अखिल भारतीय समन्वित खरपतवार प्रबंधन अनुसंधान परियोजना
All India Coordinated Research Project on Weed Management

2014–2015

वार्षिक प्रतिवेदन
ANNUAL REPORT

भा कृअनु प – खरपतवार अनुसंधान निदेशालय
ICAR - Directorate of Weed Research
जबलपुर (मध्य प्रदेश) भारत
Jabalpur (Madhya Pradesh) India
ISO 9001 : 2008 Certified

वार्षिक प्रतिवेदन Annual Report 2014-2015


DWR

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All India Coordinated Research Project on Weed Management

वार्षिक प्रतिवेदन
Annual Report
2014-15

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Director
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Coordination and editing
Dr. Shobha Sondhia
Dr. A.R. Sharma

Compilation
Dr. Shobha Sondhia
Dr. P.K. Singh
Dr. Sushil Kumar
Dr. R.P. Dubey
Dr. Bhumesh Kumar
Dr. Yogita Gharde

Technical assistance
Mr. O.N. Tiwari
Mr. Pankaj Shukla
Mr. Sandeep Dhagat

Cover page design
Mr. Sandeep Dhagat
Mr. O.N. Tiwari

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Further information
ICAR-Directorate of Weed Research
Jabalpur - 482 004 (M.P.)
Phone : 0761-2353101, 2353934
Fax : 0761-2353129
e-mail : aicrpwcjbp@gmail.com , aicrpwm@icar.gov.in

Cover page photographs

Left to right : *1. Ludwigia peruviana* – a new invasive weed recorded in Kari Anglong and Nagon districts of Assam *2.* Tomato crop infested with *Orobanche* spp. *3.* Infestation of *Cyperus esculentus* in rice *4.* Weed management in wheat *5.* Review of Research-cum-Herbicide Residue Training Workshop of AICRP-WC Centres 11-17 November, 2014 at ICAR-DWR, Jabalpur

Preface

All India Coordinated Research Project on Weed Control (AICRP-WC) was launched in 1978 to undertake the systematic research on weed management in the country. Initially, there were 6 centres in different parts of the country, which grew to 22 centres in 2014, almost in all the Agricultural Universities of the country. Over the last 36 years, information relating to weeds in different cropped and non-cropped situations, management practices, herbicide residues and utilization aspects of weeds has been generated. Location-specific improved technologies on weed management have been developed and adopted in large areas throughout the country. We can claim that weed management technologies are now available for almost all crops and cropping systems as well as for non-cropped situations which have the potential to increase productivity and profitability, and ensure environmental sustainability and biodiversity.

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

The year 2014 was a landmark in the history of this project. The proposals for the XII Plan in terms of infrastructure development, contingencies, staff restructuring and new research programmes were approved with a nearly two-fold increase in the budget compared with the XI Plan. Five low-performing centres at VNMKV Parbhani, CSAUA&T, Kanpur, V.B., Sriniketan, RAU, Bikaner and UAS, Dharwad were closed, while new centres were opened at MPUAT, Udaipur; UAS, Raichur; SKUAST, Jammu; CAU, Pasighat and PDKV, Akola. The name was also changed to AICRP on Weed Management considering the utilization aspect of weeds for beneficial purposes.

I express my sincere gratitude to Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR; and Dr. A.K. Sikka, Deputy Director General (NRM) for providing constant encouragement and guidance. I am also thankful to Dr. B. Mohan Kumar, Assistant Director General (Agronomy, Agroforestry and Climate Change) for his keen interest and support in running the project. I thank

Dr. V.P. Singh, former Incharge of the project (up to 15.11.2014) and Dr. Shobha Sondhia, present Incharge (w.e.f. 16.11.2014), and Dr. Yogita Gharde for help in running the project activities. Thanks are also due to the Nodal Officers i.e. Dr. P.K. Singh, Dr. Sushil Kumar, Dr. R.P. Dubey, Dr. Bhumesh Kumar; and Technical Officers, viz. Mr. O.N. Tiwari, Mr. Pankaj Shukla and Mr. Sandeep Dhagat.

Date : 31.07.2015
Place : Jabalpur

(A.R. Sharma)

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कार्यकारी सारांश

निदेशालय के अंतर्गत 22 समन्वित और 05 स्वैच्छिक केन्द्र देश के विभिन्न राज्यों में स्थित कृषि विश्वविद्यालयों के माध्यम से विभिन्न फसलों, फसल प्रणाली और गैर फसलीय क्षेत्रों मे खरपतवार प्रबंधन हेतु अनुसंधान कार्य कर रहे हैं । वर्ष 2014–15 के दौरान किये गये मुख्य अनुसंधानीय उपलब्धियां निम्नानुसार हैं :

खरपतवार निगरानी

- हरियाणा के भिवानी जिले में टमाटर और बैंगन की फसलों में भुईफोड़ की संक्रामकता गंभीर रूप से होने के कारण दोनों फसलों की उपज में 15–45% तक की हानि दर्ज की गई। यहां तक कि *तारामिरा,* मूली, सलजम, गोभीसरसों और पत्तागोभी में भी भुईफोड़ का संक्रमण पाया गया। भुईफोड़ का संक्रमण नवंबर में बोयी गई सरसों की अपेक्षा अक्टूबर मे बोयी गई सरसों में कम देखा गया।
- हरियाणा में कैथल, कुरूक्षेत्र, करनाल, जींद, पानीपत, फतेहबाद, अंबाला और सिरसा जिलों में *फेलेरिस माइनर* की प्रतिरोधकता क्लोडिनोफाप प्रापारजिल के प्रति विकसित हो रही है।
- *कोरनोपस डिडीमस, पोलीपोगॉन मोन्सप्लानसिस* और *पोआ अनुआ* बरसीम की फसल में प्रमुख खरपतवार दर्ज किये गये।
- केरल के उच्च क्षेत्रों में खरपतवार सर्वेक्षण द्वारा यह पाया गया कि नये आक्रामक खरपतवार *टिथोनिया डाइवर्सीफोलिया, लूडबीसिया पेरूबियाना* और *स्फेजिनेटिकोला* का फैलाव बढ़ रहा है एवं ये खरपतवार *लेन्टाना केमरा, माइमोसा इनविसा* और *पेनीसेटम* प्रजातियों को विस्थापित कर रहा है।
- ओडिशा के उत्तर मध्य पठारी क्षेत्रों में *मिकानिया मिकरेंथा, क्रोमोलिना आडोराटा, माइमोसा पुडिका,* गाजरघास, कांस और *लेन्टाना केमरा* प्रमुख खरपतवार के रूप में दर्ज किये गये।
- क्योंझर जिले में उपरॉव धान एवं रबी की दलहनी फसलों में *सीलोसिया अर्जेन्सिया* का गंभीर प्रकोप देखा गया। इस खरपतवार की आक्रामकता मुख्य रूप से उपरॉव क्षेत्र की तलहटी के पास में क्षेत्र जहां की मृदा हल्की लाल होती है, बढ़ रही है।
- संगरोध खरपतवार *एम्ब्रोसिया साइलोस्टीका* का संक्रमण तुरूवेकर के 12 ग्रामों में कृषकों के खेत में सड़क के किनारे एवं नहर क्षेत्र में अधिक पाया गया।
- वर्षा आधारित एवं सीमित सिचाई परिस्थिति मे सरसौं एवं चना में *यूफोरबिया ड्राकुलकुलाइडिस* खरपतवार का प्रकोप बढ़ रहा है।
- लुधियाना में घासकुल के खरपतवार *पोआ अनुआ, अवेना लूडोविसियाना* और चौड़ी पत्ती के खरपतवार *मेडीकागो डेन्टीकुलाटा, ऐनागेलिस अरवेन्सिस, चीनोपोडियम अल्बम, कार्नेपस डिडीमस, माल्वा पार्वीफलोरा और फ्यूमारिया पार्वीफलोरा* गेहूं में नये खरपतवार के रूप में दर्ज किये गये।
- दूब, कनकौआ और *कोनाइजा बोनारेन्सिस* में ग्लायफोसेट और 2, 4–डी के प्रतिरोधी पाये गये।

खरपतवारों का जीव एवं क्रिया विज्ञान

- भुईफोड़ के पुष्प गुच्छ सरसौं के साथ बुवाई करने पर औसतन 45–54 दिनों बाद दिखाई दिये। भुईफोड़ के पुष्प गुच्छ निकलने के 11–13 दिनों बाद बैंगनी क्रीम रंग के पुष्प दिखाई दिये।
- खरपतवारों के जीव एवं पादप कार्यकी के अध्ययन द्वारा यह पाया गया कि *इकाईनोक्लोआ कालोना* और *डेक्टीलोक्टीनम एजीपिक्टम* का उच्चतम अंकुरण सतह के 2.0 से.मी. गहराई पर बुवाई करने पर होता है। *फेलेरिस माइनर* की क्रास प्रतिरोधकता पीनोक्साडान, पेनोक्जाप्राप–पी–एथिल के प्रति देखी गई। 2, 4–डी एमाईन और ग्लाइफोसेट के अनुक्रमिक अनुप्रयोग करने पर *साइपेरस रूटेन्डस* के लिये प्रभावकारी पाया गया।
- *ट्रायनथेमा पोरटूलेक्सट्रम* बहुत ही कम समय में 45 दिन में गुणात्मक दर से वृद्धि करता हैं एवं यह 7000 बीज प्रति पौधे उत्पन्न करता है। *अमरेन्थस वेरीडिस* का पुष्पण इसको बोने के 45 दिनों बाद प्रारंभ होता है एवं इसका जीवन चक्र 65 दिनों के भीतर पूरा होता है।
- ओडीशा के खुर्दा जिले में और बिहार में उपरॉव धान में जंगली धान का ज्यादा ग्रसन पाया गया लेकिन रोपित धान में इसका ग्रसन बहुत ही कम पाया गया।
- *इकाइनोक्लोआ ग्लाबरेसेन्स* और *इकानोक्लोआ क्रसगाली* के बीज 2 से.मी. गहराई तक बोने में उच्च अंकुरण (56%) और 10 से.मी. गहराई पर कम अंकुरण (41%) पाया गया।
- पीनाक्साडिन, फेनोक्साप्राप–पी–एथाइल और क्लोडिनाफाप के प्रयोग से *पी. माइनर* बायोटाइप्स का 40% नियंत्रण पाया गया। इससे ज्ञात होता है कि ये शाकनाशी *फेलेरिस माइनर* की क्रास प्रतिरोधकता का विकास कर रहे हैं।
- पंतनगर में ग्लाइफोसेट और 2,4–डी के अकेले या इसके संयुक्त उपयोग करने पर मौंथा की गांठो पर जीवन क्षमता का कोई प्रभाव नहीं पाया गया। मौंथा के नियंत्रण हेतु 2,4–डी 125 ग्रा./हे. तदुपरांत ग्लायफोसेट 750 मी.लि./हे. के प्रयोग से 48 घंटे बाद अच्छा नियंत्रण पाया गया।
- कोयम्बटूर में ग्लायफोसेट 1.5 कि.ग्रा./हे. का प्रयोग करने पर मौथा की सघनता और शुष्क भार में कमी पाई गई और 60 दिनों के बाद इसका न्यूनतम पुर्नजनन पाया गया।

फसल और फसल प्रजातियों में खरपतवार प्रबंधन

- रोपित धान में इथाक्सीसल्फयूरान, क्लोरीयुरान + मेटसल्फयूरान या एजीमसल्फयूरान को टेंक मिक्स करने पर

या इसके अनुक्रमिक प्रयोग के साथ ग्रास शाकनाशी जैसे बिसपायरीबेक या प्रीटिलाक्लोर का प्रयोग करने पर चौड़ी पत्ती वाले एवं सेजेस पर पूर्ण नियंत्रण पाया गया। इसके अलावा तैयार मिश्रण का संयोजन शाकनासी जैसे टायफामोन + इथाक्सीसल्फयूरान, पेनोक्सुलम + साइलोफाप और प्रीटिलाक्लोर + पायराजोसल्फयूरान जटिल खरपतवारों पर पूर्ण नियंत्रण पाया गया।

- हल्दी की फसल में फेनोक्साप्राप शाकनाशी का उपयोग अंकुरण पश्चात् करने पर घास कुल के खरपतवारों पर प्रभावकारी नियंत्रण पाया गया। ग्लाइफोसेट 7.5 मि.लि./ली. पानी के साथ सीधे छिड़काव करने पर ज्यादातर सभी प्रकार के खरपतवारों पर प्रभावकारी नियंत्रण पाया गया। मेट्रीब्यूजिन 700 ग्रा./हे. या पेण्डीमीथेलिन 1000 ग्रा./हे. या एट्राजिन 750 ग्रा./हे. तत्पश्चात् मल्चिंग + हाथ द्वारा द्वारा निंदाई बोने के 45 दिन बाद खरपतवारों पर 100% नियंत्रण पाया गया एवं हल्दी की फसल में उन्नत वृद्धि भी पायी गई।
- अदरक की फसल में ग्लायफोसेट 0.80 कि.ग्रा./हे. + आक्सीफ्लोरफेन 0.2 कि.ग्रा./हे. की दर से अदरक के अंकुरण के पूर्व उपयोग करने से तीनों वर्गो के खरपतवारों पर प्रभावकारी नियंत्रण पाया गया एवं खरपतवारों की सघनता और उसके शुष्क भार में कमी दर्ज की गई।
- मूंग की फसल मे अंकुरण के पूर्व पेन्डीमीथेलिन/इमाजेथापायर 1000 ग्रा./हे. का उपयोग करने पर *ट्रायनथेमा पोरटूलेक्सट्रम* और *इकानोक्लोवा कोलोना* पर 80% तक प्रभावकारी नियंत्रण पाया गया।
- खरीफ बाजरा में अंकुरण के पूर्व एट्राजिन 0.50 कि.ग्रा./हे. तत्पश्चात् इंटर कल्टीवेशन बुवाई के 30 दिन पश्चात् करने पर महत्वपूर्ण अनाज व भूसे की उपज दर्ज की गई।
- मक्का–गेहूं फसल चक्र में, शून्य जुताई– शून्य जुताई अनुक्रम में 46.5% अधिक दानों भूसे की उपज अभिसामयिक भू परिष्करण अभिसामयिक भू परिष्करण (सीटी–संरक्षित खेती) की तुलना में दर्ज की गई एवं सभी प्रकार के खरपतवारों की सघनता एवं शुष्क भार में कमी भी दर्ज की गई।
- धान–गेहूं फसल चक्र में विभिन्न फसल स्थापना विधियों द्वारा गेहू की अधिकतम दाने की उपज बोआई (शून्य परिष्करण) + धान – गेहूं (शून्य परिष्करण) + धान फसल अवशेष ढैचा (शून्य परिष्करण) 4.7 ट./हे. एवं धान की रोपाई पद्धति गेहूं (पारंपरिक परिष्करण) 4.6 ट./हे. प्राप्त हुई।
- संरक्षण कृषि पद्धति द्वारा चना–धान फसल चक्र में चना में अभिसामयिक/शून्य भू परिष्करण के बाद धान मे अभिसामयिक भूपरिष्कण, चना में शून्य भूपरिष्करण की तुलना में अच्छा प्रदर्शन पाया गया । इसी प्रकार का प्रदर्शन गर्मी की मूंग में भी पाया गया।
- गेहूं की तुलना में लंबी अवधि के 1999 से लगातार चल रहे परीक्षण द्वारा विभिन्न उपचार हरी खाद, बिना हरी खाद की तुलना में बराबर या उच्च पाये गये। *फेलेरिस माइनर* का प्रकोप वीडी चेक प्लाट में हरी खाद व बिना हरी खाद में बराबर पाया गया लेकिन इसकी सघनता हरी खाद में महत्वपूर्ण रूप से उच्च पाई गई। चौड़ी पत्ती वाले खरपतवारों का शुष्क भार भी हरी खाद में बिना हरी खाद की तुलना में कम पाया गया।
- परंपरागत जुताई शून्य जुताई की तुलना में प्रयोग के प्रारंभिक चरण में मिट्टी के सूक्ष्म जीवी और जैव रसायनिक गुणों में सुधार करने के लिये बेहतर पाया गया। परंपरागत जुताई द्वारा चना की जड़ों में गांठो की महत्वपूर्ण वृद्धि शून्य जुताई की तुलना में फसल बोने के 50 दिन बाद दर्ज की गई।
- पेंडीमिथेलिन या आक्सीफ्लोरफिन का प्रयोग गाजर और बैंगन की फसल में करने पर घास कुल, चौड़ी पत्ती और सेजेस कुल के खरपतवारों पर प्रभावकारी रूप से कमी दर्ज की गई।

समस्याकारी खरपतवारों का प्रबंधन

- तंबाखू की बोआई के समय नीम के 200 कि.ग्रा./हे. तदुपरांत मेटालाक्सिल एम.जेड 0.2% का उपयोग बोआई के 20 दिन बाद मिट्टी में करने पर भुईफोड़ की शाखाओं के घनत्व में कमी दर्ज की गई और तंबाखू के पत्तों की अधिक उपज प्राप्त की गई।
- सरसों में, ग्लायफोसेट 25 ग्रा./हे. बोआई के 30 दिन बाद और 50 ग्रा./हे. बोआई के 55 दिन बाद और 1% अमोनियम सल्फेट सहित या इसके बिना छिड़काव करने पर भुईफोड़ के नियंत्रण हेतु बोआई के 120 दिन तक प्रभावकारी नियंत्रण (75–80%) पाया गया, यद्यपि सिर्फ ग्लायफोसेट 50 ग्रा./हे. का उपयोग बोआई के 40 दिन पर करने पर भुईफोड़ में 60% तक नियंत्रण पाया गया।
- लूसर्न में अंकुरण के पूर्व पेंडीमीथेलिन 0.5 कि.ग्रा./हे. (रेत मिलाकर) का प्रयोग करने पर विषाक्त प्रभाव पाया गया और सिर्फ 10% पौधे ही अंकुरण के बाद बच पाये।
- ब्यूटाक्लोर (अंकुरण के पूर्व) और मेटालाक्सिल का फोलियर छिड़काव बोने के 20 दिन बाद तक अमरबेल के नियंत्रण हेतु कोई सकारात्मक प्रभाव नहीं पाया गया।
- नाइजर में अंकुरण के पूर्व पेंडीमिथेलिन का छिड़काव करने पर प्रतिकूल प्रभाव नहीं पाया गया। यद्यपि इमाजथापायर का प्रयोग करने पर अमरबेल के नियंत्रण के साथ–साथ नाइजर की वृद्धि को भी प्रभावित किया।
- नाइजर में स्टेलसीड बेड तदुपरांत पेंडीमिथेलिन 1.0 कि.ग्रा./हे. के अंकुरण के पूर्व प्रयोग करने पर अमरबेल का अंकुरण कम पाया गया एवं नाइजर की उच्चतम उपज दर्ज की गई।
- गन्ने की फसल में, स्ट्राईगा के नियंत्रण हेतु एट्राजिन 1.0 कि.ग्रा./हे. रोपण के 3 दिन पर + एक निंदाई 45 दिन पर + 60 दिन पर मिट्टी चढ़ाना + 2,4–डी सोडियम साल्ट 5 ग्रा./ली. + यूरिया 20 ग्रा./ली. 90 दिनों के बाद तत्पश्चात् ट्रेस मल्चिंग 5 ट./हे. की दर से 120 दिन करने पर अमरबेल के नियंत्रण के लिये सिफारिश की गई है।

- *निकोटिना ब्रूची* का गुणन हिसार में पाया गया, जलकुंभी की पत्तियों पर इसके निशान पाये गये लेकिन पूर्ण रूप से इसकी पत्तियों को खाया जाना नहीं पाया गया।

शाकनाशी अवशेष और पर्यावरण गुणवत्ता

- आक्साडायरजिल का प्रयोग विसपायरीबैक के साथ करने पर मिट्टी में कटाई के समय तक अवशेष पाये गये। फेनक्जाप्राप–पी–इथाइल, क्लोरीमुरान–इथाइल और मेटसल्फयूरान–मिथाइल का प्रयोग खरीफ धान में करने पर इसके अवशेष का प्रभाव रबी में चना की बुआई के समय तक पाया गया।

- ब्यूटाक्लोर और एनिलोफास के अवशेष मृदा में क्रमशः 0.056 और 0.083 µg/g 60 दिन तक पाये गये । प्रिटिलाक्लोर का प्रयोग लगातार और रोटेशन रूप में करने से इसके अवशेष 0.071 और 0.049 µg/g 60 दिन तक पाये गये।

- पायरोजोसल्फयूरान – इथाइल का प्रयोग धान में 25 ग्रा. से 50 ग्रा./हे. तक करने पर इसके अवशेष 35 से 45 दिन मृदा में पाये गये। धान की कटाई के समय इसके अवशेष मृदा, दानों, भूसा और भू–जल में नहीं पाये गये।

- हरियाणा में 9 जगहों से लिये गये नमूनों में से एक जगह में क्लोडिनाफाप के अवशेष पाये गये और करनाल के नबीपुर गांव से 50 जगह से एकत्र किये गये नमूनों में से दो स्थानों के नमूनों में प्रिटिलाक्लोर शाकनासी के अवशेष 0.092 और 0.066 µg/mL सीमा तक पाये गये। आक्साडायजिल, ब्यूटाक्लोर और एनिलोफास शाकनाशी के अवशेष 50 जगहों से एकत्रित नमूनों में नहीं पाये गये।

- हरियाणा के जिले में 17 जगहों से मृदा के नमूनों में से 8 जगहों में सल्फोसल्फयूरान शाकनाशी के अवशेष 0.015 से 0.044 µg/g सीमा तक पाये गये। सल्फोसल्फयूरान के अवशेष गेहूं के दानों और भूसा में नहीं पाये गये। इसी प्रकार 21 जगहों में से 3 जगहों में प्रिटिलाक्लोर शाकनाशी के अवशेष 0.016 से 0.058 µg/g सीमा तक मृदा, धान के दानों और भूसा में पाये गये। आक्साडायजिल शाकनाशी के अवशेष मृदा, धान के दानों और भूसा में नहीं पाये गये।

कृषक प्रक्षेत्र पर शोध

- टेम्बोट्रीओन शाकनाशी का उपयोग करने पर साइप्रस *रूटेन्डस, ब्राकेरिया रेपटेन्स, कमीलीना बेन्घालेन्सिस, डिजिटेरिया सेंग्वालेन्सिस, सोरघम हेल्पेन्स* और *इलुसाइन इंडिका* खरपतवारों पर प्रभावी नियंत्रण पाया गया जो कि ये खरपतवार किसानों द्वारा एट्राजिन के उपयोग करने पर भी नहीं होते थे।

- क्लोडिनाफाप + मेट्रिब्यूजिन के तैयार मिश्रण के समायोजन से गेहूं में फेलेरिस माइनर खरपतवार पर 87 प्रतिशत से अधिक नियंत्रण पाया गया । लेकिन गेहूं की उपज कम दर्ज की गई। गेहूं की कुछ किस्मों में जैसे पीबीडब्लू 550, एचडी 2967, एचडी 2891 और बारबत को उच्च नमी की स्थिति में विषाक्ता पायी गई और कुछ मामलों में *फैलेरिस माइनर* का पुर्नजनन पाया गया।

- उत्तराखंड के तराई क्षेत्रों में क्लोडिनाफाप –प्रोपाजिल और मेटसल्फ्यूरान– मिथाईल के मिश्रित उत्पाद का छिड़काव क्लोडिनाफाप– प्रोपाजिल और मेटसल्फयूरान–मिथाईल के अलग–अलग की तुलना में खरपतवारों के नियंत्रण हेतु अधिक प्रभावी पाया गया, जबकि सल्फोसल्फ्यूरान + मेटसल्फयूरान–मिथाईल 30+2 ग्रा./हे. की दर का प्रयोग पर्वतीय क्षेत्रों में प्रभावी पाया गया।

- मूंगफली में अंकुरण के पूर्व आक्सीफ्लोरफिन तदुपरांत इमाजेथापायर + क्वाजिलाफॉप – इथाइल का 15 दिन पर छिड़काव खरपतवारों के नियंत्रण हेतु बृहद रूप से प्रभावी पाया गया और मूंगफली की उच्च उपज और आर्थिक आमदनी दर्ज की गई।

- सरसौं में भुईफोड़ के नियंत्रण हेतु ग्लायफोसेट का दो बार उपयोग 25 और 55–60 दिन बोआई के बाद करने पर सरसौं की उपज में 14.6% वृद्धि बिना उपचारित प्लाट की तुलना में दर्ज की गई।

- गेहूं में खरपतवार प्रबंधन प्रदर्शन द्वारा शून्य जुताई से बोआई करने पर अवशेष + शाकनाशी प्रभावकारी खरपतवार नियंत्रण के साथ–साथ अधिक उपज और शुद्ध लाभ, कृषक पद्धति (परंपरागत जुताई द्वारा बोआई + शाकनाशी) की तुलना में दर्ज किया गया।

जनजाति सहयोजना

- रांची केन्द्र द्वारा आदिवासी किसानों के उत्थान के लिये फलों पर आधारित भूमि के उपयोग हेतु एक तंत्र विकसित किया गया, जिससे आदिवासी किसानों को परिचित कराया गया। इसके अंतर्गत अंर्तफसलीय विधि से बगीचों में अंतर स्थान के साथ खेत की फसलों, खरपतवारों की रोकथाम और उनसे होने वाले आर्थिक लाभों से अवगत कराया गया।

- कुल 248 एकड़ क्षेत्र में 28 आदिवासी गांव जो कि बस्तर, कोडगांव, कांकेर, बिलासपुर, बलरामपुर और महासमुंद्र जिलों में है, धान में खरपतवार प्रबंधन पर प्रथम पंक्ति प्रदर्शित किया गया। कुल 248 किसानों को इस कार्यक्रम द्वारा लाभ पहुंचाया गया।

- उड़ीसा के सुंदरगढ़ जिला और छत्तीसगढ़ के क्योंझर जिलों में विभिन्न प्रकार के कृषि उपकरण और औजार वितरत कर लगभग 225 आदिवासी किसानों को लाभ पहुंचाया गया।

EXECUTIVE SUMMARY

AICRP on Weed Management has 32 regular centres and 5 volunteer centres located at different state agricultural universities for carrying out network research and generating location specific technologies on weed management in different crops, cropping system and non-cropped situations. Salient research findings of 2014-15 are presented below:

Weed surveillance and monitoring

- Tomato and brinjal crops of Bhiwani district were severely infested with *Orobanche* spp. causing 15-45 % decrease in yield. Some other crop, like taramira, radish, turnip, gobhia sarson and cabbage were also found infested with *Orobanche* at Hisar. Mustard crop sown in November was less infested with *Orobanche* as compared to October sown crop.
- *Coronopus didymus, Polypogon monspliensis* and *Poa annua* have become major weeds of berseem crop.
- Weed survey conducted in the high ranges of Kerala showed that new invasive weeds *Tithonia diversifolia, Ludwigia peruviana* and *Sphagneticola* are spreading in the region and replacing *Lantana camara, Mimosa invisa* and *Pennisetum species*.
- *Mikania micrantha, Chromolaena odorata, Mimosa pudica, Parthenium hysterophorus, Saccharum spontaneum* and *Lantana camara* were prominent weeds found in North central plateau Zone of Odisha.
- *Celosia argentea* was found a severe problem in upland rice and *Rabi* pulses in the districts of Keonjhar, Odisha. The weed is invading mostly the upland areas nearer to the foothills with the soil types belonging to light textured red soils.
- *Ambrosia psilostachya* a quarantine weed infested in 12 villages of Turuvekere in farmer's field, road side, irrigation canals and guntas.
- *Kharif* crops in south Haryana grown under light textured soils was heavily infested with broadleaf weed *Leucas aspera* which was not controlled by pendimethalin and atrazine used by the farmers.
- *Poa annua* and *Avena ludoviciana* among grasses, and *Medicago denticulata, Anagallis arvensis, Chenopodium album, Cornopus didymus, Malva parviflora* and *Fumaria parviflora* among broadleaf weeds are also emerging as new weed species in wheat crop at Ludhiana.
- *Cynadon dectylon, Commelina bengalensis, Conyza bonariensis* were found to be resistant to glyphosate and 2, 4-D.
- *P. minor* has developed resistance against clodinafop-propargyl in Kaithal, Kurukshetra, Karnal, Jind, Panipat and parts of Sonipat, Fatehbad, Ambala and Sirsa districts of Haryana state.

Weed biology and physiology

- *Orobanche* panicles appeared above soil on an average 45-54 days after sowing of mustard.
- *Echinochloa glabrescens* and *Echinochloa crus-galli* recorded higher emergence in 2 cm sowing depth (56%) and lower in 10 cm depth (41%). Sequential application of 2, 4-D amine salt and glyphosate was found effective against *C. rotundus*.
- *Trianthema portulacastrum* was having quick multiplication rate in shorter period of 45 days and produces about 7000 seeds per plant. *Amaranthus viridis* flowering started at six weeks after emergence and completed its life cycle within 65 days.
- Weedy rice infestation was highest in direct seeded rice and least in transplanted rice in Khorda district of Odisha and Bihar.
- Pinoxaden, fenoxaprop-p-ethyl and clodinafop recorded <40% control of *P. minor* biotypes (20 DAS) indicating the development of cross-resistance in *P. minor* to these herbicides.
- Glyphosate and 2, 4-D alone or in combination had no effect on the tuber viability of *C. rotundus* at Pantnagar.
- Application of 2, 4-D at 125 g/ha *fb* glyphosate 750 mL/ha after 48 hrs gave good control of *Cyperus rotundus*.

Weed management in crops and cropping systems

- Addition of ethoxysulfuron, chlorimuron+ metsulfuron or azimsulfuron as tank-mix or as sequential application with grass herbicides like bispyribac or pretilachlor, controlled broadleaf weeds and sedges in transplanted rice. Also the ready-mix combination of triafamone + ethoxysulfuron, penoxsulam + cyhalofop and pretilachlor + pyrazosulfuron provided almost complete control of complex weed flora.

- In turmeric, fenoxaprop provided effective control of grassy weeds as post-emergence herbicide. Metribuzin or pendimethalin or atrazine *fb* mulching+ hand weeding at 45 DAS provided complete control of weeds (100%) in turmeric with improved crop growth.
- Application of glyphosate 0.80 kg/ha + oxyfluorfen 0.2 kg/ha just before emergence of sprouts of ginger was found effective in reducing density and dry matter accumulation by all three categories of weeds.
- Pre-emergence use of pendimethalin + imazethapyr provided effective control of *T. portulacastrum* and *E. colona* in greengram with 80% control of weeds even up to 45 DAS without any crop suppression.
- In maize-wheat cropping system, zero tillage-zero tillage sequence recorded 46.5% more grain and straw yield compared to conventional-conventional tillage (CT-CT) sequence owing to reduced weed density and dry matter accumulation by all categories of weeds.
- Green manuring to *Kharif* rice did not influence the weed density and growth of monocots and broad leaved weeds in *Rabi* groundnut.
- Conventional tillage was found better than zero tillage to improve the microbial and biochemical properties of soil at initial stage of experimentation. Conventional tillage significantly increased the nodule biomass of chickpea over zero tillage at 50 days after sowing of crop.
- Application of oxyfluorfen or pendimethalin was found to be effective in reducing grassy, broad leaf and sedges weeds in carrot and egg plant.

Management of problematic weeds

- Neem cake 200 kg/ha at sowing *fb* soil drenching of metalaxyl MZ 0.2% at 20 DAP reduced *Orobanche* shoot density with better weed control and higher tobacco leaf yield.
- Glyphosate application at 25 g/ha at 30 DAS and 50 g/ha at 55 DAS alone or with 1% with $(NH_4)_2SO_4$ provided good (75-80%) control of *Orobanche* up to 120 days after sowing. Use of glyphosate alone at 50 g/ha at 40 DAS provided 60 % control of *Orobanche* cand 10% crop suppression in terms of chlorosis and necrosis resulted in poor yield.
- Application of pendimethalin 0.50 kg/ha (sand mix) as PE showed phytotoxic effect on lucerne crop and only 10% plants were survived after germination in pendimethalin application.
- Butachlor as PE and foliar spray of metalaxyl at 20 DAS did not *Cuscuta*.
- Application of pendimethalin as pre-emergence did not influence niger plant. However application of imazethapyr not only affected *Cuscuta* but also plant germination as well as growth of niger.
- The germination of *Cuscuta* was less in stale seedbed *fb* pendimethalin 1.0 kg/ha – pre-emergence which resulted in the highest grain yield of niger.
- Pre-emergence application of atrazine 1.0 kg/ha on 3 DAP + HW on 45 DAP + earthing up on 60 DAP + POE 2, 4-D Na salt 5 g/L + urea 20 g/L on 90 DAP *fb* trash mulching at 5 t/ha on 120 DAP could be recommended for effective control of *Striga asiatica* in sugarcane.
- Multiplication of *Neochetina bruchi* weevils was observed at Hisar but caused only scars on water hyacinth leaves; complete feeding of leaves was not observed.

Herbicide residues and environmental quality

- Oxadiargyl along with bispyribac persisted in soil up to harvest stage. Residual effect of fenoxaprop-p-ethyl, chlorimuron-ethyl and metsulfuron-methyl (applied in *Kharif* rice) was observed during *Rabi* up to sowing time of chickpea.
- Residues of butachlor and anilophos in soil were found 0.056 and 0.083 µg/g, respectively at 60 days. The residues of pretilachlor in continuous and rotational use treatments were 0.071 and 0.049 µg/g, respectively at 60 days.
- Use of pyrazosulfuron ethyl 25 to 50 g/ha in rice showed residue up to 35 to 45 days in the soil.
- Clodinafop residues were detected in one out of 9 sites of Haryana and only two sites out of 50 were detected with pretilachlor residues in the range of 0.092 and 0.066 µg/mL at village Nabipur of Karnal. No oxadiargyl, butachlor and anilofos residues were detecetd at any site out of 50 sites from were samples were taken.
- Among 17 sites, 8 were having sulfosulfuron residues in soil in the range of 0.015 to 0.044 µg/g in districts of Haryana. No residues of sulfosulfuron were observed in wheat grains and

straw. Similarly, 3 out of 21 sites were having pretilachlor residues ranging between 0.016 and 0.058 µg/g in soil, paddy grain and straw.

On-farm research

- Tembotrione provided effective control of *Cyperus rotundus, Brachiaria reptans, Commelina benghalensis, Digitaria sanguinalis, Sorghum halepense* and *Eleusine indica* which were not being controlled by atrazine being used by the farmers.
- The bioefficacy of ready mix combination of clodinafop+ metribuzin against complex weed flora in wheat provided more than 87% control of *P. minor* but decreased yield. Toxicity to some of varieties viz: PBW 550, HD 2967, HD 2891 and Barbat under high moisture conditions and regeneration of *P. minor* in some cases were also observed.
- In tarai regions of Uttarakhand, application of ready mix of clodinafop-propargyl and metsulfuron-methyl in wheat crop was found more effective to control the weeds as compared to application of clodinafop-propargyl and metsulfuron-methyl alone, whereas in hilly areas, ready mix combination of sulfosulfuron + metsulfuron-methyl 30 + 2 g/ha was found effective.
- Pre-emergence application of oxyfluorfen followed by imazethapyr + quizalofop-ethyl on 15 DAS was found effective for broad spectrum weed control and higher seed yield and economic returns in groundnut.
- Use of glyphosate twice at 25 and 55-60 DAS provided on an average 66% control of *Orobanche aegyptiaca* in mustard with yield increase of 14.6% over untreated control.
- Demonstrations on weed management in wheat using ZT sowing with residues + herbicides recorded effective weed control and higher wheat grain yield and net returns than farmers practice (CT sowing + herbicides).

TSP programme

- A fruit based land use system was developed to acquaint farmers about improved method of orchard development and introduces intercropping in orchard to utilize interspace for cultivation of field crops, suppress weeds by intercropping in newly developed orchard and to evaluate the economics of farmers.
- Front line demonstrations on weed management in rice were laid down in 28 tribal villages in districts of Bastar, Kondagaon, Kanker, Bilaspur, Balrampur, Balrampur and Mahasamund. A total of 248 farmers were benefitted by this programme.
- About 225 farmers of Odissa and Chattishgarh were given different farm machineries implements and agricultural inputs.

1. ORGANIZATION AND FUNCTIONING

1.1 Introduction

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

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

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

In the VIII Plan, 4 new centres, viz. Rajasthan Agricultural University, Bikaner; Indira Gandhi Krishi Vishva Vidyalaya, Raipur; Konkan Krishi Vidhya Peeth, Dapoli and University of Agricultural Sciences, Dharwad were initiated with total outlay of ₹ 16.41 lakhs. Seventy five percent of the total budget required by each centre was provided by the ICAR and the remaining 25% was met from the state department of agriculture as a state share. There was however 100% funding by the ICAR to Visva Bharati, Sriniketan.

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

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

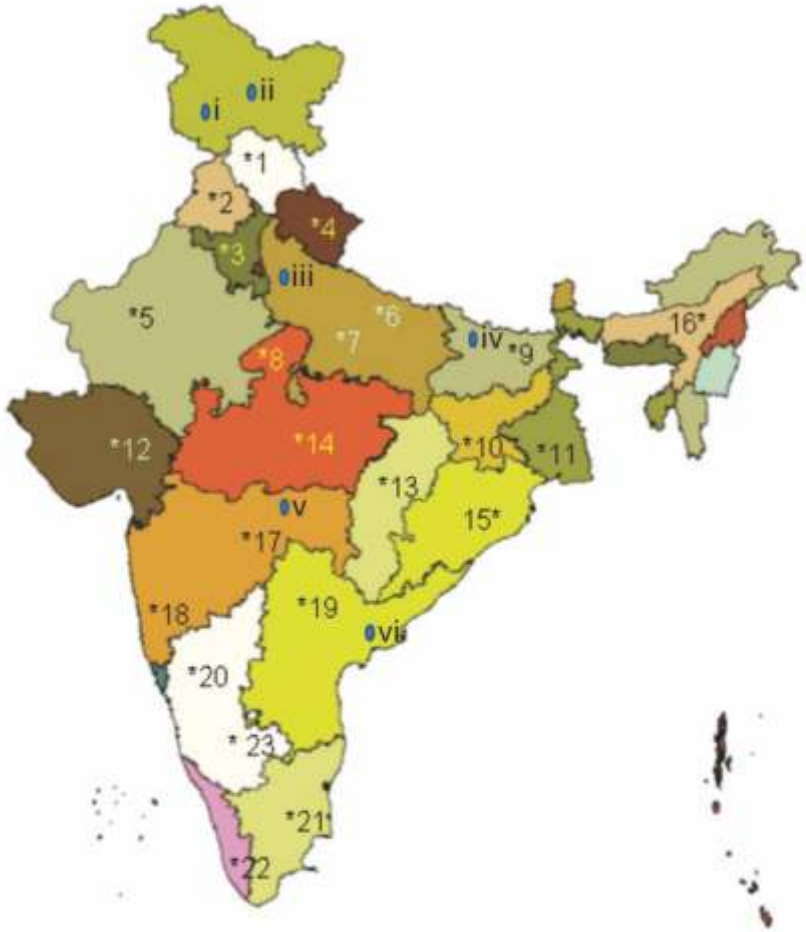
The coordinating unit of the project was located initially at Central Rice Research Institute, Cuttack, and shifted to National Research Centre for Weed Science in 1989. Later in 2009, NRC for Weed Science was upgraded to Directorate of Weed Science Research. During XII Plan (2012-17), it has renamed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

1.2 Mandate

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

1.3 Objectives

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



AICRP-Weed Control	
Regular Centres	
1	CSKHPKV, Palampur
2	PAU, Ludhiana
3	CCSHAU, Hisar
4	GBPUAT, Pantnagar
5	SKRAU, Udaipur
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, DWR, Jabalpur
15	OUAT, Bhubaneswar
16	AAU, Jorhat
17	VNMKV, Parbhani
18	DBSKKV, Dapoli
19	PJTSAU, Hyderabad
20	UAS, Dharwad
21	TNAU, Coimbatore
22	KAU, Thrissur
23	UAS, Bengaluru
Volunteer Centres	
i	SKUAST, Jammu
ii	SKUAST, Kashmir
iii	SVBPUAT, Meerut
iv	RAU, Sabour (Bihar)
v	PDKV, Akola
vi	PJNCA, Puducherry

2. STAFF POSITION AND EXPENDITURE

AICRP on Weed Management is presently under operation in 18 State Agricultural Universities in 22 different states of the country. These centres represent 18 agro-ecological regions. Altogether, 61 scientists of different disciplines (Agronomy, Plant Physiology, Taxonomy, Residue Chemistry, Microbiology and Agricultural Economics) are working in inter-disciplinary mode. Besides main centres, 5 volunteer centres are also in operation. The details of staff position and funds allocated in the financial year 2014-15 are given below:

Staff position at different coordinating centres as on 31.3.2015

Centre	Scientific		Technical (Including Driver)		Administrative		Supporting	
	Sanctioned	Filled	Sanctioned	Filled	Sanctioned	Filled	Sanctioned	Filled
PAU, Ludhiana	4	4	3	2	1	-	2	2
UAS, Bengaluru	4	4	3	2	1	1	2	2
RVSKVV, Gwalior	4	3	2	2	1	1	2	2
GBPUAT, Pantnagar	4	4	3	2	1	1	2	2
CSKHPKV, Palampur	4	4	3	3	1	-	2	1
AAU, Jorhat	4	4	3	3	1	1	2	2
VNMKV, Parbhani	4	3	3	2	1	1	2	1
AAU, Anand	4	2	3	2	1	-	2	2
TNAU, Coimbatore	4	3	3	3	1	1	2	2
NDUAT, Faizabad	4	4	2	2	1	-	2	2
VB, Sriniketan	3	2	2	2	1	1	1	1
BAU, Ranchi	3	2	2	2	1	1	1	1
CSAUAT, Kanpur	3	3	1	1	1	1	1	1
KAU,Thrissur	3	3	2	1	1	1	1	-
OUAT, Bhubaneswar	3	3	2	2	1	1	1	1
PJTSAU, Hyderabad	3	3	1	1	1	1	1	1
CCSHAU, Hisar	3	3	2	2	1	-	1	-
RAU, Pusa	3	3	2	1	1	-	1	1
DBSKKV, Dapoli	2	2	1	1	1	1	1	1
IGKVV, Raipur	2	2	1	1	1	1	1	1
UAS, Dharwad	2	2	1	1	1	1	1	1
SKRAU, Bikaner	2	2	1	1	1	-	1	1
Total	**72**	**65**	**46**	**39**	**22**	**15**	**32**	**28**

Funds released to different coordinating centres during the financial year 2014-15

(₹ in lakhs)

Sl. No.	Centre name	Pay & allowances	TA	Recurring contingency	TSP	Total (ICAR share)
1	PAU, Ludhiana	12.92	0.60	2.78	0.00	16.30
2	UAS, Bengaluru	49.03	0.60	4.20	0.00	53.83
3	RVSKVV, Gwalior	44.54	0.45	3.78	6.34	55.11
4	GBPUAT, Pantnagar	38.02	0.60	4.38	0.00	43.00
5	CSKHPKV, Palampur	58.57	0.60	6.20	6.64	72.01
6	AAU, Jorhat	37.00	0.60	2.40	4.44	44.44
7	VNMKV, Parbhani	4.17	0.00	0.00	0.00	4.17
8	AAU, Anand	14.31	0.45	1.80	6.24	22.80
9	TNAU, Coimbatore	55.62	0.60	2.40	0.00	58.62
10	NDUAT, Faizabad	29.21	0.60	3.18	0.00	32.99
11	VB, Sriniketan	25.85	0.60	2.40	0.00	28.85
12	BAU, Ranchi	22.47	0.30	1.58	6.54	30.89
13	CSAUAT, Kanpur	6.29	0.00	0.00	0.00	6.29
14	KAU, Thrissur	56.59	0.45	2.60	0.00	59.64
15	OUAT, Bhubaneswar	6.76	0.45	3.80	6.28	17.29
16	PJTSAU, Hyderabad	40.94	0.45	2.38	0.00	43.77
17	CCSHAU, Hisar	24.91	0.45	3.20	0.00	28.56
18	RAU, Pusa	28.32	0.45	1.80	0.00	30.57
19	DBSKKV, Dapoli	12.91	0.30	1.58	3.80	18.59
20	IGKVV, Raipur	37.40	0.30	1.58	9.72	49.00
21	UAS, Dharwad	16.15	0.00	0.00	0.00	16.15
22	SKRAU, Bikaner	0.00	0.00	0.00	0.00	0.00
	Total	621.98	8.85	52.04	50.00	732.87
	Volunteer centres					
23	SKUAST, Jammu	0.00	0.00	0.35	0.00	0.35
24	DPDKV, Akola	0.00	0.00	0.20	0.00	0.20
25	PJNCA & RI, Karaikal	0.00	0.00	0.19	0.00	0.19
	Total	621.98	8.85	52.78	50.00	733.61
26	PC Unit, Jabalpur	0.00	0.00	10.49	0.00	10.49
	Grand Total (ICAR Share)	621.98	8.85	63.47	50.00	744.10

3. RESEARCH ACHIEVEMENTS

WS 1. Weed surveillance and monitoring

WS 1.1. Monitoring of appearance of new weed species

Surveillance was made for appearance of any new weed/weed(s) at places of high risks (i.e., nearby area of public distribution systems, procurement centres, FCI godowns, garbage area or any other hot spot). Following observations were found at different centres.

AAU, Jorhat

Ludwigia peruviana became invasive in Dhansiri and Kopili catchments of Assam and now spreading to Morigaon and Kamrup districts with several satellite populations. It formed monocultural stands, displaced indigenous vegetation and havocked the biodiversity. *Ludwigia peruviana* and its associated species were identified in four distinct situations *viz.* Marshlands, Peatlands, Stream beds and Bordering uplands. In addition, *Alternanthera philoxeroides*, the perennial amphibious weed was found to be problematic in cropped and non-cropland situations in Lower Brahmaputra Valley zone. Jute and rice ecosystems were severely affected by this weed. Invasive grass *Panicum repens* has established in aquatic ecosystem as troublesome weed in Nalbari district.

Ludwigia peruviana – a new invasive weed recorded in Kari Anglong and Nagon districts of Assam

BAU, Ranchi

New weed, *Conyza canadensis* of Asteraceae family is infesting area of agronomical research farm of BAU. The species are annual/biennial rarely shrub, growing 30 to 75 cm in height. The weed was first noticed on the bunds. But after land development plan most of the bunds were destroyed. This resulted in spread of this weed in the main field. It appears that part of root, seeds and other propagule might be responsible for its dispersal.

CCSHAU, Hisar

Tomato and brinjal crops in Nuh and Ferozepur Jhirka areas of Mewat and Dadri tehsil of Bhiwani district were severely infested with *Orobanche* spp. causing 30-70% decrease in fruit yield of both crops. Even taramira, radish, turnip, gobhi, sarson and cabbage were found infested with *Orobanche* but Karan rye field did not infestated with *Orobanche*. A new weed *Lolium* spp., with sporadic distribution was found to pose severe crop-weed competition to wheat crop grown under high moisture conditions in Ambala, Yamauna Nagar, Kurukshetra and Dhamtan Sahib area of Jind districts. *Coronopus didymus, Polypogon monspeliensis* and *Poa annua* were becoming major weeds of berseem crop. *Avena ludoviciana* was observed as a new weed of wheat in Dighawa, Loharu, Badhra, Siwani and Tosham areas which was not found earlier in these areas.

Tomato crop infested with *Orobanche* spp.

DBSKKV, Dapoli

Extensive survey counducted during *Kharif* season 2014 at Raigad and Palghar districts did not reveal occurence of any new weed species.

GBPUAT, Pantnagar

In the farmers' field in Chandni Chowk area near Haldwani, two unknown weed species in sugarcane crop were found (GPS location: N 29° 09.290, E 79° 28.364 and Altitude 1105 ft.).

IGKV, Raipur

Alternanthera triandra has emerged as a new havoc in Raipur district and adjoining plains of Chhattisgarh in cropped fields especially in direct seeded rice which occupies around 70% area in state. The control of this weed after 4-5 leaf stage was difficult with chlorimurom + metsulfuron (almix), however, 2,4-D is still an effective solution for this weed. Other weeds invading the non-cropped area were *Malwa pusilla, Cenchrus ciliaris* in Chhattisgarh plains and *Chromolaena odorata* entering from southern parts of Chhattisgarh and knocking the door steps of Chhattisgarh plains. The intensity of these weed is multiplying at a rapid pace and replacing other vegetations even *Parthenium hysterophorus*.

