वार्षिक प्रतिवेदन

Annual Report 2006-07

National Research Centre for Weed Science
Maharajpur, Jabalpur, India

वार्षिक प्रतिवेदन
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भाकृअनुप
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राष्ट्रीय खरपतवार विज्ञान अनुसंधान केन्द्र
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Cover page
Attack of Mexican beetle (*Zygogramma bicolorata*) on *Parthenium hysterophorus*, an invasive weed.

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विशिष्ट सारांश

वर्ष के दौरान केन्द्र ने अनुसंधान एवं तकनीकी हस्तांतरण कार्यक्रमों के विभिन्न उद्धेश्यों को पूरा करने में सफलता अर्जित की है। अनुसंधान के अंतर्गत खरपतवार प्रबंधन हेतु अपनाई गई सस्य क्रियायें जैसे प्रतियोगी फसलों की प्रजातियों का चुनाव, अर्न्तवर्ती फसलें, मृदा सूर्यीकरण, मल्चिंग, फसलचक्र, संसाधन संरक्षण तकनीकों जैसे–शून्य जुताई एंव फसल अवशेष प्रबंधन, वातावरण में बढती कार्बन डायआक्साइड का फसल–खरपतवार प्रतियोगिता पर प्रभाव, शाकनाशियों के उपयोग एंव उनके भूमि में अवशेष संबंधित अनुसंधान, कीटों द्वारा खरपतवारों का जैवकीय नियंत्रण आदि शामिल है। साथ ही साथ खरपतवारों की वृद्धि एवं विकास एंव पारिस्थितिक कार्यिकी से संबंधित अनुसंधान भी किया गया। केन्द्र ने इस साल भी गाजरघास को खाने वाले मैक्सिकन बीटल का पूरे भारत में प्रभावी तौर पर विस्तार एंव वितरण जारी रखा। इसके अलावा, केन्द्र ने उन्नत खरपतवार प्रबंधन तकनीकों का कई किसानों के प्रक्षेत्रों पर परीक्षण एंव प्रदर्शन किए ।

इस वर्ष के दौरान मुख्य अनुसंधान परिणाम इस प्रकार हैं।

सस्यक्रियायों द्वारा खरपतवार प्रबंधन

⇒ धान की किस्म ''वंदना'' अन्य किस्मों जैसे ''कलिंगा'' एवं ''अन्नदा'' की अपेक्षा अपनी ज्यादा ऊँचाई एवं कल्लों की संख्या के कारण खरपतवारों की वृद्धि रोकने में प्रभावी पाई गई।

⇒ मटर व्दारा अंकरी (*विसिया सटाइवा*) एवं मेडकागो (*मेडिकागो हिस्पीड़ा*) की, राई–सरसों व्दारा बथुआ (*चिनोपोडियम अल्बम*) एवं अंकरी (*विसिया सटाइवा*) की एवं अलसी व्दारा गुल्ली डंडा (*फेलेरिस माइनर*) नामक खरपतवारों की वृद्धि एवं बढ़वार को रोकने में सफलता पाई गई।

⇒ रबी की दलहनी एवं तिलहनी फसलों की बिना जुताई बुवाई करने से गुल्ली डंडा एवं बथुआ नामक खरपतवारों की संख्या एवं भूमिगत बीजों में अर्थपूर्ण कमी पाई गई । वहीं मेडिकागो एवं अकरी की संख्या में वृद्धि दर्ज की गई।

⇒ खरपतवारों की बढ़वार को रोकने उपरांव धान में किये गये एक परीक्षण में ढैंचा को धान की फसल के साथ उगाकर फसल की बुवाई के 45 दिन बाद 2, 4–डी नामक शाकनाशी से खत्म करने से खरपतवारों पर प्रभावी नियंत्रण पाया गया तथा फसल की उपज में अर्थपूर्ण वृद्धि दर्ज की गई।

⇒ सरसों की कतारों के बीच में बरसीम को अर्तवर्ती फसल के रूप लेने से खरपतवारों की बढ़वार रोकने में अर्थपूर्ण मदद मिलती है।

शाकनाशियों द्वारा खरपतवार प्रबंधन

⇒ जूट की फसल में फिनाक्साप्राप (67 ग्राम/हेक्टेयर) का उपयोग करने से खरपतवारों को प्रभावी रूप से नियंत्रित किया जा सकता है एवं उपज में बढ़ोत्तरी दर्ज की जा सकती है।

⇒ रोपाई वाली धान की फसल से, मेटसल्फ्यूरॉन (4 ग्राम/हेक्टेयर) एवं अलमिक्स (20 ग्राम/हेक्टेयर) नामक शाकनाशियों के प्रयोग से चौड़ी पत्ती वाले खरपतवारों को मुख्य रूप से नियंत्रित कर सकते है। वही अन्य शाकनाशी जैसे इथाक्सीसल्फ्यूरॉन 20 ग्राम/हेक्टेयर एवं पिनाक्सोलाम 20–22.5 ग्राम/हेक्टेयर का छिड़काव करने से भी खरपतवारों का प्रभावी रूप से नियंत्रण किया गया।

⇒ उपरॉव धान में आलमिक्स (20 ग्राम/हेक्टेयर) का साहेलोफॉप (120 ग्राम/हेक्टेयर) या फिनाक्साप्राप (60

ग्राम/हेक्टेयर) के साथ टैंक मिश्रण बनाकर बुवाई के 25 दिन बाद छिड़काव करने से ज्यादा से ज्यादा खरपतवारों पर नियंत्रण पाया गया एवं उपज में अर्थपूर्ण बढ़ोत्तरी दर्ज की गई ।

⇒ सोयाबीन की फसल में खरपतवारों को कम करने एवं इसकी उपज बढ़ाने में इमाजेथापाइर (100 ग्राम/हेक्टेयर), क्वीजालोफाप (50 ग्राम/हेक्टेयर) एवं फिनाक्साप्राप (100 ग्राम/हेक्टेयर) बुवाई के 20–25 दिन बाद छिड़काव लाभदायक सिद्ध हुआ । इस फसल के एक अन्य परिक्षण में फ्लूमोक्सजिन (50 ग्राम/हेक्टेयर) अंकुरण पूर्व एवं फिनाक्साप्राप (100 ग्राम/हेक्टेयर) अंकुरण पश्चात् (25–30 दिन बाद) क्रमवार उपयोग करने से खरपतवार की सघनता में अर्थपूर्ण कमी आई एवं ज्यादा उपज दर्ज की गई।

⇒ गेहूँ में मेटसल्फ्यूरॉन इथाइल (4–8 ग्राम/हेक्टेयर) की सरफेक्टेंट के साथ छिड़कने से चौड़ी पत्ती वाले खरपतवारों को अर्थपूर्ण तरीके से नियंत्रित किया गया।

⇒ सरसों की फसल में कॉंस के प्रबंधन हेतु शाकनासियों का क्रमवार उपयोग काफी अर्थपूर्ण सिद्ध हुआ। ग्लायफोसेट का मई–जुलाई में पहली बार 2.0 किग्रा/हेक्टेयर एवं 2 महीने बाद 1.5 किग्रा/हेक्टेयर की दर से गैर–फसल के क्षेत्र मे उपयोग करने से लंबे अंतराल के लिए कांस पर नियंत्रण पाया गया तथा रबी के मौसम में सुरक्षित रूप से सरसों की उपज में अर्थपूर्ण बढ़ोत्तरी दर्ज की गई ।

⇒ बिना जुताई द्वारा उगाई गई उपरॉव धान में मानसून की पहली बरसात के पश्चात बोआई करने एवं पेन्डिमिथालिन (1.0 किग्रा/हे.), या प्रेटीलाक्लोर (0.75 किग्रा/हे.) को बुवाई के 4–6 दिन बाद एवं 2,4–डी का बुवाई के 30 दिन बाद एवं इसके बाद फिनाक्साप्राप (0.07 किग्रा/हे.) का उपयोग करने से खरपतवार में कमी के साथ साथ उपरॉव धान की उपज में अर्थपूर्ण बढ़ोत्तरी दर्ज की गई।

⇒ धान एवं गेंहूं की मशीन से कटाई करने पर इसका वानस्पतिक भाग खेत में ही रह जाता है । गेंहूं के अवशेष खेत मे जलाने से धान की फसल में खरपतवार की समस्या कुछ हद तक कम हो जाती है ।

भूमि में निहित सूक्ष्मजीवों एवं मृदा उर्वरता पर शाकनाशियों का प्रभाव

⇒ सोयाबीन में उपयोग होने वाले शाकनाशियों जैसे सिथाक्सीड़िम, इमाजेथापाइर, क्वीजालोफाप, एवं फिनाक्साप्राप का इसकी जड़ों की ग्रंथियों पर प्रतिकूल असर देखा गया।

⇒ गेहूँ में सल्फोसल्फ्यूरॉन नामक शाकनाशी 'वाम फफूंद' के लिये बिल्कुल सुरक्षित पाया गया।

⇒ मृदा सूर्यीकरण विधि को अपनाने से भूमि में विद्यमान तत्वों जैसे फास्फोरस, सल्फर, पोटाश, आयरन, मेंगनीज एवं जिंक की उपलब्धता में अर्थपूर्ण बढ़ोत्तरी दर्ज की गई।

फसल पद्धतियों में खरपतवार प्रबंधन

⇒ धान–गेहूँ फसल चक्र में क्लोडिनोफाप (60 ग्राम/हेक्टैयर) के साथ 2, 4–डी (0.5 किलोग्राम/हेक्टैयर) के लगातार उपयोग से गेहूँ में जंगली जई, गुल्ली डंडा एवं बथुआ की सघनता में कमी आई तथा गेहूँ की उपज ज्यादा दर्ज की गई। सल्फोसल्फयूरान (25 ग्राम/हेक्टैयर) के प्रयोग से मेडिकागो एवं बनमकोय की संख्या में कमी आंकी गई ।

⇒ रामतिल–टमाटर के सस्यक्रम में 45 दिनों तक मृदा सूर्यीकरण करने से लम्बे समय के लिये खरपतवार नियंत्रित किये गये ।

पादप जीव विष की शाकनाशीय क्षमता

⇒ जलीय खरपतवारों जैसे स्पायरोडेला एवं लेम्ना पर *सोलेनम वायरम* नामक खरपतवार के विभिन्न भागों के अर्क का प्रतिकूल असर देखा गया ।

⇒ पी. हाइड्राक्सी बेंजोइक एसिड (5 mm) नामक रसायन तैरने वाले जलीय खरपतवारों जैसे – जलकुंभी, पिस्तिया, एजोला, स्पायरोडोला, नाजस एवं लेमिना की वृद्धि रोकने में सहायक सिद्ध हुआ ।

⇒ लेंटाना नामक खरपतवार के अवशेष जलीय खरपतवार जैसे एजोला एवं ग्रीन मस्क कारा की अर्थपूर्ण वृद्धि रोकने में सहायक सिद्ध हुआ ।

⇒ गेदें के पौधों की जड़ों से प्राप्त अर्क का विभिन्न खरपतवारों जैसे वनबटरी, गुल्लीडंडा, गाजरधास, जंगली जई एवं अकरी पर विषाक्त असर दर्ज किया गया ।

भूमि एंव खाद्यान्न में शाकनाशी अवशेष

⇒ गेंहू एवं धान के बीजों पर शाकनाशी – मेटसल्फयूरान का कोई अवशेष नहीं पाया गया ।

⇒ सोयाबीन में इमाजेथापाइर नामक शाकनाषी का अवशेष 0.008, 0.102 तथा 0.301 माइक्रो ग्रा./ग्राम क्रमशः मिट्टी, दाने एवं भूसे में पाया गया ।

⇒ प्याज एवं धान में आक्सीफलोरफेन शाकनाशी के 150–300 ग्राम/हेक्टैयर की दर से प्रयोग करने पर 0.0033–0.0059 माइक्रो ग्रा./ग्राम अवशेष पाया गया ।

पर्यावरण में बढ़ती कार्बन डाय–आक्साइड का फसल–खरपतवार प्रतिस्पर्धा पर प्रभाव

⇒ एक परीक्षण के दौरान यह ज्ञात हुआ कि कार्बन डायआक्साइड की मात्रा बढ़ने से गाजरधास एवं जंगली चौलाई नामक खरपतवारों की वृद्धि एवं विकास ज्यादा दर्ज की गई ।

⇒ कार्बन डायआक्साइड के बढ़ने से ग्लायफोसेट, सल्फोसल्फयूरान एवं क्लोडिनोफाप नामक शाकनाशियों का जीवाणुओं की संख्या पर प्रतिकूल असर पाया गया । वही फफूंद पर 2,4–डी एवं ग्लायफोसेट का असर ज्यादा देखा गया ।

⇒ कार्बन डायआक्साइड के स्तर बढ़ने से शाकनाशियों के प्रभाव में अर्थपूर्ण कमी पायी गयी तथा खरपतवार को नष्ट करने के लिये वांछित समय में भी बढ़ोत्तरी दर्ज की गई ।

जैविकीय खरपतवार नियंत्रण

⇒ एक सर्वेक्षण के दौरान *ट्रायन्थेमा पोर्चूलास्ट्रम* पर दो कीड़ों का आक्रमण पाया गया । इन कीड़ों की पहचान *स्पोडोप्टेरा* लिटूरा एवं *हायमेनिया रिकरवेलिस* के रूप में की गई है । इन कीड़ों को प्रयोगशाला में उपरोक्त खरपतवार पर बनाये रखा गया । इसके अलावा 4 अन्य पौधो जैसे आल्टरनेनथेरा, ज्वार, टमाटर, चौलाई एवं बथुआ पर भी कीड़ों का आक्रमण देखा गया ।

⇒ ठंड के मौसम में भी गाजरघास के कीड़े मेक्सीकन बीटल बहुतायत में पैदा किये गये । वर्ष के दौरान लगभग सवा लाख कीड़ों को विभिन्न राज्यों में वितरित किया गया ।

⇒ जलीय खरपतवार जलकुंभी के नियंत्रण में परीक्षण के दौरान ग्लायफोसेट के छिड़काव से एक सप्ताह तक मछलियों के उपर कोई प्रभाव नहीं देखा गया । परंतु 20 दिन बाद, 5 प्रतिशत मछली जलकुंभी के सड़ने के पश्चात मरी पायी गई । जिससे पानी की शुद्धता पर भी प्रतिकूल असर दर्ज किया गया । छिड़काव के 25–35 दिन बाद पानी के पी एच में बढोत्तरी के साथ–साथ पानी में आक्सीजन की अर्थपूर्ण कमी दर्ज की गई ।

⇒ मोथा नामक खरपतवार की समस्या को देखते हुए एक सर्वेक्षण किया गया जिससे इस पर व्याप्त रोगों की संभावना को ढूढ़ने का प्रयास किया गया । माह अगस्त एवं सितंबर से फरवरी के दौरान इसकी पत्तियों पर धब्बे देखे गये । उन्हें प्रयोगशाला लाकर उनकी पहचान की गई जिसमें से एक की पहचान *कोलेटोट्राइकम डरमेटम* के रूप में की गई ।

⇒ जून 2006 में हैदराबाद में किये गये सर्वे के दौरान *लिगेसिया मोलिस* नामक खरपतवार पर रस्टरोग दर्जे किया गया तथा वर्षा ऋतु के दौरान जुलाई–सितंबर में जबलपुर एवं भोपाल में भी इसे दर्ज किया गया ।

तकनीकी हस्तांतरण

⇒ तकनीकी हस्तातंरण के दौरान खरीफ के मौसम में धान एवं सोयाबीन की फसलों में 22 प्रदर्शन किये गये तथा वहीं रबी के मौसम में गेहूं, चना, मसूर की फसल में 38 प्रदर्शन किये गये । अकृषित क्षेत्रों में 4 प्रदर्शन गाजरघास एवं आइपोमिया पर किये गये । इस दौरान कई प्रशिक्षण कार्यक्रम भी आयोजित किये गये ।

आखिल भारतीय समन्वित खरपतवार नियंत्रण अनुसंधान परियोजना

⇒ कर्नाटक में किये गये सर्वेक्षण के दौरान, सूखे एवं दक्षिणी क्षेत्र में, नये खरपतवार जैसे – *स्मालेन्टस,* तटीय क्षेत्र में *एरियोकालोन कसपीडेटम* एवं *स्फेरेन्थस इंडीकस,* दक्षिणी कर्नाटक के पूर्वी शुष्क क्षेत्र में *पालीगाला चायनेनसिस* देखे गये ।

⇒ गुजरात में अहमदाबाद जिले में पहली बार *फैलेरिस माइनर* की समस्या 1996 में दर्ज की गई थी । इस दस वर्ष के अंतराल में यह अब तक 6 अन्य जिलों में फैल चुका है ।

⇒ कोयम्बटूर में गर्मी के मौस में *साइप्रस रोटन्डस* प्रमुख खरपतवार था जबकि खरीफ मे *साइप्रस इरिया* एवं *साइप्रस डीफोरमिस* एवं रबी में *साइप्रस डीफोरमिस* देखा गया ।

⇒ सर्वेक्षण के दौरान गाजरघास का प्रकोप उद्यान की फसलों में भी पाया गया ।

⇒ पूसा केन्द्र द्वारा सर्वेक्षण के दौरान आम एवं लीची पर परजीवी खरपतवारों जैसे डेन्ड्रोफथ एवं लोरेथंस की समस्या दर्ज की गई ।

⇒ पंजाब में, फेलेरिस माइनर में शाकनाशी के प्रति प्रतिरोधकता पर एक अध्ययन से यह ज्ञात हुआ कि क्लोडिनोफाप के चक्रानुसरण रूप में प्रयोग से प्रतिरोधकता के विकास में अर्थपूर्ण कमी आती है ।

⇒ हिसार में फिनाक्साप्राप, सल्फोसल्फयूरान एवं क्लोडिनोफाप के प्रति *फैलेरिस माइनर* की बायोटाइप में प्रतिरोधकता की संभावना बढ़ रही है ।

⇒ रायपुर में उपरांव धान मे अंकुरण पूर्व पेन्डीमिथालिन (1.0 कि.ग्रा./हे.) + एक निंदाई अथवा दो निंदाई (30 एवं 60 दिन पर) के प्रयोग करने से धान की सबसे अधिक उपज प्राप्त हुई ।

⇒ गन्ने की पेड़ी की फसल में तीन होइंग या ऐट्राजिन (1.5 या 2.0 कि.ग्रा./हे.) के साथ दो होईंग या ऐट्राजिन के साथ 2,4–डी (1.25 कि.ग्रा./हे.) या ग्लायफोसेट (1.0 कि.ग्रा./हे.) का डायरेक्टेड छिड़काव या मेट्रीब्यूजिन (0.88 कि.ग्रा./हे.) अंकुरण पूर्व का उपयोग करने से गन्ने की उपज सब से ज्यादा दर्ज की गई ।

