco-friendly basis in different situations.

NDUAT, Faizabad

Department of Agronomy, College of Agriculture, N.D. University of Agriculture & Technology, Kumarganj, Faizabad organized the "Parthenium Awareness Week" during August 16-22, 2011 with great success and grandeur. The main objective of organizing the week was to create awareness among the rural and urban people, farmers, students, government officials and policy planners about the harmful effect of this noxious weed and have to manage and utilize this weed. For achieving these objectives, a series of programmes, *e.g.* Parthenium awareness rally, awareness meetings, gosthies and demonstration were conducted at different places. The wide publicity was given about the "Parthenium Awareness Programme" through radio talks and News Paper Coverage.

RVSKVV, Gwalior

Agricultural University of Rajmata Vijyaraje Scindia Gwalior celebrated the National programme on Parthenium awareness week with the collaboration of College Scientists and different KVK of gird zone from 16-23 August, 2011 with great success. On this occasion, team of DWSR-RVSKVV centre and KVK staff, Scientists, technical staff of Department of Agronomy visited villages, College, KVKs, Farm and other organizations in respect to Parthenium awareness. For this purpose the wide publicity was given through pamplet, news papers/ TV / Sangoshti lectures, documentary files on Parthenium & exhibition on management of Parthenium to aware the public regarding the hazards of this serious national weed.

BAU, Ranchi

Parthenium Awareness Week was celebrated in Birsa Agricultural University, Ranchi from 16-22 August 2011. The main activities were preparation of ante Parthenium slogans by students of Faculty of Agriculture, Birsa Agricultural University. The students also took out rally shouting anti-Parthenium slogan with objective to make people aware about hazards of Parthenium in human life.A Kisan Goshthi was also organized in which Professors of Agronomy Department participated and introduced farmers about problems of Parthenium.

CSKHPKV, Palampur

CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur organized the *Parthenium* awareness week-2011 from 16-22, August, 2011. First *Parthenium* awareness Day was organized as per last year's schedule at Dadh on August 10, 2011 in a Farmers School. About 70 farmers, extension officers and officers of the line departments participated in this activity.

V.B., Sriniketan

Visva-Bharati, Sriniketan Centre observed *Parthenium* Awareness Week during the period from 16-22 August, 2011 with various activities through awareness and action oriented programmes involving different village people, school, self-help group, farmers' club, NGOs, Gram Panchayet, teaching and non-teaching staff and students' of Visva-Bharati.

UAS, Dharwad

Parthenium awareness week was observed at UAS Dharwad during the period from 16-22, Aguest, 2011.The centre organised several programmes in order to create awareness among the public. During the said period the public were exposed to several methods in the management of Parthenium by means of uprooting the Parthenium prior to flowering, spreading of the seeds of competitive plant species, viz. *Cassia sericea*, *Tagetis erecta* and *Tephrosia purpurea.*

DBSKKV, Dapoli

Parthenium awareness week was organized in August, 2011 at Palghar, Kelava, Mahim and Bahadoli, Tal. Palghar, Dist.Thane on *Parthenium* and invasive weed awareness, in which, Mexican beeteles (*Zygogramma bicolorata*) were released in the vicinity for biological control of *Parthenium* in presence for local progressive farmers.

SKRAU, Bikaner

Parthenium Awareness Week was observed and organized the different activities with much interest by the DWSR project Centre, Bikaner from 16-22 August, 2011 with active participation of the agriculture extension personal, farmers, farm women scientists, collage students and school children.

MAU, Parbhani

Parthenium awareness week was celebrated during 16-22 August 2011. Awareness was undertaken by conducting rallies, group discussions and lectures at various places in Marathwada. Rally was arranged at University campus with agricultural school and at various places in Parbhani, Nanded and Hingoli districts.

ANGRAU, Hyderabad

Parthenium Awareness Week was observed at Weed Science Research Center, Rajendranagar, Hyderabad from 16-22 August 2011. On this occasion, a brochure on "*Parthenium* and its Management" was prepared and distributed to all the extension Institutes of the University, viz. DAATTCs (District Agro-advisory and Transfer of Technology Centers) and *Krishi Vigyan Kendras* (KVKs).

AAU, Jorhat

"Parthenium Awareness Week" was organized at Nagaon in the Nagaon district in collaboration with Krishi Vigyan Kendra, Nagaon of Assam Agricultural University.

7.0 List of Publications

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CSKHPKV, Palampur

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8.0 List of Scientific Staff Working in the Project

PAU, Ludhiana

Dr. M.S. Bhullar, Agronomist & Principal Investigator

Dr. R.K.Bhatia, Sr. Plant Physiologist - Retired on 31.10.2011

Mrs. Simarjeet Kaur, Asst Agronomist - On study leave

Dr. (Mrs.) Navjyot Kaur, Assistant Plant Physiologist

UAS, Bengaluru

Dr. T.V. Ramchandra Prasad, Agronomist & Principal Investigator

Dr. M.T. Sanjay, Jr. Scientist (Agronomy)

Dr. R. Devendra, Sr. Physiologist(Plant physiology)

Mr. G.R. Hareesh, Sr. Scientist (Residue chemistry)

RVS KVV, Gwalior

Dr. R.L. Rajput, Principal Scientist & Principal Investigator

Dr. S.S. Tomar, Principal Scientist - Transferred on 24.5.2011

Dr. K.S. Yadav, Principal Scientist (Agronomy)

Dr. Asha Arora, Principal Scientist (Residue Chemist)

Dr. A.M. Jaulkar, Principal Scientist (Economics)