KAU, Thrissur

Tithonia diversifolia was found to fast colonizing the high ranges of Kerala. It is fast spreading in the wastelands of the district. It forms dense strands and prevents the growth of the native flora. The flower heads are solitary on a peduncle 6-13 cm long yellow in colour. Currently, the distribution is limited to the high ranges of Kerala mainly on the sides of the national highway. The spread into the interior villages of the district is restricted. A few plants have also been observed in Thrissur and Palakkad districts on the national highways indicating that it can slowly spread further throughout the state.

Ludwigia peruviana is found to be spreading in Waynad district of Kerala. It is a medium-sized perennial shrub which can grow upto 1m. This weed which has been listed as invasive by the Florida Exotic Pest Plant Council. The weed is found to infest large areas where water stagnates during rainy season.

OUAT, Bhubaneswar

The weed survey has been conducted in the rainfed tracts along the state highway from Khurda to Banki under East and South Eastern Coastal Plain agro-climatic zone of the state. *Parthenium hysterophorus* has now invaded the crop fields. Heavy infestation of *Chromolaera odorata* has been noticed alongwith road side in Banki area of Cuttack district.

PAU, Ludhiana

Infestation of *Sphenoclea zeylanica* in paddy fields was observed in sub-mountainous areas.

RAU, Pusa

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

TNAU, Coimbatore

No new weed was observed in any of area surveyed during all cropping seasons.

UAS, Bengaluru

No new weed has been found except *Ambrosia psilostachya* (a quarantine weed) which has already been reported in last years. Presently this weed infested in 12 villages of Turuvekere in 158 farmers field and road side, irrigation canals of 300 acres. Efforts were made to completely eradicate the weed in collaboration with Karnataka State Department of Agriculture, and National Institute of Plant Health Management, Hyderabad by spraying glyphosate 41 SL 10 ml/L with 20 g urea + 2 drops of lime juice or glyphosate 71 SG 7.5 g/L + 2 drops of lime juice or 2,4-D sodium salt 2.5 g/L directed spray on the weed foliage with floodjet nozzle.

PJNCA&RI, Karaikal

No new weed in the Thirunallar area in Karaikal was found. However, huge presence of *Parthenium hysterophorus* was noticed in the area.

SKUAST, Kashmir

At farmers field, *Cynodon dactylon, Lolium perenne, Poa angustifolia, Poa annua* and *Poa bulbosa* were major grassy weeds. Among broad-leaved weed species *Arenaria serpyllifolia, Stellaria media, Ranunculus muricatus, Ranunculus arvensis, Polygonum aviculare, P. hydropiper, Plantago lanceolata, Vicia sativa, Rorippa sylvestris, Conyza Canadensis, Fumaria indica, Capsella bursa-pastoris* and *Papaver dubium* were major species.

Azolla pinnata, Salvinia natans, Nymphaea mexicana, Myriophyllum verticillatum, Trapa natans (Water chestnut), *Nelumbo nucifera, Typha angustata, Potamegaton distinctus, Cynodon* spp, *Nymphoides peltatum, Ceratophyllum demersum,* Azolla and *Potamogeton crispus* were found in Dal and Manasbal lake.

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

The weed flora dynamics and weed shift have been monitored in the long-term trials at different centres. Results obtained at different centres are

summarized below:

AAU, Jorhat

In the year 2014 autumn rice and *Kharif* rice was the cropping sequence. After great decline of weed species diversity and density from 2006 to 2010, gradual slow down in rate of decline was recorded after 2010 in autumn rice. However, *Kharif* rice associated weed population was continue declined since 2006-07. Suspended weeds under *Ceratophyllum-Utricularia* complex and erect semiaquatic sedge *Scirpus* spp. acquired tolerance / developed treaky means for escaping the toxicity of butachlor, pretilachlor and 2,4-D in transplanted rice-rice cropping system. However, the effect of butachlor and pretilachlor on *Leersia hexandra* and *Oryza rufipogon* could not be ascertain. Despite of continuous application of herbicides in both the cropping seasons, *M. vaginalis* and *Sagittaria guyanensis* persisted in the field. The capacity of the weeds to remain in submerged state for 2-3 weeks as well as a little bit delayed germination might be some of their treaky means of overcoming the efficacy of the herbicides. Since 2012, there was no appearance of *Isachne himalaica, Fimbristylis littoralis* and *Ipomoea aquatica* in the entire field. Seed bank of these weeds might has exhausted because of all the treatments adopted including manual ereadication coupled with double cropping.

BAU, Ranchi

Fimbristylis miliacea and *Spilanthes acmella* during 2009-10; and during 2012-13, *Ludwigia parviflora, Cyperus iria* and *Sphillencthus acmella* were dominant weeds. The trend of weed shift had been probably due to change in monsoon pattern which compelled farmers to adopt changed sowing/ transplanting of rice. In rice field on Ranchi-Gumla route. *Panicum repens, Digitaria sanguinalis* and *Sphellanthus acmella* were dominant during 2010-11. While during 2011-12, *Fimbristylis miliacea, Cyperus iria* and *Ludwigia parviflora* were dominant weeds.

CCSHAU, Hisar

Direct-seeded rice at farmers' fields was heavily infested with grassy weeds like *Dactyloctenium aegyptium, Eleusine indica, Panicum* spp. and *Leptochloa chinensis* in Fatehbad, Sirsa, Ambala, Karnal and Kurukshetra districts. Pea crop in Cheeka, Karnal, Kurukshetra, Kanina, Rewari and Yamuna Nagar districts was severely infested with grassy as well as broadleaf weeds *viz. Phalaris minor, Poa annua, Polypogon monsepliensis, Coronopus didymus, Malwa parviflora, Medicago denticulata etc.* Mustard crop sown in November was having less infestation of *Orobanche* as compared to October sown. Infestation of this weed has even spread to Balsamand area of Hisar.

Perennial sedge, *Scirpus tuberosus* was infestated in wheat sown under ZT conditions in Pehowa, Naggal (Ambala), Cheeka, Bainsi (Rohtak), Satrod, Ladwa areas of Hisar. *Parthenium hysterophorus* and *Cannabis sativa*, have started infesting sugarcane and maize also. Similarly infestion of *Cuscuta* spp. was noticed in berseem crop. Infestation of *Euphorbia dracunculoides* is increasing in mustard and chickpea crop planted under rainfed or limited irrigation conditions. Ratoon sugarcane crop mulched with sugarcane trash was heavily infested with *Ipomoea* spp. causing huge losses in Yamuna Nagar, Palwal, Ambala and some parts of Karnal and Kurukshetra districts. *Kharif* crops in south Haryana grown under light textured soils was heavily infested with broadleaf weed *Leucas aspera* which was not controlled by any herbicide used by the farmers. In north-western Haryana, weed flora in non-cropped areas along roadsides have shifted towards *Cassia occidentalis, Chenopodium ambrosioides, Cassia tora* and *Cannabis sativa*.

DBSKKV, Dapoli

In Mahad and Mangaon tehsils of Raigad district, *Blumea lacera, Ericulum hexangularis, Echinochloa colona, Isachne globosa* and *Cyperus iria* were most dominant weeds in *Kharif* rice, whereas *Drymaria cordata, Smithia sensitiva* and *Digitaria sanguinalis* were most dominant during *Kharif* 2010. In orchards Cocks comb, *Ageratum conyzoides, Ericulum hexangularis* and *Blumea lacera* were most dominant weed species, whereas *Amaranthus viridis, Digitaria sanguinalis, Cassia tora* and *Cynodon dactylon* were most dominant during *Kharif* 2010. In non-cropped area, *Blumea lacera*, Cocks comb and *Alternanthera sessilis* were most dominated in 2014, whereas *Chromolaena odorata, Cassia occidentalis* and *Hyptis suaveolens* were dominated during *Kharif* 2010.

GBPUAT, Pantnagar

After three years of the experiment on conservation tillage in rice-wheat cropping system, changes in weed density of major weed species of both rice and wheat were studied. *Echinochloa colona, Alternanthera sessilis* and *Cyperus* spp. increased in DSR (ZT)-Wheat (ZT)- *Sesbania* (ZT) and DSR(ZT)+R-

Wheat (ZT)+R -*Sesbania* (ZT) as compared to the base year 2012. *Echinochloa crus-galli* totally disappeared in DSR(ZT)-Wheat (ZT)- *Sesbania* (ZT). *Ammannia baccifera* density reduced drastically in all the rice establishment methods except in TPR (CT)-wheat (ZT)-Sesbania (ZT). In wheat crop *P. minor* was increased in conventional system of rice-wheat. However, in other systems either it was declining or remained static. An increase in *Medicago denticulata* population was observed in every method of rice. Drastic reduction in *Coronopus didymus* was observed in every establishment method. DSR(CT)-wheat (CT)-*Sesbania* (ZT), DSR(ZT)-Wheat (ZT)- *Sesbania* (ZT) and DSR(ZT)+R-wheat (ZT)+R -*Sesbania* (ZT) establishment methods showed increased population of *Polygonum plebeium, Chenopodium album* and *Rumex acetosella.*

IGKV, Raipur

Till date, no incidence of weed shift either in long-term nor in the commercial area, where cultivation of rice-based cropping systems/soybean-based cropping system are going-on since decades, were noticed due to cropping systems/climate change.

KAU, Thrissur

Among the 22 panchayaths surveyed in Thrissur Kole, six had severe (more than 10 plants/m^2), ten had moderate (5-10 plants/m^2) and five had low (2-5 plants/m^2) infestation of weedy rice. No infestation was found in Pavaratty panchayath. Among the six panchayaths surveyed in Malappuram Kole, only Nannamukku panchayath had severe infestation and others had low infestation. Among the 30 panchayaths surveyed in Alleppey district, severe, moderate and low weedy rice infested panchayaths were 8, 6 and 12, respectively. The Kuttanad rice fields of Kottayam district had severe infestation of weedy rice in Vechoor, Thalayazham, Aimanam, Thiruvarppu, Kumarakom and Arppookkara panchayaths. The rice fields in the panchayaths of upper Kuttanad region Vazhappally, Kurichi, Nattakom and Kaduthuruthy had low infestation. Seven panchayaths of Kottayam district coming under Kuttanad belt had less paddy cultivation with no infestation of weedy rice.

OUAT, Bhubaneswar

Direct-seeded rice was heavily infested with grassy weeds like *Dactyloctenium aegyptium, Eleusine indica, Leptochloa chinensis, Panicum* spp. in the farmers' field. *Celosia argentea* was observed as a severe problem in upland rice and *Rabi* pulses in the districts of Keonjhar. The weed was invading mostly the upland areas near to the foothills with the soil types belonging to light textured red soils. The yield loss in rice and pulses due to *Celosia* was observed to be 40% and 35%, respectively. *Alternanthera philoxerroides* was observed in low land rice areas and low lying swampy areas along the road sides of coastal districts (Jagatsinghpur, Kendrapara, Puri, Khurda and Jajpur). A shift from *Alternanthera sessilis* to *Alternanthera philoxerroides* was recorded in several low-land rice areas in these regions. Sporadic incidence of *Orobanche aegyptiaca* was observed in brinjal and tomato crops under the potential vegetable tracts of Cuttack and Khurda districts along river Mahanadi. Infetstation of *Cuscuta chinenesis* was observed in niger crop of Semiliguda district. Heavy infestation of *Heliotropium* spp. was observed in the green gram and black gram field of coastal districts of cuutack, Puri, Jagatsingpur. Heavy infestation of *Mikania* spp. in banana has been observed in all the coastal districts.

PAU, Ludhiana

Phalaris minor and *Rumex dentatus* were the major weed species observed in wheat crop during the year 2004. But now 10 years later in *Rabi* 2013-14, *Poa annua, Avena ludoviciana* among grasses and *Medicago denticulata, Anagallis arvensis, Chenopodium album, Cornopus didymus, Malva parviflora* and *Fumaria parviflora* among broadleaf weeds were also emerging weed species in wheat crop. *Echinochloa crus-galli, Cyperus iria, Ischaemum rugosum* and *Caesulia axillaries* were the major weed species observed in rice crop during the year 2004. But now 10 years later in *Kharif* 2014, *Ammannia baccifera, Alternanthera, Cyperus compressus* and *Leptochloa chinensis* have also started appearing in the experimental field.

RAU, Pusa

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

TNAU, Coimbatore

Echinochloa colona and *Leptochloa chinensis* and *Cyperus iria* were found in the first crop were completely absent in the second (*Rabi* 2013-14) crop. *Echinochloa crus-galli*, *Cyperus difformis* and *Ammannia baccifera, Marsilea quadrifolia* continued to persist in the field throughout the period of study. In Coimbatore district, *P. hysterophorus* was the dominant broad leaved weed as compared to dominance of *Trianthema portulacastrum* in cropped area. The incidence of *Cyperus rotundus* has come down to 11.5 SDR from 26.1 SDR during 2008 survey. *Cynodon dactylon* which was dominant (12.4 SDR) among grasses during 2008 survey in cropped area has been replaced by the dominance of *Dactyloctenium aegyptium* in cropped area. In Namakkal district, *Trianthema portulacastrum* was dominated among the broad leaved weed, *Dactyloctenium aegyptium* has dominated among grassy weeds.

PJNCA & RI, Karaikal

No shift in weed flora or appearance of new weeds was noticed in the existing rice based cropping system in Karaikal.

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

Monitoring of resistance/escape/poor control of a particular weed against a herbicide which was earlier controlled with the same herbicide was done at farmers' field during the surveys at different centres. Seeds of such a weed population were collected and its reaction to the herbicide further tested under controlled experiments. Results obtained by different centres are summarized below:

AAU, Jorhat

Sedge species belonging to *Scirpus* and suspended weed complex belonging to *Ceratophyllum, Utricularia, etc.* were recorded as escape of resistant to the combine effect of butachlor, pretilachlor and 2,4-D in the experiment "long-term herbicidal trial in rice-rice cropping sequence".

BAU, Ranchi

Cynodon dactylon and *Commelina benghalensis* were suspected to be resistant against glyphosate, while *Conyza bonariensis* was suspected to be resistant against glyphosate and 2,4-D.

CCSHAU, Hisar

Phalaris minor has developed resistance against clodinafop-propargyl in Kaithal, Kurukshetra, Karnal, Jind, Panipat and some parts of Sonipat, Fatehbad, Ambala and Sirsa districts. To control resistance problem against clodinafop at farmers fields, application of mesosulfuron + iodosulfuron (RM) 14.4 g/ha, sulfosulfuron + metsulfuron (RM) at 40 g/ha and pinoxaden at 70 g/ha exhibiting 85% control of *P. minor* resulting in good yields. In some rice-wheat cropping areas, the farmers have started using double the recommended dose of clodinafop or sequential application/tank mix of clodinafop and sulfosulfuron and metribuzin for the control of *P. minor*; even these mixtures are not working well. The problem was worse in areas under continuous use of a particular herbicide. In some cases, pinoxaden and mesosulfruon + iodosulfuron were also not working well.

GBPUAT, Pantnagar

No new case of herbicide resistance was observed in weeds of the dominant crops / cropping systems of the region except for the isoproturon resistance of *P. minor* reported earlier.

IGKV, Raipur

In Chhattisgarh, no incidence of herbicide resistance was observed.

OUAT, Bhubaneswar

A pot culture studies in *Kharif* 2014 was conducted to find out butachlor resistance in *Echinochloa*, if any, due to repeated use. *E. crus-galli* seeds were collected in previous year (2013) from different areas of coastal belt of Odisha from the field where butachlor has been using at least 5 years and where butachlor never been used. No emergence of *Echinochloa crus-galli* was recorded when recommended dose of butachlor was applied.

PAU, Ludhiana

Seeds of two *P. minor* biotypes, one susceptible and one resistant (escaped after continuous use of commonly used herbicides), were exposed to the commonly used clodinafop and sulfosulfuron herbicides at graded doses in pots. Susceptible biotype of *P. minor* recorded 80.2% reduction in dry matter as compared to its unsprayed control, however in case of resistant biotype, reduction in dry matter

was only 57.3%. Sulfosulfuron reduced the dry matter by 77.4% as compared to 60% with clodinafop, when averaged over biotypes and doses. The dry matter reduction at recommended dose of the herbicides, on an average, was 74.3%, which increased to 81.1% at double and 89.6% at four times of the recommended dose of the herbicides.

RAU, Pusa

No case of herbicides resistance was noticed under dominant cropping system.

TNAU, Coimbatore

No case of herbicide resistant / escape of weeds was observed.

UAS, Bengaluru

No case of herbicide resistance or escapes in weeds in rice-rice, rice-sugarcane cropping systems in Bhadra command area of Kathalagere, Davangere district and Cauvery command area in Mandya district was noticed.

WS 2. Weed biology and physiology

WS 2.1a. Biology of important weeds

Biology of most significant weeds of cropped area and non-cropped situation of their respective areas were studied in pots. Results obtained from experiments at different centres are summarized below:

AAU, Jorhat

2.1a.1 Cropped area

***Panicum repens* (Family: Poaceae)**

Panicum repens is reported as non-invasive introduced grass in India. However, during the last few years the plant is becoming invasive in cropped and non-cropped situations particularly in Assam. In NER, the plant is known to occur in low elevations of Nagaland, Megahalaya, Arunachal Pradesh, Tripura and plains of Manipur. Surveillance study revealed that though *P. repens* appeared as one of the most problematic weed of upland crops, it is equally problematic in transplanted rice in certain areas of Assam, like Nagaon, Jorhat and Sivasagar districts of Brahmaputra Valley zones and Cachar and Hailakandi districts of Barak Valley Zone. It shows aggressivity in acid soils of Assam and equally in saline soils, however, does not prefer sandy conditions. The plant usually grows in upland and medium lowland situations, forming tufts and colonies.

The weed growth rate was very low in the plots that received glyphosate 1.0 kg/ha, and the split application of the herbicide 0.75 kg/ha + 2% jaggery. However, complete control of *P. repens* with the doses of glyphosate tested during the experimentation was not recorded up to seven and half months. Sequential application of glyphosate was more effective than single application. Lower doses of glyphosate were rather effective than higher concentration, that might be due to better penetration of herbicide causing starving the underground storage of food stuff.

2.1a.2 Non-cropped area

***Ludwigia peruviana* (Family: Onagraceae)**

The species was first seen in Assam in 1993 in Karbi-Anglong district. During last 5 years, *L. peruviana* became rather aggressive with tremendous population explosion in Karbi-Anglong hills and its foot hill regions. The range of distribution of this plant in India also includes marshy places of Tamilnadu and Kerala of South India and South and Little Andaman. The plant has shown a little aggressivity in these regions. Recently, the plant was also recorded in West Bengal. High adaptability of *L. peruviana* was already been reported from various parts of the world. The study revealed that a pure strand of *L. peruviana* can produce 60,000 to 1 million seeds/m^2. Seeds were very light weighted (1,000 seed weight = 2.8 to 5.2 mg), very small in size and possessed above 90% viability. In the drooping and bent stems, regenerating branches with adventitious roots usually developed, more profusely in damp areas. Vegetative regeneration also occurred from the fragmented stems and branches.

CCSHAU, Hisar

***Orobanche*:** *Orobanche* spp., a root parasite germinate in response to release of stimulants from host crops. In Haryana state, this weed is causing huge losses in mustard and tomato. During April, 2013 mature seeds of *Orobanche* were collected from highly infested mustard and tomato fields across various soil types and sources of irrigation. Out of seven locations, only 4 biotypes from Juglan, Gangala, Gignau and Hisar showed infestation in mustard. *Orobanche* panicles appeared above soil on an average 45-54 DAS of mustard. Fresh weight and dry weight of shoot was in the range of 34.9 - 42.5 and 4.02 - 5.20 g/plant, respectively. Violet cream colored flowers started to appear 11-13 days after panicle emergence of

Orobanche. The capsule number per shoot varied from 38 - 45 while capsule weight was observed to be in the range of 0.094 - 0.124 g. The number of seeds per capsule varied 3870-5840 per capsule. Biotype from Gangala (Bhiwani) was found to be more robust as compared to others.

GBPUAT, Pantnagar

Cropped area

The biology *E. crus-galli* was studied in pots. Data on growth parameters at vegetative and reproductive stages are summarized in Table 2.1a.1.

Table 2.1a.1 Growth parameters of *E. colona* and *E. crus-galli*

Parameters		*E. colona*	*E. crus-galli*
Plant height (cm)	Vegetative stage	54	58
	Reproductice stage	110	92
	Maturity satge	90	93
Tller number/plant	Vegetative stage	58	65
	Reproductice stage	56	20
Dry weight/plant (g)	Vegetative stage	370	-
	At maturity	440	-
Seedling emergence at varying depth of sowing (%)	2 cm	55	25
	5 cm	35	12
	10 cm	0	0
Panicle length (cm)		8	13
Grains/panicle		350	415
1000-grain weight (g)		0.90	1.5

Non-cropped area

Lantana: *Lantana* is a genus of perennial flowering plants which are members of the family Verbenaceae. Seedlings of *Lantana* were transplanted to plots in four rows during the *Kharif* season, 2014. Plant height was found about 73 cm at vegetative stage which increased to 143 cm at the flowering stage. Number of primary branches was same at both the stages. However, the number of secondary and tertiary branches increased from vegetative to flowering stage. At vegetative stage, dry weight of plants was about 7.0 g/plant while at flowering stage it was 61.8g/plant. More than 90 flowers were recorded per plant. There were 30 florets per flower, 57.7 fruits per plant and 19 seeds per fruit.

IGKV, Raipur

Paddy field was selected for studying the biology of *Echinochloa colona, Ischaemum rugosum* and adjoining bunds was selected for *Parthenium hysterophorus* and *Cassia tora* during *Kharif* 2014. Different observations on growth and development are summarized in Table 2.1a.2.

Table 2.1a.2 Biology of importance weeds studied during *Kharif* 2014

Parameters	Weed			
	E. colona	*I. rugosum*	*P. hysterophorus*	*Cassia tora*
Plant height (cm)	67.7	76.3	54.2	64.8
Tiller/branch/plant	12.0	10.0	8.0	8.0
Total Biomass (g)	16.8	47.9	19.1	16.7
Root biomass (g)	3.7	5.2	2.8	3.0
Shoot biomass (g)	13.1	42.70	16.3	13.7
Days to flower	30.0	75.0	40.0	35.0
Days to maturity	55.0	105.0	65.0	73.0
seeds per plant (g)	5.4	10.1	7.1	19.2
Weight of 100 seeds (g)	0.094	0.48	0.044	1.61

KAU, Thrissur

A) In cropped area

Isachne miliacea: This weed species profusely grow in rice field. Soil was collected from the major rice growing regions of the state and a single seedling at two leaf stage was planted in the soil in pots and the morphological and phenological stages of the weed were noted in different soil types. There was distinct variation in the character of the plant when it was grown in the different rice growing soils of Kerala. Generally the growth of the weed was poor in palakkad soils. The intermodal length of the weed was lower when the weed grows in the soils of Kuttanad and Kole lands. The leaf number and inflorescence number was more in Onattukara and Kuttanad soils. The seed production potential of the weed was maximum in Kuttanad soils. This explains the prolific nature of the weed in Kuttanad.

Habit and habitat of *Isachne miliacea*

Monochoria vaginalis: *Monochoria vaginalis* is a fleshy, tufted, monocot annual or perennial herb with a glabrous, shiny appearance and a short rhizome belongs to family pontederiaceae and also known as heart leaf false pickerel weed and oval-leafed pondweed. Soil was collected from the major rice growing regions of the state and a single seedling (two leaf stage) was planted in the soil and the morphological and phenological stages of the weed were noted in the different soil types.

Table 2.1a.3 Growth and development of *Monochoria vaginalis* grown in soil collected from different locations

Character	Kole	Kuttanad	Onattukara	Palakkad
Root length (cm)	11.40 ± 2.27	7.60 ± 2.33	12.40 ± 3.68	11.26 ± 4.69
Shoot length (cm)	30.50 ± 6.64	3.00 ± 4.40	35.50 ± 10.41	35.00 ± 10.22
Fresh weight/plant (g)	16.88 ± 4.60	33.38 ± 6.28	23.16 ± 11.76	11.52 ±5.50
Number of leaves/plant	8.60 ± 3.20	14.80 ± 2.68	7.40 ± 2.07	5.00 ± 1.40
Leaf area/plant (cm^2)	78.15 ± 32.67	249.01 ± 37.44	80.85 ± 52.10	36.30 ± 14.69

B) Non-cropped area

Pennisetum spp.: In Kerala, *Pennisetum pedicellatum* and *Pennisetum polystachyon* are two species widely seen. *P. polystachyon* is short lived tufted perennial easily establish with seeds. It differs from *P. pedicellatum* by having an angular rachis with decurrent wings below the scars of the involucres. The colour of the panicle is also different. It is a native of tropical and sub tropical Africa and India and is a promising forage grass. The major phenological events and morphological characteristics were noted from a natural population of 25 randomly selected plants. Different phenological events in *Pennisetum spp* are summarized in Table 2.1a.4.

Table2.1a.4 Phenology and morphological characteristics of *Pennisetum* spp

Character	*P. polystachyon*	*P. pedicellatum*
Time of germination	April-June	May-July
Vegetative growth	May - September	May - September
Flowering	October	September - October
Seed formation	October-November	October - November
Seed maturation	November-December	October - December
Height at maturity (cm)	147 ± 23.14	137.4 ± 23.8
No. of main tillers/plant	26.6 ± 13.88	22.76 ± 9.14
No. of panicles/plant	25.08 ± 13.8	22.64 ± 9.21
No. of spikelets/plant	104.52 ± 23.58	102.2 ± 22.71
No. of seeds/panicle	104.52 ± 23.58	101.76 ± 23.0
No. of seeds/plant	2577.08 ± 1195.53	2326.84 ± 837.9

PAU, Ludhiana

The effect of sowing depth on seedling emergence of different weed species was studied in pots. The highest number of seedlings of *E. colona* and *D. aegyptium* emerged from depths of 0 cm (surface placed seeds) and 2 cm, respectively. Paddy recorded more than 90 % emergence up to sowing depth of 4 cm. Fresh seeds of *Parthenium hysterophorus* and *Cannabis sativa* were collected from field areas in 2014 maintained 100% dormancy and no germination could be achieved under laboratory conditions.

TNAU, Coimbatore

Trianthema portulacastrum and *Amaranthus viridis* under cropped situations and *Parthenium hysterophorus* and *Abutilon indicum* under non cropped situations were selected and biological studies were carried out in pot culture experiment.

VB, Srinikaten

Biology of two dominant weed species *i.e., E. glabrescens* and *E. crus-galli* was studied in pots. These two weeds are dominant weeds in rice-rice system. Seeds of these two weeds were placed at a depth of 0.5, 1, 2, 4, 8 and 10 cm. Different observations recorded are summarized in Table 2.1a.6.

Table 2.1a.6 Biological characteristics of *E. glabrescens and E. crus-galli*

Echinochloa glabrescens	
Emergence	Higher emergence was recorded in 2 cm sowing depth (56%) and lowest in 10 cm depth (41%).
Tillers	Tillering started at 28 DAS in surface sowing followed by 2, 5 and 10 cm sowing depth (30, 33, 35, DAS). At maturity total number of tillers per hill was recorded higher in 2 cm sowing depth (16/hill) and lower in 10 cm depth (9/hill).
Height	Height of plant recorded at 30, 60 and 90 DAS revealed that rate of increase of height at 60 DAS was double or more under each depth of sowing where as at 90 DAS the rate of increase was less then 1.25 times in each depth.
Biomass	Relative growth rate at 60 DAS was recorded higher under 5 cm sowing depth followed by 0, 2 and 10 cm sowing depth.
Panicle	At maturity maximum number of panicle was recorded under 2 cm sowing depth (15/hill) followed by surface sowing (11), 5 cm (10) and 10 cm (7) sowing depth.
Grains/panicle	Average number of grains/panicle was recorded 243/panicle under 2 cm sowing depth. Accordingly, seed production per plant was also higher under 2 cm sowing depth.
Echinochloa crus-galli	
Emergence	Highest emergence (41%) was noticed when seeds were placed at 2 cm depth, followed by 5 cm (20%), surface sowing (11%) and 10 cm (4%).
Tillers	Tillering started at 32-39 DAS, earliest in surface sowing and late in 10 cm depth. In normal sowing 2-5 cm depth tillers started at 35-36 36 DAS. At maturity 14-16 tillers were recorded per hill in 0-5 cm sowing depth and 12 tillers/hill in 10 cm sowing depth.
Height	Rate of increase of height at between 30 and 60 DAS was recorded higher in surface sowing (1.91 times) followed by 10 cm sowing depth (1.74 times) and 2, 5 cm sowing depth (1.65 times in both).
Biomass	Shoot biomass was recorded higher in 10 cm sowing depth at 30 DAS where as at 60 and 90 DAS it was higher in 2cm sowing depth. Relative growth rate at 60 DAS was recorded highest under 5 cm sowing depth and lowest under 10 cm sowing depth.
Panicle	Emergence of panicle was recorded at 66 - 80 DAS, early under 0 and 2cm sowing depth and late under 10 cm sowing depth. At maturity 8 - 10 panicles/hill were recorded being highest under 2 cm sowing depth.
Grains/panicle	Lowest number of grains/panicle was recorded in surface sowing and highest under 2 cm sowing depth and further decreased gradually with the increase of sowing depth.

PJNCA&RI, Karaikal

Echinochloa colona seeds were collected from different places in PJNCA & RI farm and were sown in pots. After germination, a plant was maintained in each pot and observations were recorded. Seedlings of *E. colona* emerged in 5-9 days. It flowers after 29-32 days after emergence. It was observed that number of seeds ranged from 2990 to 5197/plant. *Trianthema portulacastrum* seeds were collected from different places in PAJANCOA & RI farm and sown in pots. It grown to a height of 0.5-0.6 metres. The number of leaves ranged from 317 to 619 per plant. It flowers between 17-26 days after emergence. Number of seeds ranged from 2452 to 2749/plant.

agyptium emerged from depths of 0 cm (surface placed seeds) and 2 cm, respectively. Paddy recorded more than 90 % emergence up to sowing depth of 4 cm. Fresh seeds of *Parthenium hysterophorus* and *Cannabis sativa* were collected from field areas in 2014

WS 2.1b: Weedy rice

Biological characteristics of morphologically different accessions of weedy rice were studied at different locations. Results obtained at different centres have been summarized below.

AAU, Jorhat

Altogether 7 germplasm of weedy rice have been recognized in Dibrugarh district and their geo-positioning information was collected.

BAU, Ranchi

Seeds of weedy rice were collected from farmers' field at different locations and sown in pots for morphological characterization. Results obtained are summarized in Table 2.1b.1.

Table 2.1b.1 Growth and development of *E. glabrescens* and *E. crus-galli*

Farmer's name	Phenophases (days taken after sowing)					Plant hieght (cm)	Tiller/ plant	Panicle/ plant	Panicle length (cm)	Grains/ panicle
	T	P	F	M	Mat					
S. Munda	21	41	51	62	70	65	3	2	17	13
D. Mahto	30	45	56	65	72	55	5	2	16	32
D. Munda	32	39	50	61	77	45	5	3	18	44
Link women	36	46	51	59	78	70	5	3	18	55
T =tillering, P= panicle emergence, F = flowering, M= milking, Mat = marturity										

KAU, Thrissur

Five accessions of weedy rice were collected.

PAU, Ludhiana

During *Kharif* 2014, three different accessions of weedy rice were sown and data pertaining to these studies is given in Table 2.1b.2.

Table 2.1b.2 Morphological characteristics of different accessions of weedy rice

Character	WRPAU14-1	WRPAU14-2	WRPAU14-3
Plant height (cm)	51.4	59.2	64.0
Tiller no. / plant	12.4	14.6	17.0
Panicle no. /plant	5.4	6.1	8.5
Days to maturity	147	143	143

RAU, Pusa

In North Bihar, weedy rice was found as a problematic weed in deep water rice ecosystem. Under deep water ecosystem rice was grown by direct seeded method. Due to infestation of weedy rice, the yield of rice crop was reduced significantly. These weedy rice were shattering types and they matured earlier than main deep water rice crop and shattered in the field. In the areas of Darbhanga and Madhubani districts weedy rice are called as 'Jharang' or 'Lalsar'.

UAS, Bengaluru

No incidence of weedy rice were found in rice growing areas.

WS 2.1c. *Phalaris minor* (resistance to isoproturon and inheritance of resistance to alternate herbicides)

CCSHAU, Hisar

WS 2.1c (a) Management of herbicide resistant *P. minor* in wheat at farmers' fields

To study the efficacy of different herbicides against *P. minor* an un-replicated field experiment was conducetd in *Rabi* 2013-14 at village Nangla in Fatehbad district. The treatments included pendimethalin 1000 and 1500 g/ha alone and

followed by post-emergence use of pinoxaden + metsulfuron 64 g/ha, sulfosulfuron + metsulfuron (SSN+MTS) (RM) 40 g/ha, mesosulfuron + iodosulfuron (RM) 14.4 g/ha and compared with farmers practices.

Even at higher dose, post-emergence herbicides mesosulfuron + iodosulfuron at 14.4 g/ha, sulfosulfuron + metsulfuron at 40 g/ha and tank mixture of pinoxaden + metsulfuron at 60 + 4 g/ha gave only 70-73% control of *P. minor* up to 60 DAS. Pre-emergence application of pendimethalin at 1500 g/ha *fb* sequential use of SSN+MSM (RM) at 40 g/ha or pinoxaden + metsulfuron 64 g/ha at 35 DAS, and farmers' practice of SSN+MSM 32 g/ha before and after first irrigation improved *P. minor* control and provided 91-93% control of clodinafop resistant population of *P. minor* and BLW's. Post-emergence application of mesosulfuron + iodosulfuron and sulfosulfuron + metsulfuron and pinoxaden gave more than 90% control of clodinafop resistant *P. minor* in wheat up to 30 DAS where as regeneration was observed with these treatments at 60 DAT and later stages. Maximum grain yield of wheat (5.107 t/ha) was found in practice of SSN + MTS (RM) *fb* SSN + MTS (RM) which was significantly higher over rest of treatments. Lowest grain yields (4t/ha) were obtained with use of pre-emergence application of pendimethalin.

WS2.1c(b) Management of resistant *P. minor* in wheat with herbicides alone and in combination

The sequential application of pendimethalin 1000 g/ha (PRE) *fb* clodinafop 60 g/ha, sulfosulfuron 25 g/ha, mesosulfuron + iodosulfuron 14.4 g/ha or pinoxaden 50 g/ha at 35 DAS provided complete control of *P. minor* along with effective control of broadleaf weeds; which was superior to the alone application of post-emergence herbicides. The sequential treatments resulted in improvement in number of effective tillers and grain yield of wheat (5.82-6.08 t/ha) as compared to post-emergence herbicides alone (4.86-5.25 t/ha). The B: C ratio also increased from 1.12-1.19 to 1.29-1.34. Sequential combinations with pendimethalin 1000 g/ha were at par with pendimethalin (1500 g/ha).

WS 2.1c (c) Management of alternate herbicide resistant *P. minor* in wheat at farmers' fields

Pendimethalin alone was not much effective to control *P. minor*. The sequential application of pendimethalin (1000 g/ha) *fb* clodinafop (60 g/ha), sulfosulfuron (25 g/ha), sulfosulfuron + metsulfuron (32 g/ha), mesosulfuron + iodosulfuron (14.4 g/ha) or pinoxaden (50 g/ha) provided effective control of *P. minor* along with broadleaf weeds, and was similar to the sequential application with pendimethalin (1500 g/ha). Improvement in weed control due to sequential use of herbicides was reflected in improvement in number of effective tillers and grain yield of wheat. Grain yield of wheat under sequential application of post-emergence herbicides with pendimethalin 1000 g/ha (5.52-5.65 t/ha) was at par with weed free check (5.73 t/ha) and resulted in B:C ratio of 1.20-1.21.

WS 2.1c(d) Inheritance of resistance against alternate herbicides in various biotypes of *P. minor* from different parts of Haryana (pot studies)

Out of 17 biotypes of *P. minor*, clodinafop at recommended (x) dose was 90% effective against 10 biotypes, sulfosulfuron against 5 biotypes and mesosulfuron+ iodosulfuron (RM) against 8 biotypes. Pinoxaden was effective against 15 biotypes, indicated its suitability in management of herbicide resistance in *P. minor*. Clodinafop and sulfosulfuron were not effective (<20% control) against six (Deora, Ferozepur, Barot, Kheri Raiwali (Kaithal) Kalwehri, Nissing (Karnal) and one biotype (Aurangabad), respectively. Nissing biotypes was controlled only with mesulfuron + iodosulfuron at 14.4 g/ha whereas all other herbicides at recommended doses showed poor efficacy against this biotype. With 2x dose of clodinafop kalvehri biotype was not control whereas 10% control of Nissing biotype was achieved.

GBPUAT, Pantnagar

Sulfosulfuron and clodinafop recorded lowest dry matter among all the treatments. In comparison to isoproturon alone, *P. minor* from all the sources recorded higher mortality percentage when treated with isoproturon along with PBO. PBO, being a monooxygenase inhibitor, improves the efficacy of the herbicide.

PAU, Ludhiana

After development of resistance in *P. minor* against isoproturon, some alternate herbicides such as clodinafop, sulfosulfuron and fenoxaprop were recommended. To monitor the response of *P. minor*

to these herbicides, seeds of ten *P. minor* populations escaped after the application of different herbicides at farmers' field were collected during *Rabi* 2012-13 and these seeds were sown in rows during *Rabi* 2013-14. Seven herbicides *viz.* isoproturon, clodinafop, sulfosulfuron, fenoxaprop-p-ethyl, pinoxaden, mesosulfuron + iodosulfuron and metribuzin + fenoxaprop-p-ethyl were sprayed at their recom-mended doses at 30 days after sowing.

Fv/Fm values of *P. minor* plants exposed to herbicides recorded at 5 DAS revealed that isoproturon caused very less decrease in Fv/Fm ratio as compared to unsprayed and other herbicides, indicating the development of resistance in *P. minor* against these herbicides. Sulfosulfuron, mesosulfuron + iodosulfuron and metribuzin + fenoxaprop-p-ethyl treatment caused significant reduction in Fv/Fm ratio as compared to unsprayed control indicating damage to PSII and photo-inhibition that consequently resulted in mortality of *P. minor* plants.

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

Experiment was conducted to see the viability and regenation potential of *Cyperus rotundus* after appication of glyphosate and other herbicide by manipulating their doses and time of application. Results obtained from different centres are summarized below.

BAU, Ranchi

Application of glyphosate at 1.5 kg/ha was found most effective and caused 15, 98 and 100% mortality at 15, 30 and 60 DAT, respectively. Tubers planted in the pots to test regeneration did not germinate due to low temperature. However, the regeneration of tubers was seen in the plots where the treatment was applied.

GBPUAT, Pantnagar

The percent mortality was highest in the glyphosate treatment. It ranged from 47.8% to 81.0% at 0.75 to 1.5 kg/ha of glyphosate. With 2, 4-D alone, it was lower and ranged from 28.0% at 0.125 kg to 41.2% at 0.5 kg/ha. Combined application of 2,4-D (0.125 kg) and glyphosate (0.75 kg) recorded 54.4% mortality. Thus, glyphosate alone at higher dose (1.5 kg) was found more effective as compared to 2,4-D or combination of both the herbicides. Regeneration was decreased in all the treatments. Among the treatments, both the doses of glyphosate and combined application of glyphosate and 2,4-D recorded lowest regeneration as compared to that control plot. Glyphosate and 2,4-D, alone or in combination had no effect on the tuber viability of *C. rotundus*.

KAU, Thrissur

Application of 2,4-D amine salt (125 g/ha) *fb* glyphosate (750g /ha) gave the best results.

PAU, Ludhiana

2,4-D amine salt 125 g/ha for 48 h followed by glyphosate 750 g/ha was most effective in controlling *C. rotundus* which was at par with glyphosate 1500 g/ha. Minimum tuber number and tuber weight observed in 2,4-D amine salt (125 g/ha) followed by glyphosate (750 g/ha) treatment. Minimum tuber number and tuber weight were observed due to 2,4-D amine salt (125 g/ha) for 48 h followed by glyphosate (1500 g/ha).

TNAU, Coimbatore

Application of glyphosate (1.5 kg/ha) was found effective in reducing density and dry weight of *Cyperus rotundus*, with a minimum regeneration even after 60 days after herbicide application. Primary and secondary tubers from glyphosate applied 1.5 kg/ha were not regenerated. Tertiary tubers regenerated only after 45 days of herbicide spray.

WS 2.2 Development of key identification and other taxonomic criteria.

AAU, Jorhat

Seeds of five species of *Desmodium* were characterized and "KEY" for identification has been developed. Amongst the studied weeds gangeticum *D. gangeticum D. motorium* were the most common facultative weeds throughout the country. In contrary, the area of distribution of *D. caudatum, D. gyroides* and *D. velutinum* restricted to the northern India, more particularly was in the Himalayan foothill states.

Table 2.2.1 Morphological gangeticum features of *Desmodium* seeds belonging to different species

Characters	*D. gangeticum*	*D. caudatum*	*D. motorium*	*D. gyroides*	*D. velutinum*
Top outline	Ovoid	Ellipsoidal	Ovoid	Fusiform	Ellipsoidal
Lateral outline	Comma shaped	Ellipsoidal	C-shaped	Comma shaped	D-shaped
Size (mm)					
Length	2.59 ± 0.01	7.10 ± 0.05	2.97 ± 0.05	1.65 ± 0.13	1.98 ± 0.02
Breadth	1.59 ± 0.03	3.43 ± 0.16	1.43 ± 0. 03	1.17 ± 0.12	0.42 ± 0.03
Width	0.29 ± 0.04	0.35 ± 0.04	1.42 ± 0.01	0.66 ± 0.05	0.31 ± 0.04
Colour	Brick red	Black	Blackish	Blackish	Blackish
Nipple	Emergent	Emergent	Emergent	Emergent	Emergent
Depression kind	Sub-apical	Sub-apical	Sub-apical	Absent	Sub-apical
Depression Shape	Ellipsoidal	Ovoid to ellipsoidal	Ellipsoidal	-	Elongated
Integument	Smooth, glossy	-	Concentric furrows encircling hilum	Smooth	Smooth
Hilum					
Position	Central	Sub-apical	Central	Central	Central
Shape	Rounded	Ellipsoidal	Ellipsoidal	Ellipsoidal	Rounded
Outer dia. (mm)	0.18 ± 0.01	0.23± 0.02 x 0.13 ± 0.02	0.88 ± 0.04 x 0.19 ± 0.03	0.51 ± 0.03 x 0.10 ± 0.01	0.21 ± 0.13
Hole dia. (mm)	0.13 ± 0.01	0.19 ± 0.01 x 0.10 ± 0.01	0.58 ± 0.02 x 0.12 ± 0.04	0.46 ± 0.04 x 0.08 ± 0.02	0.13 ± 0.01
Colour	Blackish	Black	Blackish	Blackish	Blackish
Wall reticulation					
Pattern	Irregular	Irregular	Irregular	Irregular	Irregular
Fields	Closed	Closed	Closed	Closed	Closed
Wall thickness	Thick	Thick	Thick	Thick	Thick
Wall shape	Wavy	Wavy	Indistinct	Indistinct	Indistinct
Funicle	Straight, reddish, 1.16 ± 0.14	Straight, Black, 0.37 ± 0.05	Persistent, Bent, Cream, 0.56 ± 0.09	Persistent	Absent
Aril	Sub-basal Pinkish 0.65 ± 0.04 x 0.21 ± 0.04 mm	Absent	Ruffled Brownish 0.76 ± 0.2 4 x 0.28 ± 0.03 mm	Sub-basal Cream white 1.07 ± 0.14 x 0.36 ± 0.09 mm	Absent
1000 seed weight (g)	2.03 (±0.05)	1.24 (±0.04)	1.85 (±0.12)	1.41 (±0.05)	1.90 (±0.05)

WS 2.3 Station trials based on location-specific problems

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

AAU, Jorhat

Weed survey was conducted in Barpeta, Nalbari and Kamrup districts of the Lower Brahmaputra Valley zone of Assam during 2014. *Mikania micrantha* was prevalent only in bordering rows in some ill managed plots in 2002, which was not recorded during the survey. However, infestation of *Mikania* was continuously increased and spread to main fields of jute as recorded in 2014. Gradual increase in polulation and dominance of the most noxious weed *Cyperus rotundus* and *Alternanthera philoxeroides* in jute fields of Barpeta district was one of the most significant changes during the decade. The most dominant weeds in the deepwater paddy in Barpeta district were *C. dactylon, Eragrostis unioloides* and *Alternanthera philoxeroides*. The northern bank of Bramhaputra possessed higher species diversity probably because of presence of perennial waterlogged areas (beels). *Eichhornia crassipes* was the most dominant aquatic weed in Barpeta and Nalbari districts which need immediate attention for effective management. *Leersia hexandra* was also identified as one of the problematic dominant weed in these districts. *Ceratophyllum-Utricularia* complex as the suspended weed, commonly known as "Patal Khar", was recorded as second dominant species in Nalbari district. Another alien invasive weed, *Panicum repens*, has established in aquatic ecosystems in Nalbari district.

WS 2.3.2 Documentation of crop-weed association at different altitude in J&K region

SKUAST, Srinagar

A survey programme was undertaken during the *Rabi* season of 2013-14 in lower, middle and upper hills of the Kashmir valley (Table 2.3.1 and 2.3.2). At low altitudes and valleys, the cropping system being followed is rice- fallow, while at mid altitudes rice/maize – brown sarson/oat fodder was followed. The weed management practices followed by the farmers of these areas was butachlor 1.5 kg/ha + manual weeding at 20-25 days after planting. At higher belts only one crop is taken during *Kharif or Rabi*. Places, with terrain topography and assured irrigation, sole crop of rice is taken and where undulated land is available, maize + pulses are taken. Maize crop was mostly grown for fodder purpose.

Table 2.3.1 Weed flora of brown sarson up to 1700 m altitude

Weed species (Total no 434)	Density (m^{-2})	Relative Density (RD) (%)	Frequency (%)	Relative Frequency (RF) (%)	IVI
Grasses					
Cynodon dactylon	5	1.20	30	3.26	4.41
Lolium perenne	10	2.30	40	4.35	6.65
Poa angustifolia	20	4.60	50	5.44	10.04
Poa annua	40	9.20	52	5.65	14.85
Poa bulbosa	10	2.30	44	4.78	7.08
Broadleaf					
Anagallis arvensis	10	2.30	39	4.24	6.54
Arenaria serpyllifolia	30	6.90	35	3.80	10.7
Cannabis sativa	10	2.30	20	2.17	4.47
Capsella bursa-pastoris	5	1.15	25	2.72	3.87
Chenopodium album	10	2.30	39	4.24	6.54
Convolvulus arvensis	25	5.70	30	3.26	8.96
Crepis sancta ssp. Bifida	15	3.40	28	3.64	7.04
Descurainia sophia	4	0.92	25	2.72	3.64
Euphorbia hispida	6	1.38	30	3.26	4.64
Fumaria indica	11	2.53	31	3.37	5.92
Geranium nepalense	6	1.38	10	1.08	2.46
Gnaphalium luteo-album	4	0.92	20	2.17	3.09
Matricaria chamomilla	6	1.38	40	4.35	5.73
Plantago lanceolata	5	5.29	35	3.80	4.95
Polygonum aviculare	19	1.15	30	3.26	7.63
Polygonum hydropiper	23	4.37	36	3.91	9.2
Ranunculus arvensis	33	5.29	40	4.35	11.95
Ranunculus muricatus	49	7.60	20	2.17	13.46
Rorippa sylvestris	11	11.29	25	2.72	5.25
Stellaria media	28	2.53	35	3.80	10.25
Veronica biloba	19	6.45	40	4.35	8.72
Veronica persica	9	4.37	45	4.89	6.96
Vicia sativa	11	2.07	25	2.72	5.25

Table 2.3.2 Weed flora of oat from 1700 m to 2000 m altitude

Weed species (Total no: 45)	Density (m^{-2})	Relative Density (RD) (%)	Frequency (%)	Relative Frequency (RF) (%)	IVI
Grass					
Poa annua	7	15.5	35	23.0	38.5
Broadleaf					
Polygonum aviculare	10	22.2	26	17.1	39.3
Polygonum hydropiper	8	17.7	30	19.7	37.5
Ranunculus arvensis	13	28.8	31	20.3	49.2
Stellaria media	7	15.5	30	19.7	35.2

WS 2.3.3 Threshold study of dominant weed species

AAU, Jorhat

Two most common obligate weed of rice, *Cyperus iria* (sedge) and *Ludwigia linifolia* (broad-leaved) were selected for the study, along with a newly introduced aggressive rice associated broad-leaved species *Ludwigia decurrens*. Weed density where significant yield reduction occur was considered as threshold. Threshold level of three rice associated weeds *viz. Ludwigia decurrens, L. linifolia* and *Cyperus iria* has been observed as 2, 2 and 70 plants per square meter area, respectively, in transplanted *Kharif* rice (*var.* Gitesh).