⇒ गन्ना–लोबिया अंतवर्ती फसल चक में, मेटोलाक्लोर या पेन्डीमिथालिन (1.00 कि.ग्रा./हे.) का उपयोग करने से खरपतवार की संख्या में अर्थपूर्ण कमी पाई गई ।

⇒ धान – धान सस्य क्रम में गर्मी में ब्यूटाक्लोर (1.25 कि.ग्रा./हे.) + आलमिक्स (4 ग्रा/हे.) 3 दिन पर एवं खरीफ में प्रेटीलाक्लोर उपयोग करने से खरपतवारों की बढ़वार में अर्थपूर्ण कमी आती है एवं धान की उपज में निंदाई की अपेक्षा 5 प्रतिशत ज्यादा उपज दर्ज की गई ।

⇒ मक्का–मूंगफली सस्यकम में मूंगफली में पेन्डीमिथालिन (1.0 कि.ग्रा./हे.) बुवाई के 3 दिन पश्चात एवं मक्का में एट्राजिन (1.0 कि.ग्रा./हे.) बुवाई के 3 दिन बाद, यांत्रिक निंदाई के साथ उपयोग करने पर दो निंदाई के बराबर उपज प्राप्त हई ।

⇒ लुधियाना एवं पालमपुर में मक्का–गेंहू सस्यकम में खरपतवार के प्रभाव को अर्थपूर्ण कम करने के लिये जुताई की अपेक्षा बिना जुताई के फसल उगाना ज्यादा फायदेमंद सिद्ध हुआ ।

⇒ कोयम्बटूर में हरी सब्जियों में अंकुरण पश्चात पैराक्वाट (0.80 कि.ग्रा/हे.) या ग्लूफोसिनेट (0.40 कि.ग्रा/हे.) का 20 दिन पर डायरेक्टेड छिड़काव करने से अमरबेल की बढ़वार में कमी आती है । वही हैदराबाद मे लूसर्न में इसी परजीवी खरपतवार का नियंत्रण करने के लिये पेन्डीमिथालिन (0.5 कि.ग्रा/हे.) का अंकुरण पश्चात् छिड़काव बहुत ही प्रभावी सिद्ध हुआ ।

⇒ लुधियाना में, धान–गेहूं सस्यकम में, इनकी मिटटी, दानों एवं भूसा में विभिन्न षाकनाशियों जैसे आइसोप्रोटूरान, ब्यूटाक्लोर, एनीलोफास, क्लोडिनोफाप एवं सल्फोसल्फयूरान का अवशेष नहीं पाया गया ।

⇒ बैंगलोर एवं कोयम्बटूर में फिंगरमिलेट एवं मूंगफली की कटाई पश्चात इनकी मिट्टी में ब्यूटाक्लोर एवं पेंडीमिथालिन का कोई अवशेष नहीं पाया गया ।

EXECUTIVE SUMMARY

The Centre has achieved its targets during 2006-07 in research and transfer of technology. The major research areas include cultural methods of weed management employing competitive crop cultivars, intercrops, soil solarization, mulching, cropping systems etc., resource conservation technologies like zero tillage, crop residue management, herbicides and their residues, crop-weed interaction in elevated CO_2 and biological management of weeds through insects and plant pathogens. The Centre has continued its excellent track record of popularizing the bio-control of *Parthenium* by Mexican beetle (*Zygogramma bicolorata)* through out the county. In addition, the Centre has also taken up several on-farm trials and field demonstrations on proven weed management technologies and field days to educate farmers.

The major research achievements are summarized below.

Weed management through cultural practices

- Rice cultivar 'Vandana' with higher plant height and panicles/m^2 had greater weed suppressing ability than 'Kalinga' and 'Annada'.
- *Sesbania* (*dhaincha*) as an intercrop sown at 60 kg/ha and killed by 2,4-D at 0.5 kg/ha at 45 days after sowing was effective in managing weeds and producing higher rice seed yield of 5079 kg/ha as compared to 3938 kg/ha under weedy check in direct - seeded rice.
- Field pea and rapeseed-mustard smothered the population of *Vicia sativa* more effectively as compared to other winter pulse and oilseed crops. Population of *Medicago hispida* was suppressed in field pea.
- Zero tillage (ZT) significantly reduced the population of *C. album* but increased the population of *V. sativa*.(ZT) increased the seed bank of *Medicago hispida* and *Vicia sativa* but reduced the seed bank of *P. minor* and *C. album*.
- Intercropping of berseem between two rows of mustard at 45 cm or as paired rows of 30/60 cm reduced weed infestation effectively.

Weed management through herbicides

- In jute, application of fenoxaprop-p-ethyl at 67 g/ha was found very effective in controlling weeds and increasing seed yield.
- In transplanted rice, post-emergence application of metsulfuron methyl at 4 g/ha or almix at 20 g/ha reduced the population and dry weight of broadleaved weeds significantly. Application of ethoxysulfuron at 20 g/ha and penoxsulam at 20-22.5 g/ha was found very effective in reducing weed density and weed biomass.
- In direct seeded rice, tank mix application of cyhalofop + almix (70 + 20 g/ha) and fenoxaprop + almix (60 + 20 g/ha) applied at 25 DAS provided broad spectrum weed control and higher grain yield.

- In soybean, application of imazethapyr at 100 g/ha was as effective as quizalofop-p-ethyl at 50 g/ha and fenoxaprop-p-ethyl at 100 g/ha applied as post-emergence in reducing weed population and improving seed yield. Sequential application of flumioxazin as pre-emergence at 50 g/ha followed by fenoxaprop-p-ethyl at 100 g/ha as post-emergence significantly reduced the weed growth and yielded at par to flumioxazin as pre-emergence followed by one hand weeding.
- In wheat, application of metsulfuron-methyl with surfactant at 4 to 8 g/ha significantly reduced the broadleaved weeds.
- For the management of *Saccharum spontaneum (Kans)* in mustard, sequential application of glyphosate 2.0 kg/ha followed by 1.5 kg/ha at an interval of 2 months during May-July under non-crop situation gave season-long control of *kans* and higher seed yield of mustard.
- In zero-till direct-seeded irrigated rice, seeding after receipt of first flush of monsoon and pre-emergence application of pretilachlor at 0.75 kg/ha or pendimethalin (1.0 kg/ha) *fb* 2,4-D (0.5 kg/ha) *fb* fenoxaprop (0.07 kg/ha) produced the lowest weed biomass and higher grain yield of direct-seeded rice.

Influence of herbicides on soil micro-flora and soil fertility

- Sulfosulfuron was found safe in terms of VAM-wheat association.
- Significant increase in the availability P, S, K, Fe, Mn and Zn content of soil was noticed with soil solarization.

Weed management in cropping systems

- In transplanted rice-wheat system, continuous use of clodinafop at 60-g/ha *fb* 2,4-D at 0.5 kg/ha reduced the density of *Avena ludoviciana*, *Phalaris minor* and *Chenopodium album* and produced higher wheat yield. Whereas sulfosulfuron 25 g/ha reduced the population of *Medicago hispida* and *Physalis minima,* effectively.
- In niger-tomato cropping system, soil solarization for a period of 45 days either alone or in combination with FYM and crop residue provided season-long weed control in both the crops.
- Mechanical method of harvesting rice and wheat leaves significant amount of residues in the field. Burning of wheat residue significantly reduced weed dry weight in transplanted rice whereas burning and incorporation were found at par in wheat.

Herbicidal properties of phytotoxins

- Different plant parts of *Solanum viarum* were found lethal at 0.1-2.0% to aquatic weeds *viz.* Spirodella (*Spirodella polyrhiza* L. Schleid) and lemna (*Lemna pausicostata* Hegelm.).
- p-hydroxybenzoic acid was found inhibitory and killing all floating aquatic weeds such as water hyacinth (*Eichhornia crassipes* Mart Solms.), pistia (*Pistia stratiotes* L.), spirodella (*Spirodella polyrhiza* L. Schleid) and lemna (*Lemna pausicostata*) at 5mM. The submerged aquatic weed najas (*Najas graminea* Del.) was killed at 1 mM.
- Phytotoxic effect of root leachates of marigold plants was at par with the 10 and 1000 ppm of isolated compound in case of *Parthenium hysterophorus* and *Lathyrus sativa,* respectively; however the phytotoxic effect was more and in the order of *Lathyrus sativa*> *Phalaris minor*> *Parthenium hysterophorus*> *Avena ludoviciana*> *Vicia sativa*> *Convolvulus arvensis*.

Herbicide residues in soil and food chain

- Residues of metsulfuron-methyl were found below detection limit (BDL) in wheat grains in all the doses however, 0.002 and 0.002 µg/g, residues were found in wheat straw at doses 5 and 8 g/ha, respectively.
- Imazethapyr residues were detected as 0.008, 0.102 and 0.301 ìg/g in soil, soybean grains and straw, respectively at harvest.
- Onion and rice samples contained residues of oxyfluorfen in the range of 0.0033-0.0059 µg/g at 150-300 g/ha at harvest.

Effect of elevated CO_2 on crop-weed interaction

- The elevated CO_2 enhanced the growth and reproduction in *P. hysterophorus* and *Amaranthus viridis.* The growth enhancement under elevated CO_2 started after 60 DAS and continued till end.
- Significant reduction by glyphosate, sulfosulfuron and clodinafop on bacterial population was noticed due to CO_2 enrichment. The toxic effect of 2, 4-D and glyphosate was high on fungi even under high Co_2.
- CO_2 enrichment decreased the efficacy of herbicides and took more time for complete mortality of weeds. The impact of elevated CO_2 on weed control efficacy was more in isoproturon (mortality was delayed by 9 days) followed by clodinafop (7 days), 2,4-D (5 days) and glyphosate (3 days).

Weed management using insects and plant pathogens

- Two species of lepidopteron insects such as *Spodoptera litura* and *Hymenia recurvalis* were maintained on *Trianthema portulacastrum*. Linn. (Aizoaceae). Studies on host range and feeding preference revealed that the larvae of *H. recurvalis* could feed well on *Alternanthera philoxeroides*, *Sorghum vulgare*, *Lycopersicon esculentum*, *Amaranthus viridis* and *Chenopodium album* in addition to *Trianthema portulacastrum*.
- Mexican beetle has been reared successfully in poly cages even during winter season or in low temperature areas. About 1.25 lakh adult beetles were supplied during 2006-07 as a nucleus culture to different KVKs in the states of Assam, Nagaland, Himachal Pradesh, Chhatisgarh, Madhya Pradesh, Haryana, Punjab, Orissa, Bihar, West Bengal, Uttaranchal, and Jharkhand; 14 centres of All India Coordinated Project on Weed Control, many farmers and NGOs.
- Spray of glyphosate on water hyacinth did not lead to fish mortality up to one week after spray, however 5% mortality could occur after 20 days due to decomposition of water hyacinth in herbicide treated areas subsequently leading to deterioration of water quality by increasing pH

from 7.4 to 9. Maximum decrease in dissolved oxygen was observed between 25 to 35 days in tanks where 100% area of water hyacinth surface was treated with herbicide. There was an increase in Ca, Mg, Na, Fe, Nitrite between 20 to 35 days in herbicide treated tank with maximum increase in 100% glyphosate treatment.

- Survey made for promising pathogens against Cyperus rotundus identified two leaf spot diseases during August and one rust disease during September to February. Maximum damage of Cyperus rotundus due to rust disease in nature was noticed in the months of September-October. Out of the two fungi isolated from leaf spot, one was identified as Colletotrichum dematium.
- A rust disease on Lagascea mollis was first observed in June 2006 at Hyderabad and during rainy season of 2006 at Jabalpur and Bhopal. Maximum incidence was noticed during July to September. Heavily infected plants later died before flowering and fruiting.

Transfer of Technology

- During kharif, 22 demonstrations on weed management in rice and soybean were conducted, while 38 demonstrations were conducted during rabi in wheat, chickpea and lentil. In non-cropped situations, 4 demonstrations on management of Parthenium hysterophorus and Ipomoea sp. (two each) were conducted. In addition, several trainings as well as lectures were also organized and delivered.

AICRP-Weed Control

- In Karnataka, new weeds Smallanthus sp, of Asteraceae family in eastern dry and southern transition zones; *Eriocaulon cuspidatum* (Eriocaulaceae) and Sphaeranthus indicus in coastal zone, Polygala chinensis in eastern dry zone of Southern Karnataka were observed.
- In Gujarat, the infestation of *Phalaris minor* was recorded first time in Ahmedabad district in the year 1996. The weed has now spread in 6 districts viz. Banasankantha, Sabarakantha, Mahesana, Gandhinagar, Ahmedabad and Kheda with varying densities (15-35 plants m^{-2}).
- In Coimbatore, *Cyperus rotundus* which was dominant in summer was replaced by *Cyperus iria* and *Cyperus difformis* in kharif and Cyperus difformis alone was observed in rabi.
- Parthenium hysterophorus was observed in horticultural crops like tomato, carrot, brinjal, sugarcane, groundnut, wheat, cluster bean, chillies, banana and sweet orange.
- In Pusa (Bihar), *Dendrophthoe falcata* (l.f.) Ettingsh (Syn. *Loranthus falcatus* (c.f.) of Lorantheaceae family locally known as Banda was observed as fast spreading parasitic weed on mango and litchi.
- In Punjab, studies on cross/ multiple resistance in *Phalaris minor* indicated that clodinafop induced significantly higher mortality than isoproturon indicating the rotation of herbicide might delay the development of resistance.

à At Hisar, the possibility of evolution of cross resistance against alternate herbicides fenoxaprop, sulfosulfuron and clodinafop is increasing as GR_{50} of biotypes of P. minor collected from permanent sites is increasing every year.

- At Raipur, pre-emergence application of pendimethalin 1.0 kg/ha + one hand weeding and hand weeding twice at 30 and 45 DAS gave the highest yield of direct seeded rice.
- In sugarcane ratoon, the highest cane field was recorded with three hoeings at 30, 60 & 90 days after haust (DAH) or atrazine at 1.5 or 2.0 kg/ha supplemented with hoeings at 60 and 90 DAH or atrazine 2.0 kg/ha pre-emergence on 3 DAH + 2,4-D 1.25 kg/ha post- emergence on 90 DAH + directed spray of glyphosate 1.0 kg/ha on 150 DAH or metribuzin 0.88 kg/ha (pre-em) fb one hoeing at 45 DAS fb 2,4-D (Na salt 2.5 kg/ha) at 90 DAS.
- In sugarcane + cowpea intercropping system, application of metolachlor 1.0 kg/ha or pendimethalin 1.0 kg/ha recorded significantly lower weed population.
- In rice-rice system, use of butachlor 1.25 kg/ha + almix at 4 g/ha at 3 days after planting (DAP) in summer and pretilachlor in kharif lowered the density of weeds and gave significantly higher paddy yield over hand weeding.
- In maize-groundnut system, use of pendimethalin 1.0 kg/ha at 3 DAS in groundnut and atrazine 1.0 kg/ha at 3 DAS followed by mechanical weeding of passing Junior hoe with two tynes (3 weeks after sowing) in maize gave yield comparable (6749 kg/ha) to hand weeding (6539/ha).
- In maize-wheat system at Ludhiana and Palampur, zero tillage was as effective as conventional tillage in managing weeds.
- In rice-wheat system at Pantnagar and Hisar, zero tillage in wheat produced significantly higher yield than reduced tillage and conventional tillage.
- At Coimbatore, in green vegetable (*Amaranthus* spp.), post-emergence directed application of either paraquat 0.80 kg/ha or glufosinate 0.40 kg/ha on 20 days after sowing, reduced the Cuscuta coverage and dry weight of both Cuscuta sp. and other weeds at 25 days after sowing. At Hyderabad, pendimethalin at 0.5 kg/ha as post- emergence resulted in control of *Cuscuta* and other weeds to a greater extent and aided in a higher fodder yield in four cuts of Lucerne.
- At Ludhiana, isoproturon, 2, 4-D, butachlor, anilophos, clodinafop and sulfosulfuron approved over the years in rice-wheat cropping systems did not leave any residues in soil, grain and straw.
- At Bangalore and Coimbatore, the residues of butachlor and pendimethalin were below detectable level in soil after the harvest of finger millet and groundnut in long-term trial.
- At Gwalior, sulfosulfuron applied to Isabgol persisted in soil upto 45 DAA and leaving no residue in post harvest soil
- At Hyderabad and Jorhat, no fish mortality was observed on application of paraquat or 2,4-D and glyphosate, respectively.

1 INTRODUCTION

Brief history

The National Research Centre for Weed Science, Jabalpur is one of its kind in the world in the field of weed management research. Considering the problem of weeds in crop fields and need for weed research in India, a coordinated weed control Scheme on wheat, rice and sugarcane was initiated during 1952 in 11 states of the country by ICAR to monitor the weed flora and also to find out the relative feasibility of economical weed control. Later, a number of crop research institutes under ICAR and State Agricultural Universities (SAUs) were involved in weed control research. Different SAUs also initiated the syllabus for weed management at under-graduate and post-graduate levels to teach and train students and researchers in weeds and their management.

The weed research programme was strengthened in 1978 through All India Coordinated Research Project on Weed Control by ICAR in collaboration with the United States Department of Agriculture (USDA). Initially, six centres were started at different SAUs for a period of six years. Later seven more centres in II phase and nine more centres in III phase were added during 1982-83 and 1985-86, respectively for a period of five years each. The project was continued with plan funds of ICAR. At present, it is operating at 22 locations covering different agro-ecological zones all over the country. This project has not only assisted farming community by developing effective weed management technologies but also brought out the need for carrying out more in-depth studies for which facilities were not available at different Centres. In view of this it was decided to set up a nodal centre for basic and applied research in Weed Science in the VII Five Year Plan. Thus, the present National Research Centre for Weed Science came into being in April, 1989 with the following mandates.

- To undertake basic and applied researches for developing efficient weed management strategies in different agro-ecological zones;
- To provide leadership and coordinate the network research with state agricultural universities for generating location-specific technologies for weed management in different crops, cropping and farming systems;
- To act as a repository of information in weed science;
- To act as a Centre for training on research methodologies in the area of weed science and weed management;
- To collaborate with national and international agencies in achieving the above mentioned goals;
- To provide consultancy on matters related to weed science.

The Centre, since its inception conducting research in the field of weed science catering the need of field crops, horticultural and vegetables crops, problems weeds, in cultural, chemical, mechanical, bio-control, bioremediation, residue analysis, allelopathy etc. and has significantly contributed in the areas of identifying major weeds in different crops and cropping systems of the country, development of national database of weeds, evaluation of new herbicides and making herbicide recommendations, monitoring of herbicide residues in food chain and environment, identifying weed competitive crop cultivars, weed smothering intercrops, non-chemical and biological methods of weed control, weed dynamics in crops and cropping systems, management of parasitic weeds, allelopathic studies, management of perennial weeds and other invasive weeds in non-crop areas and transfer of improved weed management technologies.