GBPUAT, Pantnagar

Dr. V. Pratap Singh, Professor (Agronomy) & Principal Investigator

Dr. T.P. Singh, S.R.O. (Agronomy)

Dr. S.P. Singh, J.R.O. (Agronomy)

Dr. S.K. Guru, S.R.O. (Physiology)

Dr. Shishir Tandon, Jr. Scientist (Residue Chemist)

CSKHPKV, Palampur

Dr. J. Shekher, Head (Agronomy) & Principal Investigator

Dr. N.N. Angiras, Sr. Agronomist & Principal Investigator - Retired on 30.4.2011

Dr. Suresh Kumar, Sr. Scientist (Agronomy)

Dr. (Mrs.) Neelam Sharma, Residue Chemist

Sh. Rajinder Kumar, Jr. Microbiologist

AAU, Jorhat

Dr. Jayanta Deka, Agronomist & Principal Investigator

Dr. Nikunja Ch. Deka, Principal Scientist (Agronomy)

Dr. Iswar Chandra Barua, Principal Scientist (Ecologist)

Dr. Nilay Borah, Senior Scientist (Residue Chemistry)

MAU, Parbhani

Dr. A.S. Jadhav, Agronomist & Principal Investigator

Prof. (Mrs). M.G.Patil, Jr. Microbiologist

Prof. N.S. Jadhav, Jr. Residue chemist

AAU, Anand

Dr. R.B. Patel, Principal Investigator

Dr B.D. Patel, Jr. Agronomist

Shri M.I. Meisuriya, Jr. Physiologist

Shri B.T. Sheta, Residue Chemist

TNAU, Coimbatore

Dr. C. Chinnusamy, Professor (Agronomy) & Principal Investigator

Dr. P. Murali Arthanari, Jr. Scientist (Agronomy)

Dr. K. Govindarajan, Jr. Economist

Dr. P. Janaki, Jr.Scientist (Residue Chemistry)

NDUAT, Faizabad

Dr. Jaidev Sharma, Agronomist & Principal Investigator

Dr. A.K. Singh, Jr. Agronomist

Dr. S.S. Singh, Jr. Residue chemist

Dr. Raj Kumar, Jr. Microbiologist

VB, Sriniketan

Dr. B. Duary, Sr. Lecturer (Agronomy) & Principal Investigator

Mr. A. Hossain, Assistant Agronomist

Dr. D.C. Mondal, Assistant Taxonomist

BAU, Ranchi

Dr. R.R. Upasani, Agronomist & Principal Investigator

Sri. A.N. Puran, Jr. Microbiologist

CSAUAT, Kanpur

Dr. R.A. Yadav, Assoc. Prof. (Agronomy) & Principal Investigator

Dr. Mohd. Zafar Siddiqui, Jr. Agronomist

Dr. Naushad Khan, Jr. Agronomist - Transferred on 31.12.2011

Shri K.N. Singh, Jr.Residue chemist

Dr. R. N. Dixit, Jr.Residue chemist - Transferred on 31.12.2011

KAU, Thrissur

Dr. C.T. Abraham, Professor (Agronomy) & Principal Investigator

Dr. K.M. Durga Devi, Associate Professor (Residue Chemist)

Dr. T. Girija, Asst. Professor (Plant Physiologist)

OUAT, Bhubaneswar

Dr. S.S. Mishra, Agronomist & Principal Investigator

Dr. M.M. Mishra, Jr. Agronomist

Mr. C.R. Sarangi, Jr. Scientist (Res. Chemist)

Dr. K.N. Mishra, Jr. Scientist (Res. Chemist) - Transferred on 16.05.2011

ANGRAU, Hyderabad

Dr. M. Madhavi, Sr. Scientist, Agronomy & Principal Investigator

Dr. A. Srinivas, Principal Scientist (Agro.) & Principal Investigator - Transferred

Dr.T. Ram Prakash, Jr. Residue Chemist

CCSHAU, Hisar

Dr. S.S. Punia, Sr. Agronomist & Principal Investigator

Dr. Dharam Bir Yadav, Sr. Agronomist

Dr. Anil Duhan, Asstt. Residue Chemist

RAU, Pusa

Dr. Yogeshwar Singh, Principal Investigator

Mr. Dharminder, Jr. Agronomist

Dr. R.K. Pandey, Sr. Microbiologist

DBSKKV, Dapoli

Dr. M.J. Mane, Principal Investigator

Mr. Y.R. Govekar, Jr. Microbiologist

IGKVV, Raipur

Dr. A.P. Singh, Principal Scientist & Principal Investigator

Dr. Tapas Chowdhury, Jr. Microbiologist

UAS, Dharwad

Dr. Ramesh Babu, Professor (Agronomy) & Principal Investigator

Dr. P. Jonesnirmalanth, Jr. Microbiologist

RAU, Bikaner

Dr. O.L. Sharma, Agronomist & Principal Investigator

Volunteer Centres

SKUAST, Jammu

Dr. Anil Kumar, Professor & Principal Investigator

SVBPUAT, Meerut

Dr. Raghuvir Singh, Professor & Principal Investigator

ADACRI, Tiruchirappalli

Dr. S. Soma Sundarum, Principal Investigator

PDKV, Akola

Dr. V.M. Bhale, Head (Agronomy) & Principal Investigator

ACRI, Madurai

Dr. R. Balasubramanian, Professor and Head & Principal Investigator

RBS College, Bichpuri, Agra

Dr. B.P. Singh, Head (Agronomy) & Principal Investigator