WS 3: Weed management in crops and cropping systems

WS 3.1: Herbicides combinations for control of complex weed flora in rice

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

Table 3.1.1.1 Effect of different herbicides alone or in combination on dry weight weeds and performance of transplanted rice (*Kharif* 2014)

Treatment	Dose (g/ha)	Time (DAT)	Dry weight of weeds (g/m^2)	Effective tillers/ row length	Grain yield (t/ha)	B:C ratio
			Grassy			
Bispyribac	25	20	0.0	86.2	7.4	2.85
Penoxsulam	22.5	15	1.6	85.7	7.4	2.82
Bispyribac+ethoxysulfuron	25+18.8	25	4.5	86.0	7.6	2.86
Bispyribac+chlorimuron+ metsulfuron (RM)	20+4	25	35.1	86.2	7.6	2.86
Pretilachlor+pyrazosulfuron(RM)	615	0-5	0.0	87.5	7.7	3.00
Pretilachlor *fb* ethoxysulfuron	750 *fb* 18.8	0-3 *fb* 25	3.3	82.8	7.2	2.76
Pretilachlor *fb* azimsulfuron	750 *fb* 20	0-3 *fb* 25	4.3	85.2	7.4	2.79
Pretilachlor *fb* chlorimuron+ metsulfuron(RM)	750 *fb* 4	0-3 *fb* 25	3.4	83.5	7.1	2.71
Pyrazosulfuron *fb* chlorimuron+ metsulfuron(RM)	20 *fb* 4	0-3 *fb* 25	295 .6	60.5	5.5	2.12
Penoxsulam+cyhalofop(RM)	135	15	22.0	86.0	7.3	2.81
Triafamone+ethoxysulfuron(RM)	60	15	0.0	87.0	7.7	2.94
Pendimethalin *fb* bispyribac	750 *fb* 25	0-3 *fb* 25	0.0	86.2	7.7	2.79
Bispyribac+ azimsulfuron	25+20	25	0.0	86.5	7.7	2.89
Hand weeding (2)		25 *fb* 45	0.0	89.2	7.7	2.30
Weed free			0.0	90.8	7.9	2.35
Weedy check			409.3	53.2	4.6	1.87
SEm ±			13.5	1.9	0.19	-
LSD (P=0.05)			39.1	5.5	0.54	-

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

CCSHAU, Hisar

Weed flora was dominated by *Echinochloa crus-galli, Ammannia baccifera* and *Cyperus difformis*. All the herbicidal except pyrazosulfuron *fb* chlorimuron+ metsulfuron provided effective control of grassy weed *Echinochloa crus-galli* in transplanted rice and resulted in higher B:C ratio than other treatments (Table 3.1.1.1). Addition of ethoxysulfuron and chlorimuron + metsulfuron as tank-mix or as sequence improved the control of broadlead weeds and sedges. There was no phyto-toxicity of different herbicidal treatments on the crop.

PAU, Ludhiana

Echinochloa sp., *Cyperus iria* and *Caesulia axillaries* were major weeds. Pre-mix of triafamone+ ethoxysulfuron recorded complete control of all weeds at all stages. All weed control treatments recorded significantly higher rice grain yield as compared to unsprayed control and were at par to hand weeded control. Application of triafamone + ethoxysulfuron, bispyribac+ethoxysulfuron, pretilachlor *fb* chlorimuron+metsulfuron and pendimethalin *fb* bispyribac recorded the highest B: C ratio (Table 3.1.1.2.). The rice grain yield reduction in weedy check varied from 37.9 to 50.0%. All herbicides

Table 3.1.1.2 Effect of weed control treatments on weed dry matter, yield and economics of transplanted rice (*Kharif* 2014)

Treatment	Dose (g/ha)	Time of application	Total weed dry matter (g/m^2)	WCE (%)	Tiller (No/m^2) at 60 DAT	Grain yield (t/ha)	Gross returns (₹/ha)	B:C
Bispyribac-Na	25	25	4.7 (22)	100.0	383	6.80	92,480	2.8
Penoxsulam	22.5	15	12.7 (160)	81.0	383	6.20	85,680	2.6
Bispyribac + ethoxysulfuron	25+18.7	25	7.7 (58)	93.8	373	7.20	97,920	2.9
Bispyribac + almix	20+4	25	6.3 (39)	96.1	433	6.20	84,320	2.5
Pretilachlor *fb* ethoxysulfuron	750/18.7	0-3 *fb* 25	10.9 (120)	89.3	354	6.60	89,760	2.7
Pretilachlor *fb* almix	750/4	0-3 *fb* 25	5.7 (32)	97.4	375	7.10	96,560	2.9
Pyrazosulfuron *fb* almix	20	0-3 fb 25	17.2 (298)	83.1	376	5.80	78,880	2.4
Penoxsulam + cyhalofop 6% (RM)	135	15-20	10.3 (105)	87.6	361	6.70	91,120	2.7
Triafamone+ ethoxysulfuron 30%(RM)	60	15	1.0 (0)	100.0	384	6.90	95,200	2.8
Pendimethalin *fb* bispyribac-sodium	750 *fb* 25	0-3 *fb* 25	5.1 (25)	100.0	409	7.10	96,560	2.9
Hand weeding	-	25 & 45	7.3 (53)	95.3	378	6.80	91,120	2.6
Weedy check	-	-	25.8 (665)	100.0	290	3.60	48,960	1.6
SEm ±			0.5	-	20	0.51	-	-
LSD (P = 0.05)			1.3	-	57.4	1.50	-	-

OUAT, Bhubaneswar

Digitaria ciliaris, Cynodon dactylon, Echinochloa colona, Ageratum conyzoides, Cleome viscosa, Ludwigia parviflora, Physalis minima, Chrozophora rottleri and *Cyperus rotundus* were major weeds. Pre-emergence application of pendimethalin followed by the appliaction of the bispyribac-Na recorded significantly least weed density at all stages of observation followed by application of triafamone + ethoxysulfuron. At harvest, pendimethalin + bispyribac and weed free plots showed at par values of biomass.

Application of pendimethalin+bispyribac recorded significantly higher yield of 4.87 t/ha. The plot applied with pendimethalin+bispyribac recorded significantly highest number of effective

tillers/m^2 (440.5) followed by weed free treatment (450.5). Number of grains/panicle and 1000 grain weight also significantly higher with pendimethalin +bispyribac and it was at par with weed free treatment with respect to grains/panicle and followed by triafamone + ethoxysulfuron. Post-emergence application of pendimethalin+bispyribac recorded lowest weed index 3.2% followed by triafamone+ethoxysulfuron (6.5%). The highest value of 59.4 % was obtained from weedy check treatment. Highest net return of ₹ 21478/ha and B:C ratio of 2.85 were obtained with post-emergence application of pendimethalin+bispyribac followed by triafamone+ ethoxysulfuron ₹ 20713/ha.

NDUAT, Faizabad

The dominant weeds were *Echinochloa colona, E. crus-galli, Eclipta alba, Caesulia axillaris, Ammannia baccifera, Cyperus spp* and *Fimbristyllis spp*. Bispyribac-Na provided control of almost all type of the weeds but it was very effective against *Echinochloa colona* and *E. crusgalli*. Pretilachlor *fb* almix also controlled the grassy weeds very effectively but *C. axillaris* was controlled moderately. Tank mixing of almix with bispyribac-Na further improved the control of grassy and non-grassy weeds significantly over single application as it has been shown with WCE. The herbicide combination of cyhalofop + penoxsulam and triafamone + ethoxysulfuron at 60 g/ha proved superior to control all type of weeds effectively and having the higher values of weed control efficiency in the tune of 84.7 and 82.5%, respectively (Table 3.1.1.3).

The grain yield was also recorded at par due to bispyribac-Na, penoxsulam and pyrazosulfuron, along with the either tank mixing or sequential application of ethoxysulfuron with pretilachlor or bispyricbac. A combination of ethoxysulfuron + triafamone (RM) and penoxsulam + cyhalofop controlled the wide spectrum of weeds very effectively and consequently having the higher weed control efficiency (%) and grain and straw yield in the experiment. Though weed free treatment recorded maximum grain yield but due to higher cost of cultivation, values of net return and BCR were lower than other weed control treatments. Among the different weed control treatments, pre-mix application of triafamone + ethoxysulfuron showed highest BCR was followed by penoxsulfuron + cyhalofop (Table 3.1.1.3).

Table 3.1.1.3 Effect of various weed control treatments on weed dry weight, yield and economics of rice (*Kharif* 2014)

Treatment	Time (DAT)	Dry weight (g)	WCE (%)	Grain yield (t/ha)	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	BCR
Bispyribac-Na	25	(52.5) 7.31	67.69	4.75	22,700	69,854	46,884	2.06
Penoxsulam	22.5	(40.5) 6.44	75.08	5.01	22,100	72,182	43,082	1.92
Bipyribac + ethoxysulfuron	25 + 18.7	(23.7) 4.97	85.42	5.46	23,400	78,006	54,606	2.33
Bispyribac + almix	20 + 4	(20.5) 4.64	87.38	5.51	23,200	78,656	55,456	2.39
Pretilachlor *fb* ethoxysulfuron	750/18.7	(28.7) 4.97	85.42	5.46	23,000	71,797	48,797	2.12
Pretilachlor *fb* almix	750/4	(22.5) 4.85	86.15	4.91	22,800	70,856	48,056	2.11
Pyrazosulfuron *fb* almix	20/4	(32.7) 5.81	79.88	5.06	22,000	72,806	50,506	2.30
Penoxsulam+cyhalofop	135	(28.7) 5.45	82.34	5.71	22,600	81,243	58,643	2.60
Triafamone+ethoxysulfuron	60	(18.3) 4.39	88.74	5.86	22,600	83,271	60,671	2.68
Pendimethalin *fb* bispyribac	750/25	(25.3) 5.12	84.479	5.11	22,500	73,495	50,995	2.26
HW at 25 and 45 DAS		(8.5) 3.08	94.77	5.90	28,600	82,426	53,826	1.88
Weedy check		(162.5) 12.79	00.00	3.21	2,060	47,230	2,663	1.29
SEm±				1.72	-	-	-	-
LSD (P=0.05)				0.51	-	-	-	-

Original values given in parenthesis, $\sqrt{x+1}$ transformation used

VB, Sriniketan

Cynodon dactylon, Echinochloa colona, Ludwigia parviflora, Spilanthes acmella, Oldenlandia corymbosa, Ammannia multiflora, Hydrolea zeylanica, Cyperus iria and *Fimbristylis miliacea* were major weeds. Early post-emergence application of penoxsulam was less effective in controlling *Ludwigia parviflora* and *Fimbristylis miliacea*. Post-emergence applications of bispyribac and bispyribac + ethoxysulfuron were also found less effective in controlling *Hydrolea zeylanica*. For controlling sedge population, bispyribac + ethoxysulfuron, pretilachlor *fb* ethoxysulfuron, pretilacholor *fb* chlorimuron + metsulfuron, pyrazosulfuron *fb* chlorimuron + metsulfuron, penoxsulam + cyhalofop and ready mix of triafamone + ethoxysulfuron were found most effective. With respect to grain yield of transplanted rice early post-emergence application of penoxsulam + cyhalofop recorded the highest grain yield of transplanted rice (4.867t/ha) which was closely followed by hand weeding twice (4.782 t/ha) and bispyribac + ethoxysulfuron (4.762 t/ha). Pretilachlor *fb* ethoxysulfuron gave net return of ₹ 42,330/ha and B:C ratio of 2.71.

GBPUAT, Pantnagar

Echinochloa colona, E. crus-galli, L. chinensis, A. sessilis, A. baccifera , C. difformis, C. iria and *F. miliacea* were major weeds. The highest weed control efficiency was obtained with sequential application of pretilachlor *fb* ethoxysulfuron (99.6%) applied as early post-emergence which was at par with sequential application of pendimethalin *fb* bispyribac-Na (post) and ready mix of penoxsulam and cyhalofop-butyl (99.1%) and bispyribac-Na alone (98.9%). Sequential application of pendimethalin *fb* bispyribac-Na recorded the highest grain yield (6.42 t/ha) which was at par with twice hand weeding (6.34 t/ha) and application of pretilachlor *fb* ethoxysulfuron (5.9 t/ha). The highest gross return (₹ 89,347/ha), net return (₹ 36,321/ha) and B:C ratio of 1.46 was obtained with sequential application of pendimethalin *fb* bispyribac-Na which was closely followed by the sequential application of pretilachlor *fb* ethoxysulfuron.

UAS, Bengaluru

Major weed flora were *Scirpus* sp., *Fimbristylis miliacea, Paspalum distichum, Echinochloa crus-galli, Spilanthus acmella, Ludwigia parviflora, Eclipta alba, Marselia quadrifolia* and *Gnaphalium polycaulon* at 60 DAP. The combination of bispyribac + ethoxysulfuron and penoxsulam + cyhalofop recorded lower weed density and weed dry weight compared to other treatments at 60 DAP in transplanted rice. Bispyribac + ethoxysulfuron (5.29 t/ha) followed by bispyribac + chlorimuron + metsulfuron (5.24 t/ha), pretilachlor *fb* ethoxysulfuron and pendimethalin (38.7% CS) *fb* bispyribac-sodium recorded significantly higher paddy yield compared to all other treatments except two hand weedings (25 and 45 DAP) (5.29 t /ha) which was on par. Herbicides or herbicide mixtures (₹ 1250 to 4225/ha) were cheaper than hand weeding (₹ 8000/ha). Higher B:C ratio (2.90) was obtained with bispyribac + ethoxysulfuron and pendimethalin *fb* bispyribac-sodium followed by pretilachlor *fb* ethoxysulfuron and pretilachlor *fb* chlorimuron + metsulfuron (2.60) whereas it was 2.40 in the hand weeding as much low as 1.20 B:C ratio in weedy check.

TNAU, Coimbatore

The pre-dominant weeds were *Echinochloa crus-galli, Echinochloa colona, Cyperus difformis, Ammannia baccifera* and *Marsilea quadrifolia*. At 60 DAT, pretilachlor *fb* chlorimuron + metsulfuron recorded considerably lesser total weed density and was followed by pretilachlor *fb* ethoxysulfuron and hand weeding twice at 25 and 45 DAT. Pretilachlor *fb* chlorimuron + metsulfuron recorded higher weed control efficiency of 94.2% at 60 DAT. Higher dry matter production, number of productive tillers were observed in pretilachlor *fb* chlorimuron + metsulfuron at 60 DAT. It was comparable with the application of pretilachlor + ethoxysulfuron and bispyribac + (chlorimuron + metsulfuron). Lower dry matter production was observed in penoxulam. Higher net return and B: C ratio was observed with application of pretilachlor *fb* chlorimuron + metsulfuron 4 g/ha and it was followed by application of pretilachlor + ethoxysulfuron (Table 3.1.1.4).

Table 3.1.1.4 Effect of treatments on weed density, dry weight and yield performance of transplanted rice (*Rabi*, 2013-14)

Treatment	Total weed density (no./m^2)	Total weed dry weight (g/m^2)	Panicles/ m^2	Grain yield (t /ha)	Cost of cultivation (₹/ha)	Gross returns (₹/ha)	B:C ratio
Bispyribac sodium 25 g/ha	4.84 (18.33)	70.2	228	5.10	26,227	61,596	2.35
Pretilachlor 1000 g/ha	5.19 (27.00)	73.4	243	5.30	25,280	63,000	2.49
Penoxulam 22.5 g/ha	5.95 (33.38)	49.5	222	4.70	25,441	56,496	2.22
Pyrazosulfuron-ethyl 20 g/ha	4.93 (22.13)	53.2	229	4.80	25,141	57,600	2.29
Bispyribac 25 g/ha + ethoxysulfuron 18.75 g/ha	5.01 (23.08)	74.1	236	5.40	27,193	65,004	2.39
Bispyribac 20 g/ha + (chlorimuron + metsulfuron) 4 g/ha	3.74 (11.96)	85.4	244	5.50	26,266	65,400	2.49
Pretilachlor 750 g/ha *fb* ethoxysulfuron 18.75 g/ha	3.07 (7.42)	93.0	254	5.80	26,770	69,204	2.59
Pretilachlor 750 g/ha *fb* POE (Chlorimuron + metsulfuron) 4 g/ha	2.47 (4.12)	94.2	267	6.00	25,455	72,396	2.84
Pyrazosulfuron-ethyl at 20 g/ha *fb* manual weeding	5.14 (25.67)	76.0	234	5.10	28,441	61,392	2.16
PE Pretilachlor + bensulfurn 660 g/ha	3.84 (12.77)	77.8	232	5.30	26,115	64,080	2.45
Hand weeding at 25 and 45 DAT	3.33 (9.06)	91.8	248	5.70	33,215	67,800	2.04
Unweeded check	9.50 (88.31)	-	204	3.00	24,241	36,192	1.49
SEd ±	0.19	2.8	11.0	0.24	-	-	-
LSD (P=0.05)	0.40	5.8	21.9	0.49	-	-	-

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

During *Kharif*, 2014 the pre-dominant grassy weeds were *Echinochloa crus-galli, Echinochloa colonum, Cyperus difformis, Ammannia baccifera* and *Marsilea quadrifolia*. Total weed dry weight was significantly lower with the application of bispyribac + (chlorimuron + metsulfuron) (10.3 g/m^2) at 60 DAT and it was on par with pretilachlor *fb* chlorimuron + metsulfuron (13.5 g/m^2). Bispyribac + (chlorimuron + metsulfuron) recorded higher weed control efficiency of 84.2 % at 60 DAT. The grain yield was conspicuously higher in bispyribac + (chlorimuron + metsulfuron) (5197 kg/ha) and was at par with pretilachlor *fb* chlorimuron + metsulfuron (5133 kg/ha), hand weeding twice at 25 and 45 DAT (4983 kg/ha) and pretilachlor *fb* ethoxysulfuron (4947 kg/ha). Higher net return and B: C ratio (₹ 26,363 and 2.06) was observed with pretilachlor *fb* chlorimuron + metsulfuron, and it was followed by bispyribac + (chlorimuron + metsulfuron) (₹ 26,182 and 2.02) and pretilachlor + ethoxysulfuron (₹ 24,152 and 1.95).

KAU, Thrissur

All treatments involving bispyribac-sodium and penoxsulam resulted in significant reduction in the *Echinochloa* on par with the manual weeding. Among the herbicides, bispyribac-sodium was not effective against *Leptochloa* and other treatments involving bispyribac-sodium were on par with the weedy check. Pretilachlor alone was significantly better than weedy check in controlling *Leptochloa, Monochoria vaginalis* and *Ludwigia parviflora*. Pyrazosulfuron *fb* manual weeding resulted in high yield, which was on par with weed free. The highest B:C ratio of 3.9 was found with penoxsulam, pyrazosulfuron and pretilachlor + bensulfuron. However, a comparison of the cost for weed control operation and the additional returns showed that additional returns are many fold than the cost involved for weed control operations.

RAU, Pusa

Echinocloa crus-galli, E. colona, Digitaria sanguinalis, Dactyloctenium aegyptium, Cynodon dactylon, Cyperus rotundus, Cyperus diformis, Cyperus iria and *Fimbristylis miliacea, Caesulia axillaris, Lippia nodiflora, Amaranthus spinosus, Amaranthus viridis, Eclipta alba, Phyllanthus niruri* and *Monochoria vaginalis* were the major weeds.

The lowest weed population, weed dry weight and the highest grain yield of rice were recorded in hand weeding at 25 and 45 DAT which was significantly superior over rest of the treatments which was statistically at par with pendimethalin *fb* bispyribac-sodium and Bbispyribac + ethoxysulfuron. The highest weed control efficiency (72.5%) was recorded under the hand weeding at 25 and 45 DAS followed by pendimethalin *fb* bispyribac-sodium (65.7%) and bispyribac + ethoxysulfuron (53.9%). There were not any phytotoxic effects on rice crop (Table 3.1.1.5).

Table 3.1.1.5 Effect of Herbicides combinations for control of complex weed flora in transplanted rice

Treatment	Dose (g/ha)	Time (DAT)	Weed biomass (g/m^2) at 60 DAS	WCE (%)	Number of panicles/ m^2	Grain yield (t/ha)	Straw yield (t/ha)
Bispyribac-Na	25	25	32.8	28.3	268	3.88	4.82
Penoxsulam	22.5	15	34.2	25.3	265	3.89	4.87
Bispyribac + ethoxysulfuron	25+ 18.7	25 DAT (3-4 leaf stage)	21.1	53.9	295	4.59	5.63
Bispyribac + chlorimuron + metsulfuron (almix)	20+4	Do	24.8	45.7	293	4.41	5.48
Pretilachlor *fb* ethoxysulfuron	750/ 18.7	0-3 *fb* 25 DAT (3-4 leaf stage)	26.7	41.6	289	4.33	5.31
Pretilachlor *fb* chlorimuron+metsulfuron (almix)	750/4	0-3 *fb* 25 DAT (3-4 leaf stage)	26.6	41.9	292	4.42	5.53
Pyrazosulfuron *fb* chlorimuron+metsulfuron (almix)	20-Apr	0-3 *fb* 25	28.9	36.8	285	4.42	5.47
Penoxsulam+cyhalofop	135	15-20	31.3	31.5	280	4.15	5.11
Triafamone+ethoxysulfuron	60	15	32.4	29.2	277	4.06	5.04
Pendimethalin CS) *fb* bispyribac-sodium	750/25	0-3 /25	15.7	65.7	302	4.68	5.79
Hand weeding at 25 and 45 DAT			12.5	72.5	305	4.88	6.01
Weedy check			45.8	-	210	2.81	3.51
S. Em±			0.9	-	1.56	0.11	0.19
LSD (P=0.05)			2.8	-	4.59	0.33	0.55

PJNCA & RI, Karaikal

The dominant weeds were *Echinochloa crus-galli, Echinochloa colona, Leptochloa chinensis, Bergia capensis, Eclipta alba* and *Cyperus difformis*. No phytotoxicity on crop were observed due to the application of herbicides. Hand weeding twice significantly reduced the weed density (6.67 no./m^2) and dry weight (2.99 g/m^2) and resulted in higher rice yield (4.70 t/ha). Application of pretilachlor *fb* (chlorimuron +metsulfuron) and pre-emergence application of pyrazosulfuron-ethyl integrated with a hand weeding at 25 DAT and pretilachlor + bensulfuron provided high weed control and rice yield. Post emergence application of herbicides was found ineffective in weed control. Unweeded control accounted for 37.2% yield loss in coastal ecosystem of Puducherry. Application of pretilachlor *fb* (chlorimuron+metsulfuron) was found better in terms of B:C ratio (2.73). It was followed by pre-emergence application of pyrazosulfuron-ethyl integrated with a manual weeding at 25 DAT (2.54) and pretilachlor + bensulfuron (2.51), respectively.

Plate 3.a. General experimental view at coastal ecosystem of Puducherry

SKUAST, Kashmir

At 60 DAS weed flora mainly comprised of *Echinochloa crusgalli, Ammannia baccifera, Monochoria vaginalis, Aeschynomene indica,* and *Polygonum hydropiper* among broadleaf weeds and *Cyperus difformis* and *Cyperus iria* among sedges. All these weeds constitute about 92.6 % of total weed population. The other weeds which appear in very low density were *Alisma plantago-aquatica, Lindernia procumbens* and *Eclipta alba*.

The lowest density was observed with the application of 100% brown sarson extract of 36 and 24 hrs soaking at 5 and 10 DAT followed by 1:10 dilution brown sarson extract of 36 and 24 hrs soaking at 5 and 10 DAT which in turn was followed by100 percent brown sarson extract of 12 hrs soaking at 5 and 10 DAT and then by 1:10 dilution. This resulted due to presence of *Allyl isothiocynate* in the straw of the brown sarson, which has a depressing effect on weeds. Uncontrolled growth of weeds (weedy check) resulted in 75% reduction in grain yield of rice. The highest recorded yield of rice due to influence of most effective weed control treatment combinations was in the order of brown sarson extracts (100%) of 36 hrs sprayed at 5 DAT (8.67 t/ha) > brown sarson extracts (100%) of 36 hrs sprayed at 10 DAT (8.12 t/ha) > 1:10 percent dilution of 36 hr at 5 DAT (7.83 t/ha) >100 percent concentrates of brown sarson extracts of 24 hr at 5 DAT (7.67 t/ha) > 1:10 percent dilution of 36hr at 15 DAT (7.17 t/ha) > 1:10 percent dilution of 24 hr at 5 DAT (7 t/ha).

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

Cooperating centres: Hyderabad, Bengaluru and Coimbatore

PJTSAU, Hyderabad

Weed spectrum/weed flora observed in experimental area during crop growing season consist of *Cyperus difformis, Eclipta alba, Echinochloa colona, Echinochloa crus-galli* and *Paspalum distichum*. Application of herbicides alone or their sequential application and integration with manual weeding showed significant influence on weed dry matter and wed control efficiency during different stages of crop growth. During 60 and 120 DAS (harvest) lowest weed dry matter (2.38 and 6.29 g/m^2) was recorded with weed free treatment i.e, hand weeding twice at 20 and 40 DAS and it was on par with T_6, T_5, T_8, T_9 and T_7 and T_4, T_3 and T_2, respectively. However at 90 DAS, the lowest WDM was observed with pyrazosulfuron ethyl 20 g/ha (PE) *fb* manual weeding (4.57 g/m^2) and was at par with T_{11}, T_5 and T_3 treatments. Similar trend was observed with WCE, where higher weed control efficiency was noticed with weed free treatment i.e.,

hand weeding twice at 20 and 40 DAS, pyrazosulfuron-ethyl *fb* HW, bispyribac-sodium *fb* HW and pyrozosulfuron-ethyl *fb* azimsulfuron treatments. Further WCE with advancement of crop growth was reduced.

Significant increase in productive tillers/m^2 noticed in hand weeding twice at 20 and 40 DAS and was on par with pyrazosulfuron-ethyl *fb* HW, bispyribac-sodium *fb* HW and pretilachlor + safener *fb* azimsulfuron treatments. Hand weeding twice at 20 and 40 DAS recorded higher yield and was significantly superior over T_1, T_2, T_4, T_7, T_8 and T_{11} treatments. However it was recorded on par yield with T_6, T_5, T_8 and T_3 treatments. This result was reflected in terms of lowest weed Index and 5.2 in weed free treatment and pre-emergence application of pyrazosulfuron-ethyl *fb* HW respectively. Hand weeding at 20 and 40 DAS, pyrazosulfuron-ethyl 20 g *fb* HW+MW were more effective in efficient weed control and to get higher profit with B.C ratio of 1.29; its higher cost of cultivation (₹ 41000/ha) of hand weeding treatment was compensated by higher yields over other treatments.

UAS, Bengaluru

Densities of *E. colona, Fimbristylis miliacea* and *Eclipta alba* were more than other weed species indicating their dominance and competitiveness with the drum seeded rice. Bispyribac + (chlorimuron + metsulfuron), penoxsulam + cyhalofop and penoxsulam recorded higher grain and straw yield as compared to all other treatments. The herbicides alone or mixtures were cheaper than mechanical and hand weeding. Higher B:C ratio was obtained in penoxsulam followed by penoxsulam + cyhalofop compared to unweeded check. Among herbicide combinations, bispyribac + (chlorimuron + metsulfuron), penoxsulam + cyhalofop, penoxsulam and pendimethalin *fb* bispyribac-sodium were better in controlling weeds at 60 DAS and gave higher grain yields which were on par with the hand weeding under present scenario of escalating labour wages for manual weeding (Table 3.1.2.2).

Table 3.1.2.1 Influence of weed management practices on weed dry mater, yield and economics of drum-seeded rice (*Kharif*, 2014-15)

Treatment		Dose (g/ha)	Time of application (DAS)	Weed dry weight (g/m^2)	WCE (%)	No. of effective tillers/m^2	Yield of wheat (t/ha)	Cost of cultivation ₹/ ha	Gross returns (₹/ha)	B: C ratio
T_1	Azimsulfuron	35	25-30	4.32 (18.67)	70.6	248	2.20	35,325	31,178	0.88
T_2	Pretilachlor + safener *fb* HW	450	3-5 *fb* 40	4.35 (18.00)	71.7	301	2.90	34,941	40,600	1.16
T_3	Pretilachlor + safener *fb* azimsulfuron	450 *fb* 35	3-5 *fb* 25-30	4.01 (15.33)	76.0	356	3.30	37,266	45,738	1.23
T_4	Bensulfuron methyl + pretilachlor *fb* HW/MW	60 + 600	5 *fb* 40	4.19 (16.67)	73.8	315	2.60	39,375	36,036	0.92
T_5	Bispyribac-sodium *fb* HW/MW	25	20 *fb* 40	2.97 (7.83)	88.0	383	3.40	39,031	47,390	1.21
T_6	Pyrazosulfuron-ethyl *fb* HW/MW	20	8-10 *fb* 40	2.49 (5.33)	92.0	364	3.50	37,800	48,762	1.29
T_7	Oxadiargyl*fb* HW/MW	80	8-10 *fb* 40	3.21 (9.33)	85.6	204	1.70	37,682	23,254	0.62
T_8	Pyrazosulfuron-ethyl *fb* azimsulfuron	20 *fb* 35	8-10 *fb* 25-30	3.00 (8.00)	87.8	369	3.30	36,125	46,116	1.28
T_9	Oxadiargyl *fb* azimsulfuron	80 *fb* 35	8-10 *fb* 25-30	3.08 (8.67)	86.7	241	2.00	36,007	28,350	0.79
T_{10}	Hand weedings	-	20 and 40	2.38 (4.67)	93.1	389	3.80	41,000	52,920	1.29
T_{11}	Un-weeded check	-	-	7.97 (62.67)	0.0	132	0.79	33,000	11,018	0.33
LSD (P=0.05)				0.88	-	67.43	0.53	-	-	-

*Values in parenthesis are the original value

Table 3.1.2.2 Effect of herbicide mixtures on weeds, yield and economics of rice

Treatment	Weed dry wt (g/m^2)	Weed control efficiency (%)	No. of effective tillers/m^2	Yield (t/ha)	Cost of cultivation (₹/ha)	Gross returns (₹/ha)	B:C ratio
Bispyribac-sodium	1.69(49.1)	43.9	190	2.83	26,400	43,068	1.6
Penoxsulam	1.23(15.1)	82.7	240	3.64	26,700	55,326	2.1
Bispyribac+ethoxysulfuron	1.42(27.9)	68.1	214	3.31	27,600	50,347	1.8
Bispyribac+chlorimuron+ metsulfuron	1.26(16.4)	81.3	249	3.67	31,500	55,733	1.8
Pretilachlor *fb* ethoxysulfuron	1.58(36.8)	57.9	210	3.29	30,000	49,985	1.7
pretilachlor *fb* (chlorimuron + metsulfuron)	1.38(24.7)	71.8	219	3.38	30,200	51,369	1.7
Pyrazosulfuron *fb* chlorimuron + metsulfuron	1.64(41.9)	52.1	203	3.19	29,000	48,480	1.7
Penoxsulam + cyhalofop	1.29(17.5)	80.0	252	3.67	28,000	55,795	2.0
Triafamone + ethoxysulfuron	1.56(34.4)	60.7	205	3.22	27,400	48,947	1.8
Pendimethalin *fb* bispyribac-sodium	1.45(26.5)	69.7	229	3.44	30,500	52,422	1.7
Hand weeding at 25 and 45 DAS	1.36(21.6)	75.3	235	3.58	32,500	54,491	1.7
Weedy check	1.89(87.4)	0.0	115	1.69	24,500	25,568	1.0
SEm±	0.09	-	13.87	0.19	-	-	-
LSD (P=0.05)	0.28	-	40.67	0.56	-	-	-

TNAU, Coimbatore

The pre-dominant grassy weeds were *Echinochloa crus-galli, E. colona, Cyperus difformis, Eclipta alba, Ludwigia parviflora* and *Ammannia baccifera*. At 60 DAS, the total weed density was significantly lower with the application of oxadiargyl *fb a*zimsulfuron and it was followed by pretilachlor + safener *fb POE* azimsulfuron. There was remarkable reduction in total weed dry weight with oxadiargyl *fb a*zimsulfuron (19.6 g/m^2) at 60 DAS followed by pretilachlor + safener *fb POE* azimsulfuron (25.4 g/m^2). Significantly higher weed dry weight (55.2 g/m^2) was observed with pyrazosulfuron-ethyl *fb* azimsulfuron. At 60 DAS, higher weed control efficiency of 84% was obtained with oxadiargyl *fb a*zimsulfuron followed by pretilachlor + safener *fb* azimsulfuron.

The grain yield was conspicuously higher with oxadiargyl *fb a*zimsulfuron and it was on par with pretilachlor + safener *fb* azimsulfuron (6253 kg/ha) and mechanical weeding on 20 and 40 DAS. The lower grain yield was obtained with PE bensulfuron-methyl + pretilachlor *fb* HW on 40 DAS. None of the herbicides applied as pre-emergence, early post-emergence and post-emergence exhibited phyto toxicity symptoms. Higher gross return (₹ 75,800/ha) was observed with oxadiargyl *fb* azimsulfuron and it was followed by pretilachlor + safener *fb* azimsulfuron (₹ 75,040/ha). Higher net return and B:C ratio of ₹ 48,223 and 2.7 was observed with oxadiargyl *fb a*zimsulfuron and pretilachlor + safener *fb* azimsulfuron and it was followed by mechanical weeding 20 and 40 DAS (₹ 45,563 and 2.6).

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

Cooperating centres:

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

OUAT, Bhubaneswar

The dominated weeds were *Digitaria ciliaris, Cynodon dactylon, Echinochloa colona, Ageratum conyzoides, Cleome viscosa, Celosia argentea, Oldenlandia corymbosa, Ludwigia parviflora, Physalis minima* and *Amaranthus viridis*. The dominant sedges were *Cyperus rotundus* and *Cyperus iria*. Application of pendimethalin *fb* bispyribac *fb* manual weeding exhibited significantly lowest weed biomass of 1.9, 2.2 and 4.6 g/m^2 30, 60 DAS and at harvest, respectively followed by oxadiargyl *fb* bispyribac. The weedy check plots showed highest weed biomass at all the stages of crop growth. Higher grain yield of 4.4 t/ha was obtained with application of pendimethalin *fb* bispyribac *fb* manual weeding which was at par with oxadiargyl *fb* bispyribac (4.32/t), pyrazosulfuron *fb* bispyribac (4.27/t), pendimethalin *fb* bispyribac (4.1/t) and pendimethalin *fb* manual weeding (4.0 t/ha). Application of pendimethalin *fb* bispyribac *fb* manual weeding recorded lowest weed index of 1.56% followed by oxadiargyl *fb* bispyribac (3.35%). Highest net return and B:C ratio of ₹ 18,900/ha and 2.78 were obtained from application of pendimethalin *fb* bispyribac *fb* manual weeding followed by oxadiargyl *fb* bispyribac (₹ 17,600/ha and 2.72).

UAS, Bengaluru

Among the weed species, densities of *C. rotundus, D. marginata, E. colona, S. acmella, E. geniculata* and *A. conyzoides* were more than other weed species, indicated dominance and competitiveness with the direct seeded rice (Table 3.1.3.1). None of the herbicides caused phytotoxicity to rice in terms of yellowing, curling, epinasty, hyponasty, and wilting symptoms.

Effective control of weeds with combination of pendimethalin 3 DAP *fb* bispyribac-sodium (20 DAS), weeding (45 DAS) and pyrazosulfuron-ethyl *fb* bispyribac-sodium (20 DAS) was noticed at 60 and 90 DAS. Three hand weedings (20, 40 and 60 DAS) recorded significantly higher paddy grain and straw yield compared to all other treatments except pendimethalin 2 DAS *fb* bispyribac-sodium 20 DAS with manual weeding (45 DAS), pendimethalin

Table 3.1.3.1 Effect of different herbicides combinations on weed density, weed biomass, yield and economics in direct-seeded rice (*Kharif* 2014) at Bengaluru

Treatment	Dose (g/ha)	Time of application (DAS)	Weed density /m^2	Weed dry wt (g/m^2)	Grain yield (t/ha)	Gross returns	Net returns (₹/ha)	B:C ratio
Bispyribac-Na	25	20 (3-4 leaf stage)	63.1	1.53 (33.5)	2.83	43,239	16,859	1.6
Pendimethalin* *fb* bispyribac	1000 *fb* 25	0-2 *fb* 25	39.4	1.27 (16.8)	3.33	50,912	22,332	1.8
Oxadiargyl *fb* bispyribac	100 /25	0-2 *fb*25	37.8	1.36 (21.9)	3.22	49,275	21,425	1.8
Pyrazosulfuron *fb* bispyribac	20/25	0-3 *fb*25	38.6	1.25 (17.4)	3.55	54,318	26,713	2.0
Pendimethalin* *fb* bispyribac *fb* manual weeding	1000 *fb* 25	0-2 *fb* 20DAS (3-leaf stage) *fb* 45 d	26.2	1.11 (11.1)	3.87	59,045	28,965	2.0
Pendimethalin *fb* manual weeding	1000	0-2 *fb* 25-30d	47.5	1.38 (22.6)	3.00	45,920	19,620	1.7
Bispyribac + (chlorimuron + metsulfuron)	20+4	20 DAS	50.7	1.47 (28.4)	3.12	47,770	20,440	1.7
Three mechanical weedings (cono / rotary weeder)	-	20, 40, 60 DAS	21.5	1.03 (9.0)	3.76	57,536	27,436	1.9
Weed free (HW at 20, 40 and 60 DAS)	-	-	18.8	0.95 (7.4)	4.04	61,801	28,701	1.9
Weedy check	-	-	127.1	1.97 (91.3)	0.44	6,724	-17,376	0.3
SEm±			0.19	0.08	0.19	-	-	-
LSD (P=0.05)			0.55	0.25	0.57	-	-	-

(2 DAS) *fb* bispyribac-sodium (20 DAS) (and passing conoweeder at 20, 40 and 60 DAS) which were on par. The herbicides alone or mixtures were cheaper than manual weeding or passing conoweeder. The plots treated with herbicides / herbicide mixtures saved the weeding cost as compared to three times manual weeding.

CSKHPKV, Palampur

The major weeds were *Echinochloa colona, Digitaria sanguinalis, Panicum dichotomiflorum, Commelina benghalensis, Aeschynomene indica, Ageratum conyzoides* and *Cyperus iria*. The population of different weed species was significantly influenced by different treatments at 60 DAS and at harvest except *Digitaria sanguinalis, Aeschynomene indica* and *Ageratum conyzoides*. All the herbicides behaving statistically similar among themselves and with weed free resulted in significantly lower density of *Echinochloa* as compared to three mechanical weedings with cono/rotary weeder and weedy check at both the stages of observations. Similarly, all the weed control treatments behaving statistically similar except three mechanical weedings with cono/rotary weeder and bispyribac 25 g/ha (20 DAS) resulted in significant lower density of *Panicum dichotomiflorum* at 60 DAS as compared to weedy check.

All the weed control treatments except pendimethalin *fb* manual weeding (0-2 *fb* 25-30 DAS) were statistically similar resulted in taller rice plants,

Table 3.1.3.2 Effect of different treatments on total weed dry weight and yield attributes in direct-seeded rice

Treatment	Plant height (cm)	Length of panicle (cm)	Effective tillers/m row length	Spikelets /panicle	Total weed dry weight (g/m^2)		Grain yield (t/ha)
					60 DAS	at harvest	
Bispyribac 25 g/ha (20 DAS)	94.1	21.3	61.1	15.4	2.74 (4.50)	2.58 (5.70)	2.67
Pendimethalin *fb* bispyribac 1000 *fb* 25 g/ha (0-2 *fb* 25 DAS)	93.6	21.2	59.4	15.7	2.17 (3.75	3.08 (9.50)	2.79
Oxadiargyl *fb* bispyribac 100 *fb* 25 g (0 -2 fb25 DAS)	92.1	21.8	60.1	15.3	2.09 (3.40)	3.40 (8.25)	3.06
Pyrazosulfuron *fb* bispyribac 20 *fb* 25 g/ha (0-3 *fb* 25 DAS)	93.1	20.6	61.2	14.6	2.42 (4.90)	2.50 (5.30)	2.80
Pendimethalin *fb* bispyribac *fb* manual weeding 1000 *fb* 25 g /ha (0 -2 *fb* 20 DAS *fb* 45 DAS)	93.6	21.7	57.2	16.7	2.04 (3.20)	1.87 (2.50)	3.38
Pendimethalin *fb* manual weeding1000g/ha (0-2 *fb* 25-30 DAS)	89.4	19.7	58.1	10.8	3.01 (8.10)	2.76 (6.30)	2.20
Bispyribac + (chlorimuron + metsulfuron methyl) 20+ 4 g/ha (20 DAS)	91.1	21.4	59.1	14.4	2.81 (6.9)	2.59 (5.70)	2.60
Three mechanical weedings (cono/rotary weeder)	92.2	19.8	58.9	11.4	2.86 (7.2)	3.40 (10.6)	2.40
Weed free	88.4	21.2	60.6	15.0	2.45 (5.0)	2.34 (4.50)	2.81
Weedy check	82.7	17.0	47.1	8.7	6.66 (43.4)	7.52 (55.7)	1.07
SEm±	1.6	0.13	0.50	0.35	0.09	0.34	0.10
LSD (P=0.05)	4.75	0.38	1.48	1.03	0.26	1.00	0.31

Values given in the parentheses are the original means, DAS=days after sowing, *fb*= followed by

length of panicle and more number of spikelets/ panicle. Weeds in unweeded check reduced the grain yield of paddy by 54.9% over pendimethalin *fb* bispyribac *fb* manual weeding (0-2 *fb* 20 DAS *fb* 45 DAS). However, pendimethalin *fb* bispyribac *fb* manual weeding (0-2 *fb* 20 DAS *fb* 45 DAS) behaved statistically alike with all the weed control treatments except three mechanical weedings with cono/rotary weeder and pendimethalin *fb* manual weeding (0-2 *fb* 25-30 DAS) and resulted in significantly higher grain yield by effective control of weeds. It was followed by pyrazosulfuron *fb* bispyribac (0-3 *fb* 25 DAS). The lowest grain yield was recoded in weedy check treatment (Table 3.1.3.2).

AAU, Jorhat

The early emerged weeds in the field were *Cynodon dactylon, Eleusine indica, Oxalis corniculata* and *Mimosa pudica*. The most troublesome weeds in the critical crop growth period were *Digitaria setigera, Eleusine indica, Ageratum houstonianum, Borreria articularis, Ludwigia linifolia, Melochia corchorifolia. Cyperus iria Ludwigia, Melochia, Mimosa* sp. and *Cuphea balsamona* created problem in the later stage of crop growth. Deep rooted weeds like *Scoparia dulcis, Panicum repens* emerged in the field after the first shower.

At 40 DAS, weed free and pyrazosulfuron *fb* bispyribac-Na caused lowest weed density. However, at 60 DAS, pendimethalin *fb* bispyribac-Na + manual weeding (45 DAS) and pyrazosulfuron *fb* bispyribac-Na treatment resulted in lowest weed density. Pendimethalin *fb* bispyribac-Na resulted lowest weed dry weight. This treatment was closely followed by oxadiargyl *fb* bispyribac-Na at 20 DAS, pendimethalin *fb* bispyribac-Na + manual weeding (45 DAS) at 40 DAS and weed free (hand weeding 20, 40 and 60 DAS). As the treatment differences were visible beyond 20 DAS, weedy check resulted highest weed dry weight. Among the treatments involving herbicide application, highest grain yield was obtained from pendimethalin *fb* manual weeding (25 DAS).

IGKV, Raipur

Weed flora of the experimental field consisted of *Echinochloa colona, Cyperus iria, Alternanthera triandra, Spilanthes acmella* and *Cyanotis axillaris*. Broad leaf weeds and sedges dominated the weed flora at 60 DAS and at harvest as compared to grasses and other weeds. The lowest weed count at 60 DAS was

Table 3.1.3.3 Growth and yield attributes of rice as affected by treatments

Treatment	Plant height (cm)	No. of effective tillers/m^2	Filled grains/ panicle	Grain yield	Straw yield (t/ha)
Bispyribac-Na 25 g/ha	81.1	80.9	97.4	0.84	1.21
Pendimethalin 1000 g/ha *fb* bispyribac-Na 25g/ha	127.3	108.9	102.6	1.58	2.40
Oxadiargyl 100 g/ha *fb* bispyribac-Na 25 g/ha	128.4	109.0	108.1	1.41	1.91
Pyrazosulfuron 20 g/ha *fb* bispyribac-Na 25 g/ha	104.6	112.2	107.1	1.49	2.02
Pendimethalin 1000 g/ha *fb* bispyribac-Na 25g/ha + manual weeding (45 DAS)	116.8	85.73	112.0	1.58	1.92
Pendimethalin 1000 g/ha *fb* manual weeding (25DAS)	112.2	92.3	110.9	1.75	2.14
Bispyribac-Na 25 g/ha + almix 4 g/ha	91.3	61.2	102.7	1.29	1.85
Mechanical weeding 20, 40 and 60 DAS	106.4	95.8	108.9	2.06	3.08
Weed free (hand weeding 20, 40 and 60 DAS)	126.9	98.1	128. 2	2.23	3.17
Weedy	81.6	68.1	73.1	0.48	0.72
LSD (P=0.05)	4.1	NS	2.5	0.06	0.06

recorded under pendimethalin *fb* bispyribac–Na *fb* manual weeding at 45 DAS and this was closely followed by hand weeding twice, pyrazosulfuron *fb* bispyribac-Na, bispyribac-Na + (chlorimuron+ metsulfuron) and oxadiargyl *fb* bispyribac-Na.

Lowest dry matter and weed control efficiency was recorded under pendimethalin *fb* bispyribac-Na *fb* manual weeding at 45 DAS but it was statistically at par with weed free (hand weeding at 20, 40 and 60 DAS) and pyrazosulfuron *fb* bispyribac–Na. However, at harvest the lowest weed dry matter was recorded under pendimethalin *fb* bispyribac-Na *fb* manual weeding at 45 DAS which was statistically at par with weed free (hand weeding at 20, 40 and 60 DAS and pyrazosulfuron *fb* bispyribac-Na, pendimethalin *fb* manual weeding, pendimethalin *fb* bispyribac-Na and oxadiargyl *fb* bispyribac-Na, in descending order. The highest weed dry matter was found under weedy check at both the stages.

Significantly higher grain yield was recorded under pendimethalin *fb* bispyribac–Na *fb* manual weeding at 45 DAS, however, it was statistically at par with rest of the treatments except bispyribac–Na applied alone as post-emergence, bispyribac–Na + (chlorimuron+metsulfuron), three mechanical weedings (rotary weeder 20, 40 and 60 DAS) and weedy check. Various herbicide combinations did not affect test weight significantly. The highest reduction in seed yield was 83.3% in weedy check as against minimum reduction of 3.6% under combination of pendimethalin *fb* bispyribac–Na and hand weeding thrice. Though the gross return was maximum under pendimethalin *fb* bispyribac-Na *fb* manual weeding 45 DAS treatment followed by pendimethalin *fb* bispyribac-Na, but benefit-cost ratio was highest under the treatment of oxadiargyl *fb* bispyribac-Na, narrowly followed by pendimethalin *fb* bispyribac-Na.

KAU, Thrissur

Pendimethalin *fb* hand weeding was found best combination on par with the weed free treatment. There was no additional benefit from giving a post- emergence spray of bispyribac-sodium to the pendimethalin *fb* manual weeding treatment, as these treatments were statistically on par. All the herbicide treatments were on par and significantly reduced the problem of major dicot weed *Ludwigia parviflora*. Three mechanical weeding (cono weeding) was not effective in controlling the weed as indicated by the population on par with weedy check. The lowest count of total weeds and weed dry matter production were recorded in the weed free plot receiving three hand weedings, closely followed by pre-emergence application of pendimethalin *fb* bispyribac and or manual weeding. Pendimethalin *fb* hand weeding, with or without hand weeding, as well as weed free recorded highest weed control efficiency of more than 75%. The highest grain yield of 5006 kg/ha was recorded by weed free treatment followed by pendimethalin *fb* hand weeding and pendimethalin *fb* bispyribac *fb* hand weeding. The least grain yield was recorded in weedy check (1796 kg/ha). Maximum B:C ratio of 2.8 was obtained for the treatment pendimethalin *fb* mannual weeding.