Laboratories

The Centre can boast of having well-equipped laboratories with modern scientific instruments like Gas Liquid Chromatography, (GLC), Gas Chromatography, HPLC, IRGA, atomic absorption spectrophotometer, universal research microscope with photographic attachment, stereo zoom research microscope, nitrogen auto analyzer, leaf area meter, UV-visible double beam spectrophotometer with colour image analysis system, high speed refrigerated centrifuge, millipore filter assembly, multi-probe soil moisture meter, chlorophyll meter, GPS etc. The Centre has a freezing microtome for histo-pathological studies and a lyophilizer for making myco-herbicidal formulations. The Centre has also acquired two controlled environmental chambers to facilitate research under controlled conditions, four open top chambers for studies on crop-weed competition under elevated CO_2 conditions, as well as a pneumatic boat for survey and surveillance of aquatic flora and fauna. The Centre has a well-developed agricultural engineering workshop with facilities for fabrication, designing and development of weed control tools and implements. In addition to these, facilities for herbicide screening, net/poly house, quarantine insectory and containment facility and an automatic weather station to record the daily weather data are also available.

New infrastructural facilities at the Centre

ARIS Cell and Library

Centre's ARIS cell is well equipped with computers, VSAT and LAN facilities color Xerox-cum-printer and A-0 Plotter. Specialized software like ARCInfo for GIS analysis, ERDAS Imagine for satellite image analysis besides the routinely used software for data analysis are also available. All the scientists are provided with internet facility. At present the library is having a total collection of 1762 books especially pertaining to weed science. It has modern

facilities such as CAB-PEST and CAB-SAC CD-ROMs and Current Contents on Diskette (CCOD) on biological sciences. As on date, the library subscribes to 67 Indian and 19 foreign journals. Reprographic and documentation facilities have been created for preparation of documents and reports.

Net working and collaboration

NRCWS acts as the Project Coordinating Cell for the AICRP on Weed Control, which is currently operating at 22 SAU's located at different agro-climatic zones of the country. The NRCWS also collaborates with several other educational and research institutions. A MoU has been signed with Jawaharlal Nehru Krishi Vishva Vidyalaya (JNKVV), Jabalpur enabling better collaboration in the area of research, teaching and extension. It has also been recognized by Rani Durgawati Vishva Vidyalaya (RDVV), Jabalpur as a post-graduate research centre for their students. In addition, the centre is open to several educational institutions all over the country for their research and training activities.

The Centre has active collaboration with several ICAR institutes and other research organizations like Delhi University and IIT, Delhi, DBT, DST, CSIR, ISRO etc. Besides, a healthy interaction exists between the Centre and the herbicide industry, NGOs and others.

Staff and finance

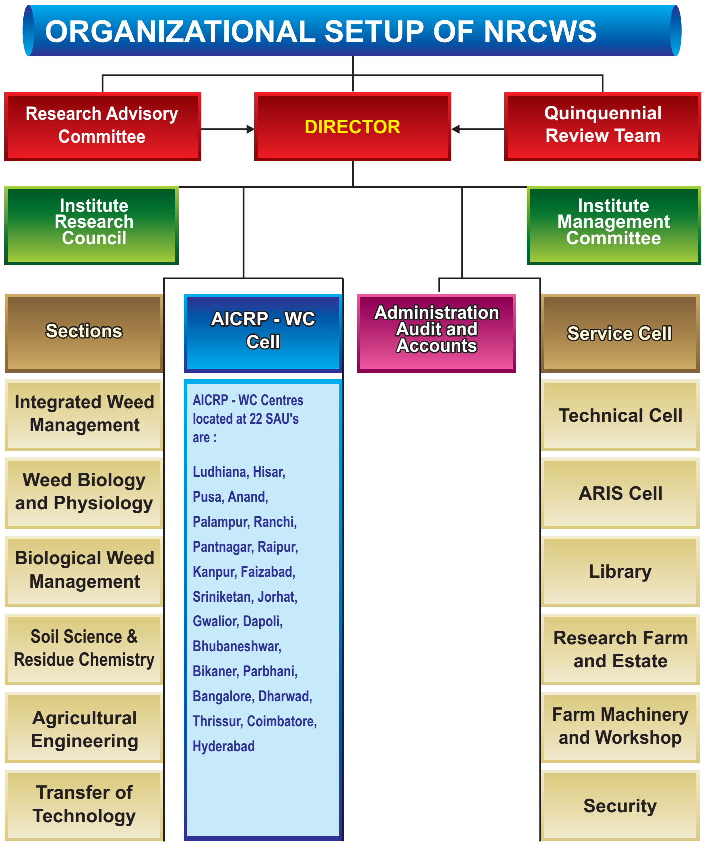
NRCWS has sanctioned cadre strength of 27 scientists, 24 technical, and 11 administrative and 23 supporting staff. The current staff position as on 31.03.2007 was 16 scientists including one post of RMP, 24 technical, 11 administrative and 21 supporting. The annual budget of the Centre for the year 2006-07 is indicated in Table1. The Centre also generates resources through the sale of farm produce and testing of new herbicide formulations provided by the industries.

Budget and expenditure for the year of 2006-07

Head	Plan		Non Plan	
	R.E.	Expenditure	R.E	Expenditure
Establishment Charges	10.00	13.73	135.00	135.00
O.T.A.	-	-	0.10	0.10
T.A	3.00	2.99	1.10	1.01
Other charges	39.16	39.15	102.80	102.77
Matching Grant	-	-	-	-
Works	67.34	63.61	-	-
Maintenance of office building	-	-	1.50	1.46
Maintenance of residential quarter	-	-	1.50	1.49
Other	-	-	-	-
Information Technology	-	-	-	-
HRD	2.00	2.00	-	-
TOTAL	**121.50**	**121.48**	**242.00**	**241.83**
AICRP-WC	**179.36**	**179.27**	-	-
NEH Region	22.00	21.99	-	-
Pension	-	-	1.60	1.59
Personal Loans & advances	-	-	8.00	7.99

Organizational set-up

Research programmes of the centre are being carried out in 6 sections under the administrative control of the director. The administrative office, accounts section, technical services, research sections and various other advisory committees of the institute support the overall administration. The Institute Management Committee (IMC) and Research Advisory Committee (RAC) assist in identifying priority research areas. The research laboratories are well equipped with state-of-art equipment and facilities.



2 RESEARCH ACHIEVEMENTS

A. HERBICIDE AS A TOOL IN WEED MANAGEMENT

1101. Testing of new molecules

Bioefficacy of fenoxaprop-p-ethyl for controlling weeds in jute

Anil Dixit and Jay G. Varshney

Jute is an important fibre crop. About 35-40% of the total cost of production in this crop goes to weeding only if done manually and 75-80% yield loss due to weed infestation is common which reduces profitability.

Fenoxaprop-p-ethyl was evaluated comprising of eight treatments as mentioned in Table 1. The experiment was conducted in a randomized block design, replicated thrice. The dominant weed flora consisted of *Echinochloa colona* (40%), *Digitaria* spp. (8%). *Cyperus rotundus* (7%), *Euphorbia hirta* (17%), *Phyllanthus niriri* (12%) and *Physalis minima (16%)*. Fenoxaprop-p-ethyl at all the rates was very effective against grassy weeds without adversely affecting the seed yield. Application of fenoxaprop-p-ethyl at lower dose also was equally effective in reducing the weed density and biomass. Weeds reduced the seed yield by 47%. Fenoxaprop-p-ethyl at 67 g/ha was significantly superior to pendimethalin and weedy check by recording the higher seed yield. This is due to reduction in crop-weed competition by fenoxaprop offering efficient and prolonged weed control leading to the higher seed yield (Table 1).

Table 1. Effect of treatments on weed density, weed biomass and seed yield of jute

Treatments	Rate of application (g/ha)	Weed density* (no./m^2)	Weed biomass (g/m^2)	Yield (kg/ha)
Fenoxaprop-p-ethyl	45	9.9 (99)	131	916
Fenoxaprop-p-ethyl	56	9.8 (96)	119	983
Fenoxaprop-p-ethyl	67	9.4 (88)	75	1033
Fenoxaprop-p-ethyl	135	8.7 (75)	66	1022
Quizalofop	62	10.7 (115)	103	1064
Pendimethalin	900	11.7 (140)	143	848
Weed free	-	0.7 (0)	-	1238
Weedy		13.2 (175)	175	651
LSD (P=0.05)		0.9	23	166

* Values are subjected to square root transformation

Bioefficacy and phytotoxicity of metsulfuron methyl 20 WG in transplanted rice

Anil Dixit and Jay G. Varshney

Bioefficacy of metsulfuron methyl 20 WG at four doses i.e. 2, 4, 5 and 8 g/ha applied at 20-25 DAT was compared with standard metsulfuron-metyl 20 WP at 4 g/ha and 2,4-D 500 g/ha alongwith weed free and weedy checks. The major weed flora of experimental plot consisted of *Echinochloa colona (28%), Commelina communis (19%), Alternanthera sessilis (33%) and Caesulia auxillaris (19%)*. The bulk of the weed flora comprised of broad-leaved weeds (71%).

Application of herbicides resulted in better control of broad leaf weeds. Weed biomass was reduced significantly as compared to unweeded check. The data on weed density and weed biomass at 60 days after sowing revealed that application of metsulfuron-methyl 20 WG at 4 g/ha reduced the weed density and weed biomass to a greater extent as compared to other treatments. Though the application of metsulfuron methyl at 8 g/ha recorded the lowest value of weed density and weed biomass but this dose was meant for phytotoxic purpose to rice plant. Weeds reduced and seed yield increased by 45%. The seed yield of rice crop was the highest under weed free situation followed by metsulfuron-methyl + 2,4-D application. There was no phytotoxicity of metsulfuron-methyl 8 g/ha on rice crop.

The aforesaid study revealed that metsulfuron methyl 4 g/ha + 2,4-D 500g/ha give an excellent control of broad-leaved weeds in transplanted rice.

Table 2. Effect of metsulfuron-methyl 20 WG on weed density, weed biomass and field of rice

Treatments	Rate of application (g/ha)	Weed density* (no./m^2)	Weed biomass (g/m^2)	Yield (kg/ha)
Metsulfuron-methyl	2+0.2% Surfactant	4.4(16)	59	3700
Metsulfuron-methyl	4+0.2% Surfactant	3.9(15)	42	4033
Metsulfuron-methyl	5+0.2% Surfactant	3.7(13)	39	3950
Metsulfuron-methyl	8+0.2% Surfactant	3.3(10)	27	4012
Metsulfuron-methyl	4+0.2% Surfactant	4.0(16)	40	3950
2,4-D	500	4.4(19)	34	3766
Metsulfuron +2,4-D	4+500	2.9(8)	23	4550
Weed free	-	0.7(0)	-	4688
Weedy		6.6(43)	88	2583
LSD (P=0.05)		0.7	10	382

*Values are subjected to square root transformation

Bioefficacy of ethoxysulfuron against broad- leaved weeds in transplanted rice

Anil Dixit and Jay G. Varshney

Weed infestation in rice reduce the seed yield to the tune of 10-70 per cent depending upon type of weed flora and severity of infestation. Barnyard grass (*Echinochloa colona*) dominated the rice crop besides some sedges and broadleaved weeds. In the present experiment, efficacy of ethoxysulfuron was tested against broadleaved weeds and sedges in transplanted rice as per treatments mentioned in Table 3.

Experimental field was infested with broadleaved weeds like *Caesulia auxillaris, Commelina benghalensis* and *Alternanthera sessilis*. *C. iria* (sedge) was also present in low density. All the weed control treatments resulted in significantly low density and biomass of weeds over weedy check. Ethoxysulfuron 60 WG at 20g/ha was as effective as 15WG of ethhoxysulfuron at 18.75g/ha and almix at 20 g/ha in reducing weed density and biomass. All the weed control treatments resulted in significantly higher grain yield over unweeded control.

Table 3. Effect of weed control treatments on weed density, weed biomass and yield of transplanted rice

Treatments	Rate of Application (g/ha)	Weed density* (no./m^2)	Weed biomass (g/m^2)	Yield (kg/ha)
Sunrice (Ethoxysulfuron) 60 WG	15	4.7(21)	56	3850
Sunrice (Ethoxysulfuron) 60 WG	17. 5	4.7(21)	39	3866
Sunrice (Ethoxysulfuron) 60 WG	20	3.8(14)	28	3873
Sunrice (Ethoxysulfuron) 15 WG	18. 75	4.3(19)	40	3800
Almix (Metsulfuron methyl 10% + Chlorimurom ethyl 10%) 20 WP	2+2	4.1(16)	27	3900
2,4-D EE	500	4.9(24)	33	3683
Manual weedings	-	0.7(0)	-	4196
Untreated control	-	7.6(57)	85	2880
LSD (P=0.05)		1.3	12	333

* Values are subjected to square root transformation

Bioefficacy of imazethapyr against weeds in soybean

Anil Dixit and Jay G. Varshney

Imazethapyr is a highly selective herbicide for the control of grassy as well as broad-leaved weeds in soybean. Imazethpyr was evaluated at 50, 75, 100, 150 and 200 g/ha applied as post-emergence and compared with quizalofop-ethyl at 50 g/ha, fenoxaprop-p-ethyl at 100 g/ha , weed free and untreated control. The experiment was conducted in a randomized block design replicated thrice.

The experimental field was infested with *Echinochloa colona, Alternanthera* sp., *Commelina communis, Dinebra retroflexa, Euphorbia geniculata,*and *Physalis minima*. The weed density recorded at 45 days after sowing revealed that the post-emergence application of imazethapyr at all rates reduced the population of weeds. Imazethapyr had shown good control of grassy as well as broad- leaved weeds in soybean. Activity of imazethapyr against monocot (*E. colona, Cyperus rotundus* and *D.retroflexa*) and dicot weeds (*C. benghalensis* and *E. geniculata*) increased with increase in dose upto 200 g/ha applied as post-emergence to soybean. Post-emergence application of imazethapyr at 100g/ha produced yield (1093 kg/ha) similar to that of quizalofop-p-ethyl 50g/ha (1054 kg/ha) and fenoxaprop-p-ethyl applied at 100g/ha (1121 kg/ha) applied as post-emergence to soybean. Weeds suppressed yield to the tune of 47% in comparison to weedy check.

Table 4. Effect of herbicides on weed density, weed biomass and yield of soybean

Treatments	Rate of Application (g/ha)	Weed density* (no./m^2)	Weed biomass (g/m^2)	Yield (kg/ha)
Imazethapyr	50	9.3(85)	99	1014
Imazethapyr	75	7.4(54)	79	1028
Imazethapyr	100	5.9(34)	52	1093
Imazethapyr	150	5.4(28)	38	1158
Imazethapyr	200	5.0(25)	32	1309
Quizalofop ethyl	50	6.1(37)	64	1054
Fenoxaprop ethyl	100	6.3(40)	72	1121
Weed free		0.7(0)	-	1479
Untreated control	-	9.8(95)	159	779
LSD (p=0.05)		0.6	13	184

* Values are subjected to square root transformation

Bioefficacy of metsulfuron- methyl 20WG in controlling broad-leaved weeds in wheat

Anil Dixit and Jay G. Varshney

Due to continuous use of herbicides for controlling grassy weeds in wheat, infestation of broadleaf weeds is increasing every year. At present mainly 2,4-D is being used against broad leaf weeds in wheat. This herbicide is less effective on field bindweed and wild pea. Moreover 2,4-D causes malformed spikes in many wheat varieties. So a new formulation of metsulfuron methyl (MSM) was evaluated in wheat against broad-leaved weeds. The experiment was carried out during *rabi* 2005-2006. Eight weed control treatments as given in table 5 were tested in a randomized block design. The experimental plot was found infested with *Avena ludoviciana*, *Chenopodium album*, *Medicago denticulata, Medicago hispida*, *Vicia sativa*, *Melilotus* sp. and *Lathyrus aphaca. Rumex dentata* and *Convolvulus arvensis* were also recorded in low quanttiy.

Significant reduction in weed density was observed due to application of herbicides when compared to untreated control (Table-5). Metsulfuron-methyl 20WG at 4 to 8 g/ha with surfactant significantly reduced the weed density particularly dicot weeds as compared to 2,4-D ethyl ester at 45 DAS. MSM 4-8 g/ha was at par but significantly better to 2,4-DEE.

Application of different doses of metsulfuron-methyl 20 WG significantly influenced grain yield. Application of metsulfuron-methyl at 4 -8 g/ha did not cause any significant influence in grain yield but showed was over metsulfuron-methyl 20 WP (Algrip) and 2, 4-D ethyl ester. No visual symptoms of injury or phytotoxicity were observed due to any of the treatments during the crop season.

Table 5. Effect of weed control treatments on weed density and biomass and grain yield of wheat

Treatment	Dose (g/ha)	Weed density (no./m^2*)	Weed biomass (g/m^2)	Yield (kg/ha)
Metsulfuron-methyl 20%WG +0.2% Surfactant	3	6.9(48)	59	3255
Metsulfuron-methyl 20%WG +0.2% Surfactant	4	6.2(38)	51	3300
Metsulfuron -methyl 20%WG +0.2% Surfactant	5	5.9(35)	49	3442
Metsulfuron -methyl 20%WG +0.2% Surfactant	8	6.0(36)	45	3510
Metsulfuron -methyl 20% WP (Algrip)	4	6.5(42)	58	3200
2,4-D ethyl ether ester	500	7.1(51)	68	3070
Weed free	-	0.7(0)	-	4312
Weedy Check	-	14.5(210)	120	1830
LSD (P=0.05)		0.5	11	234

* Values are subjected to square root transformation.

Bio-efficacy of penoxsulam (XDE 638) in Transplanted Rice

J.S. Mishra and Anil Dixit

Transplanted rice is infested with heterogeneous group of weeds under rainfed shallow lowland, which reduces yield up to 24-48%. A number of herbicides like butachlor, pretilachlor, anilofos, etc. have been recommended as pre-emergence for the control of early flushes of grassy weeds in transplanted rice. These herbicides though efficient but may not control all the weeds. Therefore, new herbicides are continuously needed for solving emerging new weed problems. A field experiment was conducted during rainy season of 2006 to evaluate the efficacy of penoxsulam 24 SC in transplanted rice. The treatments (Table 6) were evaluated in a randomized block design replicated thrice. Twenty-five days old rice (*cv*. Kranti) seedlings were transplanted on 5 July 2006 at 20 x 20 cm spacing. The total rain fall during the crop season was around 950 mm against the average rain fall of 1250 mm.