NDUAT, Faizabad

The major weed species were *Echinochloa colona*, *Echinochloa crus-galli*, *Panicum maximum*, *Caesulia axillaris*, *Eclipta alba*, *Fimbristylis miliacea* and *Cyperus difformis*. Bispyribac-Na was found very effective to control all the weed species significantly over weedy check. Pendimethalin *fb* manual weeding could not control the weeds effectively due to emergence of second flush of the weeds after manual weeding done at 30 DAS. Bispyribac-Na + (chlorimuron + metsulfuron) applied at 20 DAS controlled all the weed species significantly over rest of the treatments, except pendimethalin *fb* bispyribac *fb* manual weeding. Three mechanical weeding using the cono weeder reduced the weed density and dry weight significantly over weedy check.

A combination of two herbicides or along with manual weeding (MW) recorded significantly lower weed dry weight and higher WCE. A combination of pendimethlin *fb* bispyribac was at par with pendimethalin + bispyribac + MW and recorded significantly less weed dry weight (13.6 g/m^2) and highest value of WCE (95.2%) followed by pendimethalin *fb* bispyribac and bispyribac + almix, respectively. Application of pendimethalin followed by bispyribac-Na + one hand weeding at 45 DAS recorded the maximum grain and straw yield (4425 and 4820 kg/ha) which was at par with application of

pendimethalin *fb* bispyribac-Na and oxydiargyl *fb* bispyribac-Na. The mechanical weeding treatment (cono weeder) recorded fairly good grain yield (3907 kg/ha) as weeds remained within the rows of the crop which may declined the yield. Pendimethalin as PE *fb* bispyribac–Na as POE *fb* manual weeding (45 DAS) recorded highest gross return (₹ 57,915/ha), net return (₹ 36,445/ha) and benefit cost ratio (1.70). Phytotoxicity symptoms were not observed due to any herbicide treatment on the crop during the experimentation.

TNAU, Coimbatore

The pre-dominant grassy weeds were: *Echinochloa crus-galli* and *Echinochloa colona* and the dominant sedge was *Cyperus difformis*. Among the broad leaved weeds, *Eclipta alba*, *Ludwigia parviflora* and *Ammannia baccifera* were the dominant species. At 60 DAS, the total weed density and weed dry weight were significantly lower with oxadiargyl *fb* bispyribac-sodium (4.98 no./m^2 and 1.56 g/m^2), and followed by pendimethalin *fb* bispyribac-sodium *fb* hand weeding on 45 DAS (12.24 no./m^2, 2.84 g/m^2). Statistically higher weed density was observed with three rotary weeder weeding on 20, 40 and 60 DAS (38.53 no./m^2). At 60 DAS, higher weed control efficiency of 95.6% was obtained with oxadiargyl *fb* bispyribac-sodium 25 g/ha and it was followed by the pendimethalin *fb* bispyribac-sodium *fb* hand weeding on 45 DAS and pendimethalin *fb* bispyribac-sodium at 25 g/ha with 94.1 and 89.7%, respectively. The lower weed control efficiency (51.7%) was obtained with bispyribac-sodium 25 g/ha.

Pre-emergence application of oxadiargyl showed phytotoxicity symptoms in direct-seeded rice. It caused yellowing and stunted growth of crop with a rating of 4.0 and 3.0 at 3 and 7 DAHS. Complete recovery of affected direct-seeded rice could be observed only after 30 DAHS.

During *Rabi* 2013-14, pendimethalin *fb* bispyribac-sodium *fb* hand weeding on 45 DAS registered significantly higher productive tillers/m^2 (296/m^2). It was comparable with hand weeding on 20, 40 and 60 DAS and pendimethalin *fb* bispyribac-sodium at (278/m^2). Distinctly lower number of productive tillers/m^2 was recorded with bispyribac-sodium. The grain yield was conspicuously higher (6267 kg/ha) with pendimethalin *fb* bispyribac-sodium *fb* hand weeding on 45 DAS and it was on par with pendimethalin *fb* bispyribac-sodium (6043 kg/ha) and hand weeding on 20, 40 and 60 DAS (5956 kg/ha). The lower grain yield was obtained with application of oxadiargyl *fb* bispyribac-sodium (4730 kg/ha). Higher gross return (₹ 75,204/ha) was observed with pendimethalin *fb* bispyribac-sodium *fb* hand weeding on 45 DAS and it was followed by pendimethalin *fb* bispyribac-sodium with ₹ 72,516. Higher net return and B: C ratio of ₹ 46,837 and 2.65 was observed with pendimethalin *fb* bispyribac-sodium *fb* hand weeding on 45 DAS and it was followed by pendimethalin *fb* bispyribac-sodium (₹ 44,549 and 2.59).

VB, Sriniketan

The weed species were *Digitaria sanguinalis*, *Cynodon dactylon*, *Echinochloa colona*, *Ludwigia parviflora*, *Lindernia ciliata*, *Ammannia multiflora*, *Oldenlandia corymbosa*, *Spilanthes acmella*, *Cyperus iria*, *Cyperus difformis*, *Cyperus haspan* and *Fimbristylis miliacea*. Pre-emergence application of pyrazosulfuron *fb* bispyribac was found most effective and this was followed by pendimethalin *fb* bispyribac and tank mix of bispyribac + (chlorimuron + metsulfuron). Post-emergence application of bispyribac + (chlorimuron + metsulfuron) controlled sedges very effectively.

Highest number of tillers/m^2 was observed in three mechanical weedings and this was statistically at per with the all treatments except weedy check. Pre-emergence application of pendimethalin *fb* manual weeding produced highest number of effective tillers. Three hand weeding (weed free) recorded the highest yield (4.8t/ha) and this was statistically at par with mechanical weeding and all herbicidal treatments. Among the herbicidal treatments pre-emergence application of pendimethalin *fb* bispyribac *fb* manual weeding produced higher grain yield (4.8 t/ha) and this was followed by tank mix of bispyribac +(chlorimuron+metsulfuron) applied as post-emergence (4.8 t/ha). Post-emergence application of bispyribac + (chlorimuron + metsulfuron) showed slight toxicity on direct-seeded rice but it was recovered within a short period of time. Post-emergence application of bispyribac + chlorimuron

gave the highest net return (₹ 42,682/ha) and B:C ratio (2.69). Weed free check and three mechanical weeding gave comparatively higher gross return but net return and B:C ratios were lower as compared to bispyribac + (chlorimuron+metsulfuron). All the herbicidal treatments were at par in recording

Table 3.1.3.4 Effect of treatments on yield attributes and grain yield of wet-seeded rice

Treatment	No of effective tillers/m^2	No. of grains / panicle	Test weight (g/1000 grain)	Grain yield (t/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B:C ratio
Bispyribac-Na	373.0	78.0	22.1	4.42	61,927	36,327	2.42
Pendimethalin*fb* bispyribac	385.7	78.0	22.2	4.82	67,559	40,609	2.50
Oxadiargyl *fb* bispyribac	390.3	83.7	22.2	4.82	67,611	41,411	2.58
Pyrazosulfuron *fb* bispyribac	395.0	87.3	22.0	4.83	67,699	41,399	2.57
Pendimethalin*fb* bispyribac*fb* manual weeding	386.3	79.0	22.2	4.85	67,956	39,806	2.41
Pendimethalin*fb* manual weeding	415.7	80.7	22.3	4.80	67,312	41,662	2.62
Bispyribac + (chlorimuron + metsulfuron)	398.0	91.3	22.1	4.85	67,942	42,682	2.69
Three mechanical weedings (cono / rotary weeder) (rice spacing 25 cm)	402.0	94.0	22.2	4.86	68,161	42,061	2.61
Weed free (HW at 20, 40 and 60 DAS)	413.3	102.3	22.3	4.89	68,525	39,425	2.35
Weedy check	282.7	65.0	22.0	3.07	42,980	19,880	1.86
LSD (P=0.05)	28.1	8.9	0.10	0.48	68,282	68,282	0.26

WS 3.2: Herbicides combinations for control of complex weed flora in wheat

Cooperating centres: Ludhiana, Pantnagar, Kanpur, Faizabad, Palampur, Gwalior, Pusa, Ranchi, Anand, Parbhani, Bikaner, Dharwad and Jammu. Not reported by the centres

WS 3.3: Weed management in turmeric/other vegetables

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

Turmeric is an important spice crop and the area of this crop is increasing day by day. Due to wide spacing of planting and long duration of the crop, weeds pose a big problem in turmeric particularly during initial phase of growth during *Kharif* season. Diverse weed flora infest the turmeric crop which are hard to be controlled with a single herbicide. Weed control part is still lacking in turmeric. There is need for combination of different herbicides with cultural practices for management of different type of weeds in turmeric. Hence, this experiment was planned to find suitability of different weed control options in turmeric.

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

CSHAU, Hisar

The weed flora of the field consisted of *Dactyloctenium aegyptium, Brachiaria reptans, Eragrostis tenella* among grasses; *Melilotus indica, Coronopus didymus* and *Anagallis arvensis* among broadleaf weeds (BLW) and *Cyperus rotundus* among sedges. All the treatments except the treatments with fenoxaprop provided effective control of all type of weeds in turmeric. The treatments with straw mulch were found most effective against all type of weeds. Fenoxaprop provided effective control of grassy weeds as post-emergence herbicide. Glyphosate at 7.5 mL/litre of water (directed spray) provided effective control of most of the weeds at the time of its application. Its lower dose was not as effective. Metribuzin or pendimethalin or atrazine *fb* mulching + one hand weeding provided excellent control of weeds and the growth of the crop. Metribuzin 700 g/ha or pendimethalin 1000 g/ha or atrazine 750 g/ha *fb* mulching+ hand weeding at 45 DAP were

Table 3.3.1.1 Effect of different treatments on density and dry weight of weeds in turmeric at RRS, Karnal (*Kharif* 2014)

Treatment	Dose (g/ha)	Time (DAP)	Density of weeds (no./m²)			Dry weight of weeds (g/m²)		
			Grassy	Sedges	BLW	Grassy	Sedges	BLW
Metribuzin *fb* hoeing *fb* hoeing	700	0-3/45/75	4.85 (24.0)	5.18 (26.0)	6.61 (44.0)	33.1	6.4	6.3
Metribuzin *fb* fenoxaprop	700 *fb* 67	0-3/45	3.82 (14.7)	6.83 (46.0)	7.40 (58.7)	28.9	8.1	8.3
Metribuzin *fb* mulching *fb* hand weeding	700	0-3/3/75	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	0.0	0.0	0.0
Pendimethalin *fb* hoeing *fb* hoeing	1000	0-3/45/75	3.95 (16.7)	5.12 (25.3)	6.49 (42.0)	21.5	5.5	5.7
Pendimethalin *fb* fenoxaprop	1000 *fb* 67	0-3/45	4.43 (18.7)	6.71 (45.3)	7.90 (62.0)	34.1	8.1	10.0
Pendimethalin *fb* mulching *fb* hand weeding	1000	0-3/3/75	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	0.0	0.0	0.0
Atrazine *fb* hoeing *fb* hoeing	750	0 3/45/75	4.57 (20.0)	5.17 (26.0)	5.69 (32.0)	29.8	4.6	5.2
Atrazine *fb* fenoxaprop	750 *fb* 67	0-3/45	5.12 (25.3)	6.79 (45.3)	7.36 (53.3)	36.8	8.8	8.2
Atrazine *fb* mulching+ hand weeding	750	0-3/3/75	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	0.0	0.0	0.0
Oxyflourfen *fb* hoeing *fb* hoeing	300	0 3/45/75	4.39 (18.7)	5.83 (33.3)	6.98 (48.0)	30.9	6.7	5.9
Oxadiargyl *fb* hoeing *fb* hoeing	250	0 3/45/75	4.49 (19.3)	6.66 (43.3)	8.18 (66.0)	28.7	10.1	7.0
Glyphosate *fb* hoeing *fb* hoeing	5ml/l	25/45/75	3.88 (14.7)	3.60 (12.0)	8.79 (76.7)	32.5	5.5	12.2
Glyphosate *fb* hoeing *fb* hoeing	7.5ml/l	25/45/75	2.97 (8.0)	2.85 (7.3)	9.33 (86.0)	29.6	3.5	12.2
Hand weeding(3)	-	-	3.90 (14.7)	4.91 (23.3)	6.99 (48.7)	27.4	5.6	6.1
Weed free	-	-	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	0.0	0.0	0.0
Weedy check	-	-	6.71 (44.7)	6.80 (45.3)	9.45 (88.7)	120.5	11.1	12.7
SEm			0.41	0.33	0.56	6.9	0.7	0.9
LSD (P=0.05)			1.19	0.96	1.62	20.1	2.0	2.6

*Original figures in parenthesis were subjected to square root transformation ($\sqrt{x+1}$) before statistical analysis.

realized to be the best options for effective weed control in turmeric with improved crop growth.

CSKHPKV, Palampur

The major weeds were *Echinochloa colona, Digitaria sanguinalis, Panicum dichotomiflorum, Commelina benghalensis, Cyperus iria, Ageratum conyzoides, Polygonum* sp., *Physalis minima* and *Aeschynomene indica*. Among all treatments metribuzin *fb* straw mulch *fb* hoeing, pendimethalin *fb* hoeing, pendimethalin *fb* fenoxaprop + metsulfuron methyl, pendimethalin *fb* straw mulch *fb* hoeing and atrazine *fb* straw mulch *fb* hoeing were as good as weed free in reducing the population of *Echinochloa colona* and other grassy weeds upto 60 DAP. *Ageratum conyzoides* in the weedy check was maximum at 60 DAP and decreased thereafter probably owing to intra- or inter-specific competition. Metribuzin *fb* fenoxaprop+metsulfuron-methyl, pendimethalin *fb* fenoxaprop+metsulfuron-methyl and atrazine *fb* fenoxaprop+metsulfuron-methyl had completely eliminated *Ageratum* upto 60 DAP. Lately in these treatments as well as in others, *Ageratum* appeared in large number. The trend in the count of other weeds was similar as *Ageratum conyzoides*. However, treatment differences were not significant. This indicated contiguous or sporadic distribution of the weeds rather than uniform.

The weed control treatments brought significant variation in yield attributes and rhizome yield. Weeds in unweeded check reduced the rhizome yield by 77.6% over metribuzine/pendimethalin *fb* straw mulch *fb* hoeing. Metribuzine/pendimethalin/ atrazine *fb* mulch *fb* hoeing increased fresh rhizome and rhizome yield by three times over weed check. Benefit cost ratio was highest under pendimethalin *fb* mulch *fb* hoeing followed by atrazine *fb* mulch *fb*

hoeing, metribuzin *fb* mulch *fb* hoeing and pendimethalin *fb* hoeing.

NDUAT, Faizabad

The weed flora consisted of *Echinochloa species, Dactyloctenium aegyptium, Eleusine indica* and *Poa annua* among grasses; *Ludwigia crustacea, Commelina benghalensis, Ammannia beccifera, Ageratum conyzoides* and *Solanum nigrum* among broad leaf weeds and *Cyperus rotundus* and *Fimbristylis* among sedges.

At 60 DAP all the treatments, except in treatments with atrazine + straw mulch + HW, metribuzin + straw mulch + HW, pendimethalin+ straw mulch + HW provided very good control of all type of weeds in turmeric. However, atrazine + straw mulch + HW showed the phytotoxicity on the crop. Straw mulch *fb* one hand weeding recorded significantly less weed density as compared to rest of the treatments. These integrated treatments with all the three herbicides recorded higher weed control efficiency (85.2%) over weed free check (78.9%) at 120 DAP of crop. It might be because of the fact that last manual weeding was done at 75 days stage of the crop and later on some of the weeds of grassy and BLWs have come up which caused the reduction in the WCE. Oxyfluorfen and oxadiargyl *fb* 2 HW were very effective to control all the weeds and did not showed no phytotoxicity on the crop. But glyphosate at 5 and 7.5 ml/L water *fb* 2 HW each proved toxic to the crop and weeds both and recorded very poor crop growth and yield.

RAU, Pusa

The lowest weed dry weight was recorded under hand weeding (HW at 25, 45 and 75 DAP) which was significantly superior over rest of the treatments except metribuzin *fb* 2 hand weeding. The highest grain yield (48.8 t/ha) was recorded under hand weeding thrice (at 25, 45 and 75 DAP) which was statistically at par with metribuzin *fb* 2 hand weeding (HW at 45 and 75 DAP), metribuzin *fb* fenoxaprop + metsulfuron (at 3 DAP *fb* 45 DAP), metribuzin *fb* straw mulch 10 t/ha *fb* HW (at 3 DAP *fb* 10 DAP) *fb* 75 DAP, pendimethalin *fb* 2 HW (at 3 DAP *fb* 45 and 75 DAP) and pendimethalin *fb* fenoxaprop + metsulfuron (at 3 DAP *fb* 45 DAP). The highest weed control efficiency (87.7%) was recorded under hand weeding thrice (at 25, 45 and 75 DAP) which was closely followed by metribuzin *fb* 2 hand weeding (at 45 and 75 DAP), metribuzin *fb* fenoxaprop + metsulfuron (at 3 DAP *fb* 45 DAP), metribuzin *fb* straw mulch 10 t/ha *fb* HW (at 3 DAP *fb* 10 DAP *fb* 75 DAP), pendimethalin *fb* 2 HW (at 3 DAP *fb* 45 and 75 DAP) and pendimethalin *fb* fenoxaprop + metsulfuron (at 3 DAP *fb* 45 DAP) with their WCE values 86.6%, 77.3%, 71.5% and 67.1%. There were not any phytotoxic effects on the crop due to herbicides.

Table 3.3.1.2 Effect of treatments on total weed dry matter (g/m^2) weed control efficiency, yield and B:C ratio

Treatment	Dose (g/ha)	Time of application (DAP)	Weed dry matter (g/m^2) (90 DAP)	WCE (%)	Fresh rhizome yield (t/ha)	Cured rhizome yield (t/ha)
Metribuzin *fb* hoeing	700	0-3/45/75	4.85	94.5	7.6	5.2
Metribuzin *fb* fenoxaprop + metsulfuron-methyl	700 *fb* 67	0-3/45	2.4(4.8)	43.7	4.9	3.3
Metribuzin *fb* straw mulch *fb* hoeing	700	0-3/3/75	6.8(49.3)	54.8	14.3	13.3
Pendimethalin *fb* hoeing	1000	0-3/45/75	5.9(39.6)	93.6	8.8	7.2
Pendimethalin *fb* fenoxaprop + metsulfuron-methyl	1000 *fb* 67	0-3/45	2.5(5.6)	25.3	4.6	3.1
Pendimethalin *fb* straw mulch *fb* hoeing	1000	0-3/3/75	7.8(65.4)	48.0	14.3	13.3
Atrazine *fb* fenoxaprop + metsulfuron-methyl	750	0-3/45/75	6.7(45.5)	1.1	4.2	3.3
Atrazine *fb* straw mulch *fb* hoeing	750 *fb* 67	0-3/45	9.1(86.6)	14.6	13.8	12.0
Weed free	-	-	8.6(74.7)	83.9	9.7	8.4
Weedy check	-	-	3.9(14.1)	0.0	3.2	2 .5
SEm ±			9.2(87.5)	-	0.5	0.5
LSD(P=0.05)			1.63	-	1.0	1.1

Data subjected to square root transformation ($\sqrt{x+1}$), Values given in parentheses are the means of original values.

AAU, Jorhat

In 2013, grasses like *Panicum repens* and to some extent *Saccharum spontaneum* appeared as the most troublesome weeds. Other grasses of this crop were *Cynodon dactylon, Eleusine indica* and *Digitaria setigera.* The lowest density and dry weight of weeds at 90 DAP were recorded under the treatment with metribuzin + hoeing at 30 and 60 DAP. In general, the lowest weed dry weight were found in the treatments with metribuzin + 2 hoeing, pendimethalin + 2 hoeing and atrazine + 2 hoeing (Table 3.3.1.3).

Rhizome length and number of primary rhizome per plant were found to be highest under hand weeding (25 and 45 DAP) (weed free), metribuzin + hoeing (30 and 60 DAP), Atrazine + hoeing (30 and 60 DAP) and pendimethalin + hoeing (30 and 60 DAP). Similar trend was observed for rhizome yield.

BAU, Ranchi

Application of glyphosate (1.85) *fb* 2 HW (45 and 75DAP) recorded significantly reduced density of broad leaf weed (24.0/m^2), narrow (181.0/m^2), sedges 12.0/m^2), and total weeds (217.33/m^2) at 30 DAP, and this was similar to atrazine *fb* straw mulch *fb* HW(75DAP), oxyfluorfen *fb* 2 HW (45 and 75DAP), oxadiargyl *fb* 2 HW (45 and 75 DAP) in case of broad leaf weeds; metribuzin *fb* fenoxaprop + metribuzin, metribuzin *fb* straw mulch *fb* HW (75 DAP), atrazine *fb* 2 HW (45 and 75 DAP), atrazine *fb* fenoxaprop + metsulfuron, atrazine *fb* straw mulch *fb* HW(75 DAP), oxyfluorfen *fb* 2 HW (45 and 75 DAP), oxadiargyl *fb* 2 HW(45 & 75 DAP) and glyphosate (1.25) *fb* 2 HW (45 & 75 DAP) in case of narrow leaf and glyphosate (1.25) *fb* 2 HW (45 and 75 DAP) in case of total weeds.

Application of metribuzin *fb* fenoxaprop + metsulfuron significantly reduced broad leaf weed density (48.6/m^2) compared to rest of the treatments except pendimethalin *fb* fenoxaprop + metsulfuron at 90 DAP, narrow weed density (48.0/m^2) at 90 DAP (111.00/m^2) at 150 DAP compared to metribuzin *fb* 2 hand weeding (45 and 75 DAP), metribuzin *fb* straw mulch *fb* HW (75 DAP), pendimethalin *fb* 2 HW (45 and 75 DAP), pendimethalin *fb* straw mulch *fb* HW (75 DAP), atrazine *fb* two HW (45 and 75 DAP), atrazine *fb* fenoxaprop + metsulfuron, atrazine *fb* straw mulch *fb* HW (75 DAP) and un weeded check at 90 DAP. Application of glyphosate 25 *fb* 45 and 75 DAP *fb* 2 hand weeding (45 and 75 DAP) being similar to atrazine *fb* fenoxaprop + metsulfuron, oxyfluorfen *fb* 2 hand weeding (45 and 75 DAP), oxardiagyl *fb* 2 hand weeding (45 and 75 DAP) and hand weeding (25,45 and 75 DAP) in case of broad, narrow and sedges weeds and also metribuzine *fb* fenoxaprop + metsulfuron, metribuzin *fb* straw mulch *fb* hand weeding (75 DAP), atrazine *fb* 2 hand weeding (45 and 75 DAP) and atrazine *fb* straw mulch *fb* HW(75 DAP) in case of narrow weeds recorded 56.5% reduced dry matter accumulation by broad leaf (11.16 g/m^2); 77.3% by narrow leaf (19.47 gm^2) and 66.4% reduced dry matter accumulation by sedges compared to their respective weed dry matter under weedy checks i.e., 25.6, 85.9 and 34.5 g/m^2 at 30 DAP.

At 90 DAP, the reduction was to the extent of 81.48, 84.80 and 83.68 percent of broad leaf (81.48 g/m^2), narrow (83.71 g/m^2) and sedges (16.11 g/m^2) compared to their respective dry matter under weedy checks.

UAS, Bengaluru, GBPUAT, Pantnagar: The crop was in the field not harvested.

PJNCA & RI, Karaikal: Not reported

WS 3.3.2: Integrated control of complex weed flora in garlic

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

AAU, Anand: Experiment was under progress.

PAU, Ludhiana, GBPUAT, Pantnagar, NDUAT, Faizabad: Not reported.

UAS, Bengaluru

Major weed flora were *Cyperus rotundus, Echinochloa crus-galli, Cynodon doctylon* whereas, among broad leaf weeds, major weeds were *Ageratum conyzoides, Acanthospermum hispidum, Borreria articularis, Euphorbia hirta* at 75 DAP. The density of *E. colona, Spilanthes acmella* were higher than other weed species, indicated their dominance from the beginning of the crop cycle. In unweeded control, the density of broad leaf weeds was higher followed by grasses and sedges at 75 DAP. At 75 DAP the hand weeding treatment recorded significantly lower weed density and weed dry weight compared to other treatments. Among herbicides both without straw mulch + pendimethalin (1.0 kg /ha) and without straw mulch + oxyflurofen recorded lower weed density and weed dry weight as compared to other treatments (Table 3.3.2.1).

Table 3.3.1.3 Weed dry weight, growth and yield of turmeric as affected by treatments

Treatments	90 DAP				Rhizome yield (t/ha)
	Weed dry weight (g/m^2)	Plant height (cm)	Number of leaves/ plant	Rhizome length	
Metribuzin 700 g/ha + hoeing 30 and 60 DAP	26.7	38.3	8.2	7.1	19.9
Metribuzin 700 g/ha *fb* fenoxaprop-pethyl 67 g/ha + metsulfuron-methyl 4 g/ha)	71.5	29.1	6.7	5.2	13.8
Metribuzin 700 g/ha *fb* straw mulch 10 t/ha followed by hand weeding 60 DAP	58.8	33.7	7.6	5.8	15.1
Pendimethalin 1000 g/ha + hoeing 30 and 60 DAP	31.4	35.5	8.8	7.0	17.5
Pendimethalin 1000 g/ha *fb* fenoxaprop-p-ethyl 67 g/ha + metsulfuron-methyl 4 g/ha	70.2	26.6	6.6	5.7	13.2
Pendimethalin 1000 g/ha*fb* straw mulch 10 t/ha followed by hand weeding 60 DAP	53.1	32.8	7.5	6.4	14.1
Atrazine 750 g/ha + hoeing 30 and 60 DAP	32.6	35.5	8.5	7.8	17.6
Atrazine 750 g/ha*fb* fenoxaprop-p-ethyl 67 g/ha + metsulfuron-methyl 4 g/ha)	63.2	31.9	6.1	5.7	13.1
Hand weeding 25 and 45 DAP (weed free)	39.4	34.6	8.1	7.4	18.3
Weedy	93.0	25.4	4.5	3.2	2.4
LSD (P=0.05)			8.2	6.3	0.5

Higher amounts of N, P_2O_5 and K_2O were recorded in soils where herbicides were sprayed at harvest comparable with mechanical weeding due to the production of higher biomass and lowest quantities of N, P_2O_5 and K_2O was noticed in the weedy cheek plots where weeds have removed the major nutrients to a greater extent. Higher amounts of NPK was found in cotton plots in pendimethalin *fb* 2 HW followed by pendimethalin *fb* glyphosate direct spray and it was lowest in the weedy check. While NPK removal was less in all the herbicide sprayed plots due to effective control of weeds and higher biomass production but the degree of removal of nutrients vary with the herbicides treatments. Among herbicides, oxadiargyl significantly produced higher bulb yield followed by oxyfluorfen which was on par with manual weeding and higher weed control efficiency 91.8%, besides saving cost of weed management compared to manual weeding.

Table 3.3.2.1 Economics on bulb yield of garlic during *Kharif*, 2014

Treatment	Cost of cultivation (₹/ha)	Net returns (₹/ha)	Benefit cost ratio
Without straw mulch + pendimethalin 1.0 kg/ha pre-emergence	50,168	1,61,652	4.2
Without straw mulch + oxyflurofen 0.223 kg/ha pre-emergence	51,150	1,62,210	4.2
Without straw mulch + two manual weeding at 20 and 40 DAP	56,000	1,70,835	4.1
Without straw mulch + weedy check	48,000	- 9,430	0.8
Without straw mulch + oxadiargyl 80 WP 0.140 kg /ha pre-emergence	51,300	1,76,865	4.4
With straw mulch + pendimethalin 1.0 kg/ha pre-emergence	50,668	1,67,452	4.3
With straw mulch + oxyflurofen 0.223 kg/ha pre-emergence	51,650	1,73,260	4.4
With straw mulch + two manual weeding at 20 and 40 DAP	56,500	1,70,872	4.0
With straw mulch + weedy check	48,500	-11,155	0.8
With straw mulch + oxadiargyl 80 WP 0.140 kg/ha pre-emergence	51,800	1,81,183	4.5

WS 3.3.3: Integrated weed management in ginger

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

KAU, Thrissur

Application of glyphosate + oxyfluorfen resulted in the least count of weeds and was on par with two hand weedings. Soil solarization as well as application of pendimethalin or oxyfluorfen followed by hand weeding resulted in significant reduction in weeds count than other treatments. Glyphosate + oxyfluorfen resulted in significant reduction in weed count and was on par with the hand weeding twice. No phytotoxicity symptom was noticed on ginger plants in any of the treatments.

Higher number of tillers were produced in glyphosate + oxyfluorfen and hand weeding treatments. The highest yield was recorded by glyphosate + oxyfluorfen closely followed by two hand weeding. Glyphosate + oxyfluorfen resulted in the highest value of B:C ratio followed by pendimethalin + hand weeding and oxyfluorfen + hand weeding. Even though hand weeding resulted in high yield on par with glyphosate + oxyfluorfen the B:C ratio for hand weeding treatment was low because of the high cost of cultivation due to large number of labourers engaged for hand weeding operation (Table 3.3.3.1).

Table 3.3.3.1 Total weeds count, weed dry weight and economic analysis of different treatments

Treatments	Weed count (no/m^2)	Weed dry weight (g/m^2)	Yield (t/ha)	Cost for weed control (₹/ha)	Total cost of cultivation (₹/ha)	Return (₹/ha)	B:C ratio
	90DAP	90DAP					
Pendimethalin	4.30^{b}(18.00)	28.68 (825.5)	5.67	756	1,81,231	4,53,600	2.5
Oxyfluorfen	3.13^{d}(9.33)	28.72 (827.4)	10.10	470	1,80,945	8,05,000	4.4
Pendimethalin + 1 HW	2.318^{e}(5.00)	12.04 (146.4)	11.97	9756	1,90,231	9,57,600	5.0
Oxyfluorfen +1 HW	3.071^{d} (9.00)	11.64 (135.3)	11.72	9470	1,89,945	9,37,600	4.9
Glyphosate	3.534^{cd}(12.33)	41.03 (1685.0)	5.63	280	1,80,755	4,50,400	2.4
Pendimethalin + glyphosate	3.882^{c} (14.67)	25.75 (663.1)	9.27	1036	1,81,511	7,41,600	4.0
Oxyfluorfen +glyphosate	2.112^{e}(4.00)	18.48 (341.3)	13.53	750	1,81,225	10,82,400	5.9
Hand weeding (2)	1.774^{e} (2.67)	18.37 (337.1)	13.35	40000	2,56,475	10,68,000	4.1
Unweeded control	5.755^{a} (32.67)	53.82 (2897.0)	4.23	0	1,80,475	3,38,400	1.8
Soil solarization	3.230^{d} (10.00)	25.90 (676.5)	10.62	50,000	2,30,475	8,49,600	3.6
LSD (p=0.05)	0.562	1.834	-	-	-	-	-

$\sqrt{x+1}$ Transformed values. Original values are given in the paranthesis. In a column, values followed by same alphabets do not differ significantly in DMRT.

BAU, Ranchi

Application of glyphosate + oxyfluorfen just before emergence of sprouts of ginger being similar to application of pendimethalin after planting but before mulching *fb* hand weeding, oxyfluorfen after planting but before mulching *fb* hand weeding and hand weedings (25 and 50 DAS) recorded 94.2, 85.1 and 90.2% at 75 DAS reducetion in grassy, sedges and total weeds compared to un weeded check. Hand weeding (25 and 50 DAS) being similar to application of glyphosate + oxyfluorfen, pendimethalin after planting but before mulching *fb* hand weeding, oxyfluorfen after planting but before mulching *fb* hand weedings (25 and 50 DAS) recorded

89.3 and 88.7% less broad leaved weed density compared to un weeded control (75 and 98/m^2 respectively).

Application of glyphosate + oxyfluorfen just before emergence of sprouts of ginger being similar to application of oxyfluorfen after planting but before mulching, oxyfluorfen after planting but before mulching *fb* hand weeding, glyphosate just before emergence of sprouts of ginger and hand weeding (25 and 50 DAS) recorded maximum leaves (29 leaves/plant) compared to un weeded control which recorded 10 leaves / plant.

RAU, Pusa

The lowest weed count and weed dry weight, and number of tillers per plant, the highest plant height, no. of tillers per plant, no. of leaves per plant and rhizome yield of ginger were recorded by the hand weeding twice at 30 and 60 and it DAP was statistically at par with glyphosate + oxyfluorfen at just before emergence of sprouts of ginger. The highest weed control efficiency was recorded by the hand weeding twice at 30 and 60 DAP which was closely followed by glyphosate + oxyfluorfen at just before emergence of sprouts of ginger, glyphosate + pendimethalin at just before emergence of sprouts of ginger and pendimethalin *fb* hand weeding at after planting but before mulch.

WS 3.4: Weed management in pulses and oilseed crops

3.4.1: Studies on time of application of imazethapyr and its ready-mix combination with imazamox against weeds in blackgram

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

AAU, Anand : Results not given.

TNAU, Coimbatore

General weed flora was consisted of *Dinebra retroflexa, Setaria verticillata, Trianthema portulacastrum, Digera arvensis, Parthenium hysterophorus, Amaranthus viridis, Boerhavia diffusa* and *Cyperus rotundus*. Hoeing at 20 and 40 DAS recorded significantly lower weed density (20.9/m^2) at 40 DAS. Among the herbicides, imazethapyr + imazamox recorded lower weed density of (36.7/m^2) and it was comparable with imazethapyr + imazamox. The lower weed dry weight (12.6 g/m^2) was recorded with hoeing at 20 and 40 DAS. Among the herbicides, imazethapyr + imazamox recorded lower weed dry weight (20.1/m^2) and it was comparable with imazethapyr + imazamox. Higher weed control efficiency of more than 83% was recorded with hoeing at 20 and 40 DAS. At 40 DAS, taller and comparable plant height was recorded with hoeing twice (31.8 cm) at 20 and 40 DAS, imazethapyr + imazamox (30.9 cm) and imazethapyr + imazamox (30.6 cm). The phytotoxicity symptoms were not observed in black gram with application of pendimethalin, imazethapyr and imazamox or its combination after both pre-emergence and post-emergence application.

NDUAT, Faizabad

The prominent weed species were *Eleusine indica, Echinochloa species, Panicum maxicum, Digitaria sanguinalis, Dactyloctenium aegyptium, Celosia argentea, Solanum nigrum, Trianthema monogyna, Cloeme viscosa* and *Digera arvensis*. However, *Cyperus rotundus* was the only sedge dominating among the total weed population. The pre-mix combination of imazethapyr + imazamox and pendimethalin applied as pre-emergence found more effective in reducing the density of weeds as compared to alone application of imazethapyr applied as pre and post-emergence application. The pre mix formulation of imazethapyr + pendimethalin was par with imazethapyr + imazamox applied as pre-emergence recorded significantly highest grain yield over other herbicide treatments. Uncontrolled growth of weeds (weedy check) resulted in 56% reduction in grain yield of black gram over hoeing twice treatments.

RVSKVV, Gwalior

The major weed flora was *Cyperus rotundus, Echinochloa crus-galli, Dactyloctenium aegyptium, Acrachne racemosa, Commelina benghalensis, Digera arvensis* and *Phyllanthus niruri*. Two hand weeding at 20 and 40 DAS gave maximum seed yield (990 kg/ha) followed by pre-mix herbicides i.e., imazethapyr + imazamox as POE (963 kg/ha) and pendimethalin + imazethapyr as PE application (924 kg/ha). Whereas in case of net return and BC ratio

were higher in imazethapyr + imazamox (2.33) followed by pendimethalin + imazethapyr (2.26).

CCSHAU, Hisar

Weed flora of the field was dominated by *Trianthema portulacastrum* constituting 82% of total weed flora. Other weeds were *Cyperus rotundus* and *Convolvulus arvensis*. All pre-emergence herbicides were very effective against predominant weed *T. portulacastrum*. None of the treatment proved effective against *C. rotundus* and *C. arvensis*. Post-emergence application of imazethapyr and imazethapyr + imazamox proved less effective in minimizing density and dry weight of weeds. Although post-emergence application of both these herbicides caused suppression in *Trianthema* growth but pre-emergence treatments of pendimethalin alone or in combination with imazethapyr were very effective to minimize *Trianthema* population and dry weight of weeds at 30 and 60 DAS. Post-emergence use of imazethapyr and its combination with imazamox caused slight toxicity to green-gram in terms of yellowing, bud necrosis and crinkling of leaves which mitigated within 15 days after application but with significant reduction in plant height and seed yield.

At 60 DAS, maximum WCE (85%) was recorded with the use of imazethapyr as PPI. Presence of weeds throughout the season caused 55% reduction in seed yield of green gram. Seed yield was maximum (1.16 t/ha) in weed free treatment which was significantly at par with all PPI and PRE treatments but higher than all post- emergence treatments. Maximum grain yield (0.98 t/ha) was obtained with pre-emergence use of pendimethalin + imazethapyr which was at par with all pre-emergence treatments but higher than all post- emergence treatments. Maximum B:C ratio of 2.27 was obtained with PPI use of imazethapyr.

All herbicide treatments except pendimethalin and its ready mixture with imazethapyr caused less or more residual toxicity on mustard. Visual toxicity on mustard was more in PPI treatments (90-95%) but less in pre and post applications of various herbicides. Mustard crop in these treatments showed significant variation in plant height, germination/percentage, number of leaves per plant as compared to untreated check, weed free and two hoeing. Pre-emergence use of pendimethalin and its ready mix combination did not show any residual carry over effect on mustard crop as plant height, germination percentage, number of leaves per plant in these treatments were similar to weedy check.

PAU, Ludhiana

The residual effect of herbicides applied in greengram on succeeding mustard crop was studied. *Phalaris minor, Avena ludoviciana, Rumex dentatus, Medicago denticulata, Coronopus didymus, Chenopodium album, Malva parviflora* and *Oenothera laciniata* were the major weeds in the experimental field. All pre-and post-emergence herbicides *viz.*, imazethapyr, imazethapyr + imazamox, imazethapyr + pendimethlain and pendimethalin, applied to preceding greengram at variable doses, did not show any residual effects on any of grass and broadleaved weeds in succeeding Indian mustard crop. All the weed control treatments used in greengram did not show any residual effects on germination, growth and seed yield of succeeding Indian mustard crop, indicating that all these herbicides could be adopted for weed control in green gram- Indian mustard based cropping sequences. Application of pendimethalin as pre-em ergence and imazethapyr + imazamox as post-emergence. to preceding greengram recorded the highest B: C ratio in the succeeding mustard crop.

CSKHPKV, Palampur

Major weeds were *Digitaria sanguinalis, Cyperus rotundus, Dactyloctenium aegyptium, Echinochloa colona, Commelina benghalensis, Eleusine indica* and *Setaria glauca*. Application of imazethapyr as pre-emergence was at par with imazethapyr post-emergence, imazethapyr + imazamox applied as 20 DAS and imazethapyr + pendimethalin pre mixing recorded significantly at par with each other. The highest weed count was recorded in weedy check. The weedy check recorded significantly higher weed dry weight at 40 DAS and at harvest of the mash crop as compared to all other herbicides treatments. The treatment imazethapyr (pre-emergence), imazethapyr 80 g/ha applied (at 3-4 leaf stage), imazethapyr + imazamox pre mix and imazethapyr + pendimethalin pre-emergence remained at par with each other and

Table 3.4.1.1 Effect of different treatments on weed count, dry weight and yield in blackgram at Palampur

Treatment	Dose (g/ha)	Time (DAS)	Total weed count (No./m²)		Total weed dry weight (g/m²)		Seed yield (kg/ha)	B:C Ratio
			40 DAS	Harvest	40 DAS	Harvest		
Imazethapyr	70	Pre-emergence	1.97 (2.9)	3.53 (11.5)	2.38 (4.7)	2.87 (7.2)	1100	2.75
Imazethapyr	80	Pre-emergence	1.82 (2.3)	3.56 (11.7)	1.73 (2.0)	2.79 (6.8)	1176	2.94
Imazethapyr	70	(3-4 leaf stage)	2.89 (7.3)	3.71 (12.8)	2.28 (4.2)	2.26 (4.1)	807	2.01
Imazethapyr	80	(3-4 leaf stage)	2.64 (6.0)	3.73 (12.9)	1.92 (2.7)	1.84 (2.4)	869	2.17
Imazethapyr + imazamox (pre-mix)	70	20 DAS (3-4 leaf stage)	2.61 (5.8)	2.43 (4.9)	2.26 (4.1)	2.0 (3.0)	701	1.75
Imazethapyr + imazamox (pre-mix)	80	20 DAS (3-4 leaf stage)	2.57 (5.6)	2.41 (4.8)	1.92 (2.7)	1.55 (1.4)	795	1.98
Imazethapyr + imazamox (pre-mix)	70	20 DAS (3-4 leaf stage)	9.11 (82.0)	5.07 (24.7)	2.96 (7.8)	2.30 (4.3)	803	2.00
Imazethapyr + imazamox (pre-mix)	80	20 DAS (3-4 leaf stage)	7.03 (48.4)	3.51 (11.3)	2.36 (4.6)	2.24 (4.03)	612	1.53
Pendimethalin	1000	Pre-emergence	3.87 (14.0)	3.11 (8.7)	2.14 (3.6)	2.98 (7.9)	1000	2.50
Imazethapyr + pendimethalin (pre-mix)	1000	Pre-emergence	2.51 (5.3)	2.41 (4.8)	1.89 (2.6)	2.39* (4.7)	1050	2.62
Hoeing	-	20 and 40 DAS	4.05 (15.4)	3.62 (12.1)	1.48 (1.2)	2.37 (4.6)	877	2.19
Weedy check	-	-	10.53 (110)	9.27 (85.0)	4.12 (16.0)	4.44 (18.7)	510	1.27
SEm ±			0.56	0.38	0.20	0.43	113	-
LSD (P=0.05)			1.59	1.08	0.57	1.22	323	-

Values given in the parentheses are the original means

hoeing treatment recorded significantly lower dry weight than weedy check indicating good control of weeds.

Significantly highest seed yield of mash was recorded with imazethapyr which remained at par with imazethapyr 70 g/ha than 1000 g/ha and imazethapyr + pendimethalin application. The lowest seed yield was recorded in weedy check. The highest gross returns, net returns and B:C ratio (2.94) were recorded with imazethapyr. The applied herbicide in mash crop no residual effect/ phytotoxicity was observed on succeeding crop mustard crop.

GBPUAT, Pantnagar

The prominent weed species were *E. colona, E. indica, D. sanguinalis, P. maxicum, D. aegyptium. C. argentia, T. monogyna, C. viscosa, P. niruri, D. arvensis* and *C. rotundus*. Among various weed control treatments, ready mix of imazethapyr + imazamox and alone application of imazethapyr applied as post-emergence resulted in lowest density of weeds at 40 DAS as compared to pre and post-emergence application of imazethapyr with and without imazamox at all the doses. The ready mix application of imazethapyr+imazamox applied as post-emergence followed by ready mix imazethapyr

+ pendimethalin as pre-emergence were found more effective in reducing the density and dry weight of weeds as compared to other herbicidal treatments. The lowest population of *E. colona* and *E. indica* was obtained with ready mix application of imazethapyr + imazamox as post emergence. Post-emergence application of imazethapyr + imazamox at both the doses was found more effective than its pre-emergence application and imazethapyr + pendimethalin towards the density of BLWs *viz.*, *C. argentia* and *C. viscosa*. None of the herbicides was found effective for controlling *T. monogyna* and *C. rotundus*. The lowest weed dry matter was observed with ready mix application of imazethapyr+ pendimethalin followed by imazethapyr + imazamox. Maximum weed control efficiency was recorded with ready mix application of imazethapyr + pendimethalin (81%).

Table 3.4.1.2 Effect of treatments on weed density, total weed dry weight and WCE at 40 days after sowing (DAS) and seed yield of blackgram

Treatment	Dose (g/ha)	Appli-cation stage (DAS)	Density of broad leaf weeds (no./m^2)					Sedge	Total weed dry weight (g/m^2)	WCE (%)	Seed yield (kg/ha)
			C. argentea	*T. monogyna*	*C. viscosa*	*P. niruri*	*D. arvensis*	*C. rotundus*			
Imazethapyr	70	1	7.6 (57.3)	6.8 (45.3)	2.8 (6.7)	1.5 (1.3)	1.5 (1.3)	11.9 (141.3)	653	23.9	733
Imazethapyr	80	1	6.1 (36.7)	6.4 (40.0)	2.8 (6.7)	1.0 (0.0)	1.0 (0.0)	10.0 (100.0)	543	36.8	878
Imazethapyr	70	13	6.4 (40.0)	7.6 (57.3)	1.9 (2.7)	1.5 (1.3)	1.5 (1.3)	11.1 (124.0)	518	39.7	979
Imazethapyr	80	13	5.7 (32.0)	7.3 (52.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	9.6 (92.0)	413	51.9	1045
Imazethapyr + imazamox	70	1	8.3 (68.0)	7.9 (62.7)	4.4 (18.7)	1.5 (1.3)	1.9 (2.7)	11.9 (141.3)	606	29.5	889
Imazethapyr + imazamox	80	1	8.0 (64.0)	7.1 (53.3)	3.8 (13.3)	1.0 (0.0)	1.0 (0.0)	8.7 (74.7)	588	31.5	956
Imazethapyr + imazamox	70	13	1.0 (0.0)	12.3 (149.3)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	10.0 (100.0)	286	66.7	1012
Imazethapyr + imazamox	80	13	1.0 (0.0)	10.8 (116.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	7.5 (56.0)	204	76.3	1201
Pendimethalin	1000	1	9.5 (89.3)	3.4 (10.7)	4.6 (20.0)	2.8 (6.7)	3.0 (8.0)	14.4 (208.0)	507	40.9	778
Imazethapyr + pendimethalin	1000	1	8.6 (73.3)	3.2 (9.3)	3.4 (10.7)	1.0 (0.0)	1.0 (0.0)	8.7 (74.7)	162	81.1	1178
Hoeing	-	-	4.9 (24.0)	2.5 (5.3)	1.0(0.0)	1.0 (0.0)	2.5 (5.3)	7.9 (62.7)	228	73.5	1089
Weedy	-	-	11 (120.0)	9.4 (89.3)	3.2 (9.3)	2.2 (4.0)	2.9 (7.3)	1.2 (124.0)	859	100	422
SEm ±		-	0.33	0.56	0.12	0.05	0.07	0.57	42	-	94
LSD (P=0.05)	-	-	0.98	1.7	0.36	0.15	8.1	1.69	123	-	274

Value in parentheses were original and transformed to log $\sqrt{X+1}$ for analysis

The highest gross (₹ 51,643) and net (₹ 31,463) returns were obtained with post-emergence application of imazethapyr + imazamox at 80 g/ha which was at par with ready mix of imzethapyr + pendimethalin. Highest B:C ratio of 2.6 was registered with pre-emergence application of imazethapyr+ imazamox which was higher than rest of the weed management practices. There was no residual effect of herbicides on mustard crop.

VB, Sriniketan

Both pre and post-emergence application of imazethapyr and ready mix of imazethapyr + imazamox were most effective in controlling *Digitaria sanguinalis* and *Ageratum conyzoides*. Post-emergence application of imazethapyr and ready mix of imazethapyr+imazamox as pre-/ and post-emergence controlled *Oldenlandia corymbosa*, *Commelina diffusa* and *Spilanthes acmella* effectively.

With regards to suppression of broad leaved weeds pre-emergence application of imazethapyr + pendimethalin (pre-mix) and imazethapyr + imazamox were found effective. Regarding suppression of total weed population, pre-emergence application of ready mix of imazethapyr + pendimethalin and imazethapyr + imazamox were very effective.

Pre-emergence application of imazethapyr + pendimethalin recorded the highest yield (923 kg/ha) and it statistically at par with two hoeing operation (921 kg/ha). Post-emergence application of imazethapyr and ready mix of imazethapyr + pendimethalin showed phytotoxic effect on black gram as a result the seed yield hampered greatly. Pre-emergence applications of imazethapyr and imazethapyr + pendimethalin were found more effective in producing seed yield of black-gram. Pre-emergence application of imazethapyr + pendimethalin (pre-mix) gave the highest net return (₹ 23,835/ha) and wider B:C ratio (2.35). The two hoeing operation gave comparatively low economic return (₹ 20,245/ha) and B:C ratio (1.95) because of high cost of cultivation.