Effect on weeds

Weeds were not observed in herbicide treated plots at 20 days after transplanting (DAT). However, at 40 DAT *Echinochloa colona*, *Cyperus difformis*, *C. iria*, *Ammania baccifera*, *Caesulia axillaries* and *Alternanthera sessilis* were the major weeds. Penoxsulam 22.5 g/ha at 10 DAT was more effective in reducing the population and dry matter of *E. colona*, *Caesulia axillaries* and total weeds at 40 DAT (Table 6). Irrespective of the dose and time of application, penoxsulam was more effective in controlling major weeds as compared to butachlor and pretilachlor. All the doses and time of application of penoxsulam significantly reduced the total weed dry matter at harvest. Penoxsulam at 20-22.5 g /ha at 10 DAT and 25 g /ha at 5 DAT produced lower weed biomass and was at par to hand weeding twice.

Effect on crop

Different herbicides significantly influenced the yield attributes and yield of transplanted rice (Table 7). Different doses and time of application of penoxsulam did not significantly influence the number of panicles/hill, however, penoxsulam 22.5 g/ha at 10 DAT produced higher number of panicles as compared to other herbicidal treatments. Penoxsulam 22.5 g/ha at 10 DAT being at par with hand weeding twice significantly increased the number of grains per panicle as compared to weedy check. The 1000-grain weight was not affected due to treatments. Significantly, highest grain yield of rice (5519 kg/ha) was obtained with application of penoxsulam 22.5 g/ha at 10 DAT which was at par with hand weeding twice (5129 kg/ha) and penoxsulam 20 g/ha at 10 DAT (4840 kg/ha), but, significantly superior to butachlor (3613 kg/ha), pretilachlor (3375 kg/ha) and weedy check. The lowest grain yield (3228 kg/ha) was obtained in weedy check.

Table 6. Effect of different treatments on weed density (no./m^2) at 40 DAT

Treatment	Dose (g/ ha)	Time of application (DAT)	*Echinichloa colona*	*Cyperus spp.*	*Caesulia axillaris*	*Ammania baccifera*	*Alternanthera sessilis*	*Commelina spp.*	Total
Hand weeding	Twice	20 and 40	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)
Penoxsulam 24 SC	20	5	2.25 (4.7)	6.43 (40.7)	3.91 (14.7)	3.27 (10.3)	3.88 (14.7)	1.05 (0.7)	9.40 (87.7)
Penoxsulam 24 SC	22.5	5	2.21 (4.3)	4.00 (15.7)	3.70 (13.3)	3.90 (14.7)	1.91 (3.0)	1.17 (1.0)	7.69 (58.7)
Penoxsulam 24 SC	25	5	2.34 (5.0)	5.29 (27.7)	3.18 (9.7)	3.00 (8.7)	2.34 (5.0)	0.88 (0.3)	7.86 (61.3)
Penoxsulam 24 SC	17.5	10	2.66 (6.7)	5.39 (28.7)	3.32 (10.7)	2.50 (5.7)	2.13 (4.0)	0.71 (0.0)	8.07 (64.7)
Penoxsulam 24 SC	20	10	2.16 (4.3)	4.20 (17.0)	2.76 (7.0)	4.14 (16.7)	1.49 (1.7)	1.09 (0.7)	7.48 (55.7)
Penoxsulam 24 SC	22.5	10	1.39 (1.3)	3.75 (13.7)	2.46 (5.7)	3.32 (10.7)	2.41 (5.3)	0.71 (0.0)	6.27 (38.7)
Butachlor 50 EC	1250	5	3.01 (8.7)	2.73 (7.0)	4.18 (17.0)	3.87 (14.7)	2.02 (3.7)	1.09 (0.7)	7.48 (55.7)
Pretilachlor 50 EC	750	5	3.04 (8.7)	5.68 (31.7)	4.06 (16.0)	5.05 (25.0)	1.32 (1.3)	0.88 (0.3)	9.79 (95.3)
Weedy check			3.24 (10.0)	5.62 (31.0)	4.28 (17.7)	3.64 (12.7)	3.02 (8.7)	1.29 (1.3)	9.22 (84.7)
LSD (P=0.05)			1.36	2.21	1.00	1.02	1.92	0.68	1.99

Values are subjected to square root transformation. Figure in parentheses are original values.

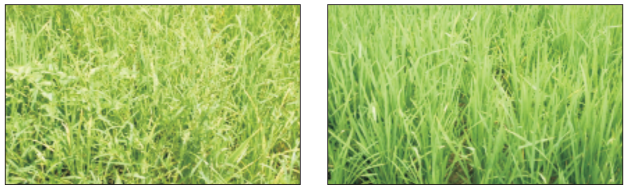


Fig. 1: Effect of penoxsulam on weeds in rice

Table 7. Effect of different treatments on weed dry weight, yield attributes and yield of rice

Treatment	Dose (g a.i. /ha)	Time of application (DAT)	Weed dry weight (g /m) at harvest*	Panicles /hill	Panicle length (cm)	Grains /panicle	1000-grain weight (g)	Grain yield (kg/ha)	Harvest index (%)
Hand weeding	twice	20 and 40	5.8 (34)	11.1	22.0	230	24.0	5129	37.0
Penoxsulam 24 SC	20	5	11.8 (139)	10.6	24.7	189	24.7	4174	34.4
Penoxsulam 24 SC	22.5	5	10.7 (115)	10.5	22.4	183	25.7	4262	32.7
Penoxsulam 24 SC	25	5	8.7 (75)	10.5	24.4	219	25.2	4351	31.6
Penoxsulam 24 SC	17.5	10	13.6 (185)	10.3	22.7	179	25.8	3885	32.9
Penoxsulam 24 SC	20	10	9.4 (87)	10.9	23.5	221	22.9	4840	38.5
Penoxsulam 24 SC	22.5	10	6.4 (41)	11.5	23.5	228	25.1	5519	38.6
Butachlor 50 EC	1250	5	14.6 (213)	10.1	23.3	196	24.3	3613	34.3
Pretilachlor 50 EC	750	5	16.2 (262)	9.7	22.6	181	25.5	3375	36.3
Weedy check			18.8 (354)	8.5	23.3	169	25.2	3228	32.5
LSD (P=0.05)			5.81	2.6	2.2	37	NS	893	7.1

*Values are subjected to square root transformation. Values in parentheses are original.

1201-Long- term effects of herbicides in cropping systems

V. P. Singh

Due to the continuous use of herbicides, there is a likelihood of development of resistant biotypes of weeds, which may cause problem in crop production system. The regular monitoring of weed flora in the system will enable to find out the change in weed flora succession and development of resistant biotypes, if any, due to the continuous use of herbicides. There is also every possibility of accumulation of applied herbicides in the food system and soil - water system of the region. Keeping the above facts in view, a long-term herbicide trial was started in 2002-03 in rice-wheat cropping system and in 2006-07 in soybean-wheat cropping system with objectives to monitor weed dynamics, weed flora shift, herbicide residues and productivity of crops due to continuous use of same herbicides.

Influence of continuous use of herbicides on weed dynamics and soil health in rice-wheat cropping system

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An experiment consisting of application several herbicides as per the details (Table 8) was laid out in a split-plot design. Rice variety 'Kranti' was transplanted in rows 20 cm x 10 cm apart in the first week of July, 2006 and wheat variety 'GW 273' was sown in rows 22.5 X 5 cm apart in mid November

2006. In rice *Echinochloa colona*, *Cyperus iria*, *Ammania baccifera*, *Commelina communis, Alternanthera sessilis* and *Caesulia auxillaris* were the dominant weed flora. Weed control treatments did not reduce the density of individual weed species except *Cyperus iria* and *Ammania baccifera*. The lowest population of these two weeds was recorded with butachlor 1.5 kg/ha that was at par with one hand weeding. Continuous use of herbicides did not influence the total weed density, however significantly lower weed dry biomass production was noticed with one hand weeding. The highest effective tillers per meter row were recorded under one hand weeding. Application of herbicides in preceding wheat had no residual effect on the growth of succeeding rice crop.

In wheat, *Phalaris minor*, *Avena ludoviciana* ssp *sterilis, Medicago hispida*, and *Chenopodium album* were dominant weed flora in the field. Continuous use of clodinafop-propargyl at 60 g/ha followed by 2, 4-D at 0.5 kg/ha significantly decreased the population of *P. minor* and *A. luidoviciana* over isoproturon at 1.0 kg/ha and weedy check, respectively. However, reduced population of *M. hispida* was recorded with sulfosufuron 25 g/ha and isoproturon 1.0 kg/ha that was significantly lower than clodinafop-propargyl at 60 g/ha. Clodinafop-propargyl at 60 g/ha followed by 2,4-D at 0.5 kg/ha had the lowest weed density and its dry matter and gave the highest grain yield of wheat, which was significantly superior to isoproturon and sulfosulfuron.

Table 8: Effect of continuous use of herbicides on weed dynamics in rice under long-term herbicide trial (rainy, 2006)

Treatments	Density (no m^{-2})					
	E. colona	*C. communis*	*C iria*	*Caesulia auxillaris*	*Ammania beccifera*	*Alternanthera sessilis*
Herbicides (rainy season)						
Butachloe 1.5 kg/ha (4 DAT)	1.9 (3.1)	1.6 (2.1)	3.4 (11.1)	2.6 (6.3)	2.8 (7.3)	2.2 (4.3)
Anilofos 0.4 kg/ha (4 DAT)	2.0 (3.5)	1.6 (2.1)	4.9 (23.5)	2.7 (6.8)	4.3 (18.0)	3.0 (8.5)
Manual weeding	1.3 (1.2)	1.0 (0.5)	3.8 (13.9)	2.5 (5.8)	3.5 (11.8)	2.6 (6.3)
Weedy check	2.0 (3.5)	1.5 (1.8)	4.9 (23.5)	2.8 (7.3)	3.6 (12.5)	1.9 (3.1)
LSD (P=0.05)	NS	NS	1.1	NS	1.2	NS
Herbicides (winter season)						
Clodinafop 60 g/ha (30 DAS) *fb* 2,4 - D 0.5 kg/ha (35 DAS)	1.7 (2.4)	1.4 (1.5)	4.7 (21.6)	2.8 (7.3)	3.9 (14.7)	2.6 (6.3)
Sulfosulfuron 25 g/ha (30 DAS)	1.8 (2.7)	1.3 (1.2)	4.5 (19.8)	2.5 (5.8)	2.9 (7..9)	2.1 (3.9)
Isoproturon 1.0 kg/ha (30 DAS)	1.7 (2.4)	1.3 (1.2)	3.9 (14.7)	2.7 (6.8)	3.8 (13.9)	2.5 (5.8)
Manual weeding	1.8 (2.7)	1.4 (1.5)	3.5 (11.8)	2.4 (5.3)	3.2 (9.7)	2.2 (4.3)
Weedy check	2.0 (3.5)	1.7 (2.4)	4.6 (20.7)	2.9 (7.9)	3.9 (14.7)	2.7 (6.8)
LSD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Values in parentheses are original

Table 9: Effect of continuous use of herbicides on weed growth, yield attributes and yield of rice as influenced by (rainy, 2006).

Treatments	Weed density (no. m^{-2})	Weed biomass (g/m^2)	Effective tillers/ meter row	Panicle length (cm)	Grains/ panicle	Grain weight/panicle (g)	Grain yield (kg/ha)
Hebicicides (Rainy season)							
Butachlor 1.5 kg/ha (4DAT)	6.4	3.4	46.6	21.1	134	3.4	4231
Anilofos 0.4 kg/ha (4DAT)	8.6	4.5	45.9	21.3	131	3.4	4119
Manual weeding	7.1	1.8	47.7	20.3	137	3.5	4322
Weedy check	7.7	4.7	39.4	19.6	129	3.2	4182
LSD (P=0.05)	NS	1.6	8.0	NS	NS	NS	NS
Hebicicides (winter season)							
Clodinafop 60 g/ha (30DAS) fb 2,4- D o.5 kg/ha (35DAS)	8.3	4.2	45.2	20.7	136	3.5	4406
Sulfosulfuron 25 g/ha (30DAS)	7.3	3.2	44.1	20.5	135	3.4	4285
Isoproturon 1.0 kg/ha (30DAS)	7.2	3.2	47.7	20.3	136	3.3	3988
Manual weeding	6.5	3.5	44.1	20.8	132	3.3	4057
Weedy check	8.0	3.9	44.6	20.5	129	3.3	4333
LSD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

Table 10: Weed dynamics as influenced by continuous use of herbicides in wheat (winter, 2005-06)

Treatment	Density (no m^{-2})				Total Weed density (no./.m^2)	Weed dry biomass (g/m^2)
	P. minor	*A. ludoviciana*	*M. hispida*	*C album*		
Butachlor 1.5 kg/ha (4DAT)- IPU 1.0 kg/ha (30 DAS)	6.7 (44.4)	3.6 (12.5)	1.1 (0.7)	0.7 (0.0)	8.0 (63.5)	9.3 (86.0)
Butachlor 1.5 kg/ha (4 DAT)- Sulfosulfuron 25 g/ha ((30 DAS)	4.4 (18.9)	3.8 (13.9)	1.7 (2.4)	2.4 (5.3)	6.9 (47.1)	8.4 (70.1)
Butachlor 1.5 kg/ha (4 DAT)- Clodinafop 60 g/ha (30 DAS)fb 2,4-D 0.5 kg/ha (35 DAS)	2.1 (3.9)	1.4 (1.5)	3.9 (14.5)	0.9 (0.3)	4.8 (22.5)	4.8 (22.5)
Anilophos 0.4 kg/ha (4 cDAT)- IPU 1.0 kg/ha (30 DAS)	4.0 (15.5)	6.6 (43.1)	1.5 (1.8)	0.7 (0.0)	6.9 (47.1)	9.1 (82.3)
Anilophos 0.4 kg/ha (4 DAT) - Sulfosulfuron 25 g/ha (30 DAS)	3.3 (10.4)	4.1 (16.3)	1.4 (1.5)	2.2 (4.3)	6.5 (41.8)	8.4 (70.1)
Anilophos 0.4 kg/ha (4 DAT) - Clodinafop 60 g/ha (30 DAS)fb 2,4-D 0.5 kg/ha (35 DAS)	1. 5 (1.8)	0.7 (0.0)	4.0 (3.5)	0.8 (0.1)	5.3 (27.6)	5.8 (33.1)
Weedy check	5.1 (25.5)	6.8 (45.7)	2.2 (4.3)	1.0 (0.15)	10.0 (99.5)	11.4 (129.5)
LSD (P=0.05)	2.4	2.9	1.4	0.9	1.8	1.5

Values in parentheses are original

Table 11: Effect of continuous use of herbicides on yield attributes and grain yield of wheat (winter, 2005-06)

Treatment	Plant height (cm)	No. of spikes /m row length	Ear length (cm)	100-grain wt (g)	Grain yield (kg/ha)
Butachlor 1.5 kg/ha(4 DAT)-IPU 1.0 kg/ha (25 DAS)	96.0	36.6	16.9	5.0	2681
Butachlor 1.5 kg/ha(4 DAT)-Sulfosulfuron 25 g/ha(30 DAS)	93.7	45.9	16.6	5.1	3331
Butachlor 1.5 kg/ha(4 DAT)-Clodinafop 60 g/ha 30 DAS) fb 2,4-D 0.5 kg/ha(35 DAS)	91.1	46.9	16.8	5.2	4203
Anilophos 0.4 kg/ha (4 DAT) -IPU 1.0 kg/ha(30 DAS)	96.0	39.5	16.5	5.0	2897
Anilophos 0.4 kg/ha (4 DAT)-Sulfosulfuron 25 g/ha(30 DAS)	92.5	43.4	16.7	5.1	3180
Anilophos 0.4 kg/ha (4 DAT)-Clodinafop 60 g/ha (30 DAS)fb 2,4-D 0.5 kg/ha (35 DAS)	88.7	49.9	16.4	5.3	3888
Weedfree	88.9	49.2	16.9	5.6	4210
Weedy check	96.8	26.7	16.2	4.7	2552
LSD (P=0.05)	5.4	7.2	0.8	0.4	799

Influence of continuous use of herbicides on weed dynamics and soil health in soybean-wheat cropping system

V P Singh, J S Mishra, Shobha Sondhia and Chandrabhanu

A field study as per the treatments given in Table 12 was laid out in a split-plot design with 3 replications. Soybean variety 'JS 335 was sown in rows 45 cm x 5 cm apart on 28th June, 2006 and wheat variety "Sujata" was sown in rows 22.5 X 5 cm apart in mid November 2006. Both the herbicides were applied as post-emergence at 20 DAS. The experimental field was mainly infested with *Echinochloa colona*, and *Dinebra* sp among grasses, *Commelina communis*, *Phyllanthus simplex*, *Physalis minima* among broadleaf weeds and *Cyperus iria* among sedges. Application of fenoxaprop 100 g/ha reduced the population of *E. colona* and *Dinebra* sp. whereas significantly lower population of *P. simplex* and *P. minima* was recorded with imazethapyr 70 g/ha. Lowest population of all weed species was observed with 1 hand weeding. Significantly lower weed density and weed biomass production was noticed with both the herbicides. Yield attributes *viz.* pods and seed weight per plant and seed yield of soybean were significantly influenced with application of both herbicides. Fenoxaprop 100 g/ha being at par with imazethapyr 70 g/ha produced significantly more pods per plant, seed weight per plant and seed yield over weedy check. However, highest yield attributes and seed yield of soybean were recorded with 1 hand weeding. Treatments of preceding crop did not show any impact on weed dynamics and growth of succeeding soybean.

Table 12: Weed dynamics in soybean as influenced by continuous use of herbicides under long-term herbicide trial (rainy, 2006)

Treatments	Density (no m^{-2})						
	E. colona	*C. communis*	*C iria*	*P. simplex*	*P. minima*	*E. geniculata*	*Dinebra* sp.
Herbicides (rainy season)							
Fenoxaprop 100 g/ha (25 DAS)	3.5 (11.8)	6.9 (47.1)	12.7 (160.8)	10.5 (109.8)	6.7 (44.4)	2.8 (7.3)	0.9 (0.3)
Imazathepyr 70 g/ha (25 DAS)	11.7 (136.4)	5.2 (26.5)	10.2 (103.5)	9.0 (80.5)	2.5 (5.8)	2.7 (6.8)	10.0 (99.5)
Manual weeding	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)
Weedy check	12.7 (160.8)	5.7 (32.0)	11.2 (124.9)	12.0 (143.5)	4.2 (70.1)	3.8 (13.9)	7.0 (48.5)
LSD (P=0.05)	1.1	3.0	2.0	2.9	1.2	1.3	2.8
Herbicides (winter season)							
Clodinafop 60 g/ha (30 DAS) fb 2,4- D 0.5 kg/ha (35 DAS)	9.2 (84.1)	4.3 (18.0)	11.6 (134.0)	8.3 (68.4)	3.6 (12.5)	3.4 (11.1)	5.7 (32.0)
Sulfosulfuron 25 g/ha (30 DAS)	9.2 (84.1)	4.5 (19.8)	10.7 (114.0)	7.4 (54.3)	3.4 (11.1)	2.8 (7.3)	6.4 (40.5)
Isoproturon 1.0 kg/ha (30 DAS)	9.6 (91.7)	4.7 (21.6)	11.6 (134.1)	7.5 (55.8)	3.3 (10.4)	3.1 (9.1)	6.3 (39.2)
Manual weeding	9.5 (89.8)	4.9 (23.5)	11.9 (141.1)	8.3 (68.4)	3.6 (12.5)	3.7 (13.2)	5.3 (27.6)
Weedy check	9.0 (80.5)	4.7 (21.6)	11.0 (120.5)	8.9 (78.7)	3.8 (13.9)	2.5 (5.8)	6.2 (37.9)
LSD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

Values in parentheses are original

Table 13: Weed growth and yield of soybean as influenced by continuous use of herbicides (rainy, 2006)

Treatments	Weed density (no./ m^2)	Weed biomass (g/m^2)	Pods/plant	Seed weight /plant (g)	Seed yield (kg/ha)
Herbicides (Rainy season)					
Fenoxaprop 100 g/ha (25 DAS)	20.6	8.9	18.7	2.9	899
Imazathepyr 70 g/ha (25 DAS)	21.4	9.4	17.2	2.6	828
1 hand weeding	0.7	0.7	30.2	6.6	1065
Weedy check	24.9	14.8	8.1	1.2	370
LSD (P=0.05)	3.0	1.7	8.9	1.4	251
Herbicides (winter season)					
Clodinafop 60 g/ha (30 DAS) fb 2,4- D 0.5 kg/ha (35 DAS)	22.3	8.6	20.3	3.3	810
Sulfosulfuron 25 g/ha (30 DAS)	22..3	8.4	23.4	3.7	798
Isoproturon 1.0 kg/ha (30 DAS)	22.3	8.2	20.7	2.9	778
1 hand weeding	22.8	8.2	19.6	3.0	829
Weedy check	21.8	8.9	21.1	3.6	737
LSD (P=0.05)	NS	NS	NS	NS	NS

1301. Influence of herbicides on soil micro-flora, soil fertility and productivity

KK Barman and PJ Khankhane

Effect of some post-emergent herbicides on soybean nodulation

Application of herbicides in *kharif* soybean is becoming the widely accepted weed control method in India. Since the symbiotic nitrogen fixation is an important aspect of soybean cultivation, a pot experiment was conducted to evaluate the impact of some new post emergence herbicides on soybean nodulation. Soybean (var. JS 335) was grown in pots-kept in a net house and the herbicides (Table 14) at recommended doses were applied after three weeks of sowing. The pots were destructively harvested at 40, 60 and 80 days; the root system was taken on a sieve, thoroughly washed against running water and the nodules were collected by separating them from the roots. The fresh nodules were cut and observed visually, nodules with pink coloured mass were considered as active nodule.

All the herbicides tested showed highly inhibitory effect on nodulation process in soybean at 40 d. Compared to control, the total and active nodule numbers and nodule dry matter per plant were significantly lower in the herbicide treated plants. Among the herbicides sethoxydim showed highest and fenoxaprop showed relatively least toxicity. The per-cent of total nodule that was found active was also lowest in case of sethoxydim. The herbicides have alos reduced the average size of the nodules (Table 15).

Table 14. Effect of herbicides on nodal count at different growth stages of soybean

Herbicides	40 days			60 days			80 days		
	Total no.(T)	Active no.(A)	100A/T	Total no.(T)	Active no.(A)	100A/T	Total no.(T)	Active no.(A)	100A/T
Imazethapyr 100g/ha	39	30	77	42	27	62	40	25	66
Quizalofop 60g/ha	45	37	82	38	22	58	55	26	50
Fenoxaprop 100g/ha	51	41	81	56	41	75	63	28	44
Sethoxydim 300g/ha	25	12	49	81	58	71	155	78	52
Control	96	83	88	144	115	81	146	93	65
LSD (P=0.05)	8	8	9	22	20	22	32	11	22

Table 15. Effect of herbicides on nodal weight at different growth stages of soybean

Herbicides	40 days		60 days		80 days	
	Total wt. mg/plant	Unit wt. mg/nodule	Total wt. mg/plant	Unit wt. mg/nodule	Total wt. mg/plant	Unit wt. mg/nodule
Imazethapyr 100g/ha	218	5.7	98	2.3	175	4.5
Quizalofop 60g/ha	303	6.7	117	3.2	181	3.6
Fenoxaprop 100g/ha	367	7.3	194	3.5	228	3.7
Sethoxydim 300g/ha	147	6.0	213	2.8	389	2.5
Control	888	9.4	236	1.7	420	2.9
LSD (P=0.05)	61	1.5	82	1.7	109	1.7

The toxic effect of herbicides on soybean nodulation was also highly significant at 60 d. Unlike at 40 d when sethoxydim showed highest toxicity, at 60d it showed lesser toxicity than imazethapyr, quizalofop and fenoxaprop in terms of active and total nodule count among the herbicides tested. Sethoxydim application resulted in the lowest nodule dry matter at 40d, but at 60d it showed highest nodule dry matter production among the herbicides tested and the value was statistically similar to that of control. At 80d, sethoxydim did not differ with control treatment in terms of total and active nodule count and also in terms of total nodule dry matter. Whereas, imazethapyr, quizalofop and fenoxaprop showed significantly lower values of both total and active nodule count as well as lower nodule dry matter production than control even at 80d. Thus, it may be concluded that all the herbicides tested were toxic to soybean nodulation, but the disappearance pattern of this toxicity varied greatly among the herbicides. The faster disappearance of toxicity was observed in case of sethoxydim. Imazethapyr, quizalofop and fenoxaprop were highly toxic to soybean-Rhizobium symbiosis and none of the tested parameters could over come the inhibitory effect of these herbicides till the growth stage of 80d. The data obtained from a field experiment with the graded doses of imazethapyr, quizalofop and fenoxaprop application (Table 18) have also reaffirmed the toxic nature of these three herbicides in terms of soybean nodulation.

Table 16. Effect of imazethapyr, quizalofop and fenoxaprop on soybean nodulation under field condition

Treatments	Nodule count			Nodule dry weight	
	Total no.(T)	Active no.(A)	100 A/T	Total wt. mg/plant	Unit wt. mg/nodule
Imazethapyr 50g/ha	98	86	88	422	4.3
Imazethapyr 75g/ha	80	64	81	294	3.7
Imazethapyr 100g/ha	69	52	76	228	3.4
Imazethapyr150g/ha	62	48	79	148	2.4
Imazethapyr 200g/ha	50	34	69	57	1.2
Quizalofop 50g/ha	70	51	74	238	3.4
Quizalofop 60g/ha	70	53	76	142	2.1
Quizalofop 75g/ha	60	47	79	73	1.2
Fenoxaprop 100g/ha	77	51	67	275	3.6
Weedy check	115	106	93	780	6.9
Manually Weeded	126	109	87	840	6.7
LSD (P=0.05)	12	7	11	74	1.1

Effect of isoproturon on decomposition and nutrient mineralization from plant residues

Isoproturon is a recommended wheat herbicide and widely used in India. The practice of sowing wheat under zero-till condition and subsequent application of herbicide to control weed infestation is increasing very rapidly in the wheat growing belt of our country. Under such condition the stubbles of the previous crops and other plant residues remain on the soil surface and hence directly receive the sprayed herbicides. An experiment was conducted to study the effect of isoproturon contamination of plant residues on their decomposition and subsequent release of plant nutrients. Rice straw, soybean crop residues and water hyacinth were chopped and taken in nylon bags and dipped in isoproturon solution (2000 ppm). After draining out the excess isoproturon solution from the plant residues, the bags were buried in a field at 0-10 cm depth. One set of bags without isoproturon treatment was also buried similarly. Three bags of each treatment were randomly taken out of the field after different periods of time, carefully washed to remove the adhering soil but without any loss of plant particles from it, dried, and analysed for the nutrient content of residues. The amount of residues disappeared from the bags were considered as the measure of decomposition.

The amount of residues remaining in the bags decreased with increase in the burial period, indicating the decomposition of residues in soil. The decomposition pattern varied significantly among the residues but not between the isoproturon treated and untreated bags. The mean P content of the residues during decomposition period also varied depending upon the resudue used but not by the isoproturon treatment (Table 19). Similar results were also noticed for S and K content (data not shown). The result thus showed that the decomposition process was affected by the quality of the residues and that isoproturon had no effect on their decomposition.

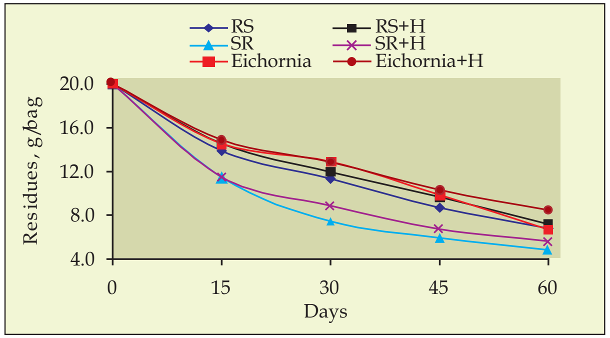


Fig. 2: Effect of isoproturon (H) on decomposition of rice straw (RS), soybean crop residues (SR) and *Eichornia*

Table 17. Effect of isoproturon on P content of the decomposing plant residues

Herbicide	P content, mg/kg			Mean
	Rice	Soybean	*Eichornia*	
Control	1.1	1.61	5.91	2.87
Isoproturon	1.04	1.72	5.85	2.87
Mean	1.07	1.66	5.88	
LSD (P=0.05)	Residue 0.24	Herbicide NS		

Effect of herbicides on VAM wheat association

VAM is a beneficial soil fungi lives in association with roots of most of the crop plants. It helps the plants in harnessing nutrients from the soil. Wheat root samples were collected from a field experiment that received post emergence application of clodinafop, sulfosulfuron and pinoxaden alone and in combination with a surfactant A12127. Wheat roots were thoroughly washed under running water, segmented and observed for VAM infection by following the standard procedures. Significant decrease in the VAM infection of wheat root was recorded with the increasing pinoxaden doses (Table 18). Pinoxaden in combination with the surfactant A12127 was found to be relatively more toxic to VAM than the pinoxaden alone. Compared to the control, clodinafop at recommended rate was more toxic than the pinoxaden and significantly decreased the VAM infection, while sulfosulfuron did not show any toxicity to VAM. It is concluded that sulfosulfuron is fully safe herbicide in terms of VAM-wheat association.

Table 18. Effect of pinoxaden, clodinafop and sulfosulfuron on wheat root infection by VAM

Treatments	% Root infection
Control	100
Pinoxaden 35g/ha (5EC)	87
Pinoxaden 40g/ha (5EC)	83
Pinoxaden 45g/ha (5EC)	80
Pinoxaden 50g/ha (5EC)	77
Pinoxaden 35g (10EC) + A12127(2L)	70
Pinoxaden 100g/ha (5EC) + A12127(1L)	70
Pinoxaden 200g/ha (5EC) + A12127(1L)	63
Clodinafop 60g/ha	60
Sulfosulfuron 25g/ha	93
LSD (P=0.05)	11

Effect of soil solarization on nutrient availability

Soil solarization is a nonchemical soil disinfestation method to control a variety of pathogens, weeds and arthropod pests. It harnesses solar energy for heating the soil. It involves hydrochemical processes leading to physical, chemical and biological changes in the soil. Soil samples collected from the plots after the solarization period of 42 d were analysed to study the changes in some of its chemical parameters (Table 19). The organic amendments, *viz*. FYM and wheat crop residue, were added at 0 and 5 t/ha prior to the imposition of solarization treatment.

Solarization showed significant effect on EC, content of soil organic carbon (SOC) and available nutrients. The EC of the soil increased in the solarized plots over their non-solarized counterparts, and the effect was highly significant in the FYM and wheat residue amended plots. This could be due to the release of cationic elements from the organic amendments during the solarization process. Compared to the unamended plots, FYM application significantly increased SOC content in both solarized and non-solarized plots. The addition of wheat residue, however, increased SOC content only under solarization treatment. The fast decomposition of residue under the effect of solarization could have made a contribution towards the soil organic carbon pool. Significant increase in the available P, S, K, Fe, Mn and Zn content in soil was recorded due to solarization treatment. No significant effect of solarization was noticed on soil pH and available Cu content.

Table 19. Effect of soil solarization on soil chemical properties and nutrient availability

Treatment	pH	EC (dSm^{-1})	SOC (%)	Available nutrient ($mg\ kg^{-1}$ soil)						
				P	S	K	Fe	Mn	Zn	Cu
NS	7.2	0.16	0.38	24.7	9.4	122	5.2	5.0	5.7	1.3
SS	7.1	0.17	0.36	37.9	13.5	138	7.4	8.2	7.2	1.4
SS+F	7.1	0.18	0.43	35.1	14.3	164	6.8	10.0	8.4	1.5
NS+F	7.2	0.10	0.45	27.8	11.3	120	4.3	4.5	5.2	1.3
SS+CR	7.2	0.18	0.45	30.0	11.1	149	5.6	7.3	6.0	1.4
NS+CR	7.2	0.14	0.39	23.3	6.3	134	5.2	5.8	5.7	1.3
LSD (P=0.05)	NS	0.02	0.04	3.7	2.4	14	0.6	0.5	1.1	NS

NS = Non-solarized, SS = solarized, F = Eym, CR = crop residue

1401. Efficient weed management through herbicide use

Effect of pre emergence and sequential application of herbicides in soybean

Anil Dixit and Jay G. Varshney

Soybean being a rainy season crop suffers badly due to severe competition by mixed weed flora. Single application of any herbicide has not been much effective in curbing the weed menace under diversified weed flora. Hence, an attempt has been made to use sequential application of herbicide for controlling weeds in soybean. A field experiment was conducted during *kharif* season consisting of eight treatments (Table 20) replicated thrice in a randomized block design. The experimental field was infested with *Echinochloa colona, Alternanthera* sp., *Commelina communis, Dinebra retroflexa, Euphorbia geniculata,* and *Physalis minima*. Results revealed that infestation of weeds reduced the seed yield of soybean by 74.6%. Metribuzin at 500g/ha was superior in reducing the weed density and biomass of weeds over pendimethalin 1000g/ha and flumioxazin 50g/ha. Sequential application of flumioxazin as pre-emergence at 50 g/ha followed by fenoxaprop-p-ethyl at 100 g/ha applied as post-emergence significantly reduced the weed growth and yielded at par to flumioxazin as pre-emergence followed by one hand weeding and metribuzin

Table 20. Effect of different herbicides in soybean

Treatments	Rate (g/ha)	Weed count (no./m^2)	Weed biomass (g/m^2)	Yield (kg/ha)
Metribuzin Pre-em	500	5.5 (30)	130	1266
Pendimethalin Pre-em	1000	5.9 (34)	156	966
Flumioxazin Pre-em	50	5.9 (34)	138	900
Flumioxazin Pre-em fb 1HW	50	4.5 (20)	108	1306
Flumioxazin Pre-em fb Fenoxaprop	50 +100	4.9 (24)	112	1283
Imazethapyr Post-em	1500	5.4 (29)	140	1076
Weed free	-	0.7 (0)	-	1833
Weedy Check		6.8 (46)	196	466
LSD (P=0.05)		0.3	24	292

Values are subjected to square root transformation

Herbicide mixture in direct seeded rice

Anil Dixit and Jay G. Varshney

Direct seeded rice is severely infested with grassy and broad -leaved weeds. With a view to find out herbicides, which can manage both the group of weeds, an experiment was laid out in a randomized block design replicated thrice. Treatments included six herbicide mixtures vis-à-vis weed free and weedy check. Herbicides were applied at 25 DAS with knapsack spayer using a spary volume of 500 L/ha. *Echinochloa colona, Cyperus iria, Ammania baccifera, Caesulia axillaries* and *Alternanthera sessilis* were the major weeds on the experimental site. Results revealed that tank mix application of cyhalofop + almix (70 g + 20 g/ha) and fenoxaprop + almix (60 g + 20 g/ha) applied at 25 DAS provided broad spectrum weed control and resulted in higher grain yield in direct seeded rice.

Table 21. Effect of treatments on weed density, weed biomass, weed control efficiency and grain yield of rice

Treatments (g/ha)	Weed density/m^{2*}	Weed biomass g/m^2	Weed control efficiency (%)	Grain Yield (kg/ha)
Cyhalofop-butyl 70	5.1 (26)	112	40	1420
Cyhalofop-butyl 90	4.7 (22)	96	49	1664
Cyhalofop-butyl 120	4.3(18)	82	56	1834
Cyhalofop-butyl +Almix (70+20)	4.2 (17)	72	61	1700
Cyhalofop-butyl +Almix (90+20)	4.2(17)	66	65	1853
Fenoxaprop+ Almix (60+20)	4.2 (17)	70	63	1848
Weed free	0.7 (0)	-	100	2387
Weedy Check	9. 6(91)	187	-	654
L.S.D (P=0.05)	0.5	11	-	211

** Data subjected to square root transformation; Values in parantheses are original.*

1601. Herbicide residues in soil and food chain

Shobha Sondhia

Herbicide residue estimation in soil and edible plant parts is very essential to determine the duration of herbicide activity in soil and its effect on the crops and to analyze the quality of the food at harvest. Since herbicides are necessary to achieve good yields, their residues may conflict with the crop management. Hence, residue studies were undertaken to see the persistence of herbicide in soil and crop produce.

Detection of metsulfuron-methyl residues in wheat grains, straw and soil

The terminal residues of metsulfuron-methyl were evaluated in wheat grains, straw and soil in *rabi* 2006. Metsulfuron-methyl was applied at 3, 4, 5 and 8 g/ha in wheat as post-emergence. Soil samples from the metsulfuron-methyl treated and untreated plots were collected at 30, 60, 100 days (at harvest) after herbicide application from a depth of 0-20 cm and used for residue studies. The soil samples were bulked together from each plot, air-dried, powdered and passed through a 2 mm sieve. The wheat grains and straw were sampled at the time of harvesting.

Soil, wheat grains and straw samples were extracted with acetonitrile: water (6:4) and after cleanup samples were analyzed by HPLC using PDA detector at 206 nm using acetonitrile: water as mobile phase with flow rate 1 ml/min. The retention time of metsulfuron-methyl was 2.2 minutes.

Metsulfuron-methyl residues in the soil of wheat crop were found to be 0.0088, 0.018, 0.0125 and 0.0236 µg/g, at 30 days at 3, 4, 5 and 8 g/ha rates respectively which decreased to 0.0002, 0.0003, 0.0006, 0.0039 µg/g and 0.001, 0.0003, 0.0002, 0.0020 µg/g at 60 and 100 DAS respectively at 3, 4, 5 and 8 g/ha rates.

Residues were found below the detection limit in wheat grains in all the doses however, 0.002 and 0.002 µg/g, residues were found in wheat straw at 5 doses and 8 g/ha respectively.