WS 3.5: Integrated weed management in cotton

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

TNAU, Coimbatore

General weed flora of the experimental field predominantly consisted of grass species like *Dinebra retroflexa, Setaria verticillata,* broad leaved weeds like *Trianthema portulacastrum, Digera arvensis, Parthenium hysterophorus, Amaranthus viridis, Boerhavia diffusa* and *Cyperus rotundus* was only sedge. Pyrithiobac-sodium + quizalofop-p-ethyl at 20 DAS *fb* directed spray of glyphosate at 60 DAS recorded lower total weed density (4.9/m^2). The efficiency of treatments on control of weeds in terms of dry weight in comparison to control plot was worked out. Higher weed control efficiency of more than 97% was recorded in pyrithiobac-sodium + quizalofop-p-ethyl at 20 DAS *fb* directed spray of glyphosate at 60 DAS. At 90 DAS, taller plant height (90.4 cm) was recorded with pendimethalin at 3 DAS *fb* pyrithiobac-sodium + quizalofop-p-ethyl at 20 DAS. Significantly higher DMP (3242 kg/ha) of cotton was recorded pendimethalin at 3 DAS *fb* pyrithiobac-sodium + quizalofop-p-ethyl at 20 DAS. The phytotoxicity symptom was observed upto 30 days after herbicide spary in the treatment directed spray of glyphosate at 45 or 60 DAS.

CCSHAU, Hisar

The experimental field was pre-dominantly infested with natural population of *Echinochloa colona* and carpet weed *Trianthema portulacastrum* to the extent of 79 and 21% at 90 DAS and 80 and 20% at harvest, respectively. Pendimethalin as pre-emergence provided effective control of *Trianthema portulacastrum* and *Echinochloa colona* up to 90 DAS. Pendimethalin integrated with non-selective herbicides (paraquat or glyphosate) proved superior over application of pendimethalin *fb* quizalofop-p-ethyl or pyhrithiobac-Na *fb* quizalofop-p-ethyl against both weeds as shown by weed control efficiency. All the treatments involving directed spray of either glyphosate or paraquat caused 8.3 to 10% toxicity to cotton crop. Weed control efficiency in all treatments except pendimethalin *fb* quizalofop-p-ethyl or pyrithiobac-Na *fb* quizalofop-p-ethyl varied between 88-99% both at 90 DAS and at harvest.

All the weed control treatments gave significantly higher seed cotton yield over weedy check. Number of bolls/plant were maximum (52) in weed free treatment which were significantly higher than all treatments except three mechanical weedings. Maximum seed cotton yield (2414 kg/ha) was obtained in weed free plots, which was significantly higher than all other treatments but at par with three mechanical weedings (2371 kg/ha) at 20, 40 and 60 DAS. Among herbicidal treatments, pre-emergence application of pendimethalin *fb* hoeing *fb* quizalofop-ethyl gave 2303 kg/ha yield which was significantly higher than seed cotton yield obtained with pendimethalin at 1.0 kg/ha supplemented with protected spray of glyphosate (0.5%) or paraquat although with higher WCE. It might be due to phytotoxic effect of non selective herbicides and beneficial effect of hoeing employed at 30 DAS.

UAS, Bengaluru

Major weed flora was *Cyperus rotundus, Digitaria marginata, Dactyloctenium aegyptium, Echinochloa crus-galli, Cynodon doctylon,* Whereas, among broad leaf weeds, major weeds were *Spilanthes acmella, Ageratum conyzoides, Alternanthera sessilis, Acanthospermum hispidum, Borreria articularis, Euphorbia hirta, Commelina benghalensis* at 60 DAP. Other weeds obsereved in lower densities were *Cyperus iria, Echinochloa glabrescens, Marselia quadrifolia, Alternanthera seassilis.* Among the weed species, the density of *Scirpus* sp., *Fimbristylis miliacea, C. difformis, E. colona, P. distichum, Spilanthes acmella* and *L. parvifolia* werer higher than other weed species, indicated dominance from the beginning of the crop cycle.

The plot treated with pendimethalin followed by hand weeding (1.46 t/ha) followed by pyrithiobac-sodium+quizalofop-p-ethyl (1.16 t/ ha), pyrithiobac-sodium+quizalofop-p-ethyl *fb* directed spray of glyphosate (1.12 t/ha) recorded significantly higher cotton yield compared to all other treatments. Un-weeded control gave the lowest cotton yield (0.23 t/ha), owing to severe competition from weeds of all types. It was observed that higher B:C ratio (4.0) was obtained in pendimethalin *fb* pyrithiobac-sodium + quizalofop-p-ethyl and pyrithiobac-sodium + quizalofop-p-ethyl (3.9) followed by pendimethalin *fb* 2 HW (3.8). Among weed management practices, pendimethalin *fb* pyrithiobac-sodium + quizalofop-p- ethyl and pyrithiobac-sodium + quizalofop-p-ethyl (3.9) followed by pendimethalin *fb* 2 HW were better in controlling weed complex and gave cotton yield higher to hand weeding, besides saving cost of weed management compared to manual weeding under present conditions of labour scarcity.

PJTSAU, Hyderabad

The important monocotyledonous weeds were *Cyperus rotundus, Cynodon dactylon, Dactylactenium aegyptium, Digera muricata, Digiteria sanguinalis, Dinebra retroflexa, Echinochloa colona, Eragrostis cilianensis, Panicum spp.* While common dicotyledonous weeds were *Acalypha rhomboidea, Amaranthus polygamus, Cleome viscose, Commelina benghalensis, Parthenium hysterophorus* and *Trianthema portulacastrum.* No phytotoxicity was observed on cotton crop with application of any of the pre and post-emergence herbicide. Glyphosate and paraquat were applied as directed spray.

More number of balls per plant, cotton yield/ plant and cotton yield/ha was observed with mechanical weeding thrice at 20, 40 and 60 DAS and was significantly differed from all other treatments, however, it was followed by pre-emergence application of pendimethalin *fb* 2 HW at 20 and 50 DAS, inturn which was on par with pre-emergence application of pyrithiobac-sodium + quizalofop-p-ethyl *fb* manual weeding at 50 DAS. Higher gross returns, net returns and B.C ratio were obtained from mechanical weeding thrice (at 20, 40 and 60 DAS) due to reduced cost of cultivation and increased yield. This was followed by pre-emergence application of pendimethalin *fb* 2 HW (at 20 and 50 DAS), which was on par with early post-emergence application of pyrithiobac-sodium + quizalofop-p-ethyl *fb* manual weeding at 50 DAS. Mechanical weeding thrice (at 20, 40 and 60 DAS) was found more economical to get higher cotton yield and net returns. However, either pre-emergence application of pendimethalin *fb* 2 HW (at 20 and 50 DAS) or early post-emergence application of pyrithiobac-sodium + quizalofop-p-ethyl (at 20 DAS) *fb* manual weeding (at 50 DAS) was found to be economical with B:C ratio of 1.38 and 1.28, respectively.

PAU, Ludhiana

Dactyloctenium aegyptium, Trianthema portulacastrum, Acrachne racemosa, Digitaria ciliaris and *Cyperus rotundus* were major weeds in experimental field. All herbicides significantly reduced dry matter accumulation of grasses and broadleaved weeds as compared to weedy check at 90 DAS, however, glyphosate or hand weeding was required for significant reduction in sedges dry matter. Pyrithiobac-sodium was more effective against broadleaved weeds and quizalofop-p-ethyl against grass weeds. Sequential application of pendimethalin and pyrithiobac+quizalofop was more effective than pendimethalin *fb* pyrithiobac or pyrithiobac + quizalofop alone, with respect to control of grasses and broadleaved weeds. Pendimethalin *fb* pyrithiobac + quizalofop recorded the highest seed cotton yield and B: C ratio (1.74) and it was at par with pendimethalin integrated with hand weeding/ glyphosate and pyrithiobac+quizalofop integrated

with hand weeding/paraquat. All weed control treatments, except pyrithiobac+quizalofop alone/*fb* glyphosate, recorded significantly higher seed cotton yield than weedy check. All herbicides were safe to cotton.

PDKV, Akola

The major weed flora in soybean crop composed of *Cynodon dactylon, Cyperus rotundus, Commelina benghalensis, Ischaemum pilosum, Digitaria sanguinalis, Dinebra retroflexa, Poa annua, Cyanotis axillaris* Roem. Dicot weeds were *Digera arvensis, Lagascea mollis, Euphorbia geniculata, Tridex procumbense, Parthenium hysterophorus, Celosia argentea, Alysicarpus monilifer, Alternanathera triandra, Portulaca oleracea, Amaranthis viridis, Acalypha indica, Cardiospermum halicacabum, Ipomoea reniformis, Corchorus acutangulus, Phyllanthus niruri, Abutilon indicum, Abelmoschus moschatus, Boerhavia diffusa, Calotropis gigantea, Ageratum conyzoides, Bidens pilosa, Mimosa pudica, Xanthium strumarium* and *Datura stramonium*. Highest seed cotton yield was observed with 3 HW (at 20, 40, and 60 DAS) which was at par with pyrithiobac sodium + quizalofop-ethyl 20 DAS (tank mix) *fb* HW 50 DAS, pyrithiobac-sodium + quizalofop ethyl (tank mix) *fb* directed spray of paraquat 60 DAS, pyrithiobac sodium + quizalofop ethyl POE 20 DAS (tank mix) *fb* directed spray of glyphosate 60 DAS and pendimethalin *fb* directed spray of glyphosate 45 DAS.

WS 3.6 Weed management in conservation agriculture systems

This experiment was conducted in rice-wheat-greengram cropping system at Ludhiana, Pantnagar, Faizabad and Pusa; rice-mustard-greengram cropping system at Sriniketan; rice-chickpea-greengram cropping system at Bengaluru (Kathelegere); rice-rice-greengram cropping system at Coimbatore; rice-rice system at Thrissur; rice-maize-cowpea system in Bhubaneswar; rice-wheat system in Raipur; and maize-wheat system in Ranchi.

Following treatments were applied in rice-based cropping system:

Tillage and residue management (main plot)

Treatment	Rice	Wheat / mustard / chickpea / maize	Greengram / cowpea
T_1	CT (transplanted)	CT	-
T_2	CT (transplanted)	ZT	ZT
T_3	CT (direct-seeded)	CT	ZT
T_4	ZT (direct-seeded)	ZT + R	ZT
T_5	ZT (direct-seeded)+R	ZT + R	ZT

Weed management (sub-plot)

W_1 Recommended herbicides

W_2 Integrated weed management (herbicide + mechanical weeding + intercrop)

W_3 Unweeded

PAU, Ludhiana

Puddled transplanted rice (PTR) recorded significantly lower population and dry matter of grass, broadleaved and sedges weeds as compared to direct-seeded rice (DSR). Recommended herbicides and integrated weed management (IWM) recorded significantly lower population and dry matter of grass, broadleaved and sedges weeds as compared to unweeded control at all stages of record. Rice grain yield, yield attributes and B: C ratio, under both weed control treatments, were significantly better than unsprayed control (Table 3.6.1). Grain yield of unweeded control, in case of PTR, was at par to herbicidal and IWM. However, in case of DSR, grain yield under unweeded control was significantly lower than under herbicidal and IWM. The residues of pendimethalin in soil and crop produce, at the time of crop harvest, were below detectable levels in recommended herbicides and in IWM treatments.

Wheat field was infested with *Phalaris minor, Rumex dentatus, Medicago denticulata, Anagallis arvensis, Chenopodium album* and *Fumaria parviflora*. Wheat grain yield and yield attributes did not vary statistically among tillage and residue management treatments, however wheat sown with ZT with residues recorded higher B: C ratio (3.0) than ZT without residue and conventional till sown wheat (Table 3.6.2). The recommended herbicides and IWM recorded significantly lower population and dry matter of grass and broadleaved weeds and higher wheat grain yield as compared to unweeded control.

Table 3.6.1 Effect of tillage and weed management on weed growth, yield and economics of rice under conservation agriculture

Treatment	Weed dry weight (g/m²)		Grain yield (t/ha)				Net returns (x10³ ₹/ha)		
	Ludhiana	Pusa	Ludhiana	Pantnagar	Faizabad	Pusa	Ludhiana	Pantnagar	Faizabad
Tillage and crop establishment									
T_1	6.6 (72)	13.01	5.23	4.6	4.75	4.76	40.07	30.06	39.09
T_2	7.8 (78)	11.65	4.94	4.5	4.60	4.66	36.25	28.70	36.97
T_3	9.8 (249)	15.47	4.70	2.4	4.30	4.04	38.59	51.40	36.10
T_4	13.2 (315)	17.94	4.32	1.7	3.57	3.49	36.17	-1.88	31.60
T_5	10.1 (238)	16.78	4.76	2.4	3.80	4.04	41.96	7.64	29.55
LSD (P=0.05)	1.5	1.59	NS	0.4	0.47	0.11	-	-	-
Weed management									
W_1	4.1 (26)	13.42	5.35	3.1	4.43	4.52	40.16	11.78	37.99
W_2	2.6 (10)	12.65	5.43	4.3	5.49	4.65	39.59	25.60	48.41
W_3	21.9 (535)	18.62	3.59	1.9	2.68	3.43	23.18	-2.66	17.59
LSD (P=0.05)	1.3	1.25	1.21	0.1	0.39	0.14	-	-	-

Data in parentheses are the original values

Table 3.6.2 Effect of tillage and weed management on weed growth, yield and economics of wheat under conservation agriculture

Treatment	Weed dry weight (g/m²)		Grain yield (t/ha)		Net returns (x10³ ₹ha)	
	Faizabad	Pusa	Ludhiana	Pusa	Ludhiana	Faizabad
Tillage and crop establishment						
T_1	82.2	12.0	4.89	4.65	38.63	44.57
T_2	55.3	10.2	5.42	4.49	46.84	45.11
T_3	52.7	14.4	5.22	4.42	44.70	42.27
T_4	64.5	16.7	5.15	4.02	47.15	39.29
T_5	65.7	15.3	5.15	4.20	47.15	36.77
LSD (P=0.05)	1.6	1.0	NS	0.13		
Weed management						
W_1	21.7	12.4	6.43	4.68	61.37	44.35
W_2	8.0	11.0	5.98	4.89	52.99	49.94
W_3	168.8	16.3	3.08	3.49	19.77	30.51
LSD (P=0.05)	2.60	1.30	0.71	0.18	-	-

Data in parentheses are the original values

GBPUAT, Pantnagar

Phalaris minor was dominant weed followed by *M. denticulata* in all the wheat establishment methods. Highest weed dry weight was observed in conventional system followed by DSR (CT)-wheat (CT)–*Sesbania* (ZT) and least in DSR (ZT) + R- wheat (ZT) + R- *Sesbania* (ZT) which was followed by TPR (CT)-wheat (ZT)-*Sesbania* (ZT). Highest grain yield of wheat was recorded 4.7 t/ha in DSR (ZT) + R- wheat (ZT) + R- *Sesbania* (ZT) along with IWM practices (Table 2). Highest net returns and benefit : cost ratio of ₹ 59,000/ha and 3.2 was recorded in the plots where wheat was sown in the system of TPR (CT) - wheat (ZT)-*Sesbania* (ZT). IWM practice recorded the highest net returns (₹ 65,250) and benefit : cost ratio (3.1).

During *Kharif* 2014, TPR (CT)-wheat (CT) cropping system recorded the lowest total density of weeds while lowest total dry weight of weeds was recorded under TPR (CT)-wheat (ZT)-*Sesbania* (ZT) than the other rice establishment methods. Integrated weed management was found superior to recommended application of herbicides towards the density and dry weight of weeds at 60 days of crop stage. Highest grain (4.6 t/ha) and straw (8.1 t/ha)

yield was recorded under TPR (CT)-wheat (CT) being at par with TPR (CT)-wheat (ZT)-*Sesbania* (ZT) (Table 3.6.1). Integration of weed management practices (herbicide+ one hand weeding) revealed higher yield of grain (4.3 t/ha) and straw (7.0 t/ha) of rice followed by recommended practice. Highest net returns and benefit : cost ratio ₹ 30,060 and 1.9, respectively were recorded in the plots where rice was sown/ transplanted in the system of TPR (CT)-wheat (CT). IWM practice recorded highest net returns (₹. 25,605) and benefit : cost ratio (1.8).

NDUAT, Faizabad

Density of *Phalaris minor* was significantly lower in the treatments where wheat was sown as zero-till than conventional till system. Integrated weed management practice was found superior to alone application of herbicide with regard to the density of weeds at 30 and 60 DAS. Significantly lower dry weight of weeds was recorded in the zero-till residue-wheat (ZT) + crop residue – *Sesbania* (ZT) and rest of the treatments revealed similar level of dry matter accumulation of weeds. Significantly higher grain yield (4.45 t/ha) was recorded with TPR (CT) - wheat (CT) as compared to other establishment methods (Table 3.6.2).

During *Kharif* 2014, the dominant weed species were : *E. colona, E. crus-galli, E. indica, D. aegyptium, C. axillaris, A. sesslis, E. alba, Cyperus* sp., and *F. miliacea* at 30 DAS. Highest grain yield (4.75 t/ha) and straw yield (6.21 t/ha) were recorded under TPR (CT) - wheat (CT) over other methods of rice (Table 3.6.2). Highest net returns (₹ 48,410/ha) and BCR (2.14) were recorded in plots where rice was grown in the system of TPR (CT) - wheat (CT) along with IWM practices.

RAU, Pusa

Highest grain yield of rice (4.76 t/ha) was recorded under T_1 CT (transplanted) – CT- which was statistically at par with CT (transplanted)-ZT-ZT. The lowest grain yield of rice (3.49 t/ha) was recorded under ZT (direct-seeded) – ZT- ZT. In wheat, the highest grain yield (4.65 t/ha) was recorded under CT (transplanted) – CT- which was significantly superior over rest of the treatments. The highest grain yield of wheat (4.68 t/ha) and the lowest weed count and weed dry weight were recorded under integrated weed management (herbicide + hand weeding). In greengram, the highest grain yield was recorded under CT (direct seeded) – CT-ZT and integrated weed management (herbicide + hand weeding) (Table 3.6.2).

VB, Sriniketan

Conventional tillage in transplanted rice culture was found most effective in reducing the number as well as the dry matter of total weed flora. The conventional tillage in transplanted rice recorded the highest grain yield but the conventional tillage did not produce more yield than that of zero tillage in direct

Table 3.6.3 Effect of tillage and weed management on weed growth and yield performance in rice-mustard-greengram cropping system at Sriniketan

Treatment	Weed dry weight (g/m²)		Grain yield (t/ha)			Net returns (x10³ ₹/ha)		
	Rice	Mustard	Rice	Mustard	Greengram	Rice	Mustard	Greengram
Tillage and crop establishment								
T_1	7.9 (66.2)	2.4 (7.2)	4.19	1.08	0.0	25.72	20.57	0.0
T_2	7.7 (70.8)	2.7 (9.2)	4.20	0.95	0.79	26.56	17.69	17.12
T_3	4.5 (23.6)	2.5 (7.3)	3.72	1.03	0.81	21.68	18.73	18.27
T_4	6.2 (41.3)	3.1 (10.9)	3.20	0.87	0.72	20.25	14.35	14.08
T_5	5.4 (35.9)	3.0 (10.6)	3.19	0.87	0.74	20.32	14.33	15.11
LSD (P=0.05)	062	0.1	0.12	0.03	0.024	3.70	1.20	1.11
Weed management								
W_1	5.6 (36.1)	2.1 (3.8)	3.83	1.029	0.70	25.88	19.83	16.87
W_2	4.2 (17.8)	1.4 (1.6)	4.07	1.120	0.75	27.95	22.70	18.15
W_3	9.2 (88.8)	4.7 (21.8)	3.20	0.737	0.38	14.89	8.86	3.73
LSD (P=0.05)	0.52	0.2	0.24	0.032	0.022	3.56	1.26	0.98

Data in parentheses are the original values

seeded rice (Table 3.6.3). Among the weed control measures integrated weed management system produced the highest grain yield in rice. The highest seed yield of mustard was maximum under CT-CT and it was followed by CT-CT-ZT, and under integrated weed management. The seed yield of greengram was maximum under CT-CT-ZT and it was statistically at par with CT-CT-ZT.

UAS, Bengaluru

Results of three cycles of experimentation indicated that *Kharif* rice (transplanted/direct seeded) – *Rabi* chickpea - summer greengram performed better under conventional tillage followed by *Kharif* rice (transplanted) under conventional tillage – *Rabi* chickpea - summer greengram under zero tillage due to better establishment, high seedling vigour, superior growth and yield attributes as a consequence of better land preparation compared to direct seeded *Kharif* rice) – *Rabi* chickpea - summer greengram under zero tillage. Among weed management practices, integrated approach of pre-emergence herbicide followed by one mechanical weeding at 30 DAP / DAS effectively controlled the weeds upto critical period of crop-weed competition in rice, chickpea and green gram crops thereby resulted in significantly higher yield and yield attributes over application of pre-emergence herbicide alone and unweeded control in rice-chickpea-greengram cropping sequence (Table 3.6.4).

Table 3.6.4 Effect of tillage and weed management on weed growth and yield performance in rice-chickpea-greengram cropping system at Bengaluru

Treatment	Weed dry weight (g/m^2)			Grain yield (t/ha)		
	Rice	Chickpea	Greengram	Rice	Chickpea	Greengram
Tillage and crop establishment						
T_1	2.1 (144.1)	-	2.0 (129.9)	4.28	1.39	0.72
T_2	2.1 (145.5)	-	2.1 (137.0)	4.27	1.36	0.66
T_3	2.1 (149.3)	-	2.0 (124.7)	4.10	1.41	0.68
T_4	2.2 (164.8)	-	2.1 (146.3)	3.67	1.12	0.57
T_5	2.2 (187.7)	-	2.1 (139.6)	2.99	1.15	0.62
LSD (P=0.05)	0.08	-	NS	0.42	0.17	NS
Weed management						
W_1	2.1 (127.7)	-	2.0 (111.1)	4.30	1.43	0.67
W_2	1.9 (84.2)	-	1.8 (59.7)	5.27	1.92	1.02
W_3	2.4 (263.0)	-	2.4 (235.8)	1.64	0.52	0.26
LSD (P=0.05)	0.10	-	0.08	0.29	0.11	0.11

Data analysed using transformation, log (X+2). Values within the parentheses are original values

TNAU, Coimbatore

Different crop establishment methods showed significant difference with respect to grain yield in transplanted and direct-seeded rice (Table 3.6.5). Direct-sown rice recorded lower grain yield, whereas transplanted rice registered higher grain yield. Transplanted rice with conventional tillage in CT-CT-ZT system recorded noticeably higher grain yield. Significantly higher grain yield was recorded in pretilachlor 1.0 kg/ha for transplanted rice and pretilachlor for direct sown rice + inter crop with daincha incorporation and mechanical weeding on 40 DAS/DAT. Lower grain yield was recorded in unweeded check. Discernibly higher grain yield in *kharif* rice (4.97 t/ha) was observed in transplanted conventional tillage in CT-CT. Conspicuously lesser grain yield (3.96 t/ha) was registered with direct seeded zero tillage in ZT+R- ZT+R-ZT (T_5) treatments. Among the weed management methods, butachlor (transplanted rice) and pretilachlor (direct-seeded rice) + intercrop *Sesbania* incorporation with mechanical weeding on 40 DAS/T (W_2) recorded higher grain yield (5.92 t/ha).

Table 3.6.5 Effect of tillage and weed management on weed growth and yield performance in rice-rice-greengram cropping system at Coimbatore

Treatment	Weed dry weight (g/m^2)		Grain yield (t/ha)			Net returns (x10^3 ₹/ha)	
	Rabi rice	*Kharif* rice	*Rabi* rice	*Kharif* rice	Green gram	*Rabi* rice	*Kharif* rice
Tillage and crop establishment							
CT_CT	5.79 (38.0)	4.53 (18.5)	5.43	4.97	1.04	40.58	38.27
CT_ZT_ZT	6.18 (42.3)	4.68 (19.9)	5.03	4.66	0.96	39.64	33.72
ZT_ZT+R_ZT	6.53 (46.3)	5.20 (25.0)	4.66	4.57	1.13	28.20	30.91
CT-CT-ZT	6.10 (40.1)	5.18 (24.9)	4.97	4.53	0.99	36.81	34.87
CT_ZT_ZT	6.59 (47.2)	6.76 (43.7)	4.22	4.45	0.87	30.96	33.67
ZT_ZT+R_ZT	8.56 (76.9)	7.20 (49.9)	3.22	3.96	0.73	10.66	25.14
LSD (P=0.05)	0.46	0.45	0.75	0.32	0.12	-	-
Weed management							
W_1	4.41 (18.4)	4.32 (16.7)	5.02	5.20	1.01	37.82	43.59
W_2	9.96 (98.0)	7.43 (53.2)	5.82	5.62	1.14	46.30	47.33
W_3 (unweeded)	0.50	-	2.92	2.74	0.68	9.30	8.33
LSD (P=0.05)	5.79	-	0.83	0.42	0.12	-	-

Data in parentheses are the original values

KAU, Thrissur

Continuous zero tillage resulted in poor growth (height) and tiller production in rice. Maximum grain yield was in conventional tillage plot, closely followed by tillage in alternate years. Continuous zero tillage resulted in reduction in yield (3.75 t/ha compared to 5.64 t/ha in conventional tillage and 5.32 t/ha in ZT-CT plots). Hand weeding resulted in the highest yield of 6158 kg followed by herbicidal control with 5.94 t/ha, whereas unweeded control resulted in 2.62 t/ha only. Maximum net returns and B:C ratio were obtained for the continuous conventional tillage plot. Continuous zero tillage resulted in poor yield and hence low returns. Herbicidal control of weeds gave higher net returns and B:C ratio.

OUAT, Bhubaneswar

Practice of CT (transplanted) tillage method reduced the weed densities over ZT (direct-seeded) in the *Kharif* rice. During the initial stages (60 DAP), application of butachlor reduced the weed density by 57% over control and 64% in case of IWM over unweedy check. The yield reduction in ZT (direct-seeded) method was not significant compared to CT method. Integration of ZT method and use of butachlor 1.5 kg/ha gave the maximum B:C ratio in the *Kharif* rice. Use of pendimethalin with manual weeding produced better B:C ratio (2.78) as compared to sole herbicide appliaction (2.57). The ZT-ZT-ZT system along with use of herbicide obtained the maximum B:C ratio of 2.87 in *Rabi* maize and 2.82 in *Kharif* rice as compared to other combinations of tillage and weed management practices.

IGKV, Raipur

Grain yield of transplanted as well as direct-seeded rice under CT and ZT conditions did not vary significantly due to different tillage practices (Table 3.6). However, seed yield under CT-transplanted rice was marginally higher over ZT-direct-seeded rice. Among weed management practices, significant variation in yield attributes as well as seed yield were obtained. Significantly higher seed yield was recorded under recommended practice i.e., pyrazosulfuron *fb* pinoxsulam than unweeded check, but was at par with integrated weed management i.e., oxadiargyl *fb* hand weeding at 25 DAT/S and both were significantly superior over unweeded check.

Table 3.6.6 Effect of tillage and weed management practices on weed growth and yield performance of rice under conservation agriculture at Raipur

Treatment	Weed dry matter at harvest (g/m^2)	Grain yield (t/ha)	Net returns (x10^3 ₹/ha)
Tillage			
CT (transplanted)	6.00 (35.4)	4.65	33.74
CT (transplanted)	7.02 (48.7)	4.55	32.38
CT (direct-seeded)	9.56 (90.8)	4.06	30.08
ZT (direct-Seeded)	9.57 (91.0)	3.98	37.39
ZT(direct-seeded) + R	1072 (11 4.4)	3.68	30.31
LSD (P= 0.05)	2.17	NS	-
Weed management			
Pyrazosulfuron 20 g/ha fb pinoxsulam 22.5 g/ha POE	5.05(25.0)	5.76	52.99
Oxadiargyl 80 g PRE *fb* hand weeding at 25 DAT/S	6.14(37.2)	5.60	49.72
Unweeded	12.91(166.0)	1.20	-6.06
LSD (P=0.05)	1.18	0.26	-

Data in parentheses are the original values

BAU, Ranchi

Adoption of ZT+R-ZT+R-ZT sequence recorded 46.5% more grain and straw yield of maize compared to conventional- conventional tillage (CT-CT) sequence (Table 3.7.7). Integrated weed management (IWM) being similar to recommended herbicide recorded 49.6% more grain yield (3.09 t/ha) compared to weedy check (WC).

Table 3.7.7 Effect of conservation tillage and weed control methods on maize-wheat cropping system at Ranchi

Treatment	Weed dry matter (g/m^2)		Grain yield (t/ha)		Net returns (x10^3 ₹/ha)
	Maize	Wheat	Maize	Wheat	(Wheat)
Tillage					
CT-CT	8.89 (80)	3.58 (14.33)	1.67	6.05	91.42
CT-ZT	9.14 (85)	3.83 (16.27)	1.87	5.44	83.84
ZT-ZT	8.40 (73)	4.97 (27.58)	2.69	5.16	78.89
ZT-ZT+R	8.33 (71)	4.56 (22.99)	2.83	5.27	80.00
ZT+R-ZT+R	8.19 (67)	4.81 (24.49)	3.13	5.33	53.89
LSD (P=0.05)	1.04	NS	1.41	NS	26.15
Weed control					
RH	7.87 (62)	3.78 (15.47)	2.67	5.53	79.50
IWM	7.70 (59)	3.26 (10.58)	3.09	5.86	82.61
WC	10.20 (104)	6.01 (37.35)	1.55	4.96	70.71
LSD (P=0.05)	2.21	2.79	1.17	1.36	NS

Data in parentheses are the original values

AAU, Anand

In pearlmillet, the grain and straw yield were significantly higher with atrazine as PE *fb* IC at 30 DAS (Table 3.6.8). Significantly lower weed dry weight was recorded with conventional tillage (CT) which was at par with zero tillage. Among weed management practices, significantly the lowest weed dry weight was recorded with atrazine as PE *fb* IC at 30 DAS. Seed and straw yields of following mustard were also not significantly influenced by tillage but were the highest with integrated approach.

Table 3.6.8 Effect of conservation tillage and weed management on pearlmillet-mustard cropping system at Anand

Treatment		Weed dry weight (g/m^2)		Grain yield (t/ha)	
Pearlmillet	Mustard	Pearlmillet	Mustard	Pearlmillet	Mustard
CT	CT	12.8 (178.8)	7.1 (52.4)	2.27	1.42
CT	CT	13.4 (196.1)	7.2 (52.9)	2.26	1.36
ZT	ZT	13.0 (187.0)	7.2 (53.5)	2.20	1.43
ZT	ZT	12.9 (181.2)	7.3 (53.7)	2.22	1.41
ZT + residue	ZT + residue	13.2 (192.8)	7.3 (54.1)	1.98	1.39
LSD (P=0.05)		0.34	NS	0.076	NS
Weed management					
Atrazine 0.50 kg/ha	Pendi 0.50 kg/ha	12.3 (150.5)	7.1 (50.0)	2.31	1.52
Atrazine 0.50 kg/ha *fb* IC 30 DAS	Pendi 0.50 kg/ha *fb* IC 30 DAS	8.4 (70.3)	5.5 (29.8)	2.33	1.65
Unweeded	Unweeded	18.5 (340.8)	9.0 (80.2)	1.92	1.04
LSD (P=0.05)		0.18	0.12	0.045	0.054

Data in parentheses are the original values

WS 3.7: Long-term herbicide trial in different cropping systems

Cooperating centres: All centres (except Pantnagar and Bhubaneswar)

The modifications requested by Hyderabad and Jorhat in respect to this trial is effective from 2014

Cooperating centre: Hyderabad

Modified technical programme ANGRAU, Hyderabad

Treatments

Rice	Maize
Pretilachlor 750 g/ha as PE at 3-5 DAT *fb* HW at 25-30 DAT	Atrazine 1000 g + paraquat 600g /ha as PE
Bispyribac sodium as PoE at 20-25 DAT 25 g/ha *fb* HW at 40-45 DAT	Oxyfluorfen 150 g/ha + paraquat 600 g/ha as PE
Pretilachlor *fb* ethoxysulfuron 750/18.75 at 25 DAT (3-4 leaf stage)	Atrazine EPoE 1000 g/ha at 15-20 DAS
Farmers practice (20, 40 DAT HW)	Farmers practice(HW at 20, 40 DAS)
Unweeded check	Unweeded check

Design: RBD Replications:3 Plot size: 50 (10X5) m^2

Maize-wheat cropping system

AAU, Anand

The experimental wheat field was infested with *Dactyloctenium aegyptium, Eragrostis major, Phyllanthus niruri, Commelina benghalensis, Cyperus rotundus, Mollugo nudicaulis, Oldenlandia umbellata, Digera arvensis, Chenopodium album, Cyperus rotundus,* and *Melilotus indica.* In maize, dry weed biomass of weeds recorded at 60 DAS and at harvest were found significant due to different weed management practices during *Kharif* 2013-14. Significantly lowest weed dry weight was recorded in IC + HW carried out at 20 & 40 DAS. WCE varies between 45 to 78% in these treatments. Significantly the highest grain yield was recorded in pendimethalin + atrazine (tank mix) applied as PE. Straw yield also significantly influenced by weed management practices.

Significantly lower dicot weed dry biomass was recorded in pre-emergence of atrazine. Interactive effect of M x W was found significant on monocot, dicot and total weed counts and monocot, dicot and total weed dry biomass recorded at 30 and 60 DAS and at harvest. Grain yield of wheat in hand weeding carried out at 30 DAS was significantly at par with pre-emergence application of pendimethalin. Straw yield was not significantly influenced by the treatments imposed in maize. Straw yield of wheat recorded in farmers practices (HW at 30 DAS) was significantly at par with pre-emergence application of pendimethalin and application of MAS as PoE (25-30 DAS). Interactive effect was found significant on straw yield.

Table 3.7.1 Effect of weed management practices on dry weed biomass, plant height, grain yield and straw yield of maize under maize (*kharif*)- wheat cropping system

Treatment	Weed dry weight at 60 DAS (g/m^2)	Weed dry weight at harvest (g/m^2)	WCE at harvest (%)	Plant height at harvest (cm)	Grain yield (t/ha)
Weedy check	10.7 (114.7)	14.6 (214.0)	-	233.3	4.10
FP (IC+HW at 20 and 40 DAS)	5.6 (31.0)	6.8 (46.0)	78	227.7	4.87
Pendimethalin0.25 kg/ha + atrazine 0.50 kg/ha PE	6.0 (36.3)	10.8 (117.0)	45	228.3	5.01
Atrazine 1.0 kg/ha PE	7.1 (50.7)	9.8 (96.0)	55	229.0	4.68
Atrazine 2.0 kg/ha PE	6.7 (44.7)	8.2 (67.0)	69	229.0	4.70
SEm ±	0.17	0.22	-	1.94	0.25
LSD (P=0.05)	0.53	0.67	-	NS	0.78

AAU, Jorhat

Rice-rice cropping system

Rotation of butachlor with pretilachlor maintained lower weed density till 60 DAT. The highest yields were obtained with butachlor + 2,4-D rotated with pretilachlor (75% NPK through chemical fertilizer, 25% through organic source) and butachlor (75% NPK through chemical fertilizer, 25% through organic source) (Table 3.7.3). Highest grain and straw yields were achieved with butachlor + 2,4-D rotated with pretilachlor (75% NPK through chemical fertilizer, 25% through organic source). It was closely followed by butachlor + 2,4-D rotated with pretilachlor (100% chemical fertilizer). The available major and micronutrients were increased significantly with herbicide treatments in surface soil (0-15 cm) over the subsurface soil (15-30 cm), whereas bulk density followed the reverse trend. Microbial count and enzyme activities was higher in herbicide treatments and was higher for winter rice over autumn rice.

Rice-wheat cropping system

Weed species like *Polygonum viscosum, P. plebeium* and *Stellaria media* were the highest populated in the field during *Rabi* season. These broadleaved weeds along with *Rorippa dubia* and grasses *Cynodon dactylon* and *Eleusine indica* emerged in the field within 7 to 14 days after emergence of wheat. Other common weeds were *Vicia sativa, Oxalis*

Table 3.7.3 Weed density, dry weight and grain yield as affected by treatments in rice crop at Jorhat.

Treatment	Weed density ($no./m^2$)			Weed dry weight (g/m^2)			Grain yield (t/ha)
	30 DAT	60 DAT	Harvest	30 DAT	60 DAT	Harvest	
Autumn rice							
Farmers' practice (one HW)	7.62(58)	6.03(36)	5.94(35)	3.79(14)	6.01(36)	5.94(35)	2.10
Butachlor + 2,4 -D (100% NPK through chemical fertilizer)	5.84(34)	5.95(36)	5.83(34)	3.22(10)	5.66(32)	5.83(34)	2.62
Butachlor + 2,4 -D (75% NPK through chemical fertilizer, 25% through organic source)	5.81(34)	6.01(36)	5.34(29)	3.25(11)	5.78(33)	5.34(29)	3.07
Butachlor + 2,4 -D rotated with pretilachlor (100% chemical fertilizer)	5.33(29)	5.66(32)	5.20(27)	3.36(11)	5.49(30)	5.20(27)	3.10
Butachlor + 2,4 -D rotated with pretilachlor (75% NPK through chemical fertilizer, 25% through organic source)	5.66(32)	5.39(29)	5.49(30)	3.57(13)	4.98(25)	5.49(30)	3.15
LSD (P=0.05)	0.33	0.32	NS	NS	0.34	NS	0.58

Data in parentheses are the original values

corniculata and *O. debilis, Ageratum houstonianum, Chenpodium album, Lathyrus aphaca* and *Polygonum viscosum*. The pattern of weed flora composition has shown no remarkable difference with that of earlier years in winter season.

The lowest weed density and dry weight at 30 and 60 DAT were recorded with pretilachlor applied to preceding rice crop. Among different weed management treatment imposed on wheat crop, isoproturon + surfactant resulted lowest weed density and dry weight at both the growth stages (30 and 60 DAS) which was closely followed by isoproturon + 1% urea. Application of isoproturon 0.75 kg/ha + surfactant recorded highest grain yield of wheat closely followed by isoproturon + 1% urea. Application of pretilachlor to rice resulted in highest yield of wheat (Table 3.7.4).

Table 3.7.4 Effect of treatment on weed density, dry weight and yield in wheat

Treatment	Weed density (number/m^2)			Weed dry weight (g/m^2)			Grain yield (t/ha)
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest	
A. Main plot (treatments in rice)							
Weedy	95.4	116.2	145.8	98.6	132.8	191.7	1.07
Mechanical weeding	93.3	109.6	99.2	77.3	117.3	134.6	1.48
Butachlor 1000 g/ha	112.0	108.0	124.0	108.5	124.5	145.3	1.46
Pretilachlor 750 g/ha	86.9	92.8	141.6	89.3	131.7	134.6	1.74
LSD (P=0.05)	21.3	19.4	34.7	17.9	16.1	25.6	0.32
B. Sub plot (treatments in wheat)							
Weedy	118.0	130.6	139.6	110.0	135.0	171.3	1.28
Mechanical	72.3	110.6	119.3	94.0	130.0	140.3	1.38
Isoproturon 1 kg/ha	78.6	113.0	126.3	88.3	133.3	141.3	1.47
Isoproturon 0.75 kg/ha + 1% urea	84.0	94.0	122.0	93.3	109.0	144.3	1.48
Isoproturon 0.75 kg/ha + surfactant	71.3	85.0	131.0	81.6	125.6	160.6	1.56
LSD (P=0.05)	15.5	27.1	32.0	20.7	22.9	38.9	0.45

Application of pretilachlor caused significant increase in plant height and yield as compared to weedy as well as mechanical weeding. This could be attributed to effective control of weeds under these treatments. Applying isoproturon + surfactant to wheat resulted in higher grain yield in rice.

BAU, Ranchi

Rice - wheat cropping system

Application of Almix PoE in rice and pendimethalin + 2,4-D in wheat reduced 93.7% weed density of grassy, 93% broad leaf weeds, 30 days after sowing. At 60 days after sowing application of almix in rice and pendimethalin + 2,4-D in wheat being similar to all weed control methods except application of almix in rice and application of pendimethalin 1 kg/ha in wheat and weedy check treatment recorded 94.3, 93.7 and 93.9% reduced grassy, broad leaf and total weeds. Application of almix in rice and pendimethalin + 2,4-D ha in wheat recorded maximum weed control efficiency 93% and 94%, respectively at 30 and 60 days after sowing. Hand weeding at 25 and 40 days after sowing was similar to application of almix in rice and pendimethalin + 2,4-D in wheat, butachlor + almix in rice and pendimethalin in wheat and butachlor + almix in rice and pendimethalin + 2,4-D in wheat recorded 22% higher total tillers (299/m^2) and 21.3% effective tillers (291/m^2). Application of butachlor + almix in rice and pendimethalin + 2,4-D in wheat recorded 23.1% grains per spike (26), 50% grain (3000 kg/ha) and 50% more straw yield (4050 kg/ha) as compared to weedy check.

CCSHAU, Hisar

Wheat

Clodinafop as a continuously used herbicide provided effective control of *P. minor* and was at par with weed free check. *Melilotus, Coronopus* and *Chenopodium* were comparatively more under green

manuring while reverse was true for *Lathyrus* and other broadleaf weeds. Total dry weight of BLWs was less under green manuring. Herbicide treated plots significantly increased the effective tillers and grain yield of wheat compared to weedy check under with and without green manure condition. Effective tillers were higher under green manuring than non-green manuring. The differences in plant height and earhead length were non-significant. The grain yield wes more in green manured plots than non-green manuring. The continuous or rotational use of clodinafop provided lower yields with weed free plots under both the situations of green manuring. However, higher B:C ratio was found under herbicide treated plots as compared to weed free and weedy checks particularly under green manuring. The B:C ratio increased due to green manuring.

Rice

The continuous use of butachlor or rotational use of anilofos provided almost complete control of all type of weeds under both the situations of green manuring. The number of effective tillers, panicle length and grain yield under herbicide treated plots were significantly higher than weedy plots. Also, effective tillers, panicle length and grain yield of rice under different treatments were increased significantly due to green manuring except weedy check plots where reverse was true. Similarly higher B:C ratio were found under green manuring than non-green manuring, except under weedy check plots. Also, B:C ratio was more under herbicide treated plots than weed free and weedy checks.

DBSKKV, Dapoli

Rice-groundnut cropping sytem

Groundnut

Green manuring to *Kharif* rice did not influence the weed density and growth of monocots and BLWs. While the various weed control measures significantly influenced the weed density and weed growth at 30, 50 DAS and at harvest. The fixed and rotational herbicides reduced weed density and weed growth resulted in increased dry pod yield of groundnut (3.09 and 2.95 t/ha) over weedy check (2.45 t/ha).

Rice

Green manuring with *Sesbania* did not influence the weed density and weed growth at 30, 50, DAT and at harvest. Weed density of monocots was reduced significantly due to the application of fixed and rotational herbicides at 30 and 50 DAT. Weed growth of monocots and BLWs was also significantly influenced due to various weed control measures. The grain and straw yield of rice was significantly highest in weed free check (3.49 and 4.43 t/ha) followed by fixed herbicide (3.14 and 3.61 t/ha). The soil microflora such as, bacteria, fungi, free living nitrogen fixers, phosphate solubilisers and microbial biomass carbon, basal soil respiration, dehydrogenase enzyme and phosphatase enzyme activity were found significantly higher in green manuring treatment as compared to without- green manuring treatment in *Rabi* groundnut crop and *Kharif* rice crop at all the above mention stages of the crops.

IGKV, Raipur

Rice-chickpea

Rice

The major weed flora in rice field was *Echinochloa colona, Ischaemum rugosum, Alternanthera triandra, Cyanotis axillaris* and *Cyperus iria* during all the five years of experimentation.

At 60 DAS, the weed population was lowest under oxadiargyl *fb* bispyribac and pyrazosulfuron fb hand weeding at 25 DAS, but at harvest stages, it was lowest under hand weeding twice and pyrazosulfuron *fb* hand weeding at 25 DAS. At both the stages, dry matter of weeds was significantly lower in hand weeding twice. Significantly higher seed yield was recorded from two hand weedings and this was at par with pre-emergence application of oxadiargyl *fb* post-emergence bispyribac, pyrazosulfuron *fb* hand weeding at 25 DAS, fenoxaprop + chlorimuron + metsulfuron at 20 DAS and all were significantly superior over weedy check. Seed yield was significantly lowest under unweeded control as compared to rest of the weed management treatments.

Though, the gross income was highest under hand weeding twice but net income was higher under

oxadiargyl *fb* bispyribac followed by fenoxaprop + chlorimuron + metsulfuron. The benefit: cost ratio was also found highest under oxadiargyl *fb* bispyribac but was similar for treatment of fenoxaprop + chlorimuron + metsulfuron at 20 DAS. The net return and benefit: cost ratio showed negative response. Similar results were observed during previous four years of experimentation.

Chickpea (*Rabi* 2013-14)

Medicago denticulata, Chenopodium album and *Melilotus indica* were the predominant weeds in the field of chickpea. Other weeds were *Alternanthera triandra, Anagalis arvensis, Echinochloa colona* etc. However, broad leaf weeds completely dominated the weed flora mainly *M. denticulata* through-out the growing period of the crop. Treatments applied to direct seeded rice during *Kharif* had no significant effect on dry matter of weeds during subsequent *Rabi* during last three years of experimentation, but, in fourth year, the significantly lowest weed dry matter was recorded under hand weeding twice treatment applied during *Kharif* season and this was significantly superior over rest of the treatments at both the stages. However, tillage practices had no significant effect on dry matter production of weeds at any stage. While, the dry matter was marginally lower under zero tillage than conventional tillage at all the crop growth stages. Among weed control practices, pre-emergence application of pendimethalin 1.0 kg /ha produced significantly lowest weed dry matter as compared to weedy check and farmers' practice at 60 DAS and at harvest.

Effect of treatments applied to direct seeded rice during *Kharif* on seed yield of chickpea during *Rabi* was not found significant. However, seed yield of chickpea was slightly higher where hand weeding twice was done during *Kharif* season and was narrowly followed by oxadiargyl *fb* bispyribac. Tillage practices had no significant effect on seed yield of chickpea, though the seed yield was slightly higher under conventional tillage than zero tillage. The effect of weed control methods was found significant on seed yield of chickpea. Among weed control methods, pre-emergence application of pendimethalin produced significantly higher seed yield as compared to weedy check and farmer's practice but both were statistically superior over weedy check.

KAU, Thrissur

Rice-rice system

Severe incidence of *Echinochloa* sp. was seen during the second crop of 2013, due to long dry periods. Cyhalofop-butyl was applied at higher concentration to control of *Echinochloa* except in hand weeded control treatment. Even then, rice yield was very low due to the lack of adequate amount of water and severe infestation of *Echinochloa*. Phytotoxicity due to butachlor and pretilachlor application was much higher in the FYM applied plots (25% N substituted by FYM) during the first crop 2014. *Echinochloa* was the major weed species in the experimental plots. Build up of *Echinochloa* population was seen starting from the year 2008. *Echinochloa* population was higher in all the treatments which could not be completely eliminated by cyhalofop-butyl application. Grain yield obtained in the different herbicide treatments was very much lower due to the higher population of *Echinochloa*. The soil organic carbon showed higher cumulative changes than that of pH. Reduction in organic carbon was noticed all the treatments over a period of 11 years. The cumulative changes in available P was very much higher than that of available K. Herbicides with FYM gave higher positive changes in P and K than the other treatments. The cumulative P and K changes in the different treatments ranged from 62.7 to 115.1 % (available P) and 20.7 to 33.8% (available K).

PAU, Ludhiana

A long-term field experiment in rice-wheat system was started in *Kharif* 1993. Eight treatments starting with rice were kept for both rice and wheat on fixed plot basis. Rotation of the herbicides in rice was in the sequence of butachlor/pretilachlor/anilophos with pretilachlor applied during 2014. To cope with the increasing pressure of weeds in rice crop, post-emergence application of bispyribac, 20-25 days after transplanting, after butachlor/pretilachlor/anilophos was added from this year. Bispyribac-sodium was also added in the rotational herbicide treatment and metsulfuron was replaced by azimsulfuron 20 g/ha. Rotation of herbicides in wheat was in sequence of pendimethalin/clodinafop/sulfosulfuron with pendimethalin applied during 2013-14. Pendimethalin was applied as pre-emergence.