Detection of metsulfuron-methyl residues in rice grains, straw and soil

The terminal residues of metsulfuron-methyl were evaluated in rice grains, straw and soil in *Kharif* 2006. Metsulfuron-methyl was applied at 2, 4, 5, 8 g/ha and 4g/ha with surfactant in rice as post-emergence. Soil, rice grains and straw samples from the metsulfuron-methyl treated and untreated plots were collected at harvest after herbicide application from a depth of 0-20 cm and used for residue studies. The soil was bulked together from each plot, air-dried, powdered and passed through a 2 mm sieve. The wheat grains and straw were sampled at the time of harvesting.

Soil, rice grains and straw samples were extracted with acetonitrile: water (6:4) cleaned and analyzed by HPLC using PDA detector at 206 nm using acetonitrile: water as mobile phase with flow rate 1 ml/min. The retention time of metsulfuron-methyl was 2.2 minutes.

Metsulfuron-methyl residues were found to be below the detection limit (<0.001 ug/ml) in the soil of rice crop, paddy grains and straw at harvest in all the metsulfuron treated samples.

Imazethapyr residues in soybean grains, straw and soil at harvest

The terminal residues of imazethapyr were evaluated in soybean crop. Imazethapyr was applied at 100 g/ha as pre-emergence during *kharif* 2006. The soil, soybean grains and straw samples from the treated and untreated plots were collected at harvest from a depth of 0-20 cm to see the persistence of imazethapyr in soil. Samples were bulked, air-dried, powdered and passed through a 2 mm sieve. The soybean grains and straw were sampled at the time of harvesting (100 days).

Soil, grain and straw samples were extracted, cleaned and analyzed by HPLC. PDA detector at 250 nm was used to detect imazethapyr residues in various matrices at the detection limit of 0.001 ug/ml.

Imazethapyr residues were found 0.008, 0.102 and 0.301 µg/g in soil, soybean grains and straw respectively at harvest.

Evaluation of oxyfluorfen residues in onion and soil at harvest

The terminal residues of oxyfluorfen were evaluated in onion crop and soil in *rabi* 2006. Oxyfluorfen was applied at 150, 200, 250 and 300 g/ha in transplanted onion crop as post-emergence. The soil and onion samples from the oxyfluorfen treated and untreated plots were collected at harvest from a depth of 0-20 cm. Samples were bulked, air-dried, powdered and passed through a 2 mm sieve.

Soil and onion samples were analyzed at the detection limit of 0.001 µg/g. Oxyfluorfen residues were found 0.0015 µg/g in soil at 300 g/ha rate, however at lower application rates *viz*. 150-250 g/ha residues were found below the detection limit. Onion samples contained 0.0034, 0.0035, 0.0050 and 0.0460 µg/g residues of oxyflorfen at 150, 200, 250 and 300 g/ha rates respectively at harvest.

Evaluation of oxyfluorfen residues in rice grains and soil at harvest

The terminal residues of oxyfluorfen were evaluated in rice crop and soil. Oxyfluorfen was applied at 150, 175, 200, 225, 240 and 300 g/ha in transplanted rice crop as post-emergence. The soil and rice samples from the oxyfluorfen treated and untreated plots were collected at harvest from a depth of 0-20 cm to see the persistence of oxyfluorfen in soil. Samples were bulked, air-dried, powdered and passed through a 2 mm sieve. Soil, grain and straw samples were analyzed as described by Sondhia (2006) at the detection limit of 0.001 µg/g.

Oxyfluorfen residues were found to be 0.045, 0.048, 0.048, 0.049, 0.050, 0.051 µg/g in soil at 150 to 300 g/ha rates respectively. Rice grains samples contained 0.0053, 0.0053, 0.0055, 0.0058, 0.0058 and 0.0062 µg/g residues of oxyfluorfen at 150, 175, 200, 225, 240 and 300 g/ha rates respectively at harvest. However, rice straw showed 0.0033, 0.0032, 0.0033, 0.0037, 0.0038 and 0.0044 µg/g residues of oxyfluorfen at 150, 175, 200, 225, 240 and 300 g/ha rates respectively at harvest. .

Flumioxazin residues in soybean grains, straw and soil at harvest

The terminal residues of flumioxazin were evaluated in soybean crop and soil. Flumioxazin was applied at 30, 45, 60 and 90 g/ha as pre-plant incorporation (PPI) as well as pre-mergence (PE) in soybean crop during *kharif* 2006. The soil, soybean grains and straw samples from the flumioxazin treated and untreated plots were collected at harvest from a depth of 0-20 cm to see the persistence of flumioxazin in soil. Samples were bulked, air-dried, powdered and passed through a 2 mm sieve. The soybean grains and straw were sampled at the time of harvesting (100 days).

Twenty grams and fifty grams of each representative soil and crop samples were taken in 250 ml Erlenmeyer flask, and extracted with 50 and 100 ml of methanol: water (4:1) for 1 hour in a horizontal shaker (repeated twice) and further the flasks were washed with 50 ml of methanol: water (4:1). The contents were transferred to a 250 ml separatory funnel and partitioned the solution with methylene chloride 50 ml (twice). The lower methylene chloride layer was collected and combined. The organic layer was dried on anhydrous Na_2SO_4 and passed through activated charcoal. The solvent was evaporated to dryness on rotary evaporator. Finally residues were dissolved in 2 ml of methanol and analyzed by HPLC using RF 280 (Ex) and 405 (Em) nm. Using methanol: water (70:30) as mobile phase with flow rate 0.8 ml/min. At these conditions the retention time of sulfosulfuron was found 3.80 min. The detection limit of the method was 0.001 µg/ml.

Flumioxazin residues were found BDL the soil and grains applied as PPI. Residues in the grains and soil were BDL of 0.001 µ/g in treatment applied as PPI at the of doses 30 to 90 g ai./ha. However, 0.0012, 0.0022 and 0.0031 µg/g residues were detected in grains in treatments where flumioxazin was applied as PE at the doses 45, 60 and 90 g a.i./ha. Residues were BDL the straw at 30 and 45 g a.i./ha in PPI, however 0.0015 and 0.0024 µg/g were detected at 60 and 90 g a.i./ha doses respectively.

Terminal residues of fluazifop-p-butyl in soybean grains, straw and soil

The terminal residues of fluazifop-p-butyl were evaluated in soybean crop and soil. The treated soil and crop samples were collected during *kharif* 2006. Fluazifop-p-butyl was applied at 125, 250 and 300 g/ha as pre-mergence (PE) in soybean crop. The soil, soybean grains and straw samples from the fluazifop-p-butyl treated and untreated plots were collected at harvest from a depth of 0-20 cm to see the persistence of fluazifop-p-butyl in soil. Samples were bulked, air-dried, powdered and passed through a 2 mm sieve. The soybean grains and straw were sampled at the time of harvesting (100 days).

Soil, grain and straw samples were analyzed by HPLC using PDA detector at 225 nm using methanol: water (70:30) as mobile phase with flow rate 0.8 ml/min. At these conditions the retention time of fluazifop-p was found 3.60 min. and the detection limit of the method was 0.001 ug/g. The residue level of fluazifop p-butyl in soil was found 0.051, 0.064 and 0.079 µg/g at application rates of 125, 250 and 500 g/ha. Fluazifop translocated in the soybean crop and got accumulated in the grains and straw. Residues of fluazifop p-butyl were 0.472, 0.554 and 0.702 µg/g in soybean straw and 0.297, 0.300 and 0.312 µg/g in soybean grains at 0.125, 0.250 and 0.500 kg ai ha, respectively. Residues of fluazifop-p were found below the MRL value (2.0 mg/kg) at harvest in soil, grains and straw.

Terminal residues of anilofos in paddy grains, straw and soil at harvest

The terminal residues of anilofos were evaluated in paddy crop and soil. The anilofos treated soil and crop samples were collected during *kharif* 2006. Anilofos was applied at 300, 450 and 600 g/ha (GR) as pre-mergence (PE) in rice crop. The soil, soybean grains and straw samples from the anilofos treated and untreated plots were collected at harvest from a depth of 0-20 cm to see the persistence of anilofos in soil. Samples were bulked, air-dried, powdered and passed through a 2 mm sieve. The rice grains and straw were sampled at the time of harvesting (100 days).

Soil, rice grains and straw samples were extracted with acetone, partitioned with dichloromethane, cleaned and analyzed by HPLC using RF detector at 280 (Ex) and 405 (Em) nm. Using methanol: water (70:30) as mobile phase with flow rate 0.8 ml/min. At these conditions the retention time of anilofos was found 3.83 min. the detection limit of the method was 0.001 µg/ml.

The residue level of anilofos in soil was found to be 0.049, 0.058 and 0.070 µg/g at application rates of 300, 450 and 600 g/ha. Anilofos translocated in the rice crop and got accumulated in the grains and straw. Residues of anilofos were 0.076, 0.078 and 0.160 µg/g in rice grains and 0.079, 0.084 and 0.110 µg/g in rice straw at application rates of 300, 450 and 600 g/ha, respectively. Residues of anilofos were found below the MRL value (2.0 mg/kg) at harvest in soil, grains and straw.

1801. Studies on herbicide residues in long-term herbicide trial in soybean-wheat cropping system

Shobha Sondhia

Soil samples from field at different time interval viz. 1, 30, 60, 90 and 120 days after spraying of herbicides isoproturon, clodinafop and sulfosulfuron were collected. Samples were processed and analyzed for herbicide residues by HPLC using PDA detector at 215, 206 and 230 nm for clodinafop, isoproturon and sulfosulfuron respectively using acetonitrile: water as mobile phase at 1.0 ml/min flow rate.

Isoproturon residues in the soil of wheat crop were found to be 1.25 µg/g at 0 days which got down to 0.65, 0.36, 0.010 µg/g at 30, 60 and 90 DAS respectively. Isoproturon dissipated almost 100 % after 120 days in the soil of wheat crop. 0.012 and 0.031 µg/g, residues were found in wheat grains and straw, respectively which were below the maximum residue limit.

Sulfosulfuron residue in the soil of wheat crop was 0.20 ppm at 0 days which decreased to 0.020, 0.012, 0.001 µg/g at 30, 60, and 90 DAS, respectively. Sulfosulfuron residues were not detected at 120 days after spraying and dissipated 100 % in the soil of wheat. However , 0.001 and 0.0013 µg/g residues were was detected in the wheat grains and straw at harvest.

Clodinafop residue in the soil of wheat crop was found 0.539 and 0.12 µg/g at 0 and 30 DAS, respectively which got further degraded to 0.002 and 0.001 µg/g at 60 and 90 DAS respectively. Residue was not detected at 120 DAS. However, in grains and straw, 0.032 and 0.040 µg/g residues respectively were detected at harvest.

1901. Studies on herbicide residues in long-term herbicide trial in rice-wheat cropping system

Shobha Sondhia

Monitoring of anilofos residues in long term herbicide trial of rice-wheat cropping system

The field trial in rice-wheat cropping was conducted to see the persistence of anilofos under rice-wheat cropping system in a randomized block design with three replicate plots during *kharif* 2006. Anilofos was applied at 500 g/ha as pre-mergence (PE) in rice crop. The soil, rice grains and straw samples from the of anilofos treated and untreated plots were collected 0, 15, 30, 60, 90 and 120 days after herbicide application from a depth of 0-20 cm to see the persistence of anilofos in soil. Samples were bulked, air-dried, powdered and passed through a 2 mm sieve. The rice grains and straw were sampled at harvest.

Soil, rice grains and straw samples were extracted with (1:1), partitioned, cleaned and analyzed by HPLC using RF detector at 280 (Ex) and 405 (Em) nm. Using methanol: water (70:30) as mobile phase with flow rate 0.8 ml/min. At these conditions the retention time of anilofos was found 3.83 min. The detection limit of the method was 0.001 µg/ml

The residue level of anilofos in soil was found 0.442, 0.294, 0.211, 0.154 and 0.075 µg/g at 0, 15, 30, 60 and 90 days after herbicide application. However, at 120 days residues were fund BDL(<0.001µg/g). Halflife of anilofos in soil under long-term rice-wheat cropping system was found to be 37.62 days.

Anilofos translocated in the rice crop and got accumulated in the grains (0.056 µg/g) and straw(0.071 µg/g).

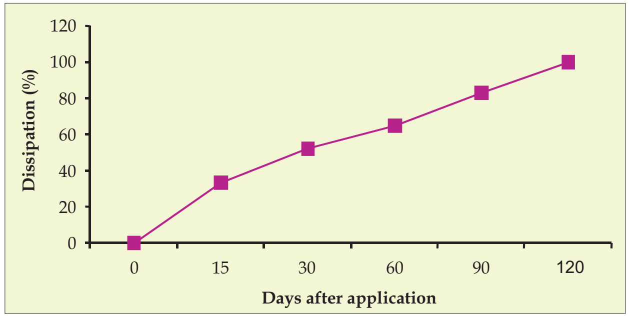


Fig. 3: Dissipation of anilofos in rice field

Anilofos dissipated at a faster rate initially and by 15 and 30 days approximately 34 and 52 % dissipation was noticed under field condition. However, by 60 and 90 days more than 65 and 83 % dissipation was observed and at 120 days it dissipated completely (Fig.3).

Monitoring of fenoxaprop residues in a long-term trial of rice -wheat cropping system.

Shobha Sondhia

Field trial was conducted to see the persistence of fenoxaprop under rice-wheat cropping system in a randomized block design with three replicate plots during *kharif* 2006. Fenoxaprop-p-ethyl was applied at 100 g/ha in rice. The soil samples from the of fenoxaprop treated and untreated plots were collected 0, 15, 30, 60, 90 and 120 days after herbicide application from a depth of 0-20 cm to see the persistence of fenoxaprop in soil. The soil samples were bulked together from each plot, air-dried, powdered and passed through a 2 mm. The rice grains and straw were sampled at the time of harvesting (100 days).

Soil, rice grains and straw were analyzed by HPLC using PDA detector at 235 nm using acetonitrile-water as mobile phase at 1.0 ml/min flow rate. Under these conditions fenoxaprop was eluted at 2.15 min.

The residue level of fenoxaprop in soil was found to be 1.253, 0.535, 0.275, 0.203, and 0.089 µg/g at 0, 15, 30, 60 and 90 days after herbicide application. However, at 120 days residues were found BDL(<0.001µg/ml) in the soil samples. Half life of fenoxaprop in soil BDL was found 26.03 days (Figure 4). Fenoxaprop residue was found 0.0024 and 0.0013 µg/g at harvest in the paddy grains and straw, respectively which were below the maximum residue limit (0.5 mg/kg).

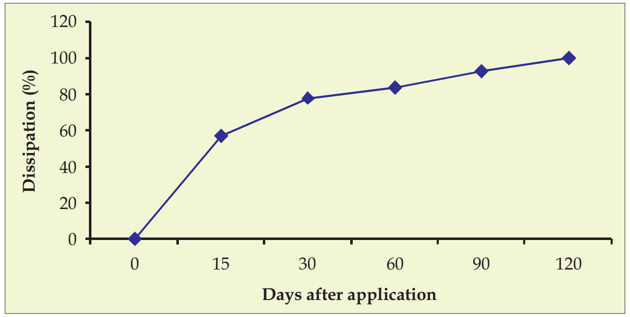


Fig: 4 Dissipation of fenoxaprop residues in rice field

Fenoxaprop dissipated at a faster rate initially and by 15 and 30 days approximately 57 and 78 % dissipation was noticed under field condition. However, by 60 and 90 days more than 83 and 92 % dissipation was observed and at 120 days it dissipated completely.

B. WEED BIOLOGY AND ECO-PHYSIOLOGY

2101. Biology of major weeds

Influence of soil type and moisture availability on the success of *Cassia tora* in suppression of *Parthenium hysterophorus*

V.S.G.R. Naidu

A series of lab and pot culture experiments were conducted to study the effect of *Cassia tora* seed leachates, moisture availability and soil type on the suppression of *Parthenium hysterophorus* by *Cassia tora*. In a first experiment, the C*assia tora* seeds were placed in close contact with *Parthenium* seeds (fresh and washed seeds separately) on filter paper in different combinations (Cassia:Parthenium in the ratios of 1:24, 5:19, 9:16 and 10:15). The filter papers were watered sufficiently to allow the seed leachates to move out. Then the germination was observed. It was observed that the leachates from the *C. tora* seeds were clearly visible as dark brown stain surrounding the seed. The fresh seeds of *Parthenium* did not germinate but the seeds that were subjected to washing showed germination in all the combinations of *C. tora* associations (Fig 1.) This indicates the self inhibition of *Parthenium* seed germination rather than the effect due to contact with and leachates from the *C. tora* seeds.

In second experiment, the *Cassia tora* seeds were soaked over night and the seed leachates of different concentrations (0%, 1%, 5%, and 10% of aqueous extracts of seeds) were prepared. These leachates were applied to *Parthenium* seeds on both fresh and washed seeds (washing durations were 24, 28 and 32 hours) which were placed on filter paper in Petri-dishes. The germination was observed. There was no germination when leachates were applied to fresh seeds. Whereas, in case of washed seeds the % germination was reduced with the increasing concentration of *C. tora* seed leachates but not completely inhibited even at high (10%) concentration (Fig 2, Plate. 1). This also suggests that the seed germination in *P. hysterophorus* was self inhibitory and *C. tora* might have an additive effect.

The third experiment was conducted in continuation of the above two experiments and to confirm the role of soil moisture availability and soil type on the Parthenium seed germination and on the performance of *Cassia* tora on the suppression of Parthenium. The seeds of *Cassia tora* and of *Parthenium* were sown in different combinations in pots filled with sandy and clay soils separately. The density was twenty seeds per pot. These pots were watered at variable intervals (T_0-Intial watering with subsequent no watering, T_1- Daily watering, T_2- Watering once in two days T_3- Watering once in three days and T_4- Watering once in four days) to create different durations of moisture availability in two different types of soils.

It was observed that the daily watering (T_1) increased the germination. The enhanced germination in *Parthenium* seeds in T_1 compared to T_0 especially in sandy soil was due to the removal of germination inhibitors from the seeds by regular watering. In case of combination (*Cassia* + *Parthenium*), the *Parthenium* seed germination (76%) was higher than that of *Cassia tora* (63%) in sandy soil, whereas, in clay soil the *Parthenium* seed germination (34%) was less than that of *C. tora* (53%) especially in case of regular moisture supply (T_1). This is the clear indication that when there is plenty of moisture availability the *Parthenium* seeds will have quick and increased germination provided the seed born inhibitors are leached out and this can be possible in light soils. In this case the *C. tora* can not be so successful if *Parthenium* seeds germinate prior to *C. tora*. Withholding the water for more than two days has affected the germination of both the species but the effect was more on *Parthenium*. Intermittent rain or little moisture availability in clay soil and a heavy rain followed by a dry spell in sandy soil can favour the advancement of *C. tora* over *Parthenium*.

In this case the *C. tora* cannot be so successful if *Parthenium* seeds germinate prior to *C. tora*. Withholding the water for more than two days has affected the germination of both the species but the effect was more on *Parthenium*. Intermittent rain or little moisture availability in clay soil and a heavy rain followed by a dry spell in sandy soil can favour the advancement of *C. tora* over *Parthenium*.

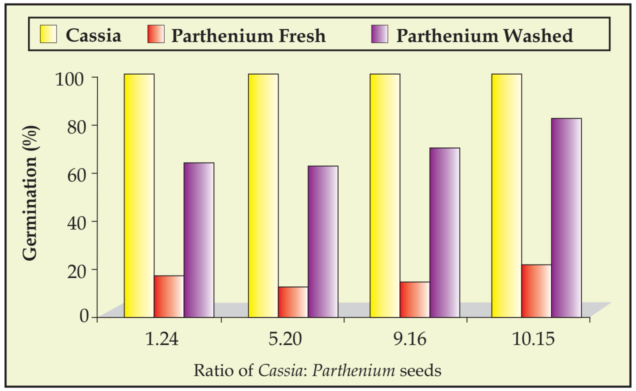


Fig. 5: Effect of seed leachates from co-existing *C. tora* seeds on *Parthenium* seed germination on filter paper.

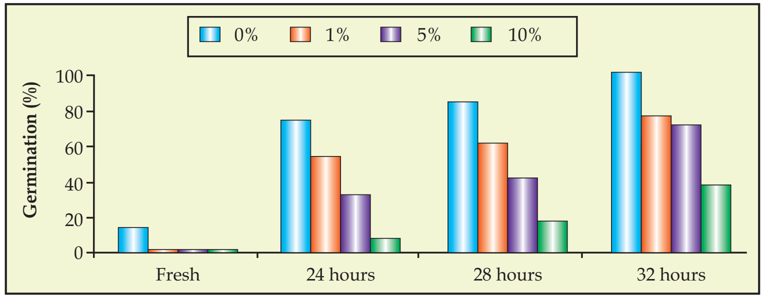


Fig. 6: Effect of aqueous seed leachates of *C. tora* on *Parthenium* seed germination on filter paper

Plate 1: Effect of different concentrations of aqueous extracts of *Cassia tora* seed leachates on germination of *Parthenium* seeds subjected to 32 hours washing.

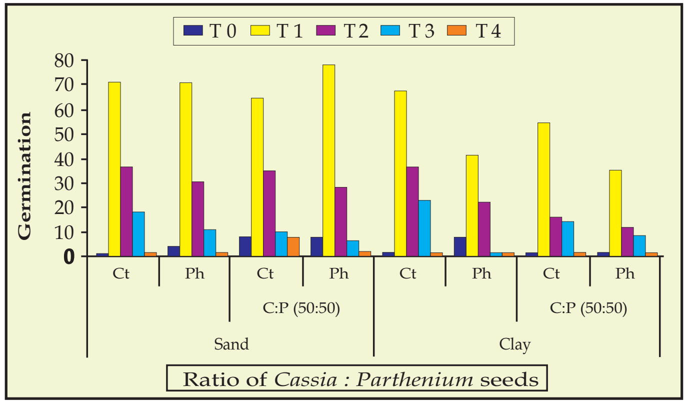


Fig. 7: Effect of moisture availability and soil type on seed germination in *C. tora* and *Parthenium hysterophorus*.

2201-Weed flora shift in cropping systems

Effect of alternate use of herbicides on weed dynamics in direct seeded rice-wheat and transplanted rice-wheat cropping systems

V P Singh, J S Mishra and Shobha Sondhia

Crop rotations facilitate herbicide rotation in the cropping systems and may reduce the chance of undesirable ecological shift to tolerant weed species, minimize the chance of herbicide residue in the soil and cause reduction in the weed seed population in the soil. Therefore, a field experiment was conducted to study the weed flora distribution under two cropping systems *viz*. direct seeded rice-wheat and transplanted rice-wheat with four weed control treatments *viz*. continuous application of sulfosulfuron 25 g/ha, clodinafop 60 g/ha fb 2,4-D 0.5 kg/ha and alternate year use of clodinafop 60 g/ha fb 2,4-D 0.5 kg/ha and sulfosulfuron 25 g/ha along with weedy check. The experiment was laid out in split-plot design with three replications. Results revealed that different cropping systems did not influence the weed dynamics. However, lowest density of *Avena ludoviciana*, *Phalaris minor* and *Chenopodium album* was noticed under transplanted rice-wheat system. Among weed control measures, significantly lesser density of *Avena sterilis*, *Phalaris minor* and *Chenopodium album* were recorded with continuous use of clodinafop 60 g/ha *fb* 2,4-D 0.5 kg/ha which was at par with alternate year use of clodinafop and sulfosulfuron. Whereas lowest population of *Medicago hispida* and *Physalis minima* was noticed with sulfosulfuron 25 g/ha as compared to weedy check. Continuous application of clodinafop at 60 g/ha followed by 2, 4-D 0.5 kg/ha was found effective in reducing the weed growth and increasing yield attributes and grain yield of wheat. None of the cropping systems influenced the yield attributes and grain yield of wheat. However, higher yield attributes and grain yield of wheat were recorded under direct seeded rice-wheat cropping system.

Table 22. Effect of cropping systems and herbicides on weed dynamics and weed growth in wheat at 90 DAS (Winter, 2005-06)

Treatments	Density (no./m²) at 90 DAS						Total weed density (no./m²)	Weed biomass (g/m²)
	Avena sterilis	*Medicago hispida*	*Chenopodium album*	*Phalaris minor*	*Lathyrus aphaca*	*Physalis minima*		
Cropping systems								
Direct seeded rice-wheat	7.8 (60.3)	3.5 (11.8)	2.7 (6.8)	3.1 (9.1)	1.8 (2.7)	1.5 (1.8)	11.1 (122.7)	14.2 (201.1)
Transplanted rice-wheat	6.7 (44.4)	3.7 (13.2)	2.4 (5.3)	2.8 (7.3)	1.8 (2.7)	2.0 (3.5)	10.6 (111.9)	15.0 (224.5)
LSD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Herbicides								
Sulfosulfuron 25 g/ha	13.3 (176.4)	1.3 (1.2)	2.8 (7.3)	3.8 (13.9)	0.9 (0.3)	1.4 (1.5)	14.3 (204.0)	16.7 (278.4)
Clodinafop 60 g/ha *fb*. 2,4-D	1.1 (0.7)	5.5 (29.8)	1.6 (2.1)	2.9 (7.9)	2.4 (5.3)	2.8 (7.3)	7.7 (58.8)	11.4 (129.5)
Alt. use (Clodinafop 60 g/ha *fb*. 2,4-D)	1.5 (1.8)	5.5 (29.8)	1.9 (3.1)	2.0 (3.5)	2.3 (4.8)	2.2 (4.3)	7.3 (52.8)	9.7 (93.6)
Weedy check	13.0 (168.5)	2.2 (4.3)	3.9 (14.7)	3.0 (8.5)	1.3 (1.2)	0.7 (0.0)	14.1 (198.3)	20.8 (432.1)
LSD (P=0.05)	1.8	0.7	1.1	1.4	0.7	1.0	1.8	2.6

Values in parentheses are original.

Table 23. Effect of cropping systems and herbicides on plant height, yield attributes and grain yield of wheat. (Winter, 2005-06)

Treatments	Plant height (cm)	Tillers/meter row length	Grains/ear	100 grain wt (g)	Grain yield (kg/ha)
Cropping systems					
Direct seeded rice-wheat	94	56	41	5.52	2718
Transplanted rice-wheat	93	51	43	5.32	2441
LSD (P=0.05)	NS	NS	NS	NS	NS
Herbicides					
Sulfosulfuron 25 g/ha	95	52	41	5.36	2487
Clodinafop 60 g/ha *fb*. 2,4-D	93	67	43	5.39	3667
Alt. use (Clodinafop 60 g/ha *fb*. 2,4-D)	92	64	46	5.80	3490
Weedy check	95	31	37	5.12	675
LSD (P=0.05)	2.8	9.0	6.9	0.58	493

Effect of soil solarization on weed dynamics in niger-tomato cropping system

V P Singh, J S Mishra, K K Barman and Chandrabhanu

Interest in non-chemical approaches for weed management has been growing due to increased concern regarding the hazardous effects of chemicals to environment and the consumers. Considering this harvesting of solar energy through soil solarization for controlling soil-borne pests including weeds may be the key option to reduce the dependency on chemicals. Therefore a field experiment was designed to assess the effectiveness of soil solarization for a period of 45 days on weed dynamics in niger-tomato cropping system. Treatments consisted of non-solarization and soil solarization with and without FYM and crop residue as main plot treatments along with 3 weed-control measures, *viz*., recommended dose of herbicide, half of recommended dose of herbicide as per crop and weedy check. Treatments were replicated 3 times in a randomized block design in factorial arrangement. The experimental field was infested mainly with *Echinochloa colona Cyperus iria, Phyllanthus niruri, Commelina communis, Dinebra* sp. and *Euphorbia geniculata* during rainy season in niger and *Avena ludovieiana, Cichorium intybus, Vicia sativa* and *Medicago hispida* during winter season in tomato. Soil solarization (SS) for a period of 45 days either alone or in combination with FYM and crop residue provided season long control by reducing the emergence of all weed species by over 85 per cent in niger and by more than 70 per cent in tomato. Emergence of *M. hispida* and *V.sativa* during winter season was not checked by soil solarization. Similar trend was also observed with total weed density and weed biomass production. Among weed control treatments, application of recommended dose of metribuzin (0.5 kg/ha) or half of its recommended dose (0.25 kg/ha) reduced emergence of all weed species except *P. niruri* and *C communis* in niger and *A.ludoviciana, C.intybus* and *M. hispida* in tomato. Higher seed yield of niger (4.41 kg/ha) and fruit yield of tomato (31.6 t/ha) were recorded with soil solarization + FYM, which were at par with SS alone or with crop residue. Highest seed yield of niger under soil solarization was due to its favourable effect on yield attributes *viz*., capsules per plant, seeds per capsule and seed weight per plant. Recommended dose of metribuzin under non-solarized (NS) condition helped to attain the maximum seed yield of niger and fruit yield of tomato. However, in solarized treatments even half of recommended dose of herbicide was found appropriate to produce the similar yield of the crops.

Table 24. Long-term effect of soil solarization on weed dynamics weed growth and seed yield of niger (Rainy 2006)

Treatments	Density (no/m)								
	Echinochloa colona	*Cyperus iria*	*Phyllanthus niruri*	*Commelina communis*	*Dinebra* sp.	*Physalis minima*	Total Weed density (no.m^2)	Weed dry biomass (g m^{-2})	Seed yield (Kg/ha)
Solarization									
Non-solarization (NS)	5.2 (26.5)	8.2 (66.7)	9.1 (82.3)	3.7 (13.2)	2.8 (7.3)	2.9 (7.9)	15.9 (252.3)	8.3 (68.4)	104
NS+FYM	4.9 (23.5)	9.4 (87.9)	8.3 (68.4)	3.9 (14.7)	3.7 (13.2)	3.6 (12.5)	16.9 (285.1)	9.2 (84.1)	224
NS+ Wheat straw	5.9 (34.3)	9.6 (91.7)	9.8 (95.5)	3.5 (11.8)	3.8 (13.9)	3.3 (10.4)	17.5 (305.8)	8.0 (63.5)	112
Soil solarization (SS)	1.9 (3.1)	2.9 (7.9)	1.5 (1.8)	0.8 (0.1)	2.9 (7.9)	0.8 (0.1)	6.8 (45.7)	4.7 (21.6)	425
SS +FYM	1.3 (1.2)	2.6 (6.3)	1.1 (0.7)	0.9 (0.3)	3.2 (9.7)	0.9 (0.3)	7.6 (57.3)	5.5 (29.8)	441
SS + Wheat straw	2.3 (4.8)	3.7 (13.2)	1.2 (0.9)	1.0 (0.5)	3.7 (13.2)	0.9 (0.3)	7.8 (60.3)	5.2 (26.5)	401
LSD (P=0.05)	1.4	2.8	2.7	0.8	NS	0.9	1.9	1.5	118
Weed control									
Pendimethalin 0.65 kg/ha PE	3.0 (8.5)	6.2 (37.9)	5.9 (34.3)	2.3 (4.8)	2.0 (3.5)	2.3 (4.8)	11.5 (131.8)	6.6 (43.1)	307
Pendimethalin 1.25kg/ha PE	2.1 (3.9)	4.1 (16.3)	6.0 (35.5)	2.6 (6.3)	2.0 (3.5)	2.0 (3.5)	10.8 (116.1)	6.1 (36.7)	337
Weedy check	5.6 (30.9)	8.0 (63.5)	3.6 (12.5)	1.9 (3.1)	6.0 (35.5)	1.9 (3.1)	13.9 (192.7)	7.8 (60.3)	209
LSD (P=0.05)	0.7	1.7	0.9	0.4	1.2	0.5	1.8	0.6	98

Values in parentheses are original

Table 25. Long-term effect of soil solarization on plant growth of niger (Rainy 2006)

Treatments	Plant Population (No./m^2)	Plant height (cm)	Capsules /plant	Seeds /capsule	Seed yield (kg/ha)
Solarization					
Non-solarization (NS)	13.8	142	38.8	30.3	104
NS+FYM	15.6	143	38.6	25.9	224
NS+Wheat straw	14.2	127	29.1	25.9	112
Soil solarization (SS)	19.4	182	96.6	33.6	425
SS +FYM	21.8	171	92.4	31.5	441
SS + Wheat straw	17.4	143	58.9	27.7	401
LSD (P=0.05)	4.8	11	18.7	6.4	118
Weed control					
Pendimethalin 0.65 kg/ha	17.3	163	58.5	28.5	307
Pendimethalin 1.25kg/ha	21.2	167	69.8	34.4	337
Weedy check	12.7	136	48.4	24.6	209
LSD (P=0.05)	4.4	6	7.0	2.8	98

Table 26. Long-term effect of soil solarization on weed dynamics, weed growth at 60 DAS and fruit yield of tomato (winter 2005-06).

Treatments	Density (no.m^{-2})					Total Weed density (no./m^2)	Weed dry wt (g/m^2)	Fruit yield (t/ha)
	A. ludoviciana	*C. intybus*	*M. hispidai*	*V. sativa*	*P. minima*			
Soil solarization								
Non-solarization (NS)	5.1 (25.5)	3.6 (12.5)	6.8 (45.7)	1.4 (1.5)	2.5 (5.8)	10.9 (118.3)	10.0 (99.5)	18.3
NS+FYM	5.2 (26.5)	3.5 (11.8)	7.2 (51.3)	1.4 (1.5)	4.8 (22.5)	12.3 (150.8)	9.8 (95.5)	19.3
NS+Wheat straw	6.4 (40.5)	4.0 (15.5)	8.2 (66.7)	1.3 (1.2)	2.8 (7.3)	14.6 (212.7)	11.4 (129.5)	15.9
Soil solarization (SS)	0.8 (0.1)	1.1 (0.7)	9.0 (80.5)	2.9 (7.9)	0.8 (0.1)	10.2 (103.5)	6.5 (41.8)	27.0
SS +FYM	0.8 (0.1)	1.0 (0.5)	11.4 (129.5)	3.9 (14.7)	0.7 (0.0)	12.9 (165.9)	8.5 (71.8)	31.6
SS + Wheat straw	0.9 (0.3)	0.9 (0.3)	11.6 (134.1)	4.4 (18.9)	0.7 (0.0)	13.4 (179.1)	9.2 (84.1)	28.0
LSD (P=0.05)	1.2	0.8	2.9	1.7	1.3	NS	1.1	8.7
Weed control measures								
Metribuzin 0.50 kg/ha	2.9 (7.9)	1.7 (2.4)	4.4 (18.9)	2.2 (4.3)	2.3 (4.8)	7.8 (60.3)	6.1 (36.7)	34.6
Metribuzin 0.25 kg/ha	3.2 (9.7)	2.0 (3.5)	7.0 (48.5)	2.8 (7.3)	2.2 (4.3)	9.7 (93.6)	8.0 (63.5)	25.9
Weedy check	3.5 (11.8)	3.3 (10.4)	15.7 (246.0)	2.7 (6.8)	3.1 (9.1)	19.6 (383.7)	13.6 (184.5)	9.6
LSD (P=0.05)	0.5	0.6	2.9	NS	NS	2.9	1.2	4.1

Values in parentheses are original

Integrated management of *Saccharum spontaneum* in mustard

V P Singh and J S Mishra

Tiger grass (*Saccharum spontaneum* L.) popularly known as *Kans* is a serious perennial weed of pastures, sugarcane and tea. It is a common weed of wheat and unranked weed of cotton, jute, maize, peanut, rice and sorghum in India. It has infested nearly 4 million hectares of fertile cultivable land of the country. Hence, a field experiment was conducted to develop an integrated management strategy for tiger grass in cropped situations. Treatments comprised of glyphosate 2.0 kg/ha alone, sequential application of glyphosate 2.0 kg/ha followed by glyphosate 1.5 kg/ha, cutting followed by glyphosate 2.0 kg/ha and control. These treatments were given before sowing during May - July. After sowing, pre-treated plots were superimposed by different doses (100-150 g/ha) of quizalofop. Initial count of shoots of *Saccharum spontaneum* was recorded before spraying of glyphosate. The field was kept undisturbed for 2-3 months after spray and thereafter, it was ploughed and mustard variety '*Pusa bold*' was sown in rows 40 X 15 cm apart in mid October, 2006. Results revealed that sequential application of glyphosate 2.0 kg/ha followed by 1.5 kg/ha at an interval of 2 months during May-July under non-crop situation gave season-long control of *kans* and higher seed yield of mustard. Further application of quizalofop with 100-150 g/ha in glyphosate treated plot did not show any more response toward control of *kans* but under weedy check plot, quizalofop gove effective control of *kans* and higher seed yield of mustard.

In another experiment crops *viz.,* chickpea, pea, lentil and mustard were evaluated against *S. spontaneum* under weedy check, weed free and herbicide treated situations. Reduction in yield of different crops due *kans* infestation varied from 11-35 and 25-52 per cent over herbicide and weed free condition, respectively. Lowest reduction in yield was recorded with pea and lentil.