Rice

In weedy check, population of *Echinochloa* sp. decreased and of *Ischaemum rugosum, Caesulia axillaris, Cypeurs iria, C. compressus, Ammannia baccifera* and *Alternanthera* sp. increased over last year. All herbicidal treatments recorded significantly higher crop dry matter, effective tillers and rice grain yield than weedy check. The B:C ratio under herbicidal treatments was significantly higher as compared to weedy check (0.72). During 1994, the base year of the trial, only *Echinochloa crus-galli* and *Cyperus iria* were observed in rice crop (Table 3.7.5). However, in 2014, nine weed sp. *viz. E. Crus-galli, E. colona, C. iria, C. compressus, Ischaemum rugosum, Caesulia axillaris, Leptochloa chinensis, Ammannia baccifera, Alternanthera* sp. were observed. This indicated that seven new weed species have come up in the rice field in 20 years time.

Soil weed seed bank consisted mainly of *E. crus-galli, I. rugosum, Leptochloa chinensis* and *Trianthema portulacastrum* during *Kharif* 2014 in rice. The seed bank of *E. crus-galli* has increased as compared to previous season and of *I. rugosum* has decreased in all treatments. Minimum weed seed bank of *E. crus-galli* was observed when grass herbicides anilofos and butachlor were *fb* broadleaved herbicide. Application rotational herbicide recorded minimum seed bank of *I. rugosum* and *L. chinensis. T. portulacastrum* was observed during this year in all treatments, except continuous butachlor and unsprayed control.

Table 3.7.6 Long-term effect of herbicides on growth, yield attributes and grain yield of rice (2014)

Treatment	Plant height at harvest (cm)	Effective tillers (no/m^2)	Crop dry matter (g/m^2)	Weed dry matter (g/m^2)		Grains/ panicles	Grain weight/ panicle (g)	Rice grain yield (t/ha)	Biological yield (t/ha)
				Grasses	BLW				
Butachlor 1.5 kg/ha *fb* bispyribac 25 g/ha	60.7	406.3	1003.5	1.3 (1)	1.1 (0)	83.6	3.1	5.99	18.93
Pretilachlor 0.75 kg/ha *fb* bispyribac 25 g/ha	54.6	362.5	863.0	1.5 (2)	1.4 (1)	91.5	3.3	5.83	19.10
Anilofos 0.4 kg/ha *fb* bispyribac 25 g/ha	59.2	398.8	993.5	1.5 (2)	2.3 (4)	100.1	3.6	5.68	17.92
Butachlor /pretilachlor* /anilophos *fb* bispyribac*/ azimsulfuron	58.2	313.8	851.0	1.6 (2)	1.0 (0)	102.4	3.5	5.78	19.00
Butachlor 1.5 kg/ha *fb* azimsulfuron 20 g/ha	56.2	352.5	962.0	3.0 (9)	1.0 (0)	76.1	2.9	5.05	17.35
Pretilachlor 0.75 kg/ha *fb* azimsulfuron 20 g/ha	59.3	368.8	987.5	3.6 (12)	1.0 (0)	96.3	3.4	5.20	17.34
Anilofos 0.4 kg/ha *fb* azimsulfuron 20 g/ha	60.2	441.3	1068.5	2.4 (5)	1.3 (1)	91.1	3.0	5.56	19.21
Weedy check	54.3	260.0	715.5	9.3 (89)	2.8 (7)	86.8	3.1	1.56	6.60
SEm±	3.8	25.0	49.6	0.5	0.2	9.3	0.2	0.41	1.32
LSD (P = 0.05)	NS	73.6	145.7	1.5	0.5	NS	NS	1.20	3.71

* denotes herbicide used in *Kharif* 2014. Data subjected to square root transformation. Parentheses are original values.

In weedy check, population of *Phalaris minor, Avena ludoviciana, Poa annua, Rumex dentatus, Medicago denticulata* and *Fumaria parviflora* was increased as compared to last year. *P. minor* population increased over last year in continuous herbicidal treatments. Population of *A. ludoviciana* in continuous pendimethalin, *M. denticulata* in continuous pendimethalin and 2,4-D, *P. annua* in continuous clodinafop, *R. dentatus* in continuous sulfosulfuron and *F. parviflora* in continuous 2,4-D were increased during *Rabi* 2013-14. Population of *R. dentatus* decreased in continuous pendimethalin and metsulfuron, *M. denticulata* in continuous metsulfuron, *Coronopus didymus* in continuous 2,4-D treatments. The continuous use of same herbicide resulted in rapid weed flora shifts which reduced the crops productivity.

During 1994, the base year of the trial, eight weed species *viz. Phalaris minor, Avena ludoviciana, Rumex dentatus, Chenopodium album, Coronopus didymus, Anagallis arvensis, Melilotus* sp., *Medicago denticulata* were recorded in wheat field. In 2014, 12 weed species

viz. P. minor, R. dentatus, M. denticulata, A. ludoviciana, C. album, Fumaria parviflora, C. didymus, A. arvensis, Poa annua, Malva parviflora, Silene conoidea, Oenothera drummondii were recorded, indicating that four new weed species have come up over period of 20 years. All weed control treatments had significantly lower weed seed bank. Rotational herbicide treatment recorded minimum weed seed bank of *P. minor*. Minimum seed bank of *P. annua* was observed in sulfosulfuron *fb* 2, 4-D. Among broadleaved weeds, *R. dentatus* had the highest weed seed bank. The continuous use of pendimethalin for 3 years and clodinafop-propragyl for 12 years to wheat did not leave any residues in soil, grain and straw.

Table 3.7.7 Long-term effects of herbicides on weed dry matter and crop growth at harvest, yield and yield attribute of wheat (2013-14)

Treatment (dose kg/ha)	Weed dry matter (g/m^2)		Plant height (cm)	Crop dry matter (g/m^2)	Effective tillers/m^2	Spike length (cm)	Wheat grain yield (t/ha)	Biological yield (t/ha)
	Grasses	Broadleaved						
Pendimethalin 0.75	19.0 (421)	8.3 (69)	83.6	421.4	200.0	10.5	3.08	8.45
Pendimethalin 0.75 *fb* 2,4-D 0.5	19.1 (403)	3.3 (12)	83.6	603.8	253.8	11.7	4.75	10.66
Clodinafop 0.06 + metsulfuron 0.005	8.1 (68)	5.0 (29)	85.5	711.4	275.0	11.4	4.34	10.88
Clodinafop 0.06 + 2,4-D 0.5	14.8 (246)	5.2 (36)	83.6	666.2	252.5	12.2	3.85	10.58
Sulfosulfuron 0.025	13.2 (191)	7.3 (62)	85.8	806.2	330.0	11.7	3.51	10.66
Sulfosulfuron 0.025 *fb* 2,4-D 0.5	8.9 (80)	7.6 (57)	85.9	873.9	281.3	12.0	4.97	11.76
Pendimethelin/ sulfosulfuron/ clodinafop 0.75 *fb* 2, 4-D 0.5	12.5 (159)	3.5 (12)	84.5	744.9	293.8	12.1	4.17	9.63
Weedy check	24.0 (623)	10.1 (106)	84.9	356.3	126.3	10.7	1.02	8.01
SEm±	2.8	1.0	1.2	91.1	29.3	0.3	0.44	0.49
LSD (P = 0.05)	8.2	2.8	NS	267.9	86.2	0.9	1.31	1.45

*herbicide applied during 2013-14. Parentheses are original values. Data subjected to square root transformation.

RVSKVV, Gwalior

Pearlmillet-wheat cropping system

Wheat

The dominant weeds were *Cyperus rotundus, Phalaris minor, Chenopodium album, Medicago hispida, Fumaria parviflora* and *Convolvulus arvensis*. Weed population and dry weight of weeds at 30 and 60 DAS were significantly influenced by different weed management practices except *Cyperus rotudnus*. Alone application of isoproturon and combined with 2,4-D or one hand weeding at 30 DAS markedly reduced the population of *Phalaris minor, Convolvulus arvensis, Chenopodium album, Medicago hispida* and *Fumaria parviflora*. But these herbicides failed to control *Cyperus rotundus*. Both treatments being significantly reduced the total weed population as compared to weedy check.

Six years pooled data indicated maximum net return of ₹ 46,174 /ha and B:C ratio 2.50 with the application of isoproturon 0.75 + one hand weeding *fb* isoproturon 0.75 + 2,4-D 0.5 kg/ha (net return ₹46,126/ha with B:C ratio 2.76). However, weed free situation higher productivity, net return (₹ 47,436 /ha) and B:C Ratio 2.38 were recorded. While weedy check gave lowest net return of ₹ 22,686 /ha with B:C ratio of 1.93. Hand weeding twice at 30 and 60 DAS (weed free) treatment gave maximum grain yield 4522 kg/ha and net return obtained ₹ 47,436/ha followed by isoproturon + one hand weeding at 60 DAS (₹ 46,174/ha). Consequently application of isoproturon 0.75 kg/ha + 2,4-D 0.5 kg/ha was also more effective weed management practices for control of mixed weed flora in wheat crop.

TNAU, Coimbatore

Rice-rice cropping system

Among the grasses, *Echinochloa crus-galli* was the dominant species and the major sedge was *Cyperus difformis*. Among the broad leaved weeds, *Marsilea quadrifoliata, Ammannia baccifera, Ludwigia parviflora* and *Eclipta prostrata* were the dominant species. *Echinochloa colona* and *Leptochloa chinensis* under grasses and *Cyperus iria* under sedges which were found in the first crop were completely absent in the 28th crop. *Echinochloa crus-galli* in grasses, *Cyperus difformis* in sedges and *Marselia quadrifolia* in broad leaved weeds continued to persist in the field throughout the period of study. *Panicum repens* under grasses emerged as a new weed. Over a period of time from the first crop to 28th crop dominance of grass weeds have increased from 50.2 to 56.8%. Whereas, the relative density of broad leaved weeds decreased from 41 to 40.2%, respectively.

During *Rabi* (2013-14) at 60 DAT, significantly lower total weed density was recorded with herbicide rotation ie., butachlor + 2, 4-DEE (*Kharif*) and pretilachlor + 2,4-DEE (*Rabi*) along with integration of nutrients which was on par with butachlor + 2,4-DEE for both seasons with integration of nutrients in rice - rice cropping system. In *Rabi* 2013-14, hand weeding recorded significantly higher total weed dry weight than chemical treatments. Rotational application of herbicides, butachlor + 2,4-DEE (*Kharif*) and pretilachlor + 2,4-DEE (*Rabi*) and integration of nutrients recorded lesser weed dry weight at 60 DAT which was comparable with butachlor + 2,4-DEE for both seasons with integration of nutrients.

Significantly higher grain yield was recorded with butachlor + 2, 4-DEE (*Kharif*) and pretilachlor + 2, 4-DEE (*Rabi*) along with integration of nutrients (5.99 and 5.89 t/ha) which was on par with butachlor + 2,4-DEE for both seasons with integration of nutrients for both *Kharif* 2013 and *Rabi* 2013-14, respectively. Significantly lower grain yield was recorded with hand weeding plots. Higher net return of ₹ 47,879 and 44,388/ha and benefit cost ratio (3.17 and 2.51) was recorded with butachlor + 2,4-DEE (*Kharif*) and pretilachlor + 2,4-DEE (*Rabi*) along with integration of nutrients during *Kharif*, 2013 and *Rabi* 2013-14, respectively.

During *Kharif* 2014 at 60 DAT, significantly lower total weed density dry weight and yield was recorded with herbicide rotation ie., butachlor + 2, 4-DEE (*Kharif*) and pretilachlor + 2, 4-DEE (*Rabi*) along with integration of nutrients which was on par with butachlor + 2,4-DEE for both seasons with integration of nutrients in rice - rice cropping system. Higher gross return (₹ 68,100/ha) was observed with

Table 3.7.8 Performance of rice as influenced by long-term herbicide and sources of N at Coimbatore (*Rabi*, 2013-14)

Treatment combination	Productive tillers (no./m^2)	Grain yield (t/ha)	Net returns (₹/ha)	B:C ratio
HW twice + 100% inorganic N	245	3.85	13,302	1.38
HW twice + 75% inorganic N + 25% organic N -hand weeding twice + 100% inorganic N	279	4.18	21,577	1.61
PE Butachlor 0.75 + POE 2,4 - DEE 0.4 kg/ha + 100% inorganic N	295	5.53	37,785	2.30
PE Butachlor 0.75 + POE 2,4 - DEE 0.4 kg/ha + 75% inorganic N + 25% organic N -PE butachlor 0.75 + POE 2,4- DEE 0.4 kg/ha + 100% inorg. N	336	5.80	39,917	2.37
PE Butachlor 0.75 + POE 2,4-DEE 0.4 kg/ha + 100% inorganic N - PE pretilachlor 0.75 + POE 2,4-DEE 0.4 kg/ha + 100% inorganic N	303	5.49	40,762	2.39
PE Butachlor 0.75 + POE 2,4 -DEE 0.4 kg/ha+ 75% inorganic N + 25% organic N -PE pretilachlor 0.75 + POE 2,4 DEE 0.4 kg/ha + 100% inorganic N	350	5.89	44,388	2.51
SEm±	19.63	0.16	-	-
LSD (P=0.05)	41.84	0.35	-	-

butachlor + 2, 4-DEE (*Kharif*) and pretilachlor + 2, 4-DEE (*Rabi*) along with integration of nutrients. Higher net return of ₹ 34,721 and benefit cost ratio (2.04) was recorded with butachlor + 2,4-DEE (*Kharif*) and pretilachlor + 2,4-DEE (*Rabi*) along with integration of nutrients.

UAS, Bengaluru

Rice-rice cropping system

Major weed flora was *Cyperus difformis, Fimbristylis miliacea, Scirpus* sp., *Paspalum dilatatum* and *Echinochloa cruss-galli, Ludwigia parviflora, Spilanthes acmella, Eclipta alba, Dopatrium junceum, Marselia quadrifolia, Rotala verticillaris*. At 30, 60 DAS and harvest broad leaf weeds were dominated followed by sedges and grasses. Among different weed species *Fimbristylis miliacea, Scirpus sp., Spilanthes acmella, Eclipta alba* and *Dopatrium junceum* were dominant. Mean data of 28 seasons (1999 to 2013) indicated that application of butachlor + 2,4-D EE (3 DAP, applied in sequence) during *Kharif fb* pretilachlor in summer (7.01 t/ha) resulted in higher grain yield than application of butachlor + 2,4-D EE in both the seasons (6.26 t/ha) due to effective control of sedges and broadleaf weeds and it gave almost similar yield as that of imposing two hand weedings (7.30 t/ha). With respect to sources of fertility continuous application of integrated source of nutrients (FYM + inorganic fertilizers) over 28 seasons was positively reflected in terms of higher grain yield (6.92 t/ha) compared to application of 100% nutrients through inorganic source (6.80 t/ha).

Transplanted rice *Kharif*

Major weed flora was *Cyperus difformis, Fimbristylis miliacea, Scirpus* sp. (sedges), *Panicum dilatatum* and *Echinochloa colona,* (grasses), *Ludwigia parviflora, Dopatrium junceum, Spilanthes acmella, Marselia quadrifolia, Eclipta alba* and *Glinus oppositifolius* (broad leaf weeds), *Fimbristylis miliacea, Scirpus* sp., *Spilanthes acmella* and *Dopatrium junceum* were the dominant weed species. The broad leaf weeds and sedges were dominated followed by grasses at 30 and 60 DAS whereas, sedges were more in number at harvest. Mean data of 29 seasons indicated that application of pretilachlor during summer *fb* butachlor + 2,4-D EE during *Kharif* resulted in 4.8% higher paddy grain yield than application of butachlor + 2,4-D EE both during *Kharif* and summer. Use of herbicides was cheaper than manual weeding and treatment involving application of pretilachlor during summer *fb* butachlor + 2,4-D EE during *Kharif* resulted in higher B:C ratio.

Groundnut-transplanted fingermillet cropping system

The major weed species were *Cyperus rotundus, Cynodon dactylon, Digitaria marginata, Dactyloctenium aegyptium, Echinochloa colona, Commelina benghalensis, Euphorbia geniculata, Ageratum conyzoides, Borreria articularis, Amaranthus viridis* and *Acanthospermum hispidum*. In alachlor applied plots, *Digitaria marginata, Spilanthes acmella* and *Ageratum conyzoides* were noticed whereas in pendimethalin applied plots, higher density of *Cyperus rotundus, Spilanthes acmella, Ageratum conyzoids* and *Commelina benghalensis* were noticed during summer 2014 as compared to summer 2000. Substantial reduction in the density of sedges and grasses was noticed in hand weeded plots due to uprooting of *Cyperus rotundus* tubers and *Cynodon dactylon* roots. The pod yield was significantly higher in plot treated with pendimethalin (2075 kg/ha) as compared to alachlor (1.81 t/ha), which was on par with hand weeded plots (2.13 t/ha) as result of good control of weeds particularly grasses and sedges. Grasses offered severe competition to groundnut crop and resulted in significant reduction in the pod yield. Sources of fertility had no significant influence on the pod yield of groundnut however combined application of FYM + inorganic fertilizers over the past fifteen years had positive influence on the soil properties and resulted in higher pod yield (2.05 t/ha) as compared to plot applied with fertilizer along (1.95 t/ha). Interaction effect was non-significant.

Use of herbicides was found cheaper (₹ 1250-2168/ha) resulted in saving in weeding cost to the tune of (₹ 5332-6250/ha). Higher B:C ratio 3.30 was obtained in the treatment butachlor + OM in finger millet production whereas, it is 4.12 in groundnut production system. However the B:C ratios were 2.3 and 3.3 in the hand weeding without organic matter treatment in finger millet and ground nut production system respectively even through grain pod yields are on par with the herbicides treatments.

Transplanted finger millet (17th crop of the system, *Kharif* 2014)

The major weed species were *Cyperus rotundus, Cynodon dactylon, Digitaria marginata, Dactyloctenium aegyptium, Echinochloa colona, Commelina benghalensis, Lagascea mollis, Ageratum conyzoides, Spilanthes acmella, Amaranthus viridis* and *Euphorbia hirta*.

Over fifteen years, use of herbicide butachlor was found relatively better in controlling grasses and subsequent yield (3.34 t/ha) higher than the plot treated with 2,4-D Na salt (2.71 t/ha) and was similar to hand weeding (3.43 t/ha). Butachlor was effective in suppressing the grasses which were the competitors with finger millet for critical growth resources during the critical period of crop weed competition of finger millet. The use of herbicides was cheaper (₹ 850 in butachlor to ₹ 1,100/ha in 2,4-D Na salt in finger millet and ₹ 1,100/ha in alachlor to 1965/ha in pendimethalin in groundnut) than hand weeding (₹ 7,200/ha in finger millet and ₹ 6,750/ha in groundnut). The saving in weeding cost through herbicides amounted to ₹ 4,785/ha in pendimethalin in groundnut to ₹ 6,350/ha in butachlor in finger millet as compared to hand weeding in finger millet-groundnut cropping system. Continuous use of herbicides either in finger millet or groundnut had no adverse effect on soil physico-chemical properties and soil microbial activity at the time of harvest of crops as compared to unsprayed hand weeding as well as initial value at the time of start of experimentation in 1999.

VB, Sriniketan

Rice - mustard cropping system

In the initial year (*Kharif* 1999), *Hydrolea zeylanica* and *Fimbristylis miliacea* were pre-dominant whereas in *Kharif* 2014, *Ludwigia parviflora, Lindernia ciliata* and *Fimbristylis mileacea* appeared as pre-dominant in rice. In mustard, *Digitaria sanguinalis* was dominant in initial year (*Rabi* 1999-2000) whereas in *Rabi* 2013-2014, *Cynodon dactylon, Polygonum plebeium* and *Anagallis arvensis* were predominant weed species along with *Digitaria sanguinalis*.

Mustard

Pre-emergence application of pendimethalin successfully controlled *Polygonum plebeium* and isoproturon was effective in controlling *Gnaphalium purpureum* and *Spilanthes acmella*. Number of plants/m^2, number of branches/plant, no. of siliquae/plant, no. of seeds/siliqua, test weight, and seed yield of mustard did not differed significantly among the treatments. In case of seed yield of mustard, rotational application of isoproturon/ pendimethalin + FYM produced more seed yield as compared to fertilizer application. Rotational application of isoproturon/pendimethalin in addition to FYM gave more seed yield in the plot where rotational application of pretilachlor/ butachlor + OM were exercised in previous *Kharif* rice. Though the gross return, net return and B:C ratio did not differ significantly but the highest gross return (₹ 52,080/ha), net return (₹ 29,980/ha) and wider B:C ratio (2.36) were recorded under rotational application of isoproturon / pendimethalin + FYM (where rotational application of pretilachlor / butachlor + *fb* 2,4-D + OM was applied in previous *Kharif* season) and it was closely *fb* rotational application of isoproturon/pendimethalin+ fertilizer (where rotational application of pretilachlor/ butachlor + *fb* 2,4-D + OM fertilizer was applied in previous *Kharif* season). The gross return (₹ 47320/ha), net return (₹ 22,020/ha) and B:C ratio (1.87) was narrow in farmer's practice + fertilizer.

Rice

Both repeated and rotational application of butachlor and pretilachlor/butachlor controlled *Cynodon dactylon, Echinochloa colona, Lindernia ciliata, Cyperus iria* and *Fimbristylis mileacea* at 30 DAT. Pre-emergence application of butachlor in repeated and pretilachlor / butachlor in rotation supplemented with 2,4-D controlled *Ludwigia parviflora* at 60 DAT. Repeated application of butachlor and rotation application of pretilachlor / butachlor supplemented with 2,4-D successfully controlled total weed population. Though the gross return, net return and B:C ratio did not differ significantly but the highest gross return (₹ 62,799/ha), net return (₹ 36,499/ha) and B:C ratio (2.39) was obtained in rotational use of pretilachlor / butachlor *fb* 2, 4-D + OM. Farmers' method of weed control recorded more gross return (₹ 61,829/ha) but the net return (₹ 32,129/ha) and B:C ratio (2.08) were narrow as because of high cost of cultivation.

PJTSAU, Hyderabad

Rice fallow maize

The predominant weed flora in transplanted rice was *Cyprus rotundus, Cyprus difformis, E. crus-gulli, E. colona, Eclipta alba, Fimbristylis dichotoma* and *Paspalum distichum* in *Kharif* 2014. No phytotoxicity was observed with application of pre or post-emergence herbicides on transplanted rice. At 60 DAT and at harvest, significantly the lowest weed drymatter was observed with farmers practice. However, significantly lower panicle length, test weight and grains/panicle was observed with unweeded check and inturn all other treatments onpar with each other. Pre-emergence application of pretilachlor at 3-5 DAT *fb* HW at 25-30 DAT recorded more grain and straw yield but it showed on par yields with farmers practice. Significantly the lowest yield and yield attributes were recorded with unweeded check. Higher gross returns, net returns and B:C ratio (₹ 89,292, ₹ 48,572 and 2.19) were obtained with pre-emergence application of pretilachlor. This was closely followed by farmers practice (hand weeding twice at 20 and 40 DAS). The reduced B:C ratio in farmers practice was due to increased cost of cultivation with manual weeding practices.

NDUAT, Faizabad

Rice-wheat cropping system

Wheat

Phalaris minor, Anagallis arvensis, Chenopodium album, Melilotus spp. *Coronopus didymus* and *Medicago denticulata, Vicia sativa, Lathyrus aphaca, Rumex acetosella, Polypogon monspeliensis* and *Poa annua* were sparsely present in the wheat field. Tank mix application of isoproturon + 2,4-D Na salt being at par with hand weeding 20 and 40 DAS showed effective control of weeds as compared to weedy treatment. The effect of *Kharif* season treatments reduce the weed density during *Rabi* season in wheat crop. Application of isoproturon + 2, 4-D Na salt (tank mix) being at par to HW 20 and 40 DAS provided significantly higher grain yield than weedy treatment. The treatments applied during *Kharif* season in rice had their significant effect on grain yield in rice-wheat cropping system. Hand weeding 20 and 40 DAS which was par to butachlor increased the grain yield of wheat during *Rabi* season. A major shift in weed flora has not been observed. However, in herbicide treated plots few new weed spp., eg., *Polypogon monspeliensis* and *Poa annua* among grassy and *Rumex* spp. and among BLWs were recorded.

Rice

Among grassy weeds, *E. Colona, E. Crus-galli* and *Paspalum* spp. existed predominantly while *Fimbristylis dichotoma* and *C. iria* of sedges group existed with the highest population. BLWs included *Ammannia baccifera, Eclipta alba, Lindernia* spp. *Casulia axillaris* and *Phyllanthus niruri* were also recorded. The effect of weed management practices i.e., HW 20 and 40 DAS and tank mix application of isoproturon+2,4-D Na salt caused significant reduction in weed dry weight recorded in rice during *Kharif* season. Interaction effect was not visible. There was no certain trend in change of weed shift due to different treatments being used for the last several years. However, few new weeds viz., *C. axillaris, Rumex* spp. and *Lindernia* spp. were recorded in the weedy plots. Weed control treatments applied during *Rabi* and *Kharif* season did not show any significant effect on bulk density, pH, EC and organic carbon in the soil at initial and at harvest stage. However, effect of herbicides on free living N fixing bacteria (FLNB), phosphate solubilizing bacteria (PSB), soil respiration (SR), percent root colonization (PRC), alkaline-P, acid-P and dehydrogenase activity (DHA) was significant at initial and harvest stages during *Rabi* and *Kharif* season 2014.

CSKHPKV, Palampur

Rice-wheat cropping system

In transplanted rice, *Echinochloa crusgalli, Panicum dichotomiflorum, Cyperus iria, Ammannia baccifera* and *Ageratum conyzoides* were the dominating weeds during *Kharif* 1999. The population of all these weeds decreased considerably during *Kharif* 2000 and only *Echinochloa* and *Panicum* were the dominating weeds. However, during 2007, *Echinochloa crus-galli, 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 to 2014, *Echinochloa crus-galli, Cyperus, Ammannia 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 *fb* 2,4-D resulted in significantly lower population and dry matter of *Phalaris minor, Lolium temulentum* and *Avena ludoviciana* over farmer's practice and continuous use of isoproturon + 2,4-D. Whereas, during *Rabi* 2008-09, *Stellaria, Coronopus* and *Trifolium* were the new weeds. There was not much change in weed flora during *Rabi* 2010-2014 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. Total beneficial soil microflora population dehydrogenase activity, basal soil respiration, microbial biomass carbon, acidic phosphatase and alkaline phosphotase were not influenced significantly in both the crops.

SKUAT, Jammu

Long-term trial on rice- wheat cropping system

In wheat crop grown during *Rabi* 2013-2014, 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 3792 kg/ha was recorded in the treatment with isoproturoni 1.0 kg/ha and was at par with 0.75 kg isoproturon +1% tank mix urea or 0.1 % surfactant. 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, Fumaria parviflora, Phalaris minor, Medicago denticulata* and *Anagallis arvensis*. Herbicidal weed management with application of isoproturon either 1.0 kg/ha or 0.75 kg/ha with 1% tank mixed urea or 0.1% surfactant in wheat remained economically superior to mechanical weeding recording relatively higher net returns and B:C ratio. However, lowest net returns and B:C ratio values were observed in weedy check.

Rice, 2014

During the rice growth period the predominant weed species were *Eichnochloa crus-galli, Eichnochloa colona, Cyperus iria, Cyperus difformis* and *Cyanodon dactylon*. Amongst the weed control treatments in rice, the lowest weed population of 2.10 and 4.41 was recorded at 30 and 60 days after transplanting, respectively where application of butachlor was made (which was previously treated with isoproturon in wheat crop) followed by two mechanical weeding (MW at 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 2689 kg/ha with herbicidal application of butachlor followed by two mechanical weedings recording 107.6 and 79.8% higher grain yields, respectively over weedy check. Application of butachlor or anilophos in rice remained economically superior to mechanical weeding and weedy check recorded relatively higher net returns and B: C ratio. However, lowest net returns and B:C ratio values were observed with mechanical weeding treatment thus making it economically inferior to all other weed management treatments including the weedy check.

WS 3.8: Station trials based on location-specific problems

WS 3.8.1: Integrated weed management in direct seeded rice (*Kharif* 2014)

IGKV, Raipur

The dominate weeds were *Alternanthera traiandra, Cyanotis axillaris, Cyperus iria, Echinochloa colona* in direct-seeded rice. Weed polulation was slightly low under of oxadiargyl *fb* bispyribac-Na followed by bispyribac-Na *fb* pretilachlor + bensulfuron along with first top dressing of nitrogen and motorized weeding twice at 15 and 25 DAS *fb* bispyribac-Na, respectively at 60 DAS. Whereas at harvest stage, the weed population was lowest under oxadiargyl *fb* bispyribac-Na followed by bispyribac-Na *fb* pretilachlor + bensulfuron along with first top dressing of nitrogen and azimsulfuron *fb* bispyribac-Na. Significantly lowest weed dry matter was recorded under azimsulfuron *fb* bispyribac-Na as compared to weedy check, but, it was statistically at par with bispyribac-Na *fb* pretilachlor + bensulfuron, along with first top dressing of nitrogen at 60 DAS and at harvest.

The higher seed yield was recorded under azimsulfuron fb bispyribac-Na as compared to weedy check, but was at par with rest of the treatments except motorized weeding twice at 15 and 25 DAS *fb* bispyribac-Na and bispyribac-Na. The highest reduction in seed yield was recorded under weedy check (86.4%). The gross income, net income and B:C ratio was found to be highest under azimsulfuron bispyribac-Na (2.23) followed by bispyribac-Na *fb* pretilachlor + bensulfuron along with first top dressing of nitrogen (2.12), narrowly followed by oxadiargyl *fb* bispyribac-Na (2.12) as against negative B:C ratio under weedy check .

WS 3.8.2: Weed control in carrot

BAU, Ranchi

Effect of application of oxyfuorfen was similar to glyphosate. Pre-plant burn down and pendimethalin recorded 82.9 and 82.7% reduction in grassy weed dry matter accumulation compared to weedy check at 30 (10.8 g/m^2) and 60 (14.4 g/m^2) days after sowing. Application of oxyfuorfen being similar to carfentrazone pre-plant burn down, pendimethalin. In case of broad leaf weeds and and also glyphosate pre-plant burn down and paraquat 1.0 kg/ha pre-plant burn down in case of sedges recorded 85 and 69% reduced dry matter compared to weedy check at 30 days after sowing and 89.2 and 70.4% as compared to weedy checks at 60 days after sowing. No phytotoxicity on carrot plant was visible.

WS 3.8.3: Weed management in egg plant

BAU, Ranchi

Application of oxyfuorfen was similar to pendimethalin 0.95 kg/ha 0-2 DAP in case of grassy, and also similar to carfentrazone 0.030 kg/ha pre-plant burn down, glyphosate 0.5 kg/ha pre-plant burn down, paraquat 1.0 kg/ha pre-plant burn down and pendimethalin 0.95 kg/ha 0-2 DAP in case of broad leaf at 30 and 60 days after recorded 83.8 and 75.3% at 30 days after sowing and 83.5% at 60 days after sowing compared to their respective densities under weedy checks i.e., 33 and 25.67/m^2 at 30 and 60 DAP. Application of paraquat 1.0 kg/ha pre-plant burn down recorded reduced dry matter sedges at 30 and 60 days after planting and was similar to all treatments except weedy checks. The extent of reduction was to the tune of 69.3 and 63.1% compared to weedy check.

WS 3.8.4(i): Pre-emergence herbicides for pineapple

KAU, Thrissur

Borreria latifolia, Cleome burmannii, Commelina diffusa, Emilia sonchifolia and *Lindernia crustacea* were the major weeds in the field. No phytotoxicity symptoms from the herbicides were seen on pineapple plants. Diuron 0.2 kg/ha completly controlled weeds at 60 DAS whereas, diuron 0.3 kg/ha gave complete control of weeds upto 120 DAS. Oxyflourfen 0.2, 0.3 or 0.4 kg/ha control led all weeds upto 60 DAS and thereafter weeds started emerging. For these treatments there was no dry matter accumulation at 60 DAS. Thereafter even though some weeds emerged, the dry matter production was significantly lower than the unweeded control, and on par with the hand weeded control (5 hand weedings) even at 150 DAS.

WS 3.8.5 (ii): Effect of glyphosate formulations on chemical and biological properties of lateritic soil

KAU, Thrissur

In the field study, application of glyphosate in the banana ratoon crop caused short term inhibitory effect on soil fungus up to 30 days after spraying only. Soil bacteria count and dehydrogenase enzyme activity were unaffected by glyphosate application. Application of glyphosate did not produce any significant effects on chemical characteristics of the soil such as pH, organic carbon and available nutrients.

WS 3.8.6: Evaluation of tembotrione at different doses and times for post emergence weed control in maize

CSKHPKV, Palampur

The major weed flora was *Echinochloa sp., Commelina benghalensis, Polygonum sp. Ageratum conyzoides* which appeared at silking stage of maize and other weeds *(Cynodon dactylon, Bracharia* sp. and *Galinsoga parviflora)*. The application of tembotrione 125 g/ha + surfactant applied at 20 DAS produced significantly lowest total dry weight of weeds at 60 DAS which was at par with tembotrione 150 g/ha + surfactant applied at 20 DAS and tembotrione 150 g/ha applied at 30 DAS, tembotrione 150 g/ha + surfactant applied at 20 DAS produced lowest total

dry weight of weeds at harvest and yield of maize crop which was at par with tembotrione 125g/ha + surfactant applied at 20 DAS, and tembotrione 150 g/ha applied at 30 DAS. Significantly higher total dry weight of weeds at 60 DAS and at harvest was produced by weedy check followed by atrazine + pendimethalin treatment.

The lowest grain yield was recorded with weedy check treatment. The grain yield of maize was recorded higher with application of tembotrione 150 g/ha + surfactant remaining at par with tembotrione 125 g/ha+surfactant, tembotrione 100g/ha+ surfactant applied at 30 DAS as compared to all other treatments. The increase in yield due to these treatments over unweeded check was 192.5, 189.4 and 178.3%. Manual weeding was also found statistically similar to atrazine+atrazine 1000 + 750 g/ha applied as pre and post-emergence (20 DAS), respectively.

WS 3.8.7: Control of complex weed flora in brown sarson with the extracts of SKUAST-Kashmir

Straw of rice, red clover, *Urtica urens, Chenopodum album, Amaranthus viridis* was soaked in water for 24 to 36 hr and was applied at 100% concentration at 30 days after sowing and in the first fortnight of march, these treatments were compared with farmers practice.

Weed flora under farmers mainly comprised of *Poa annua, Arenaria serpyllifolia, Stellaria media, Ranunculus arvensis, Cynodon dactylon, Euphorbia hispida* and *Rorippa Sylvestris*. Among different treatments the lowest density was observed with the application of extracts of rice, *Chenopodium album* and *Amaranthus viridis* at 140 days after sowing. Among different treatments, extracts of rice, *Chenopodium album* and *Amaranthus viridis* at 140 days after sowing, recorded the highest seed yield as compared to 30 DAS. Spray of extracts at 30 days after sowing showed effective results but was not found effective during spring due to next flush of weeds.

WS 3.8.8: Effect of different herbicide combination on weed and yield of maize

SVBPUAT, Meerut

The major weeds of experimental field were *Trianthema portulacastum, Digera arvensis, Commelina benghalensis, Echinochloa colona, Dactyloctenium aegyptium, Cyperus iria* and *Parthenium hysterophorus*. The lowest weed population and dry weight were recorded in two hand weedings. Among the herbicide treatments, the lowest weed population, dry weight and highest weed control efficiency (89.5%) were recorded in atrazine + pendimethalin. The highest grain yield (5.35 t/ha) of maize was recorded in treatment two hand weedings followed by atrazine + pendimethalin (4.96 t/ha). Pre-emergence application of atrazine + pendimethalin gave maximum gross return (₹ 82,040/ ha) and net return (₹ 60,073/ha).

WS 3.8.9: IWM in soybean

PDKV, Akola

The major weed flora comprised of *Cynodon dactylon, Cyperus rotundus, Commelina benghalensis, Ischaemum pilosum, Digitaria sanguinalis, Dinebra retroflexa, Poa annua* and *Cyanotis axillaris* among the monocots, and dicots like *Digera arvensis, Lagascea mollis, Euphorbia geniculata, Tridex procumbense, Parthenium hysterophorus, Celosia argentea, Alysicarpus monilifer, Alternanathera triandra, Portulaca oleracea, Amaranthis viridis, Acalypha indica, Cardiospermum halicacabum, Ipomoea reniformis, Corchorus acutangulus, Phyllanthus niruri, Abutilon indicum, Abelmoschus moschatus, Boerhavia diffusa, Calotropis gigantea, Ageratum conyzoides, Bidens pilosa, Mimosa pudica, Xanthium strumarium, Datura stramonium*. At 40 DAS and at harvest, maximum WCE was recorded in tank mix application of imazethapyr 0.100 kg/ha PoE + quizalofop-ethyl 0.050 kg/ha PoE 15 DAS. The weed free treatment was the best in all parameters but was found at par with tank mix combination of imazethapyr 0.100 kg/ha POE + quizalofop-ethyl 0.050 kg/ha POE 15 DAS which was found better in controlling weeds, weed dry matter accumulation (8.3 g/m^2), weed control efficiency (74.7%), weed index (0.99), seed yield (2.20 t/ha) among various herbicide treatments, while on the basis of economics, this treatment also recorded the highest B:C ratio (2.39).

WS 3.8.10.1: Integrated weed and nutrient management through inter-cropping and fertilizer-herbicide-compost mixture

AAU, Jorhat

The weed density at 20, 40 and at harvest were significantly lower under the treatment pretilachlor

750 g/ha + incorporation of cowpea-*sesbania* + HW with 50% RDF- vermicompost (2 t/ha) mixture. Weed dry weight was lowest under pretilachlor + incorporation of cowpea-*sesbania* + HW with 50% RDF- vermicompost mixture. It was followed at 20 and 40 DAS by the treatment with pyrazosulfuron 25 g/ha + incorporation of inter-row cowpea-sunhemp (20 DAS) + HW 40 DAS and at harvest by pretilachlor +HW. The grain and straw yields were significantly higher under pretilachlor + incorporation of inter-row cowpea-*sesbania* + HW 40 DAS with 50% RD fertilizer applied as vermicompost mixture followed by pyrazosulfuron + incorporation of inter-row cowpea-dhaincha + HW with 50% RD fertilizer applied as vermicompost mixture.

WS 3. 8. 10.2: Weed management in brinjal under rice fallow sequence

AAU, Jorhat

Application of oxadiargyl 90 g/ha + GH at 30, 50, 80, 80 DAP and oxadiargyl 90 g/ha + GH at 30, 60 DAP recorded lowest weed density and dry weight up to 60 DAP. Highest fruit yield was recorded under garden hoeing at 20, 40, 60, 80 DAP which was at par with garden hoeing at 25, 50, 75 DAP, oxadiargyl 90 g/ha + GH at 30, 50, 80, 80 DAP and oxadiargyl 90 g/ha + GH at 30, 60 DAP.

WS 3.8.10.3: Weed management in marigold

AAU, Jorhat

In general, oxadiargyl 90 g/ha *fb* garden hoeing at 30 DAP maintained lower weed density and dry weight during the crop growing period. Total number and yield of fresh flower were highest under oxadiargyl 90 g/ha fb garden hoeing at 30 DAP.

WS 3.8.10.4: Nutritional and physiological response of marigold to comlizer and vermiwash application

AAU, Jorhat

Applicationon of vermicompost 2500-N: P_2O_5: K_2O 30:10:30 kg/ha mixture (basal and 30 DAP) + vermiwash 10% (2nd and 3rd week) and 20% (4th and 5th week) spray increased plant heights, number of primary and secondary branch per plant, plant spread, flower yield per plant, numbers of flower per plant and flower yield per plot. In general, these treatments also resulted a higher content of NH_4-N, NO_3-N and available K in soil at 45 DAP.

WS 3. 8. 10.5: Weed management in garlic

AAU, Jorhat

Application of oxadiargyl 90 g/ha followed by garden hoe at 30 and 60 DAP and pretilachlor 750 g/ha followed by garden hoe at 30 and 60 DAP controlled weed population and growth through out the growing season of the crop. The highest yield was obtained from oxadiargyl 90 g/ha followed by garden hoe at 30 and 60 DAP and pretilachlor 750 g/ha followed by garden hoe at 30 and 60 DAP

WS 3. 8. 10.6: Weed management in potato

AAU, Jorhat

Application of metribuzin 750 g/ha as pre-emergene or early post-emergence, pretilachlor 750 g/ha as pre-emergence and oxadiargyl 90 g/ha pre-emergence caused reasonably low weed density and dry weight during the crop season. The tuber yields resulted by the above treatments were similar.

WS 3.8.10.7: Weed management in chilli after winter rice

AAU, Jorhat

Metribuzin 500 g/ha + garden hoe 30, 60 DAP and metribuzin 500 g/ha + garden hoe 30, 50, 80 DAP resulted lowest weed density and dry weight at 20 and 80 DAP. Better growth and yield attributing characters under metrbuzin + garden hoe caused higher fruit yield from the crop.

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

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

WS 4.1a (i). Crop: Mustard

Cooperating Centre: CCSHAU, SKRAU and RVSKVV

Bioefficacy of neem cake, pendimethalin and post-emergence application of glyphosate at low concentrations was evaluated at Hisar. Data on number of *Orobanche* panicle/m^2 and visual control of

Orobanche was assessed at 120 DAS using 0-100 scale. Pendimethalin alone or in combination with neem cake did not prove useful in minimizing population of *Orobanche aegyptiaca* (Table 4.1). Use of *Trichoderma viride* at 5 kg/ha and neem cake at 200 and 400 kg/ha did not cause any inhibition of *Orobanche* emergence. Glyphosate application at 25 g/ha at 30 DAS and 50 g/ha at 55 DAS alone or with 1% with $(NH_4)_2SO_4$ provided good (75-80%) control of *Orobanche* up to 120 days after sowing. In the same treatment, 10% crop suppression in terms of chlorosis and necrosis was observed resulting in poor yield. Maximum seed yield of mustard (1800 kg/ha) was observed with use of glyphosate 25 g/ha at 30 DAS and 50 g/ha at 40 DAS which was at par with all glyphosate treatments. Presence of *Orobanche* throughout crop season caused 20.4% reduction in seed yield of mustard as compared to use of glyphosate 25 g/ha at 25 DAS and 50 g/ha at 55 DAS (RP). In a survey, the incidence of *Orobanche* was found higher in Bhiwani district (37 stalks/m^2) as compared to Hisar district (12 stalks /m^2). In Hisar, mustard was grown in sandy loam to sandy soils while in Bhiwani mustard was mainly grown in loamy sand soils. Similarly mustard crop irrigated with sprinkler and grown under rainfed conditions (92%) had more infestation of *Orobanche* as compared to irrigated with flooding method (28% infestation).

Table 4.1: Effect of different weed control measures on *Orobanche* population and seed yield of mustard

Treatment	*Orobanche* panicles /m^2			Visual control at 120 DAS (%)	Seed yield (kg/ha)	Remarks
	DAS					
	60	90	120			
Neemcake 200 kg/ha in furrow and pendimethalin methalin 0.5 kg/ha *fb* HW at 60 DAS	1.73	1.73	4.79	0	1480	-
Neemcake 400 kg/ha in furrow *fb* HW at 60 DAS	2.65	2.45	4	0	1440	-
Neemcake 200 kg/ha in furrow *fb* HW at 60 DAS	1.96	2.0	4.2	0	1453	-
Pendimethalin 1.0 kg/ha *fb* HW at 60 DAS	2.52	2.65	4.97	0	1220	Germination suppressed by 10%
Neemcake 400 kg/ha in furrow *fb* pendimethalin 0.5 kg/ha *fb* HW at 60 DAS	1.96	2.76	4.47	0	1380	-
Glyphosate 35 and 50 g/ha at 30 and 55 DAS	1	1	1.73	75	1786	-
Glyphosate 25 and 50 g/ha at 30 and 55 DAS with 1% $(NH_4)_2SO_4$	1	1	1.41	80	1760	15% toxicity
Glyphosate 25 and 50 g/ha at 30 and 55 DAS (RP)	1	1	1.73	75	1780	-
Glyphosate 25 g/ha at 30 DAS and 50 g/ha at 40 DAS	1	1	1.73	75	1800	5% crop suppression
Glyphosate 50 g/ha at 40 DAS	1	1	2.24	60	1700	10% crop suppression
HW at 30, 60 and 90 DAS	1.9	0.51(11.3)	4.73(21)	0	1580	-
Trichoderma viride at 5 kg/ha before sowing	2.24(4)	3.42(10.7)	4.2(17)	0	1600	-
Weedy check	2.63(6)	3.51(11.3)	4.83(22)	-	1400	-
SEm±	0.60	0.06	0.08	-	11.8	-
LSD (P=0.05)	0.20	0.18	0.22	-	34.7	-

Data in parentheses are original value

Application of low doses of glyphosate against *Orobanche* in mustard at the farmer's field at Hisar

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

Cooperating centres : UAS (B), OUAT, ANGRAU and RVSKVV (UAS (B), (PJTSAU and RVSKVV have not conducted the study)

OUAT, Bhubaneswar

A field trial as OFT on management of *Orobanche* in brinjal crop was initiated in vegetable tract in the farmers field of Cuttack district. Observations on the biology of *Orobanche* indicated that the emergence of the shoot takes around 49 days and there were about 5.2 shoots per a single brinjal plant on an average. The shoot of *Orobanche* grow up to a height of 14.3 cm and the shoot dries in 38 days. The parasite produces around 4500 seeds/floret and there were 40 florets per shoot. Application of neem cake 200 kg/ha at sowing fb pendimethalin 1.0 kg/ha as pre-em, 3 DAP *fb* soil drenching of metalaxyl MZ 0.2% recorded significantly the lowest number of *Orobanche* shoots/plant (9.2) at 30 DAP and thus recorded the highest *Orobanche* control efficiency (67.1%) at 30 DAP and highest yield (34.3 t/ha) next to hand weeding (34.7 t/ha). The practice of two hand weeding was observed to be the best (64.3%) at harvest. The lowest yield of 11.6 t/ha was obtained from the control plot.

WS 4.1.a. (iii) Crop: Tobacco

Cooperating centre: TNAU, AAU (A) and NDUAT (NDUAT did not submit the report)

An experiment was taken up in the farmer's field of Karikulam village, and Sathyamangalam Taluk of Erode District, where tobacco was grown as the only commercial crop during *Rabi* season. At 45 DAT, lower *Orobanche* shoot density was observed with neem cake 200 kg/ha at sowing *fb* soil drenching of metalaxyl MZ 0.2% at 20 DAP and drenching of metalaxyl MZ 0.2% at 20 DAP recorded higher leaf yield per plant (2785 g/plant). Similarly, DCA of imazethapyr at 30 g/ha on 55 DAT registered higher leaf yield of 2624 g/plant and it was followed by manual weeding at 20 days interval. Lower leaf yield of 1124 g/plant was recorded in weedy check. Studies conducted at AAU, Anand indicated that imazethapyr 30 g/ha applied on 55 DAP of tobacco caused severe phytotoxicity on tobacco leaves. The growth of plant was severely stunted and size of leaves was decreased leading to loss in yield of the crop.

Table 4.2 Herbicidal management of *Orobanche* in tobacco

Treatment	No. of *Orobanche* shoots / tobacco plant				Tobacco leaf yield (g/plant)
	45	60	90	At harvest	
Neem cake 200 kg/ha at sowing *fb* soil drenching of metalaxyl MZ 0.2% at 20 DAP	5.4	8.3	11.1	18.5	2785
Imazethapyr 30 g/ha at 40 DAP	9.6	13.1	16.0	22.0	1987
Glyphosate 0.2 g/L at 20 DAP	9.3	12.6	16.4	22.6	1865
Drenching of metalaxyl MZ 0.2% at 20 DAP	6.4	9.5	13.4	20.8	2324
Weedy check	16.5	28.2	33.3	41.5	1124

DAT - Days after transplanting

WS 4.1.b : Management of *Striga* in sugarcane

Cooperating centre: TNAU, ANGRAU and UAS (D) (UAS (D) did not conduct the study, ANGRAU did not submit the annual report)

TNAU, Coimbatore standardized weed control methods in striga as the application of atrazine as pre-em 1.0 kg/ha 3 DAP+ HW on 45 DAP *fb* earthing-up on 60 DAP *fb* post-emergence spraying of 2,4-D sodium salt at 5 g/L + urea 20 g/L on 90 DAP *fb* trash mulching 5 t/ha on 120 DAP and included in the package of practices of the state.

WS 4.1c: Management of *Cuscuta*

4.1. c. (i) Crops: Niger

Cooperating centre: OUAT and BAU

A field experiment was conducted at farmer's field to find out the efficacy of herbicide on weed dynamics, phytotoxicity and productivity of Niger crop. Application of pendimethalin (1.0 kg/ha) as pre-emergence did not show any phytotoxic effect on niger and suppressed the germination of *Cuscuta*. However imazathapyr suppressed *Cuscuta* germination and it caused phytotoxicity to niger by suppressing plant germination and growth. Similar results were obtained by the Bhubaneshwar centre with the application of imazathapyr and *Cuscuta* germination was delayed up to 18 days when applied with pendimethalin (1.0 kg/ha) as PE. The germination of *Cuscuta* was less in stale seedbed *fb* pendimethalin (1.0 kg/ha–PE) (2.0/m). Stale seedbed *fb* pendimethalin (1.0 kg/ha) as PE recorded the lowest *Cuscuta* density of 3.2/m^2 and 12.4/m^2 at 30 and 60 DAS followed by pendimethalin (1.0 kg/ha PE) (4.3 and 13.1/m^2).

4.1. c. (ii) Crop: Lucerne

Cooperating Centre: SKRAU, PJTSAU and AAU (A) (SKRAU and PJTSAU have not conducted the study)

An experiment conducted at AAU, Anand indicated that application of pendimethalin 0.50 kg/ha (sand mix) as PE showed phytotoxic effect on Lucerne. The herbicide reduced germination resulting in very poor crop stand and severely suppressed the growth and development of the plants. Only 10% plants were survived after germination in pendimethalin application. Butachlor as PE (1.5 kg/ha) and foliar spray of metalaxyl (MZ 0.2%) at 20 DAS did not control *Cuscuta*.

WS 4.1.c. (iii) Onion

Cooperating centre - UAS (D) and UAS (B)
UAS (B) has not conducted the study

WS 4.1.d: Management on *Loranthum*

Cooperating centre: KAU, UAS (B) and PJTSAU

Observations were taken two weeks after application of herbicides showed that cotton padding with 4 g copper sulphate+0.5g 2,4-D sodium salt caused drying and was observed only the branch on which the chemical padding was done. Paraquat application resulted in the drying of the weed. However, regrowth was observed after two months. Application of 1% glyphosate did not have any effect on the parasite. Application of ethrel 25 ml/L showed complete defoliation and drying of the weed and regrowth was not observed even after 8 months of application. Hence, this treatment alone was adopted for field demonstration.

WS 4.2: Making of *Parthenium* - free campus

At Anand, *Parthenium* plants were removed from experimental field of the project and nearby research area. At Jorhat, overall *Parthenium* infestation was low in the campus. Nevertheless, these plants were removed and destroyed. Now the campus is free from *Parthenium* and campus was declared as *Parthenium*-free campus. At Ranchi, efforts were made to clean the campus nearby Department of Soil Science and Agricultural Chemistry. All the *Parthenium* plants were removed from these areas. Gradually other areas will be taken to remove the *Parthenium*.

Efforts were made by Hisar center to make RRS Uchani (Karnal) campus free from the *Parthenium*. Glyphosate at 1.5-2% concentration was applied in July 2014. Remaining plants and fresh germinated plants were again sprayed in last week of August. In spite of herbicide treatment, new growth of *Parthenium* occured, which was manually uprooted before flowering. Konkan region comes under the Jurisdiction of Dapoli center. The overall *Parthenium* problem was low in this area. The inspection and awareness programme was organized for the farmers in the Kelwa, Dahanu and Palghar area of Palghar

district, where *Parthenium* incidence was observed about 6 to 8 years back, along with road sides and in some of the fields. Dapoli main campus is almost free of the *Parthenium*.

At Pantnagar, intensive efforts were made to make the campus *Parthenium* free. To support this activity, an amount of ₹ 50,000/- was contributed by the weed control group from different projects for herbicides and other expenditure.

Table 4.3 Activities carried out at Pantnagar in 2014

Month	No. of days	Places where glyphosate sprayed
March	06	Gandhi park, Agriculture college, UCO Bank, Ta Colony
April	06	Jha colony, Field Hostel, Trai Bhawan, Lal bagh, Phool Bagh centera
June	08	Badi market, field Hostel, Lal bagh, Lal bagh and Phool bagh, CABM park, Gandhi park, SBI, UCO, PNB, Gandhi park, Sahid Chowk
July	04	Hostel road, Near by stadium, Chakpheri, Jha colony, Ta colony
August	13	Field Hostel, Lal bagh, Hospital and colony, Badi market, Agriculture College, UCO Bank, Ta Colony, Jha colony, Ta Colony
September	03	Gandhi park

Entire campus of IGKV, Raipur was cleaned from *Parthenium* during 22 August, 2014 to 23 October, 2014. The efforts to uproot *Parthenium* was made taking help of administration/departments/farm services under the regular reminders/guidance and monitoring by AICRP-Weed Management. At Bhubaneswar, spraying of herbicides glyphosate, 2,4-D, metribuzin was done on emerging *Parthenium* seedlings after pre-monsoon rains when *Parthenium* germinates. Manual and mechanical cleaning was also done at OUAT campus. At PAU, efforts were made to manage *Parthenium* by spraying herbicides (glyphosate, 2,4-D, atrazine). Uprooting of *Parthenium* was done during rainy season, first from road side and community land of campus and after that from cropping areas involving agriculture students, NSS and NCC students in general and other faculty in particular. Regular watch of campus for new emerging *Parthenium* plants, and their time-to-time uprooting was done during rainy season, before onset of flowering. Spot herbicide treatment of scattered *Parthenium* plants at regular interval in the campus during summer and winter season was also followed.

At RAU, Pusa, glyphosate and 2,4-D were sprayed on emerging *Parthenium* seedlings after pre monsoon rains for making *Parthenium* free campus. In this regard, huge number of *Zygogramma bicolorata* (Coleoptera: Cyrysomilidae) were collected from natural abode and released in *Parthenium* infested areas. Uprooting of *Parthenium* during rainy season was done with the help of students, labourers and staffs of the university. At TNAU, Coimbatore, efforts were made to manage *Parthenium* in the campus. Mexican beetles were released in high *Parthenium* infested area and observations on egg, grub and adults were taken (Table 4.4). Gwalior centre did awareness programme at large scale to make people aware about the menace and management of *Parthenium*. Jorhat, Dapoli and RSS Uchani of Hisar centres were suggested to put board of " *Parthenium* free campus" at the entrance of main gate to proclaim '*Parthenium* free campus'.

Table 4.4: *Zygogramma bicolorata* infestation and *Parthenium* damage at Coimbatore

Plant no.	Number			Damage to *Parthenium* (0-5 scale)
	Egg	Grub	Adult	
1	5	4	5	3
2	6	3	6	3
3	5	5	4	3
4	5	3	7	2
5	3	5	4	3
6	4	2	7	3
7	7	4	6	2
8	5	4	6	3
9	6	5	4	2
10	7	4	5	3
Mean	5.3	3.9	5.4	3

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

All the centres except Thrissur, Bengaluru and Pantnagar were assigned the programme of biological control of water hyacinth using *Neochtina spp.* Biological control work was initiated by selecting the ponds and releasing bioagent by Anand, Assam, Ranchi, Hisar, Dapoli, Raipur, Bhubaneswar, Ludhiana, Hyderabad, Pusa and Coimbatore centres. There was no report from Sriniketan and Gwalior centres. RAU, Pusa selected two perennial ponds at

two different locations at Biraul in Darbhanga district and Pusa in Samastipur district. Weevils were released for biological control of water hyacinth. No encouraging results for effective biological control was recorded from any of the centers except Hyderabad. At Mylardevpally tank of Hyderabad where weevils were released in 2013 brought significant increase in population of weevil. The number of weevils/water hyacinth plant (based 10 plant data) during December 2013 was 3.2 weevils/plant. During September 2014, the number of weevils/water hyacinth plant (based on 10 plant data) during December 2013 was increased to 5.3 weevils/plant and the number of scars/ leaf (based 10 leaf count) 68-87 (average 76.2). At the end of 2014, most of the water hyacinth in the tank (more than 90 % of the surface area of the tank) was totally dried. Number of weevils/plant based on 10 plant average was 4.3. It was expected that soon water hyancith will collapse in this pond.

In another water tank at Pragathinagar in Hyderabad, where weevils were released in 2013, water hyacinth was completely controlled by December 2014. This early control may be due to less denisity of water hyacinth in the tank. One new tank, near University campus in Sivarampally village was selected for biological control experiment and weevils were released into this tank during December 2014. This tank was also totally infested by the water hyacinth. It was also observed that no systematic efforts were made by most of the centers to adhere on the technical programme to take the observations after release of bioagents.

Dried water hyacinth in Mylardevpally tank at Hyderabad

Release of bioagent in Sivarampally tank at Hyderabad

WS 5: Herbicide residues and environmental quality

WS 5.1: Herbicides residues in long-term herbicide trial HAU, Hisar

Chemical control of weeds is an integral part of integrated approach for weed management in numerous crops. However, the potential hazard of herbicide residue in soils and plants is a great concern to all quarters. Therefore, residues status of herbicides in soil and plant under various agro-climatic conditions was evaluated. The residues were determined in paddy crop and wheat were grown in *Kharif* and *Rabi* seasons in 2013-14 at Karnal in long-term herbicide trial. Butachlor and clodinafop residues were analyzed by GCMS/MS Triple Quadrupole. Limit of detection (LOD) and limit of quantification (LOQ) for butachlor and clodinafop were found 1.0 and 3.0 ppb and 3.0 and 9.0 ppb, respectively.

Under green manuring, the butachlor residues dissipated faster than under non-green manuring conditions. The residues were dissipated to near 82% on 30th day and 100% before 45 days under non-green manuring, whereas residues reached to 0.01 mg/kg on 30th day, thereby showed about 98% dissipation under green manuring. The half life of butachlor was found 13.3 and 9.2 days, under non-green manuring and green manuring, respectively. The clodinafop residues were dissipated near 100% on 30th day under non-green manuring and under green manuring. The half life of clodinafop was found 3.2 and 2.7 days, under non-green manuring and green manuring, respectively. Residues of butachlor and clodinafop were not detected in grains and straw.

The dehydrogenase enzyme activity was used as an indicator of biological activity using triphenyl formazon extraction method at Thrissur to find out deleterious effects of herbicides on soil health. The dehydrogenase activity was not inhibited by the application of herbicides. The lowest enzyme activity was registered by hand weeded plot. This could be due to the low organic matter content of soil in this particular treatment which was resulted from the continuous removal of weeds by hand weeding without application of organic matter. Persistence of commonly and continuously used herbicides, such as butachlor (1.5 kg/ha), anilophos (0.375 kg/ha) and pretilachlor (0.75kg/ha) to rice crop, and pendimethalin (0.75 kg/ha) and clodinafop (0.06 kg/ha) to wheat crop was studied in

Table 5.1 Residue of herbicides used in rice-wheat cropping system

Treatment dose (kg/ha)	Experimental year	Crop	Residues at 60 days (µg/g)	Herbicide residue at harvest		
				Soil	Straw	Grain
Pendimethalin	3	Wheat	0.041	BDL	BDL	BDL
Clodinafop 0.060	12	Wheat	BDL	BDL	BDL	BDL
Pretilachlor1.0	17	Rice	0.071	-	-	-
Butachlor 1.5	20	Rice	0.056	-	-	-
Anilophos 0.375	20	Rice	0.083	-	-	-
Pretilachlor1.0	20	Rice	0.049	-	-	-

BDL–Below detectable limit, pendimethalin, clodinafop, pretilachlor, butachlor, anilophos < 0.01 µg/g

Herbicide residues were determined in rice based cropping system under conservation agriculture experiments (rice-maize-cowpea) at OUAT, Bhubaneswar in sandy clay loam acidic soil which was low in available N, P and medium in available K. The pattern of persistence was found similar in both the herbicides in all the treatments. Pretilachlor and alachlor residues were not detected (LOQ= 0.01mg/kg) after 30 and 60 days of application. The crop residue increased the organic carbon content in the soil which decreases the residues rapidly. The bacterial population of the soils varied from 20.0 to 25.0 x 10^9/g soil. Addition of crop residue increased the moisture content of the soil which directly helps in microbial activity. Application of pretilachlor reduced the bacterial population by 9.0 % and 7.0 % over hand weeded treatments. Application of organic matter in the form of crop residue did help in stabilizing the bacterial population (24.2 x 10^9) and recorded an increase of 9% over the treatments without organic matter. The population of fungi varied from 69.0 to 84.2 x 10^5/g soil. Similarly, application of herbicides decreased the fungal population by 6.4% to 9.5% over hand weeded treatments and addition of crop residue enhanced the fungal population (79.2 x 10^5/g soil) by 8.4 %. The variations in fungal population due to herbicide application both in *Kharif* and *Rabi* were not significant.

Application of herbicides to *Kharif* rice reduced the urease activity by 3.6 to 10.8% over hand weeded treatment. However, phosphatase activity was increased by 4% and dehydrogenase by 20.3% to 28.3% through herbicidal applications along with crop residue. However the available nutrients status of the soils showed an increasing trend over the years in treatments with organic matter.

Soil, plant and grains samples were collected from 28th (*Rabi*, 2013-14) and 29th experiments (*Kharif*, 2014) for determination of butachlor, 2,4-D and pretilachlor residue in rice crop at Coimbatore. A progressive decline in butachlor residue content was observed with advancement of crop growth. Nearly 80% of applied pretilachlor got degraded within 30 days of its application and it was found below detectable level at harvest during *Rabi* 2013-14. The pretilachlor degradation rate was higher under 75% inorganic N source + 25% organic source treatment. Pretilachlor residue were not found in grain and straw samples of under the treatment of alternate application of butachlor / pretilachlor. More than 90% of the applied butachlor degraded from the soil within 30 days of application in both the seasons. Fifty percent of the

applied 2,4-D degraded from the soil within 15 days of its application. Continuous application of either butachlor + 2,4-D or butachlor/ pretilachlor + 2,4-D herbicide mixtures did not show build up of butachlor residues in the post harvest soil of 28th and 29th crops. Grain and straw samples were found to have below detectable level of applied herbicides.

Similarly butachlor residues in soil, grains and straw after harvest of finger millet were below the limit of quantification at recommended and double the recommended level of application at Bengaluru. Soil pH and EC were increased towards neutral by the application of FYM and BD were slightly increased over years and accompanied by decreased organic carbon. In the soil, grains and straw samples, residues were found below the limit of quantification at recommended and double the recommended level of application in transplanted rice-rice system at Kathalagere, Bengaluru. Post harvest soil samples from long-term weed control experiment on rice-wheat sequence at Palampur were collected to determine clodinafop-propargyl and isoproturon residues. Initial concentrations of clodinafop acid after its application varied from 1.54 µg/g to 1.62 µg/g which dissipated to below detectable level at 30 days. Isoproturon residues in post harvest soil, wheat straw and grains were non detectable.

WS 5.2 : Studies on herbicides persistence in water

The water samples from the tube-wells at farmers' fields were taken before transplantation/sowing of crop and after 45 days of herbicide application to analyze clodinafop, pretilachlor, butachlor and oxadiargyl residues at Hisar. For confirmation and quantification a programming was developed in Multiple Reaction Monitoring (MRM) mode on the basis of *m/z* ratio and collision energies used in SCAN and PI monitoring. It was observed that none out of nine sites were having clodinafop residues. Only two sites out of 50 were having pretilachlor residues of 0.092 and 0.066 µg/mL at village Nabipur of Karnal. No oxadiargyl residues were observed at any site out of 50 sites from were samples were taken.

Samples of water were drawn from water bodies at 0-5, 15-20 and 30-35 days after application of herbicides in nearby fields of Pantnagar. 2,4-D residues were found below detectable limits of 0.01 mg/mL in the water samples collected from different places and location in both *Rabi* and *Kharif*. The study under laboratory conditions did not show presence of herbicide residue after 30 days of application. Ground water samples were collected from tube-wells where farmers had applied pretilachlor, butachlor and anilophos in rice and clodinofop-propragyl and pendimethalin in wheat in rice-wheat cropping system near Ludhiana, Punjab. In tube well water samples, residues of pretilachlor, butachlor, clodinafop-propragyl and pendimethalin herbicides were found below detectable limit.

Water samples were collected from the cropped field bore well, pond (tail end of the area where the drained water from the rice ecosystems were collected and stored) during 3, 7 and 30 days after herbicide applications near Coimbatore to determine persistence and residue of 2,4-D, pyrazosulfuron-ethyl, butachlor, pretilachlor, pendimethalin, and bispyribac-sodium. Similarly, water samples were collected from streams, wells, pits and around Malankara rubber estate, Thodupuzha, Ernakulam district, one month after application of Roundup (glyphosate-41% SL) for estimating glyphosate residues in water near Thrissur. Glyphosate residues in water were below the detectable level at 1.0 kg/ha. The study showed that glyphosate was quickly dissipated from water.

After the herbicide treatment the residues of pyrazosulfuron-ethyl were not detected up to 22nd day in underground water collected with the help of Piezometers at Bengaluru. The residues ranged from 0.0071 to 0.0042 mg/L between 21st and 28th day, respectively, after which the residues were below the detectable level both at recommended and double the recommended level of application. A maximum of 0.0154 mg/L on 21st day and minimum of 0.23 mg/L of pyrazosulfuron-ethyl residues on 35th day were detected in the underground water. Residues of pyrazosulfuron-ethyl were found 0.065 and 0.0021 µg/g at 30 and 45 days, respectively at 25 g/ha application rate, however, 0.0204 and 0.002 µg/g residues were found at 50 g/ha applied dose in underground water under transplanted paddy at Bengaluru during summer 2014. However on 45th day it was below the limit of quantification at recommended and doubles the recommended level of application.

Water samples collected from garden land area did not show residues of any herbicides even on 3rd day after application at Coimbatore. Under submerged ecosystem, residues of herbicides were found below detectable limit on 3rd day after application irrespective of source of water except for 2,4-D, pretilachlor and butachlor in the field water. An experiment was conducted in concrete tubs of height 90 cm with an internal diameter of 78 cm having water hyacinth under controlled conditions to determine 2,4-D residues and to study the partitioning of herbicides to the soil sediments.

Dissipation of 2,4-D sodium salt was relatively rapid at both the concentrations in water and sediments. Within 3 days, more than 90% of the applied amount was degraded from the water and on day 7, the residue of 2,4-D becomes below detectable limit (0.001 ppm). The presence of water hyacinth reduced the quantity of 2,4-D that reaches the water surface and also in the soil sediment. In water, the degradation of 2,4-D was faster while in sediment, it was very slow. Butachlor residues were not detected in water samples collected at two sites near the agricultural field at Palampur after one month of herbicide spray to detect butachlor in water. In an laboratory experiment 2,4-D 95% of the applied herbicide degraded from the aquatic system within 20 days. Half life of 2,4-D was found less than 10 days. There was no effect noticed on water pH.

WS 5.3: Testing of persistence of herbicides in soil, straw and grains at farmers fields

The soil, wheat grain and straw samples were collected from farmers' fields where farmers were continuously using the pretilachlor and sulfosulfuron from many years at harvest from different rice-wheat growing regions of Haryana to determine herbicide persistence in the farmer's field. It was observed that 8 out of 17 sites were having sulfosulfuron residues in soil which were ranging between 0.015 to 0.044 µg/g in *Rabi* 2013-14. Whereas 3 out of 21 sites were having pretilachlor residues ranging between 0.016 – 0.058 µg/g. No residues of oxadiargyl were observed in soil, grain and straw samples in *Kharif* 2014 (Table 5.2).

Clodinafop-propargyl, butachlor and anilofos residue were found below the detectable limits (0.1µg/g) in sandy clay loam soil samples collected at harvest of the crop near Pantnagar at the time of harvest of wheat. At Thrissur, soil samples were collected from farmer's fields at Chithaly and Palakkad. Application of fenoxaprop, cyhalofop butyl, bispyribac sodium and penoxsulam at the recommended rate of application did not reduce the enzyme activity in the soil. The soil samples collected from metamifop treatment registered low activity enzyme compared to control. Sandy loam (deltaic alluvial soil) and rice plant samples collected from farmers' fields of Pipili and Puri districts near Bhubaneswar did not show any residues from 20 days after application of pretilachlor (0.5 kg/ha). The residue of butachlor, pretilachlor, anilophos, clodinafop-propragyl and pendimethalin in soil and crop samples were found below the detectable limit at harvest during 2013-14 at Ludhiana, Moga, and Kapurthala districts of Punjab.

Sand clay to silty clay loam soil samples from onion, rice, ragi and groundnut crops field treated with quizalofop-ethyl and imazethapyr of Bhavanisagar area near Coimbatore were collected during *Rabi* 2013-14. Soil samples were also collected at the time of harvest from the rice and ragi grown fields during *Kharif* 2014 from Thondamuthur block of Coimbatore that received bispyribac sodium, pretilachlor in rice and 2,4-D in ragi fields. Quizalofop ethyl and imazethapyr residues in soil and crop produce were found below 0.01 µg/g. The residues of bispyribac-sodium and pretilachlor were not detected in the different matrices of rice and soil. Similarly, no residues of 2,4-D was detected in ragi grain, straw and soil. This suggested that the dissipation of herbicides was faster at the initial stage of crop growth period and there may not be any accumulation in the grain or straw. Isoproturon residues were found below detectable limits in soil and wheat grain samples collected from the isoproturon treated fields of ten farmers of Mandi district at the harvest of the crop.

WS 5.4. Studies on metabolites of herbicides

Soil samples were collected from the rice grown field where 2,4-D sodium salt was applied at 0.50 kg/ha as post-emergence to control the weeds at Coimbatore. While 2,4-D acid was detected in field water up to 7 days after its application, 2,4-dichlorophenol 2,4-DCP was detected only up to 5th day after its application. Dissipation of 2,4-D acid and 2,4-DCP in field water from rice grown field followed first order reaction kinetics. A study was conducted to estimate metsulfuron-methyl and its metabolites in wheat at Palampur. Metsulfuron-methyl and its major

Table 5.2. Sulfosulfuran residues status in soil, wheat grain and straw at farmer's field in Haryana

Sr. no	Farmer name and address	Dose	Residues (µg/g)		
			Soil	Grain	Straw
1	Jashwant, Tohana	X	BDL	BDL	BDL
2	Prem, Pundari	2X	0.044	BDL	BDL
3	Satpal, Kaithal	X	BDL	BDL	BDL
4	Jagdish, Sirsa	X	BDL	BDL	BDL
5	Darya, Jind	X	0.015	BDL	BDL
6	Chatru Ram, Pundari	X	BDL	BDL	BDL
7	Satnam Singh, Sirsa	2X	0.026	BDL	BDL
8	Ramkumar, Thana	2X	0.030	BDL	BDL
9	Rohtash, Sirsa	X	BDL	BDL	BDL
10	Balbir, Kaithal	X	BDL	BDL	BDL
11	Bhan, Pundari	2X	0.025	BDL	BDL
12	Ravi, Kaithal	2X	0.030	BDL	BDL
13	Dalbir Mann, Jind	X	BDL	BDL	BDL
14	Tarsem, Hisar	X	0.015	BDL	BDL
15	Raj Singh, Gumthala	X	BDL	BDL	BDL
16	Inderjeet Singh, Kaithal	X	BDL	BDL	BDL
17	Baboo Nangla, Hisar	X	0.023	BDL	BDL

metabolites *viz.* methyl-2-sulfonyl-amino benzoate (I), 2-amino-6-methoxy-4-methyl triazine (II) and saccharin (III) were eluted at 4.06 3.22, 3.23 and 3.88 min, respectively in HPLC.

WS 5.5: Herbicide residues in conservation agriculture

Isoproturon (1.0 kg/ha) in wheat and anilofos and pendimethalin in rice (0.4 and 1.0 kg/ha) were applied which was changed in 2012-13 to clodinafop-propargyl + metsulfuron-methyl (60 g/ha) in wheat and bispyribac- sodium (20 g/ha) in rice continuously in every season in a long-term trial of rice-wheat cropping system under different tillage conditions. Clodinafop-propargyl and metsulfuron-methyl residues were found below the detectable limit (0.1 µg/g and 0.05 µg/g) at the time of harvest in soil, wheat grains and straw in both tillage and residue management techniques. Metsulfuron-methyl and bispyribac sodium residues were also below detection limit at the time of harvest in soil, rice grain and rice straw in both tillage and residue management techniques.

Pendimethalin, butachlor and pretilachlor were found below the detectable level (0.005 µg/g) in the post harvest soil, rice straw and grain irrespective of method of planting and type of tillage at Coimbatore.

WS 5.6: Herbicide residues in crops and cropping systems

Soil and rhizome samples were collected at the time of harvest for determination of metribuzin, pendimethalin, atrazine, oxyfluorfen, oxadiargyl and metsulfuron methyl residues. The residues of all the herbicides were below detectable level (BDL) in the post harvest soil. Similarly none of the herbicides analyzed were detected in the turmeric rhizome except metsulfuron-methyl. The residue of metsulfuron-methyl in the turmeric rhizome was found 0.015 ppm at harvest.

Soil samples were collected from the black gram field on 30, 60 and 90 days after the application of herbicide and analyzed for the residues of imazethapyr at Coimbatore. Residue of imazethapyr in soil samples were found below BDL (0.01 ppm) irrespective of the dose and time of application. Pendimethalin residues were persisted in the soil up to 30 days while quizalofop-ethyl was up to 15 days only (Table 5.3). After 60 days both the herbicides were found below the detection limit.

Table 5.3: Persistence of pendimethalin and quizalofop-ethyl residues in soil under cotton

DAHA	Pendimethalin (ppm)	Quizalofop-ethyl (ppm)
0	0.615	0.104
1	0.429	0.079
5	0.275	0.052
10	0.124	0.019
15	0.062	0.013
30	0.014	BDL
60	BDL	BDL
90	BDL	BDL
LOQ	0.01	0.05

The atrazine residues were detected in soil and maize plant up to 10 days under zero tillage practice and 30 days under conventional tillage practice.

WS 6.0 Transfer of technology

WS 6.1: On-farm trials

At Hisar, OFTs were conducted at 8 locations. Tembotrione at 100 g/ha as post-emergence was found very effective to control *Cyperus rotundus, Brachiaria, reptans, Commelina, Digitaria sanguanalis* and *Elusine indica* in maize crop (92%). These weeds were not controlled by the existing farmers practice of atrazine application. The new chemical was very effective for control of diverse weed flora in this crop without any phytotoxic effect on the maize crop. B:C ratio with use of tembotrione varied 4.11-6.42 against 3.11-6.44 in farmer's practice. In another OFT, bio-efficacy of ready mix combination of clodinafop + metribuzin was tested against complex weed flora in wheat at 10 locations and compared with earlier recommended herbicides i.e., mesosulfuron + iodosulfuron and sulfosulfuron + metsulfuron. On an average clodinafop + metribuzin had an edge over farmer's practice as it provided more than 87.2% control of *P. minor* as against 75.6% by use of mesosulfuron+iodosulfuron or sulfosulfuron+ metsulfuron. These molecules showed good efficacy against grassy and broadleaf weeds but with toxicity to some of varieties viz: 'PBW 550', 'HD 2967', 'HD 2891' and 'Barbat' under high moisture conditions and regeneration of *P. Minor*.

At Ludhiana, four on-farm trials were conducted in transplanted rice with penoxsulam 25g/ha at 8-10 days after transplanting, which gave effective control of annual grasses, broadleaved and sedges weeds and recorded similar rice grain yield and economic return compared to already recommended herbicides *viz.* bispyribac and pretilachlor at all locations. Similarly, four on-farm trials for the control of hardy broadleaved weeds in wheat with pre-mix of metsulfuron + carfentrazone + 0.2% NIS at 25 g/ha as post-emergence were conducted which gave effective control of all broadleaved weeds including hardy ones.

At Pantnagar, OFTs on rice and soybean were conducted at seven locations of the districts US Nagar (Tarai area), Almora (Hill area) and Nainital (Bhabar area) during *Kharif*, 2014. In Tarai region, application of herbicides, bispyribac-Na at 25 g/ha and pretilachlor 750 g/ha were found more effective against weeds in rice crop as compared to farmers practice (butachlor 1000 g/ha) and recorded highest (42%) increase in grain yield due to application of bispyribac-Na followed by pretilachlor (39.3%) and farmers practices (35.7%). Among the different weed control treatments highest gross return of ₹ 56,000/ha with B:C ratio 1.87 was obtained with application of bispyribac-Na followed by pretilachlor (₹ 54,600/ha with B:C ratio 1.76) followed by farmer's practices. Whereas, in hill region the application of pretilachlor 750 g/ha *fb* metsulfuron-methyl + chlorimuron-ethyl 4 g /ha produced highest grain yield (2.79 t/ha) with gross return of ₹ 43,204/ha and B:C ratio 1.98 followed by bispyribac-sodium with gross return of ₹ 39,130/ha and B:C ratio (1.82). Similarly, in soybean, imazethapyr (0.1kg/ha) at 15 DAS and alachlor (2.5 kg/ha), PE were used for evaluation. The highest grain yield was obtained with early post-emergence application of imazethapyr (2 t/ha) followed by pre-emergence application of alachlor (1.8 t/ha) and farmer practice (1.5 t/ha). During *Rabi* nine OFTs were conducted in the districts US Nagar, Almora and Nainital. In Tarai and Bhabar regions of Uttarakhand, application of ready mix of clodinafop-propargyl + metsulfuron-methyl (60+4 g/ha) in wheat crop was found more effective against weeds at farmer's field as compared to application of sulfosulfuron + metsulfuron-methyl (30+2g)/ha. While in Bhabar areas, application of sulfosufuron + metsulfuron methyl was found effective to control the weeds in wheat crop.

At Thrissur, OFTs were conducted at two locations. *Echinocloa crus-galli* and *E. stagnina* were the major weeds in this locality which contributed to considerable yield loss in rice. Cyhalofop-butyl was found very effective against these weeds and resulted in higher grain yields and economic benefits. At Ranchi, on-farm trials using pendimethalin at 1.0 kg/ha was conducted at five farmers field for weed management in brinjal, okra and tomato crops. The tested technology gave higher yield over farmer's practice. The mean net returns and B:C ratio were higher under chemical method as compared to farmers practice of weed control. At Anand, OFTs

were conducted at two locations showed that interculture + hand weeding carried out at 20 and 40 DAS was more effective for weed management in soybean as compared to post emergence application of quizalofop-ethyl 50 g/ha *fb* HW.

At Palampur, two OFTs using atrazine (1 kg/ha as PE) in maize and two OFTs using bispyribac-sodium (25 g/ha as POE) in rice were conducted during *Kharif* season at different locations which gave higher grain yield and B:C ratio as compared to farmer practices. similarly, two OFTs were conducted in wheat with clodinofop at 60 g/ha (POE). Application of clodinofop found better in respect to control of grassy weed and higher grain yield as compared to farmer practices. In non-crop situations, two OFTs were conducted using glyphosate for the control of *Lantana*. The *Lantana* bushes were cut in the month of August, 2014, and 10% solution of glyphosate was applied in the month of September end on regenerated plants growth. Complete control of the *lantana* was achieved by this method.

At Bhubaneswar, four OFTs were conducted on transplanted rice at Alasua, Banki villages of Cuttack districts. The maximum yield of 3.63 t/ha was recorded in the plot applied with pretilachlor 1.0 kg/ha followed by oxadiargyl 90 g/ha. A net saving of ₹ 1575 - 1650/ ha was obtained in the plots treated with herbicides. Similarly, three OFTs on groundnut were conducted in Singhberhampur, Delanga, of Puri districts during *Rabi* 2013-14. Highest yield of 2.47 t/ha was obtained with oxyfluorfen (0.05 kg/ha) applied field followed by 2.35 t/h with pendimethalin (0.5 kg/ha) treated field. The saving in weeding cost over farmers practice was in the tune of ₹ 2,000 /ha.

At Gwalior, five OFTs using imazethapyr + imazamox (80 g/ha PE) were conducted in blackgram which gave 54.4% higher yield (1.22 t/ha) as compared to farmer practices (1.03 t/ha). Similarly, two OFT were conducted in potato with metribuzin at 250 g/ha (EPoE). Application of metribuzin found effective to control weed flora and 13.8% higher tuber yield were recorded as compared to farmer practices. At Bengaluru, OFTs using bensulfuron-methyl 60g/ha + pretilachlor 600 g/ha, 3 DAP were conducted in transplanted rice in southern dry zone which gave higher yield over farmers practice. Similarly, 5 OFT on bispyribac-sodium (25g/ha) as POE gave higher yield than farmers practice of two hand weeding (20 and 40 DAP), besides saving weeding cost and time considerably at Karnataka during *Kharif*, 2014. At Dapoli, one OFT was conducted at Konde (Lanja tehsil) of Ratanagiri district in groundnut. The tested weed management technology, pendimethalin 1.5 kg/ha PE gave higher yield (1.9 t/ha) and net returns (₹ 41,500/ha) with higher B:C ratio (1.53) compared to farmer's practice of weed management.

At Faizabad, six OFTs were conducted in tobacco to control *Orobanche cernua*. Application of neem cake 200 kg/ha gave higher tobacco leaf yield (2.61 t/ha), net return (₹ 2,94,000/ha) and B:C ratio (3.84) followed by imazethapyr 30 g/ha at 55 DAP (net return ₹ 2,78,400 and B:C ratio 3.56). Similarly application of clodinafop + metsulfuron-methyl (60 g+4 g/ha) as POE or clodinafop 60 g/ha as POE *fb* one hand weeding at 45 DAS in wheat showed higher, grain yield and economic benefits, whereas in rice, application of pretilachlor 1000 g/ha as PE *fb* one hand weeding recorded higher grain yield (5.3 t/ha) with net profit of ₹ 46,000/ha. At Sriniketan, nine OFTs were carried out using bispyribac sodium and fenaxoprop in *Kharif* rice, pendimethalin in ladies finger, pendimethalin and oxyflourfen in onion, pyrazosulfuron in boro-rice nursery and pendimethalin in radish under Birbhum and Burdwan districts of West Bengal. In all the cases farmers were satisfied with improved weed management technology as these technologies were more effective in managing weeds producing higher yield and economic return as compared to existing technologies.

At Pusa, 10 OFTs were conducted using the chemical weed management technologies for rice crop in *Kharif* and wheat in *Rabi* season at different farmers field. Pretilachlor (750 g/ha) at 0-3 DAT followed by almix (4 g/ha) at 25 DAT in rice, clodinofop (60 g) + metribuzine (122.5 g/ha) at 28 DAS in wheat were found effective in term of grain yield and B:C ratio over farmers practices. At Coimbatore, five OFTs were carried out in groundnut. Pre-emergence applications of oxyflourfen (250 g/ha) followed by imazethapyr (100 g/ha) + quizalofop-ethyl (60 g/ha) as POE at 15 DAS were found effective then farmers practice in terms of broad spectrum

weed control and seed yield (3.2 t/ha) and gross and net returns were also higher (₹ 47,880-48,800/ha and ₹ 40,150-44,070/ha). Similarly five OFTs were conducted for weed control in onion using oxyflourfen at 250 g/ha on 3 DAS followed by wheel hoe weeder on 40 DAS, showed higher onion yield. Gross and net returns were also higher.

WS 6.2 Frontline demonstrations

At Ranchi, 15 FLDs were conducted in direct seeded rice in Pradhandih village of Saraikela Kharsawa, district using pretilachlor (1.0 kg/ha PE). The demonstrated technology performed better than farmers practice (one hand weeding at 25 days after sowing) and recorded higher gross return and B:C ratio (₹ 34,000 and 1.88). Similarly, 16 demonstrations were conducted for weed management in maize using atrazine 1.0 kg/ha. Under improved practice of weed control i.e., application of atrazine as PE gave higher gross return and B:C ratio (₹ 37,920 and 2.26). At Anand, two FLDs on weed management in *Kharif* maize were conducted at farmers fields. The higher grain yield and B: C ratio (1.88) were recorded with improved weed management technology over farmer's practice. At Raipur, FLDs were conducted on weed management in rice, maize and wheat in 26 tribal villages of Bastar, Kondagaon, Kanker, Dhamtari, Balod, Bilaspur, Balrampur, Korea, Sarguja and Mahasamund Districts. Front line demonstrations in transplanted rice (60), direct seeded rice (115), *Rabi* maize (65) and wheat (15) were conducted during *Kharif* and *Rabi* seasons with the help of KVK's of respective district. The overall average benefit cost ratio of recommended weed management practices were recorded higher as compared to farmer's practices.

At Bhubaneswar, 10 FLDs were carried out in the village munida and satyabadi of Puri district on transplanted rice during *Kharif* 2014. The yield increase of 21-42% was obtained with application of bispyribac-sodium at 25 g/ha at 25 DAT over farmers practice (two hand weeding). In groundnut, four FLDs were conducted at Puri district showed that application of pendimethalin 1.0 kg/ha (PE) increased yield by 21.6 - 39.4% over farmers practice. At Gwalior, 11 FLDs on weed management in wheat were conducted during *Rabi* in different locations. Clodinafop at 60 g/ha gave higher yield (3.9 t/ha). Similarly during *Kharif*, 10 FLDs were conducted in pearl millet at farmer's field. Atrazine 0.5 kg/ha PE gave higher grain yield 3.26 t/ha with highest net return ₹ 15,772/ha and B:C ratio of 2.16 as compared to farmers practice.

At Hisar, results of 35 FLDs conducted on 88 acres in different blocks of Hisar district revealed that post-emergence application of glyphosate 25 g/ha at 25 DAS followed by its repeated application at 55 DAS provided effective control (66%) of *Orobanche aegyptiaca* in mustard with yield increase of 14.6%. Ready-mix combination of pretilachlor + pyrazosulfuron was demonstrated against complex weed flora in transplanted rice at 20 locations in various parts of Haryana and compared with existing herbicide pretilachlor. A 94.2% control of complex weed flora was found with tested new herbicide against 86.8% with pretilachlor and also yield increase of 316 kg/ha.

At Bengaluru, five FLDs on each using pre-emergence and post-emergence herbicide in transplanted rice were conducted at Mandya. Pretilachlor (600 g/ha)+bensulfuron methyl (60 g/ha) as PE and bispyribac sodium (25 g/ha) as PO provided more grain yield and a saving of weeding cost compared to farmers practice of two hand weeding at 20 and 40 DAT. At Jorhat, several FLDs were conducted on weed management in boro rice and winter rice in farmers fields at different locations of Assam using recommended herbicide pretilachlor at 750 g/ha as PE followed by paddy weeder at 35 DAT. Higher average grain yield (4.3 t/ha) was recorded with 22% increase over farmers practice in all the locations. At Pantnager, 23 FLDs using herbicides for managing weeds in rice, soybean and wheat were conducted at farmers field in different locations. In rice, bispyribac-sodium 25 g/ha at 25 DAT gave broad spectrum weed control and increased mean net return with higher B: C ratio over farmer's practice.

In soybean, application of imazethapyr (0.1 kg/ha) as post-emergence produced 20% higher grain yield as compared to farmer's practice. Similarly in wheat, ready mix application of clodinafop-propargyl +metsulfuron (64 g/ha) at 30 DAS effectively controlled broad leaved weeds in all locations and increased grain yield, mean net return and B: C ratio

compared to farmer's practice. In some locations, specially hill area, 23% reduction in grain yield was recorded in farmer's practice due to uncontrolled weeds because farmers are generally using weeds as fodder for their livestock.

At Thrissur, FLD on integrated management of weedy rice was successfully conducted in rice at Kuttanad area by exhausting soil seed bank with stale seed bed technique and pre sowing herbicide application and its further addition to soil by direct contact application. Other management options like higher seed rate, scientific water management, straw burning, appropriate tillage practices, adoption of mechanized transplanting or dibbling and hand weeding also proved to be successful in the integrated approach. The weedy rice infested rice fields which yielded less than 1.25-1.50 t/ha before management could produce nearly 6.25-6.50 t/ha on adoption of the integrated management technology. The technology is getting wider adoption as it is effective in eradicating weedy rice infestation and increase the yield to sustain rice farming in Kuttanad. At Dapoli, during *Kharif* 2014, four FLDs were conducted in rice and groundnut at different locations. The recommended weed management technology oxadiargyl at 0.1 kg/ha as PE in rice and butachlor (PE) in groundnut was compared with farmers practice. On an average, improved weed management practices gave higher seed yield, economic benefit with high B:C ratio in both the crops.

At Ludhiana, thirty two demonstrations on weed control in direct seeded basmati rice with pendimethalin (750 g/ha) as PE *fb* bispyribac-sodium (25 g/ha) and azimsulfuron (20 g/ha) or fenoxaprop-p-ethyl with safener (67.5 g/ha) as POE and one spot weeding were conducted in seven districts of Punjab. All the demonstrated technologies showed effective control of mixed weed flora. Direct seeded rice recorded similar grain yield but higher net returns and B:C ratio than farmers practice (puddle transplanted rice). In *Rabi*, ten demonstrations on weed management in wheat using zero tillage sowing with residues + herbicides were conducted in seven districts. The demonstrated technologies recorded effective weed control and higher grain yield and net returns than farmers practice i.e. conventional tillage sowing + herbicides. At Palampur, five FLDs were conducted in Kangra district on transplanted rice (bispyribac-sodium 25 g/ha at 25 DAT) for the control of complex weeds. Applied herbicide effectively controlled weeds with enhanced yield and reduced cost of cultivation.

At Hyderabad, FLDs were conducted in Nalgonda, Warangal, Ranga Reddy and Mahaboobnagar districts for rice and cotton. In rice, FLDs were conducted at 10 farmer's fields in Nalgonda (1), Warangal (5), Khamman (2), Ranga Reddy (2) districts. The integrated weed management involving pre-emergence application of bensulfuron-methyl + pretilachlor *fb* one hand weeding at 35-40 DAT resulted in higher B: C ratio (1.85-2.3) as compared to farmer's practice (1.55-2.1) of hand weeding twice at 25 and 50 DAT. In cotton, FLDs were conducted at four farmer's fields in Srikakulam (2) and Ranga Reddy (2) districts. The integrated weed management involving post-emergence application of pyrithiobac sodium + propaquizafop *fb* inter cultivation resulted in higher B: C ratio (1.59-1.89) as compared to farmers practice (1.35-1.51) in Srikakulam district. Whereas in Ranga Reddy district, relatively higher B:C ratio was recorded (2.45) with herbicidal treatment as compared to farmer's practice (2.27). At Faizabad, 10 FLDs were conducted during *Rabi* 2014 in wheat with improved weed management technologies using 0.4 ha land for each FLD in Faizabad and adjoining districts. Compared to the farmers practices, yield increase ranged from 15 to 22% (average 18.5%) were recorded. Herbicidal weed control methods increased additional net return in the tune of ₹ 11,178/ha. Similarly ten demonstrations were conducted for rice during *Kharif* 2014 using bispyribac-sodium at 25 g/ha (PO). Result showed that grassy and broad leaved weeds were controlled very effectively and increased yield in the range 12.4 to 21.0% with an additional return of ₹ 5,820 to 9,200/ha (average value of ₹ 7,902/ha).

At Pusa, ten farmers were selected from Darbhanga, Madhubani, Samastipur, and Nawada districts of Bihar for FLDs during *Kharif* 2014 to demonstrate performance of pretilachlor 750 g/ha at 0-3 DAT followed by almix 4 g/ha at 25 DAT. Highest grain yield of rice (4.4 t/ha) was recorded with the demonstrated weed management technology which was 29% higher than farmer's practice. Similarly,

Table 6.1: Extension activities undertaken by coordinating centres

Centre	Trainings imparted	Radio talks	TV programmes	Kisan melas/ day	Hand-outs/ folders/ pamph-lets	Bulle-tins/ booklet	Train-ing parti-cipated	On-farm trials	Front-line demons-trations	*Parthenium* awareness day/week
PAU, Ludhiana	01	-	01	-	-	01	05	08	42	-
UAS, Bengaluru	05	-	-	-	-	01	01	05	10	-
RVSKVV, Gwalior	-	-	-	-	-	-	-	07	21	✓
GBPUAT, Pantnagar	04	15	-	-	-	-	-	16	20	-
CSKHPKV, Palampur	-	-	-	-	-	-	-	08	05	-
AAU, Jorhat	02	-	02	-		-	02	06	20	-
AAU, Anand	09	-	02	01	-	-	-	02	02	✓
TNAU, Coimbatore	-	-	-	-	-	-	01	05	20	-
NDUAT, Faizabad	03	05	-	-	-	-	-	06	20	-
VB, Sriniketa n	08	02	01	-	-	-	-	10	10	-
BAU, Ranchi	-	-	-	-	-	-	-	05	31	-
KAU, Thrissur	06	-	-	-	-	-	01	02	01	-
OUAT, Bhubaneswar	02		-	-	-		-	07	01	-
PJTSAU, Hyderabad	02	03	08	-	-	01	01	-	10	✓
CCSHAU, Hisar	13	02	01	01	-	02	01	15	55	-
RAU, Pusa	05	-	04	01	-	-	-	05	20	-
DBSKKV, Dapoli	-	-	-	-	-	-	-	01	02	✓
IGKV, Raipur	-	08	08	-	-	-	-	08	248	✓
Total	**60**	**35**	**27**	**03**	**-**	**05**	**12**	**121**	**538**	

FLDs were conducted in 10 farmers fields using clodinofop 60g + metribuzin 122.5 g/ha at 28 DAS for managing weeds in wheat in Darbhanga, Madhubani, Samastipur, Muzaffarpur, Sitamarhi and Nawada districts. Compared to farmers practice, wheat yield was 30.8% higher with clodinofop + metribuzin (4.35 t/ha). At Coimbatore, 10 FLDs were carried out in onion crop at Narasiupuram village, Thondamuthur block of Coimbatore district. Due to adoption of improved weed management technology (oxyflourfen 250 g/ha PE on 3 DAS + weeding with twin wheel hoe at 40 DAS), average onion yields increased by 18.3 to 25.5% higher over farmers practice (two hand weeding). The highest income also obtained in improved practice over farmers practice. Majority of the farmers (70%) were fully satisfied with the performance of improved weed management technology.

4. RECOMMENDATIONS FOR PACKAGE OF PRACTICES

AAU, Jorhat

Direct-seeded upland rice: Application of pre-emergence herbicide pretilachlor (750 g/ha) followed by working with grubber at 30 days after sowing for control of broad leave weeds and annual grasses.

Management of *Ipomoea carnea:* Spraying of glyphosate (1.5 kg/ha) + 2,4-D amine salt (0.75 kg/ha) as tank-mix with a spray volume of 500-600 l/ha at active growing stage was found effective to control *Ipomoea carnea*.

BAU, Ranchi

Turmeric: Application of metribuzin 0.7 kg/ha *fb* two hoeings reduced weed dry matter accumulation similar to hand weedings at 30 and 60 DAS and produced maximum net returns and B:C ratio.

Long-term trial on tillage in different cropping systems: Zero tillage in rice followed by conventional tillage in wheat produced maximum grain and straw yield and higher net returns and B:C ratio.

Weed management in conservation agriculture systems: Maize crop sown as zero tillage produced grain yield similar to conventional tillage. Inter-cropping blackgram with maize in 1:2 row ratio can be practiced to achieve weed control through smothering effect similar to application of atrazine 1.0 kg/ha as pre-emergence.

Management of *Cuscuta* in niger: Application of pendimethalin (1.0 kg/ha) is recommended to reduce appearence of *Cuscuta* in niger.

IGKV, Raipur

Wheat: Combinations of sulfosulfuron + metribuzin (25 + 105 g/ha) and clodinafop + metribuzin (60 + 105 g/ha) were effective herbicides for the control of mixed weed flora in wheat.

Wheat: Combinations of pinoxaden + carfentrazone (50+20 g/ha) and pinoxaden + metsulfuron (50 + 4 g/ha) were effective herbicides for the control of mixed weed flora in wheat.

KAU, Thrissur

Dry-seeded rice: Spray any one of the pre-emergence herbicides such as, butachlor (1.25 kg/ha), oxyfluorfen (0.15 kg/ha), pendimethalin (1.50 kg/ha), pretilachlor (0.75 kg/ha) on the same day of seeding or within six days of seeding in dry-seeded rice to control *Ludwigia parviflora*.

Wet-seeded rice (direct seeding with sprouted seeds under puddled conditions): Spray any of the following herbicides to control *Echinochloa* sp. in wet seeded rice.

(a) Butachlor 1.25 kg/ha 6-9 DAS

(b) Pretilachlor + safener 0.45 kg/ha at 3-5 DAS. Give a follow up application of 2,4-D 0.8 kg/ha at 20 DAS.

(c) Pretilachlor 0.45 kg/ha at 3-4 DAS and one light hand weeding at 28 DAS for wet-sown rice in kole land.

(d) Cyhalofop-butyl 0.08 kg/ha at 15-18 DAS.

Transplanted rice:

For controlling broadleaved weeds and sedges-2, 4-D sodium salt may be applied at 1.0 kg/ha on 25 DAT.

Pre-emergence application of 2, 4-D sodium at 0.8 kg/ha on 5 DAT can control all the three groups of weeds, *viz.* grasses, sedges and broadleaved weeds.

Almix (chlorimuron-ethyl+metsulfuron-methyl 4 g/ha+ 0.2% surfactant at 20-25 DAS/DAT is equally effective as 2,4-D for controlling sedges and broadleaved weeds in rice fields. This combination is effective for controlling *Marsilia quadrifolia* also. Almix can be given as follow-up application to cyhalofop-butyl used for the control of grass weeds with a minimum of one-day gap between the applications.

Fenoxaprop-p-ethyl 60 g/ha, azimsulfuron 35 g/ha and penoxsulam 25 g/ha at 2-4 leaf stage are

effective against *Echinochloa crus-galli*. Penoxsulam and azimsulfuron are effective against dicots and sedges.

Pineapple: Pre-emergence spray of diuron (1.0 kg/ha) in 600 litres of water can keep the field free of weeds for about four months. For subsequent weed control, herbicide application may be repeated. For controlling *Mikania micrantha*, spot application of diuron can be adopted. Spraying should be done in moist soil, but avoid rainy periods. Weeds in interspaces can be controlled by spraying glyphosate (0.8 kg/ha) taking extra care that the herbicide does not fall on pineapple plant.

Banana: During early stages, complete control of weeds could be obtained by raising cowpea in the interspaces. In gardens, pre-emergence application of diuron (1.5 kg/ha) or oxyfluorfen (0.2 kg/ha) is effective. Weeds emerging later can be controlled by the application of glyphosate (0.4 kg/ha). If hand weeding is resorted to, give 4-5 surface diggings depending on weed growth. Avoid deep digging. Do not disturb soil after plants start producing bunches. If green manure crop is grown, weeding operations can be reduced to 1-2 diggings.

***Loranthus*:** Spraying ethrel (25 ml/L) on *Loranthus* leaves is effective to control its growth. In case of regrowth, padding with 2,4-D 1 g/20 ml water on major attachment points is recommended.

OUAT, Bhubaneswar

Groundnut: Pre-emergence application of oxyfluorfen (0.02 kg/ha) in 500 litre of water at 1-2 DAS is recommended to control grassy weeds and *Celosia argentea*. For control of grassy weeds, application of quizalofop-ethyl (0.05 kg/ha) in 500 litres of water at 20-25 DAS can also be made.

Jute: Post-emergence application of quizalofop-ethyl 0.05 kg/ha at 21 days crop stage along with one hand weeding at 6 week stage is the best weed management schedule. It reduces the cost of weeding by ₹ 2400/ha.

Rice-rice cropping system: Pre-emergence application of pretilachlor (0.75 kg/ha) 2 DAP in *Kharif* rice and butachlor (1.25 kg/ha) + Almix (4g/ha) at 3 DAP in *Rabi* rice is recommended for control of mixed weed flora.

Rice-groundnut cropping system: Butachlor 0.75 kg/ha + 2,4 DEE 0.4 kg/ha (4 DAS) in *Kharif* and alachlor 1.0 kg/ha (2 DAS) + hoeing at 35 DAS in *Rabi* groundnut is recommended for control of mixed weed flora.

PAU, Ludhiana

Wheat: Post-emergence application of a pre-mix of metsulfuron + carfentrazone 25 g/ha effectively controls all kinds of broadleaved weeds.

Control of aerobic grasses in direct-seeded rice: Direct-seeded rice is infested with aerobic grasses which pose heavy competition with the crop. Herbicide mixture fenoxaprop + safener at 67.0 g/ha applied at 20 days after sowing in 375 litres of water was effective to control of *Dactyloctenum aegyptiacum*, *Leptochloa* sp. and *Eragrostis* sp.

Control of mixed-weed flora in transplanted rice: Early post-emergence (10-12 DAT) application of penoxsulam (25 g/ha) in 375 litres of water provided effective control of mixed weed flora including grasses, broadleaf and sedges weeds in transplanted rice.

Control of aerobic grasses in transplanted rice: In puddled transplanted rice, hardy grass weeds including *Leptochloa* sp., *Ischaemum rugosum* along with *Echinochloa* sp. can be controlled by fenoxaprop + safener 67.0 g/ha applied at 20 DAT.

Weed control in autumn sugarcane-wheat intercropping system: Post-emergence application of sulfosulfuron 25 g/ha, metsulfuron 5 g/ha, sulfosulfuron + metsulfuron 30 g/ha, pinoxaden 50 g/ha, mesosulfuron + iodosulfuron 14.4 g/ha and carfentrazone-ethyl 20 g/ha in 375 litres of water at 30-35 days after intercropping wheat in sugarcane is recommended for effective control of annual weed flora.

TNAU, Coimbatore

Rice in conservation agriculture system: Conventional tillage method (disc ploughing with 2

times cage wheel puddling) with integrated weed management methods (transplanted rice-pre-emergence application of butachlor (1.0 kg/ha) for first season and pre-emergence application of pretilachlor (1.0 kg/ha) for second season are recommended. In direct-seeded rice - PE of pretilachlor (S) 0.45 kg/ha + mechanical weeding at 35 to 40 DAS/T+ intercrop with sabania incorporated at 35 to 40 DAS/T) is recommended higher grain yield of transplanted and direct-seeded rice.

UAS, Bengaluru

Transplanted rice: Post-emergence application of bispyribac-sodium (20 g/ha) at 20 DAP is recommended for southern transition zone of Karnataka in transplanted rice.

Transplanted onion: Post-emergence application of quizalofop-p-ethyl (37.5 g/ha) or fenoxaprop-p-ethyl (67.5 g/ha) at 15-20 DAP is recommended for central dry and eastern dry zones of Karnataka.

Groundnut: Post-emergence application of quizalofop-p-ethyl (37.5 g/ha) for control of grassy weeds at 15-20 DAP or post-emergence herbicide imazethapyr (125 g/ha) at 15-20 DAP for broad-spectrum control of weeds are recommended for central dry and eastern dry zones of Karnataka.

VB, Sriniketan

Conventional tillage (CT) integrated with pyrazosulfuron-ethyl + mechanical weeding in transplanted rice, CT/ZT integrated with pendimethalin in mustard and CT/CT/ZT or CT/CT/ZT integrated with pendimethalin in greengram are recommended.

5. TRIBAL SUB PLAN PROGRAMME

AAU, Anand

In the year 2014-15, Dahod district was chosen to distribute weed management inputs i.e., ASPEE Bakpak sprayer, plastic pumps, hand hoe *Dharti* brand, spray nozzles XL-54 and spray nozzles FFP/95/900. Forty farmers for spray pumps and 94 farmers for hand hoe were selected. Herbicide spraying Nozzles were distributed to all farmers who have participated in group meeting at village level. Selection and distribution of inputs was carried out in collaboration of KVK, Dahod and Tribal Women Farmer Training Centre, Devgadh Baria (Dahod district). Collection of land records and Election Voters Card of each beneficiary was completed.

In tribal area, programme on weed management were conducted and folders, leaflets and booklets of weed management technologies were distributed in each programme. On-farm trial (OFT) was also conducted in Dahod district. Special lectures were delivered by the scientists of the project in farmer's day and meeting organized by KVK, Dahod and KVK, Devgadh Baria in tribal's.

Training and distribution of inputs to tribal farmers

AAU, Jorhat

Frontline demonstrations on weed management in winter rice were conducted at Topatoli, Kamrup rural districts and Sidhabari under Mariani district, where 20 farmers participated. Inputs were distributed individually to the participating farmers well in time. A hands on training was organized in each location and the participating farmers were trained on " Weed management in *sali* rice" including demonstration on application technique of herbicide in transplanted rice. The highest grain yield of 46.3 q/ha was recorded in the farmer field in Kamrup rural district. The average grain yield over all locations was found to be 38.4 q/ha which was about 20% higher than the maximum average yield of the locations. A field day was also organized in each location. About 65 farmers attended and participated the field day at Topatoli. At Sidhabari, and Marigaon districts, 82 farmers attended the field day.

BAU, Ranchi

A fruit based land use system was developed to acquaint farmers about improved method of orchard development, introduced intercropping in orchard to utilize interspace for cultivation of field crops, suppress weeds by intercropping in newly developed orchard and to evaluate the economics of farmers.

A comprehensive plan for alternative use of land by developing orchard at five tribal farmers of Ranchi district was selected. Based on land situation lay out plan was developed in the month of April and May of 2014. As soon as monsoon started 200 plants to each farmer were transported and planted by showing the

Planting of mango saplings

correct method of planting. The plants are now settled and appears healthy.

CSKHPKV, Palampur

Five trainings programmes were conducted in different villages *viz.*, Leo, Nesang, Nako, Gunehar and Jhikali Bhet of the tribal district and more than five hundred farmers were made aware of the losses being caused by the weeds in commercial crops, field crops as well as in grasslands/pastures. Provided package of practices to the farmers for *Rabi* and comprising of four bookets on weed management in wheat, rice, potato and maize. Farmers were also provided knapsack sprayers and hand tools for weed management.

TSP activities at Palampur Centre

OUAT, Bhubaneswar

Tribal sub plan programme was initiated in the two tribal dominated villages of Sundargarh and Keonjhar districts for the overall development of tribal livelihood by supplying different farm machineries implements and agricultural inputs. About 225 farmers were directly benefited under this programme.

IGKV, Raipur

In an area of 248 acres, front line demonstrations on weed management in rice were laid down in 28 tribal villages in districts of Bastar, Kondagaon and kanker, Bilaspur, Balrampur and Mahasamund. Of vital, 90 demonstrations were taken on puddled rice and 158 demonstrations were laid down in direct seeded line sown rice with the help of KVKs, Raipur. An average increase of 15.8 % in benefit :cost ratio was obtained due to recommended practice over farmers practice in rice established either direct line seeded or puddled rice. Training on weed management and distribution of inputs such as herbicides, seeds, flat fan nozzles, fertilizers were also provided to the participating farmers before the conduction of FLDs.

DBSKKV, Dapoli

Tribal sub-plan programme was implemented in two villages in Sakri Tahsil of Dhule district in Maharashtra by selecting 106 farmers beneficiaries. The awareness programme regarding the use of pre and post-emergence herbicides, along with application, time of application, calibration of sprayer, maintenance of spray pumps etc. was conducted. Tools like weeder, toothed spades, weeding hook, spray pumps and herbicides were distributed. Along with farmers beneficiaries Gramsevak and Sarpanch and progressive farmers from Amba Pada, Kudashi, Sakri, and Mahalyacha Pada Kudashi Sakri villages were actively participated in the programme. About 250 farmers from two villages were participated for one day awareness programme on weed management.

TSP activities at Dapoli centre

RVSKVV, Gwalior

Fifteen FLDs each on soybean and maize were conducted on weed management practices under TSP programme during *Kharif* 2014. Demonstration of soybean and maize were conducted each in 1 acre (0.4 ha) area. Soybean demonstrations were conducted in Bisoli (Jhabua block) and Mokampura (Rama block), while maize demonstrations were conducted in Mokampura (Rama block), Bisoli (Jhabua block) and Amba (Rama block) villages. Inputs like seed, herbicides were provided to these farmers.

Average yield in the demonstration plots of soybean was 1538 kg/ha while in farmer's field average yields was 1123 kg/ha. Yield in demonstration plots were higher by 37.0% as compared to farmer's field. Average yield in the demonstration plots of maize were 2967 kg/ha while in farmer's field average yield was 2073 kg/ha. Yield in demonstration plot was higher by 43.3% as compared to farmer's field. Average B:C ratio generated in FLDs was 2.01 as against 1.50 in farmer's practices.

6. LINKAGES AND COLLABORATION BETWEEN AICRP-WM AND AICRP-IFS

IGKV, Raipur

Integrated nutrient supply in rice-wheat cropping system

Experimental field was dominated by *Alternanthera triandra, Spilanthes acmella, Cynotis axillaris, Cyperus iria, Fimbristylis miliacea* and *Echinochloa colona* at 60 DAT and harvest during *Kharif* 2014. The significantly lowest weed dry matter was recorded under treatment 50% RDF + 50% N (GM) which was comparable with 100% RDF, 50% RDF + 50% N (FYM) and 75% RDF + 25% N (GM). Weed control efficiency at harvest stage was maximum under 50% RDF + 50% N (GM) (44.91%), narrowly followed by 100% RDF treatment (Table 1).

Table 1. Effect of integrated nutrient supply in rice-wheat cropping system on weed dry matter accumulation at 60 DAT and at harvest and weed control efficiency, *Kharif* 2014

Treatments	Weed dry matter (g/m^2)		Weed control efficiency at harvest (%)
	60 DAT	At harvest	
No fertilizer, No OM (Control)	5.06 (25.2) *	5.81 (33.4)	-
50% RDF	4.83 (22.9)	5.44 (29.2)	12.5
50% RDF	4.58 (20.6)	5.19 (26.5)	20.6
75% RDF	4.47 (19.5)	5.05 (25.0)	25.1
100% RDF	3.98 (15.4)	4.49 (19.8)	43.1
50% RDF + 50% N (FYM)	4.12 (16.6)	4.62 (21.0)	37.1
75% RDF + 25% N (FYM)	4.25 (17.6)	4.84 (23.0)	31.1
50% RDF + 50% N (RS)	4.49 (19.7)	5.03 (25.0)	25.1
75% RDF + 25% N (RS)	4.4 (18.9)	4.96 (25.1)	24.8
50% RDF + 50% N (GM)	3.8 (14.1)	4.34 (18.4)	44.9
75% RDF + 25% N (GM)	4.12 (16.5)	4.69 (21.6)	35.3
FP 50:30:20 N:P:K kg/ha	4.91 (23.7)	5.54 (30.3)	9.28
SEm±	0.13	0.14	-
LSD (P= 0.05)	0.39	0.43	

*Figures in the parentheses are original values; data were transformed through $\sqrt{x + 0.5}$

High - value cropping system in organic farming (rice-onion cropping system)

Transplanted rice

Experimental field was dominated by *Alternanthera triandra, Monochoria vaginalis, Cyanotis axillaris, Commelina benghalensis, Cyperus iria, Fimbristylis miliacea, Echinochloa colona* and *Ischaemum rugosum* at 60 DAT and harvest during *Kharif* 2014. The lowest weed dry matter was recorded under 100% N ($1/3^{rd}$ each CDM + NC + EC) + GM in rice, which was comparable with 100% RDF, and 100% N ($1/3^{rd}$ each CDM + NC + EC) + deep summer ploughing (DSP). At harvest variation in weed dry matter was not found significant (Table 2). Weed control efficiency at harvest stage was maximum under 100% N ($1/3^{rd}$ each CDM + NC + EC) + GM in rice narrowly followed by 100% RDF treatment.

Table 2. Effect of high value cropping system in organic farming package on weed dry matter accumulation at 60 DAT and at harvest and weed control efficiency, *Kharif* 2014

Treatment	Weed dry matter (g/m^2)*		Weed control efficiency at harvest (%)
	60 DAT	At harvest	
50% RDF + 50% N (CDM)	4.55 (20.2)	5.17 (26.3)	5.05
100% N (1/3rd each CDM + NC + EC)	4.71 (21.7)	5.31 (27.7)	-
100% N (1/3rd each CDM + NC + EC) + GM in rice	4.12 (16.6)	4.87 (23.7)	14.44
100% N (1/3rd each CDM + NC + EC) + deep summer ploughing (DSP)	4.40 (19.0)	4.94 (24.2)	12.63
50% N (CDM) + *Azospirillium* + P+ PSB	4.84 (23.1)	5.28 (27.5)	7.22
100% N (1/3rd each CDM + NC + EC) + *Azospirillium* + PSB	4.57 (20.4)	5.08 (25.1)	9.38
100% RDF	4.27 (17.9)	4.93 (24.1)	13.0
SEm±	0.105	0.212	-
LSD (P= 0.05)	0.32	N.S.	-

*Figures in the parentheses are original values; data were transformed through $\sqrt{x + 0.5}$

TNAU, Coimbatore

Study of weed dynamics in integrated farming system in irrigated upland

The integrated farming system was imposed in an area of 1.02 ha with the 1) cowpea (veg.) - cotton - sunflower, 2) Bhendi - maize + cowpea (F) – sunflower 3) GM - chillies -maize 4) Maize –cowpea (grain) – tomato/radish 5) Perennial fodder grass + Desmanthus (3:1) cropping systems in order to study the system productivity and the weed dynamics.

Cropping system - I (cowpea (veg.) - cotton - sunflower)

For weed management, pendimethalin 1 kg/ha was applied and hand weeding was carried out on 35 DAS. Major weed species were *Dactyloctenium aegyptium, Dinebra retroflexa, Echinochloa colona, Chloris barbata, Cyperus rotundus, Trianthema portulacastrum, Digera arvensis, Portulaca quadrifida, Euphorbia prostrata* and *Parthenium hysterophorus*. In general, broad leaved weeds (BLW) were dominated in cowpea field at 30 and 60 DAS and at harvest. The relative density of BLW was 60, 60.8 and 65.4 percent at 30, 60 DAS and at harvest. Among the BLW, higher relative density was observed with *Trianthema portulacastrum* (33.3%) and was followed by *Digeria arvensis* (16. 6%) at 30 DAS and the same trend was observed in 60 DAS and at harvest. Among the grassy weeds, *Dactyloctenium aegyptium* recorded higher relative density. At all the stages of observation weed dry weight was higher in BLW and was followed by grasses. Cowpea yield was 550 kg / 0.25 ha from the system productivity. Broad leaved weeds dominated in cotton field at 30 DAS with a relative density of 64.2%. *Amaranthus viridis* (21.4%) recorded higher relative density followed by *T. portulacastrum* (17.8%). Among the grassy weeds, *Dactyloctenium aegyptium* recorded higher relative density (10.71 %). Weed dry weight was higher in BLW (12.8 g/m^2)

Cropping system-II (bhendi - maize + cowpea (F) – sunflower)

Bhendi crop was raised without herbicide application. Hand weeding was practiced to manage the weeds. Predominant weeds observed in the bhendi field were *Dinebra retroflexa, Dactyloctenium aegyptium, Chloris barbata* under grasses, *Cyperus rotundus* was the only sedge observed and *Amaranthus polygamus, Trianthema protulacastrum, Digera arvensis, Euphorbia prostrata, Parthenium hysterophorus, Corchorus olitorius* under BLW.

Broad leaved weeds dominated with higher relative density of 55% with higher dry weight (14.6 g/ha) at 30 DAS, followed by grassy weeds (relative density - 40% and dry weight - 6.3 g/ha). Among the broad leaved weeds, *Amaranthus polygamus* was dominant and was followed by

Trianthema portulacastrum at 30, 60 DAS and at harvest. From the cropping system of bhendi - maize + cowpea (F) – sunflower, bhendi yield was found 365 kg / 0.20 ha from the system productivity.

Maize + cowpea

After harvesting bhendi crop, maize + cowpea were raised. To manage the weeds, pendimethalin 1.0 kg/ha was applied as pre emergence. At 30 DAS, among broad leaved weeds, *Amaranthus polygamus* recorded higher relative density (26.3%). Grassy weed *Dinebra retroflexa* dominated among the grassy weeds with a relative density of 15.7%. Among the group of weeds, the relative density of BLW was higher (57.8%) and was followed by grasses (36.8%).

System -III (GM - chillies –maize)

Chillies was raised without herbicide application. Major weed species were *Dactyloctenium aegyptium, Echinochloa colona, Chloris barbata, Cyperus rotundus, Trianthema protulacastrum, Digera arvensis, Amaranthus spinosus, Portulaca quadrifida* and *Parthenium hysterophorus*. In chillies, *Amaranthus viridis* was the dominating BLW at all the stages of observation and was followed by another BLW *Trianthima portulacastrum*. Among the grass weeds, *Dinebra retroflexa* was the dominating weed. The dry weight of BLW was higher than grasses and sedges. From the cropping system of GM - chillies – maize, chillies yield was found 128 kg/0.20 ha from the system productivity.

System -IV (maize – cowpea (grain) – tomato/radish

Maize crop was applied with atrazine 0.25 kg/ha as pre-emergence. Predominant weeds in the fields were *Dinebra retroflexa, Dactyloctenium aegyptium* under grasses, *Cyperus rotundus, Trianthema protulacastrum, Amaranthus viridis, Portulaca quadrifida, Parthenium hysterophorus* and *Corchorus olitorius. Amaranthus viridis* (relative density of 23.8, 23.3 and 21% at 30, 60 DAS and at harvest) was the dominant BLW irrespective of the stage of observation. *Trianthema portulacastrum* was the next dominant BLW in the maize field. Among the group of weeds, BLW followed by grasses was in order for having higher relative density. Broad leaved weeds recorded higher weed dry weight than grasses and sedge at all the stages of observation.

System V (perennial fodder grass + *Desmanthus* (3:1))

Cumbu Napier (CN) as grass and *Desmanthus* as legume fodder were raised. Major weed species in the field were *Dinebra retroflexa, Dactyloctenium aegyptium, Chloris barbata, Cyperus rotundus, Amaranthus spinous, Trianthema protulacastrum* and *Parthenium hysterophorus*. Weed density in fodder grass was lower due to profuse growth of grasses. The relative density of BLW was higher at all the stages of observation. *Amaranthus viridis* was the dominating weed and was followed by *Trianthema protulacastrum* and *Dactyloctenium aegyptium*. With the advance in the age of the crop, weed dry weight reduced. From the intercropping of perennial fodder grass + *Desmanthus* with the ratio of 3:1 in an area of 0.17 ha yield of 5028 kg/ha of cumbu napier and 954 kg/ha of *Desmanthus* were obtained.

UAS, Bengaluru

Field visits to on farm research center at Kolar district under AICRP on integrated farming system and interaction with farmers during site visits was made. It was decided that integrated weed management practices for cereals and vegetables will be adopted for experiment conducted on "Response of plant nutrients in predominant cropping systems". For experiments under IFS conducted under both innovative approach and holistic approach, the different enterprises and activities of small and marginal farmers were examined and agreed to provide different weeds biomass suitable for recycling through vermi-composting. A collaboration of AICRP-WM and AICRP-IFS on training and demonstration of integrated weed management in vegetable crops and pre-and post-emergent herbicide sprays for aerobic rice will also be done in future.

AAU, Anand

Capacity building for the AICRP-IFS staff in weed management

One day training programme on weed management was collaboratively organized by AICRP-WM Anand Centre, and AICRP-IFS, Sardarkrushinagar for the scientists of AICRP-IFS on "Strengthening

experiments of AICRP on IFS". Different methods of weed management and utilization of weeds for vermicompost and mulch was presented.

CSKHPKV, Palampur

Integrated nutrient management in rice-wheat cropping system

Wheat

All weed species in wheat did not influence to a significant level at 90 DAS of wheat except *Polygonum sp.* (Table 3). Total dry weight of weed at 90 DAS of wheat was significantly higher with 75% NPK+25% N through FYM treatment and minimum in control. Similarly, significantly highest total dry weight of weeds in wheat was recorded with 75% NPK treatment remaining at par with 50% NPK + 50% N through green manure and 75% NPK +25% N through green manure treatment.

Rice

Weeds *Monochoria vaginalis, Ammannia baccifera, Cyperus* sp. *viz. Eleocharis* sp. dominated in rice at 60 DAT. Minimum weed dry weight was recorded with 75%NPK+50%NPK through green manure treatment at 60 DAT. Significantly, the highest dry weight of weed at harvest was recorded with control (No fertilizer, no manures) and highest with 50% NPK + 50% N through farm yard manure treatment. However, no trend was observed with respect to total dry weight of weed due to different treatments.

Identification of need-based cropping system for different climate conditions

The dominant weed species were *Commelina benghalensis, Echinochloa* sp. and other weeds. Different treatments did not influence the weed density of weed.

Table 3. Effect of treatments on total dry weight (g/m^2) in rice during *Kharif* 2014

Treatment		Total dry weight (g/m^2)	
Kharif	Rabi	60 DAT	At harvest
Control (No fertilizer, no manures)	Control (no fertilizers, no manures)	179.4	216.78
50% NPK	50% NPK	296.4	306.19
50% NPK	100% NPK	103.3	213.55
75% NPK	75% NPK	175.5	230.66
100% NPK	100% NPK	184.2	270.56
50% NPK + 50% N through farm yard manure	100% NPK	224.0	420.77
75% NPK + 25% N through farm yard manure	75% NPK	269.4	250.50
50% NPK + 50% N through wheat straw	100% NPK	246.7	701.46
75% NPK + 25% N through wheat straw	75% NPK	313.5	335.49
50% NPK + 50% N through green manure	100% NPK	210.2	288.38
75% NPK + 50% N through green manure	75% NPK	72.8	327.55
Farmers' Practice	Farmers' practice	231.3	312.43
SEm±		30.0	39.4
LSD (P=0.05)		85.5	112.3

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Summary of publications

Centres	Research paper	Popular articles	Paper presented in seminars/ symposia/ conferences	Books	Book chapter	Lectures delivered during training	Students guided	
							M.Sc	Ph.D
PAU, Ludhiana	09	10	11	-	-	21	09	02
UAS, Bengaluru	03	09	17	-	-	-	06	-
RVSKVV, Gwalior	03	-	17	-	-	-	02	-
GBPUAT, Pantnagar	06	08	26	-	-	16	05	05
CSKHPKV, Palampur	07	-	03	-	-	18	02	-
AAU, Jorhat	03	01	04	-	-	03	03	03
AAU, Anand	02	02	05	-	-	13	-	-
TNAU, Coimbatore	07	-	08	01	-	05	04	01
NDUAT, Faizabad	02	02	09	-	-	-	-	-
VB, Sriniketan	-	-	05	-	-	-	-	-
BAU, Ranchi	05	-	06	-	-	-	-	-
KAU, Thrissur	02	-	01	-	-	-	06	01
OUAT, Bhubaneswar	02	01	03	-	-	-	01	-
PJTSAU, Hyderabad	07	02	15	-	02	03	05	03
CCSHAU, Hisar	03	-	19	-	-	36	02	02
RAU, Pusa	-	01	05	01	-	-	-	-
DBSKKV, Dapoli	-	-	-	-	-	-	03	-
IGKV, Raipur	02	01	12	-	-	-	-	-
Total	**63**	**37**	**166**	**02**	**02**	**115**	**48**	**17**

8. AWARDS / RECOGNITIONS

KAU, Thrissur

Dr. C.T. Abraham was awarded CWSS Gold medal of the Crop and Weed Science Society for the year 2014.

GBPUAT, Pantnagar

Dr. V. Pratap Singh awarded ISWS *Gold Medal Award* (2012) of ISWS during Biennial Conference of ISWS held at DWR, Jabalpur from 15-17 February, 2014.

PJTSAU, Hyderabad

Dr. T. Ramprakash received the "Meritorious Research Scientist Award of Acharya N.G. Ranga Agricultural University" in recognition of his contributions as Research Scientist on 20-3-2014.

Dr. T. Ramprakash received the "Fellowship Award" by the Society for Scientific Development in Agriculture and Technology in National conference on "Emerging problems and recent trends in applied sciences" Meerut, Uttar Pradesh during 8-9 February 2014.

CCSHAU, Hisar

'Best AICRP-WM Centre Award' was given to CCSHAU, Hisar Centre for significant achievements in weed management during XXI Annual Review Meeting of AICRP-WM from 12-14 February, 2014 at DWR, Jabalpur.

TNAU, Coimbatore

Dr. N.K. Prabhakaran received appreciation certificate for 25 years of service in TNAU on the occasion of 44th Foundation Day of TNAU held on 1.7.2014.

9. RECOMMENDATIONS OF AICRP-WM ANNUAL REVIEW MEETING

Recommendations of Annual Review Meeting of All India Coordinated Research Project on Weed Management held at Directorate of Weed Research, Jabalpur (Madhya Pradesh) during 12-14 February, 2014 are given below:

1. The recommendations of QRT and RAC should be complied seriously.
2. Information generated over the years on weed survey and surveillance is required to be compiled, documented and uploaded in the DWR website before the next Review Meeting.
3. Benchmark survey must be done before starting weed survey/surveillance programme in a particular location.
4. Biology and management of five major weeds of crop and non-crop situations should be documented.
5. Services of statistician at DWR may be utilized for data analysis and drawing inferences.
6. Herbicide residue work through bioassay should be avoided.
7. Station trials proposed by the centres should also be discussed in the review meeting.
8. Yield levels in some trials are not up to accepted levels, which should not be reported.
9. Weed management in organic farming systems should be given less priority as per the recommendation of RAC.
10. Weed management in vegetable, horticulture and plantation crops should receive priority.
11. The experiment on conservation agriculture needs more refinement, mechanical weeding as a component of IWM should be made as manual weeding.
12. It was noted that a common format for economic analysis of the experiments is still not being followed by the Centres. Dr. P.K. Singh, Nodal Officer was requested to prepare a uniform methodology for economic analysis in consultation with economists at JNKVV.
13. All the Coordinating Centres will compile data on herbicides consumption in their respective states and provide the information to the Coordinating Unit.
14. Annual report of most centres is not prepared as per the prescribed format. Detailed guidelines in this regard will be refined further.
15. PIs should give information on contract research trials pertaining to herbicide testing and resource generation in the Annual Report.
16. It was emphasized to improve data analysis and annual report for some of the centres.
17. Action taken report on the previous ARM should be included in the Annual Report of the Centre.
18. Centres should timely send the information required for RFD.
19. Inspite of providing guidelines, the presentation of most centres was not up to the mark.
20. From next year the number of slides to be presented for every centre should not exceed 10 slides per scientist per centre for timely conclusion of all the technical sessions so that sufficient time is available for discussion. While making presentation in the Review Meeting, only the salient findings need to be presented and that too be discussed with reasons. The results should be synthesized before presentation.
21. All the centres should publish quality research papers in reputed journals.
22. Monitoring of Coordinating centres is lacking in AICRP-WM, which should be made more

effective. Performance of the centres will be judged based on the reports of the monitoring teams, implementation of approved technical programme, quality of data in the Annual Report, presentation made in the AGM, research publications, OFTs/FLDs conducted, timely submission of AUC, staff position, expenditure statement and other information sought by the HQ, budget utilization, extension activities, awards / recognitions etc.

23. Coordinating centres should organize awareness programmes like quiz contest among the students, for which, funds can be provided by the ISWS.
24. Technologies generated at different centres of AICRP-WM should be documented.
25. Funds under TSP will be allotted to those states having tribal districts as per classification of the Planning Commission. These funds should be effectively utilized for On-Farm Research Trials / FLDs, training and capacity building, and for development of physical assets as per guidelines.
26. Several proposals have been included in the XII plan SFC for strengthening of coordinating centres, which are pending with the ICAR.
27. All the centres should follow a common nomenclature, for example AICRP-WM Anand Centre, and not as DWSRC Anand.
28. The coordinating centres should not send their annual report or any other document to DDG (NRM) or the ADG (Agronomy & Agro forestry) in the Council. However, copies of the annual report may be shared with other coordinating centres.
29. General recommendations of QRT and specific recommendations for each centre should be effectively implemented. Centres identified as 'Average' and 'Below average' need to do serious introspection and improve their performance considerably.

10. SCIENTIFIC STAFF

DWR, Jabalpur

Dr. A.R. Sharma
Director, ICAR- DWR, Jabalpur
Coordinator, AICRP-Weed Management
e-mail: sharma.ar@rediffmail.com
Mob.: 9425807290

Dr. Yogita Gharde
Scientist (Agril. Statistics)
email: yogita_jasri@rediffmail.com
Mobile: 9425412748

Dr. P.K. Singh
Principal Scientist (Agril. Extn.)
e-mail: drsinghpk@gmail.com
Mob.: 9425388721

Dr. Bhumesh Kumar
Senior Scientist (Plant Physiology)
e-mail: kumarbhumesh@yahoo.com
Mob.: 9806622307

Dr. Shobha Sondhia
Senior Scientist (Organic Chemistry)
& Incharge, AICRP-Weed Management
e-mail: shobhasondia@yahoo.com
Mob.: 9425464997

NODAL OFFICERS

Dr. R.P. Dubey
Principal Scientist (Agronomy)
e-mail: dubeyrp@gmail.com
Mob.: 9425412041

Dr. Sushil Kumar
Principal Scientist (Entomology)
e-mail: sknrcws@gmail.com
Mob.: 9425186747

Dr. Raghwendra Singh
Senior Scientist (Agronomy)
email: singhraghu75@gmail.com
Mobile: 9806637031

REGULAR CENTRES

PAU, Ludhiana

Dr. M.S. Bhullar
Agronomist & Principal Investigator
aicrpwc_pau@rediffmail.com;
bhullarms@pau.edu, Mob.: 9872811350
Dr. (Mrs.) Simerjeet Kaur
Assistant Agronomist
simer_abh@yahoo.com, Mob.: 9814081108
Dr. (Mrs.) Navjyot Kaur
Asstt. Plant Physiologist
Dr. (Mrs.) Parvinder Kaur
Asstt.Residue Chemist
pervi_7@yahoo.co.in, Mob.: 9646105418

UAS, Bengaluru

Dr. G.N. Dhanapal
Professor(Agronomy) & Principal Investigator
dhanapalgn@yahoo.com;
gndhanapal@rediffmail.com, Mob.: 9480315492
Dr. M.T. Sanjay, Jr. Agronomist (Agronomy)
mt.sanjay@gmail.com; Mob.: 9449393273
Dr. G.R. Haresh, Associate Professor (Residue Chemistry)
hareeshramaiah@gmail.com; Mob.: 9902860256

RVSKVV, Gwalior

Dr. J.P. Dixit
Principal Scientist & Principal Investigator
aicrp_wcgwl@yahoo.in; Mob.: 9424895188
Dr. K.S. Yadav, Principal Scientist (Agronomy)
aicrp_wcgwl@yahoo.in; Mob.: 9977032481
Dr. Asha Arora, Principal Scientist (Residue Chemistry)
aicrp_wcgwl@yahoo.in;
ashaaroragwl@gmail.com, Mob.: 9981827896

GBPUAT, Pantnagar

Dr. V. Pratap Singh
Professor (Agronomy) & Principal Investigator
vpratapsingh@rediffmail.com; Mob.: 9411159669
Dr. T.P. Singh, SRO (Agronomy)
drtpsingh2010@gmail.com; Mob.: 9411184948
Dr. S.P. Singh, JRO (Agronomy)
spdrsingh@gmail.com; Mob.: 9410657005
Dr. S.K. Guru, SRO (Physiology)
skguru123@yahoo.com; Mob.: 9411195441
Dr. Shishir Tandon, Jr. Scientist (Residue Chemistry)
shishir_tandon2000@yahoo.co.in

CSKHPKV, Palampur

Dr. D. Badiyala
Professor (Agronomy) & Principal Investigator
badiyala@gmail.com; Mob.: 9816185743
Dr. Pawn Pathania, Principal Scientist (Agronomy)
Dr. (Mrs.) Neelam Sharma
Principal Scientist (Residue Chemistry)
sharma_neelam29@rediffmail.com; Mob.: 9318847457
Mr. Rajinder Kumar, Junior Microbiologist
rajinder.kumar226@gmail.com; Mob.: 9816275798

AAU, Jorhat

Dr. Jayanta Deka
Principal Scientist (Agronomy) & Principal Investigator
jayantadeka.2008@rediffmail.com
jayantadeka.assam@gmail.com; Mob.: 9435052301
Dr. N.C. Deka, Principal Scientist (Agronomy)
nikunja.deka@rediffmail.com; Mob.: 9435713567
Dr. Iswar Chandra Barua, Principal Scientist (Ecology)
iswar_barua@yahoo.co.in; Mob.: 9435094326
Dr. Kaberi Mahanta, Junior Scientist (Residue Chemistry)
kaberi.jorhat@gmail.com; 9435524056

AAU, Anand

Dr. B.D. Patel
Agronomist & Principal Investigator
anandweedcontrol@yahoo.co.in
bdpatel62@yahoo.com; Mob.: 9978102123
Mr. D.D. Chodhari, Junior Agronomist
ddcsms@gmail.com; Mob.: 9427639492
Dr. J.C. Patel, Junior Scientist (Residue Chemistry)

TNAU, Coimbatore

Dr. N.K. Prabhakaran
Professor (Agronomy) & Principal Investigator
dwsrc.cbe@gmail.com; Mob.: 9443715655
Dr. N. Sakthivel, Junior Scientist (Agronomy)
sakthi_agr@yahoo.com; Mob.: 9865472509
Dr. P. Janki, Junior Scientist (Residue Chemistry)
janakibalamurugan@rediffmail.com; Mob.: 9443936160
Dr. A. Ramalakshmi, Junior Microbiologist
ramalakshmia@gmail.com; Mob.: 9994060865

NDUAT, Faizabad

Dr. Jaidev Sharma
Professor (Agronomy) & Principal Investigator
jdsnduat@gmail.com; Mob.: 9456241425
Dr. Ravi Shankar Singh, Junior Agronomist
dr.ravi.singh12@gmail.com; Mob.: 9415188017
Dr. S.S. Singh, Junior Residue Chemist
singhss2009@gmail.com; Mob.: 9450763891
Dr. Raj Kumar Pathak, Junior Microbiologist
rkpnduat@gmail.com; Mob.: 9453956534

VB, Sriniketan

Dr. G.C. Malik
Associate Professor & & Principal Investigator
ganeshmalik_2004@rediffmail.com
aicrpwcsriniketan@gmail.com; Mob.: 9434220839
Mr. A. Hossain, Assistant Agronomist
ahossaindwsrc@yahoo.in; Mob.: 9434199504

BAU, Ranchi

Dr. R.R. Upasani
Professor (Agronomy) & Principal Investigator
upasani.ravikant@gmail.com; Mob.: 9431107234
Dr. (Mrs.) Sheela Barla, Junior Agronomist
sheela.barla123@gmail.com; Mob.: 9431584432
Mr. A. N. Puran, Junior Microbiologist
anpuran@gmail.com; Mob.: 957089642

KAU, Thrissur

Dr. T. Girija
Professor (Plant Physiology) & Principal Investigator
girijavijai@gmail.com
weedsvka@kau.in; Mob.: 9447004940
Dr. K.M. Durgadevi
Associate Professor (Residue Chemistry)
durgadevikm@rediffmail.com; Mob.: 9447513910

OUAT, Bhubaneswar

Dr. M.M. Mishra
Agronomist & Principal Investigator
mishramm2012@gmail.com
mmmishra2004@yahoo.co.in; Mob.: 9861066131
Dr Rabiratna Dash, Jr. Agronomist
rabiratnadashouat@gmail.com; Mob.: 9777535224
Mr. Mohit Mohan Behera, Jr. Scientist (Residue Chemistry)
behera_2004@rediffmail.com; Mob.: 9439009630

PJTSAU, Hyderabad

Dr. M. Yakadri
Principal Scientist (Agronomy) & Principal Investigator
weedhydap@yahoo.co.in; Mob.: 9866458165
Dr.P. Leela Rani, Sr. Agronomist; Mob.: 9704157445
Dr T. Ram Prakash, Jr. Scientist (Residue Chemistry)
trp.soil@gmail.com; Mob.: 9440121398

CCSHAU, Hisar

Dr. S.S. Punia
Sr. Agronomist & Principal Investigator
puniasatbir@gmail.com; Mob.: 9416280828
Dr. Dharam Bir Yadav, Sr. Agronomist
dbyadav@gmail.com; Mob.: 9416220028
Dr Anil Duhan, Asstt. Residue Chemist
a.duhan@rediffmail.com; Mob.: 9466051639

RAU, Pusa

Dr. Dhirendra Kumar Roy
Associate Professor (Agronomy) & Principal Investigator
dr_dhirendra_krroy@yahoo.com; Mob.: 9430181071
Mr. Dharminder, Jr. Agronomist
dchau@rediffmail.com; Mob.: 8521341114, 8092308584
Dr. R.K. Pandey, Professor (Microbiology)
Mob.: 9430046364

DBSKKV, Dapoli

Dr. S.B. Gangawane
Agronomist & Principal Investigator
niwspdapoli@gmail.com
niwsp.dapoli@gmail.com; Mob.: 9545468469
Mr. Y.R. Govekar, Jr. Research Scientist (Microbiology)
govekaryr@gmail.com; Mob.: 9405227666

IGKV, Raipur

Dr. A.P. Singh
Principal Scientist & Principal Investigator
apalsingh@yahoo.com; Mob.: 9406300759
Dr. Tapas Choudhary, Jr. Microbiologist
tapas_mb@rediffmail.com; Mob.: 9406250794

SKUAST, Jammu

Dr. Anil Kumar
Professor (Agronomy)
anillau@gmail.com
anillau@rediffmail.com; Mob.: 9419132807

PDKV, Akola

Dr. J.P. Deshmukh
Associate Professor & Principal Investigator
jpdagro@rediffmail.com; Mob.: 9421792901

MPUAT, Udaipur

Dr. Arvind Verma
Agronomist & & Principal Investigator
arnd_verma@rediffmail.com; Mob.: 9414386206

UAS, Raichur

Dr. R.B. Negalur
Principal Investigator
tushberkipilli@rediffmail.com; Mob.: 7829629407
Dr. Anand N., Jr, Agronomist
akananda@gmail.com; Mob.: 9731593733

CAU, Pasighat

Dr. Dinesh Sah
Principal Investigator
dr.d.sah@gmail.com; Mob.: 9862567430

VOLUNTEER CENTRES

SKUAST, Kashmir

Dr. Purshotam Singh
Asstt. Professor (Agronomy)
drpurshotam@gmail.com; Mob.: 9419057547

SVBPUAT, Meerut

Dr. Raghuvir Singh, Professor (Agronomy)
raghuvir_55@yahoo.com; Mob.: 9412593692

PJNCA & RI, Karaikal

Dr. P. Saravanane, Asstt. Professor (Agronomy)
psaravanane@rediffmail.com; Mob.: 9443049653

BAU, Sabour (Bihar)

Dr. G.S. Panwar, Associate Professor (Agronomy)
gspanwarbau@gmail.com; Mob.: 9472613769

CIARI, Port Blair

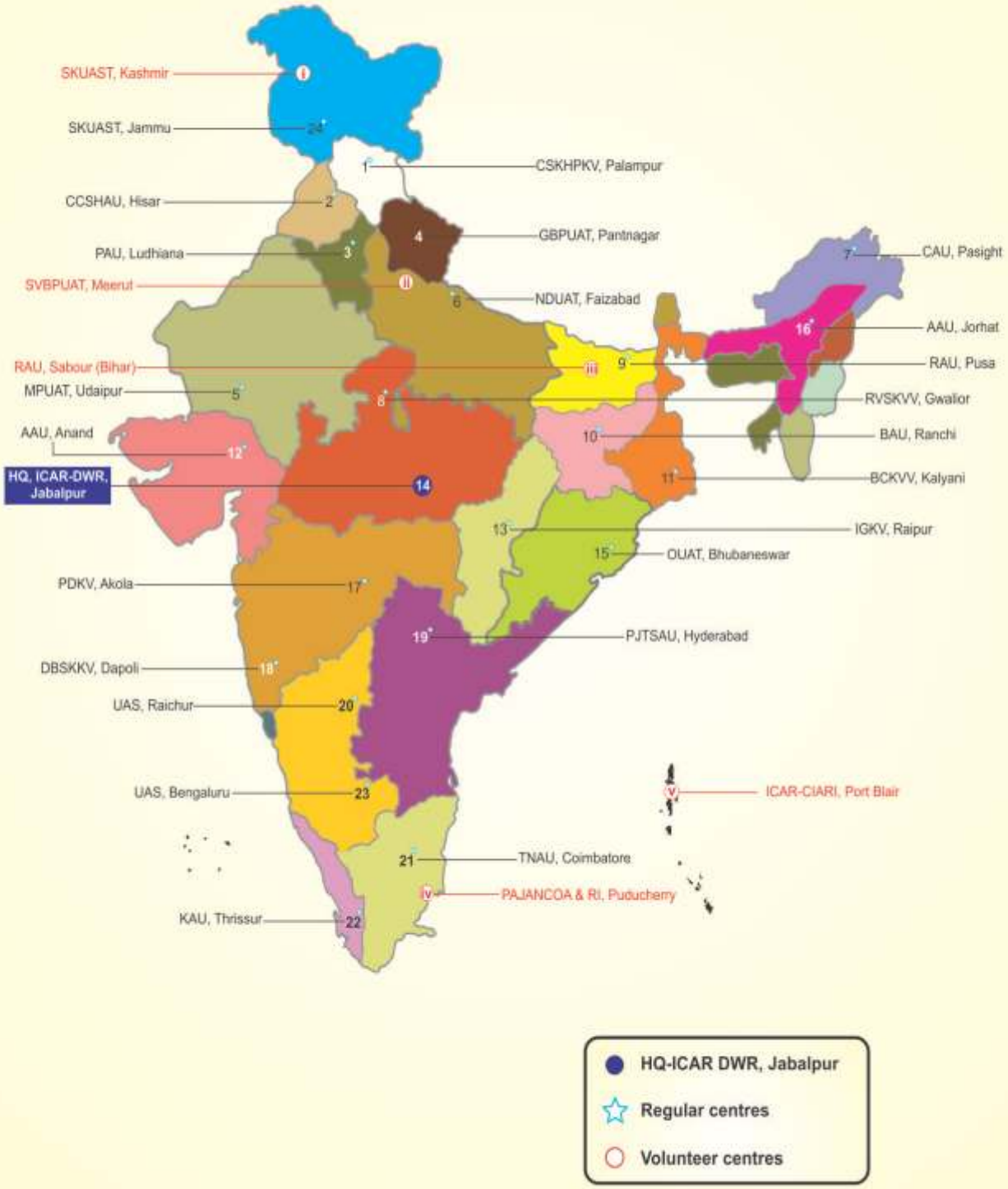
Dr. B. Gangaiah, Principal Scientist (Agronomy)
bandla_gan@hotmail.com; Mob.: 9531808744

11. STATUS OF ANNUAL REPORT FOR THE YEAR 2014

Sl No.	Centre's name	Received	
		Before due date (15.01.2015)	After due date
Regular centres			
1.	PAU, Ludhiana	14.01.2015	-
2.	UAS, Bengaluru	15.01.2015	-
3.	RVS KVV, Gwalior	-	24.01.2015
4.	GBPUAT, Pantnagar	15.01.2015	-
5.	CSKHPKV, Palampur	-	20.02.2015
6.	AAU, Jorhat	-	21.01.2015
7.	VNMKV, Parbhani	-	-
8.	AAU, Anand	10.01.2015	-
9.	TNAU, Coimbatore	14.01.2015	-
10.	NDUAT, Faizabad	10.02.2015	-
11.	VB, Sriniketan	29.12.2014	-
12.	BAU, Ranchi	19.01.2015	-
13.	CSAUAT, Kanpur	-	-
14.	KAU, Thrissur	16.01.2015	-
15.	OUAT, Bhubaneswar	19.01.2015	-
16.	PJTSAU, Hyderabad	-	31.01.2015
17.	CCSHAU, Hisar	14.01.2015	-
18.	RAU, Pusa	17.01.2015	-
19.	DBSKKV, Dapoli	15.01.2015	-
20.	IGKV, Raipur	16.01.2015	-
21.	IGKV, Raipur	-	-
22.	IGKV, Raipur	-	-
Volunteer Centres			
1	SVBPUAT, Meerut	19.01.2015	-
2.	PDKV, Akola	-	24.01.2015
3.	SKUAST-Kashmir	18.01.2015	-
4.	SKUAST-Jammu	02.01.2015	-
5.	PJNCA & RI, Karaikal	18.01.2015	-
6.	BAU, Sabour	Not submitted	


AICRP-WM activities
XXI ANNUAL REVIEW MEETING
OF
ALL INDIA COORDINATED RESEARCH PROJECT
ON WEED CONTROL
DIRECTORATE OF WEED SCIENCE RESEARCH, JABALPUR
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
DWSR
Celebrating
25years

Location of AICRP-WM Coordinating Centres



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