Table 27. Integrated management of *Saccharum spontaneum* in mustard

Treatments	*Saccharu m* population (no./m²) at 60 DAS	*Saccharum* population (no./m²) at Harvest	Weed dry weight (g/m²)	Seed yield (Kg/ha)
Glyphosate 2.0 kg/ha fb Glyphosat 1.5kg/ha	12.4	36.5	58.4	957
Cutting fb Glyphosate 2.0kg/ha	19.2	58.8	107.3	726
Glyphosate 2.0 kg/ha alone	23.4	55.4	113.3	815
Control	70.6	178.0	314.3	380
Selective herbicide				
Quizalofop 100 g/ha	24.4	90.7	139.3	677
Quizalofop 125 g/ha	21.2	73.3	110.8	682
Quizalofop 150 g/ha	18.4	30.3	61.3	1006
Check	61.5	134.4	281.8	514
LSD (P=0.05)	12.7	24.5	15.8	88

Table 28. Evaluation of crops against *Saccharum sontaneum*

Treatments	Seed yield (kg/ha)			
	Pea	Lentil	Mustard	Chickpea
Herbicide	1948	1223	890	867
Weed free	2322	1445	1486	1058
Weedy check	1733	1095	701	570
% reduction over herbicide	11.0	10.5	21.2	34.3
% reduction over WF	25.0	24.0	52.0	46.2

2501. Effect of nutrient supply on crop-weed competition

M.B.B. Prasad Babu and V.P. Singh

Effect of nitrogen application on competitive interaction between rice and *Echinochloa colona*

Increasing the supply of nitrogen (N) can increase the ability of cereals to suppress weeds leading to a decline in the number of species, density and biomass. However, the effects on individual weed species differ. Growth of some species can be expected to decrease as a result of greater competition, while that of others, which can gain competitive advantage, may be increased. In order to investigate the effects of N application on inter-specific competition between rice and *Echinochloa colona*, field experiments were conducted in microplots. Six treatments comprising three species combinations (rice monoculture, weed monoculture and rice and weed mixture in equal proportions) and two levels of N supply (0 kg and 60 Kg N/ha) were replicated four times in a randomized block design.

Leaf area index (LAI) and plant height of rice and *E. colona* both in monoculture and mixtures were found to increase with the application of 60 kg N/ha. The plant height of rice was significantly lower than that of *E. colona*, both with and without N application (Table 29).

Table 29. Effect of N and crop-weed (*E. colona)* interaction on LAI and plant height of rice

Treatment	Plant height (cm) at DAS						LAI at DAS					
	Rice			*E. colona*			Rice			*E. colona*		
	20	40	60	20	40	60	20	40	60	20	40	60
Monoculture												
N_0	18.9	36.1	43.6	41.1	60.3	70.1	0.71	1.2	1.9	1.2	2.5	2.7
N_{60}	20.5	45.6	59.3	50.2	70.9	80.3	1.5	1.9	2.6	2.9	3.6	4.2
Mixture												
N_0	17.1	31.1	33.6	40.1	55.3	65.3	0.4	0.8	1.3	1.1	2.5	2.6
N_{60}	18.5	41.1	48.5	45.3	61.6	72.9	0.5	1.2	1.6	2.1	3.1	3.3
LSD (P=0.05)	0.11	4.22	4.51	0.61	5.14	5.53	0.11	0.12	0.11	0.21	0.13	0.13

Application of N decreased the dry weight of *E. colona* in mixture with rice as compared to that in monoculture. *E. colona* caused 38 and 34 per cent biomass reduction at N0 and N60 levels, respectively. The reduction in rice seed yield due to competition by *E. colona* was 35 per cent at N_{60}, which was lower than that of 39 per cent at No.

Table 32. Effect of N on crop-weed (*E. colona)* interaction and yield attributes of rice

N level	Crop biomass (g/m²)	Effective tillers/m	No. of seeds/panicle	Test wt (g)	Seed yield (g/m²)	Harvest index
Monoculture						
N_0	400.0	100.0	30.0	29.1	140.0	35.0
N_{60}	550.0	170.0	38.0	31.1	200.0	36.4
Mixture						
N_0	250.0	50.0	22.0	27.3	85.0	34.0
N_{60}	360.0	81.1	31.0	29.1	130.0	36.1
LSD (P=0.05)	36.0	15.3	2.3	1.1	25.0	0.9

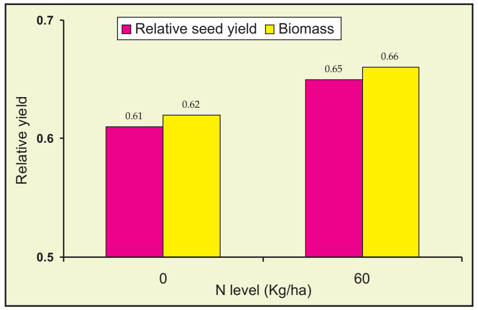


Fig. 8: Relative yield of rice as affected by N application

2601. Germination, dormancy and ageing of weed seeds

D.K. Pandey

Germination of *Parthenium hysterophorus* seeds collected at monthly intervals

The study was aimed at investigating germination of *Parthenium hysterophorus* seeds collected at monthly intervals at different temperatures to see interaction of seasons if any. The seeds collected were air dried and subjected to germination at different temperature in the dark following the method standardized in the laboratory.

Results of the experiment during second year confirmed those obtained earlier in that i. parthenium seeds collected from the weed stands in different months germinate well at about 20°C; ii. the seeds in general show slow germination at 10 and fewer seeds germinated at 30°C; iii. the seeds which fail to germinate at 10°C, do germinate on subsequent incubation at about 20°C; iv. the seeds which fail to germinate at 30°C, do germinate on subsequent incubation at 20°C; v. thus, suitable temperature of about 20-24°C is critical for germination of majority of the seeds of the weed.

Germinability of *Parthenium hysterophorus*, *Phalaris minor* and *Avena ludoviciana* seeds in response to submergence in water at different temperatures

Repetition of the experiment on germination of *Parthenium hysterophorus* seeds in response to submergence in water at different temperatures showed that submergence of the seeds at 40°C resulted in loss of germination by 8.4±9 days. The *Phalaris minor* seeds treated similarly at 40°C lost germination by 6.5±0.5 days. Similarly, *Avena ludoviciana* seeds submerged in water at 40°C lost germination by 6.5±0.5 days. The results have implications on devising eco-friendly weed management strategies.

C. DEVELOPMENT AND EVALUATION OF INTEGRATED WEED MANAGEMENT TECHNIQUES

3101. Role of weed competitive crop cultivars in integrated weed management

R. P. Dubey

Competitiveness of upland rice genotypes against *Alternanthera sessilis* (*kharif* 2006)

Alternanthera sessilis is a serious weed in direct seeded up land rice**.** A field experiment was conducted to evaluate the **c**ompetitiveness of 3 upland rice genotypes against various densities of *A. sessilis*. Three rice varieties (Vandana, Kalinga and Annada) in main plots and *A. sessilis* densities (0,0.5,1,2,4,6,and 8 plants / m^2) in sub plots were evaluated in split plot design with three replications.

Among the 3 upland rice varieties, 'Vandana' was a better competitor than 'Kalinga' and 'Annada'. The plant height and panicles/m^2 were significantly higher in 'Vandana' as compared to 'Kalinga' and Annada. Eight plants of *A. sessilis* caused 61 % reduction in grain yield of rice.

Table 31. Effect of rice varieties and densities of *A. sessilis* on their growth and yield

Treatments	Plant height (rice) (cm)	Plant height *A. sessilie* (cm)	Panicles (/m²)	*A. sessilis* seed yield (g/m²)	Rice grain yield (g/m²)
Varieties					
Vandana	76	86	506	96	237
Kalinga-III	64	83	343	137	184
Annada	44	50	328	133	169
LSD (P=0.05)	2	6	47	35	32
A. sessilis (No./m²)					
0	65	77	664	0	284
0.5	63	75	441	46	247
1	61	76	458	88	228
2	61	73	432	120	203
4	60	72	291	166	166
6	59	66	222	197	140
8	59	73	235	236	110
LSD (P=0.05)	NS	7	78	30	23

3201. Design, development and evaluation of mechanical weeding tools as a component of integrated weed management

H.S. Bisen

Design improvement and prototype development of different designs of improved weeding tools and implements

With the objective of transferring the mechanical weed control technology fabrication of prototypes of different improved mechanical weeders (17 nos.) *viz.,* twin wheel hoe, three tyned hand cultivator, crescent hand hoe has been carried out in center's workshop. The angle of sharpness of blade of these improved weeders has been kept between 10 to 15 degrees. The blades have been made in such a way that the rake angle of cutting blade vary between 20 to 25 degrees in order to improve penetration of blade in soil. These mechanical weeders were sold to interested farmers and organizations.

Evaluation of engine-powered aquatic weed cutter was carried out in Gosalpur pond near Sihora. The aquatic weed cutter was improved during the year in its power transmission from engine to cutterbar through propeller shaft, and similarly from engine to blade type rotor. Sliding system of cutterbar was also refined and improved by collapsible square section. These improvements were carried out keeping proper balancing of the machine particularly shifting the foundation of AD-8 engine and second boat/ propelling engine. The performance of the aquatic weed cutter was evaluated in actual aquatic weedy conditions.

Table 32. Performance of engine power aquatic weed cutter

Particulars	Performance data
Working width of cut of aquatic weed cutter, (m)	1.2
Forward speed of operation of aquatic weed cutter/harvester, (km/hr.)	0.9 to 1.8
Work capacity of machine, (sq. m/hr)	1080 to 2160 (0.108 to 0.216 ha/hr)
Cost of engine powered aquatic weed cutter/harvester	12.0 lakhs
Fixed cost of machine, (Rs/hr)	260.0 (Keeping 600 hrs of use per year).
Operating cost of machine (Fuel etc), (Rs/hr)	140/-
Labour required during operation of machine, (Rs/hr)	4 persons 60/-
Operating cost of machine, (Rs/hr)	200/-
Total cost of operatio n machine (fixed cost + operating cost) , (Rs/hr)	260/- + 200/- = 460/-
Cost of aquatic weed cutting, (Rs/hr)	4500/- (Considering the work capacity of 0.108 ha/hr)

Development of weed collection unit for ponds and water bodies

This project was initiated to develop a weed collector unit to work in conjunction with the aquatic weed cutter. In order to develop a weed collector unit, quantities of weed mases present in aquatic weedy situation were assessed by its volume and weight. The typical dry matter produced in by different aquatic weeds were ranging from 23.0 to 50.6 t/ha in case of fast growing aquatic weeds namely *Typha latifolia, Eichhornia crassipes, Phragmites communis, Thalassia testudimm, Cyperus attemifolius, Saggittaria sublata.* Studies have indicated that 20-40 tonnes of wet water hyacinth could be harvested per ha per day. About 800 kg dry matter per ha per day has been reported to be yielded.

Studies have indicated that about 300 man-hrs are required to remove one ha of water hyacinth by manual harvesting using simple tools. Mechanical weeding methods achieve only incomplete removal due to considerable regeneration of biomass from root, remaining shoot and root parts available in the water bodies after cutting the weeds.

The weed collector conceived for development will be a mobile unit with an engine of 30 hp (minimum). It will pick-up the cut weeds from a waterbody and conveys these to the shore in batches after its collection. Dragnets and a belt conveyor will be designed and used for collecting the weeds but small weeds will be skimmed out of net.

The background and review of designs of the problem is carried out for development of weed collector unit. The problems faced are that except floating weeds e.g. water hyacinth, other emerged weeds are not found in ponds of Jabalpur region. The other constraints faced were that the water reduces drastically in ponds and reservoirs after rainy season. The development of the aquatic weed collector machine is being undertaken.

3301. Effect of tillage and weed control measures on weed dynamics in different cropping systems

J.S. Mishra and V.P. Singh

Effect of tillage and herbicide on weed dynamics and productivity of winter crops after transplanted rice

Keeping the success of zero tillage in wheat in rice-wheat system, an experiment was repeated during 2005-06 to see the effect of this technology on weed dynamics and productivity of other winter season crops. The crops included were pulses (lentil-JL 40-70, chickpea-JG 315 and field pea-JP 885) and oilseeds (rapeseed-mustard-Pusa bold and linseed-JL 23). The main plot treatments were winter crops, tillage in sub-plots (Conventional and zero), and weed control (weedy and pendimethalin 1.0 kg/ha as pre-em) in sub-sub plots. Samples for soil seed bank studies were taken from different soil depths (0-5, 5-10 and 10-20 cm) after completion of 2nd year.

Field pea and rapeseed-mustard smothered the population of *Vicia sativa* more effectively as compared to other crops. Population of *Medicago hispida* was suppressed in field pea, but wild oat became a dominant weed in lentil. Linseed suppressed *Phalaris minor* and mustard *Chenopodium album* (Table 33). Zero tillage significantly reduced the population of *C. album* but increased the population of *V. sativa*. Population of *M. hispida* was not affected significantly. Pendimethalin 1.0 kg/ha as pre-em. gave effective control of *C. album* but less effective against dominant weeds viz., *V.sativa, M. hispida* and *Avena ludoviciana*. Zero tillage reduced the yields of rapeseed-mustard but did not affect much the yields of other crops (Table 34). Soil weed seed bank studies revealed that irrespective of the tillage and weed species, maximum seeds were found on the upper surface (0-5 cm depth). Zero tillage increased the seed bank of *Medicago hispida* and *Vicia sativa* but reduced the seed bank of *P. minor* and *C. album* (Table 35).

Table 33. Effect of different crops, tillage and herbicidal treatments on weed population at 30 DAS

Treatment	Weed population (No/m²)					
	V. sativa	*M. hispida*	*A. luduviciana*	*P. minor*	*C. album*	Total
Crops						
Lentil	9.5 (90)	9.5 (90)	3.6 (12)	3.1 (9)	3.2 (10)	14.7 (216)
Pea	4.3 (18)	8.4 (70)	2.1 (4)	3.5 (12)	5.1 (26)	11.7 (136)
Chickpea	9.1(82)	9.7 (94)	1.7 (2)	4.0 (16)	3.7 (13)	15.0 (225)
Linseed	8.6 (73)	10.6 (112)	1.6 (2)	2.9 (8)	3.8 (14)	14.8 (219)
Mustard	5.9 (34)	10.8 (116)	2.8 (7)	3.4 (11)	2.8 (7)	14.6 (213)
LSD (P=0.05)	1.4	0.6	0.5	0.6	0.9	1.1
Tillage						
ZT	8.4 (70)	9.9 (98)	2.4 (5)	3.3 (10)	2.2 (4)	14.1(198)
CT	6.6 (43)	10.1(102)	2.3 (5)	3.5 (12)	5.2 (27)	14.2 (201)
LSD (P=0.05)	0.8	NS	NS	NS	1.4	NS
Herbicide						
Pendimethalin 1.0 kg/ha as per-em	7.0 (49)	8.8 (77)	2.0 (4)	3.2 (10)	3.0 (9)	12.5 (156)
Weedy check	8.0 (64)	10.3 (106)	2.7 (7)	3.6 (12)	4.4 (19)	15.7 (246)

Data subjected to square root transformation, Values in parentheses are original

Table 34. Interaction effect of crops and tillage on seed yield (kg/ha)

Crops	ZT			CT		
	Pendimethalin	Weedy	Mean	Pendimethalin	Weedy	Mean
Mustard	2133	2167	2150	2633	2200	2417
Lentil	303	129	216	264	157	210
Linseed	1500	966	1233	1318	951	1135
Pea	2583	1458	2021	2042	1083	1562
Chickpea	715	253	484	711	337	524

Table 35. Effect of tillage on soil weed seed bank in different soil depths

Tillage (T)	Mean of different crops (No./500 g soil)							
	M. hispida				*V. sativa*			
	0-5 cm	5-10 cm	10-20 cm	Mean	0-5 cm	5-10 cm	10-20 cm	Mean
ZT	34.67	12.4	4.8	12.29	2.91	2.25	0.33	1.83
CT	16.27	8.6	4.67	9.85	0.50	0.75	0.0	0.47
Mean	25.47	10.5	4.74		1.71	1.50	0.17	
LSD (P=0.05)	T-2.67	D-3.18	TxD-4.35		T-0.58	D-0.70	T x D-1.0	
	P. minor				*C. album*			
ZT	2.42	1.0	0.42	1.28	2.83	2.67	0.67	2.06
CT	2.75	2.17	0.42	1.78	8.17	3.75	2.41	4.78
Mean	2.59	1.59	0.42		5.50	3.21	1.54	
LSD (P=0.05)	T-2.45	D-3.01	T x D-4.08		T-1.11	D-1.09	T x D-1.92	

Integrated weed management in zero-till direct seeded irrigated rice

J.S. Mishra and V.P. Singh

Due to rising cost of labour and excessive water use in puddling for transplanting, direct seeding of rice is gaining importance. Weed management is however, a major concern in direct seeded rice (DSR). Uncontrolled weeds in DSR cause 80-100% reduction in grain yield. With the availability of proper weed management technology, it is possible to raise the productivity of DSR. The cost of weed management could partially or completely be compensated with savings in tillage operations in zero tillage (ZT). Keeping these facts in view, the present experiment was conducted to find out the effective integrated weed management practices in ZT DSR during rainy season of 2006. Treatments (Table 36) were replicated thrice in a split-plot design. Rice 'Kranti' was sown with zero-till seed drill on 17 June and 4 July, 2006. The seeding rate was 100 kg/ha. Pre-emergence herbicides were applied 3 days after sowing (DAS). *Dhaincha* plants were killed by spraying 2,4-D (0.50 kg/ha) at 30 DAS. The crop was raised under irrigated conditions as per recommended package of practice.

The experimental field was infested mainly with *Echinichloa colona*, *Commelina communis* and *Cyperus iria*. Dry seeding after receipt of first flush of monsoon significantly reduced the population of all weeds except *Commelina* spp.which was at par with sowing before monsoon. Weed biomass was also reduced significantly in sowing at later date (Table 36). Various weed control treatments significantly reduced the population and dry matter of weeds as compared to weedy check. Among different weed control treatments, pretilachlor 0.75 kg/ha *fb* 2,4-D (0.5 kg/ha) *fb* fenoxaprop (0.07 kg/ha) being at par with pendimethalin 1.0 kg/ha + 1 HW produced the lowest weed biomass. Sowing after first flush of monsoon produced higher grain yield than dry seeding before monsoon. Pre-emergence application of pendimethalin 1.0 kg/ha followed by one hand weeding at 30 DAS proved significantly superior to other treatments and was at par to hand weeding twice (Table 37). Integration of fenoxaprop and 2,4-D with pretiachlor and pendimethalin was also effective. Infestation of weeds caused 63.9 % reduction in grain yield of direct-seeded rice.

Fig. 9: Effect of herbicides in in zero-till direct seeded irrigated rice

Table 36. Effect of date of sowing and weed control methods on density and dry matter of weeds

Treatments	Weed density (No./m²) at 60 DAS				Weed biomass at harvest (g/m²)
	E. colona	*Commelina* spp.	*C. iria*	Total	
Date of sowing					
Sowing before monsoon	2.7 (6.8)	1.6 (2.2)	2.1 (3.7)	4.7 (21.2)	5.1 (25.5)
Sowing after first flush of monsoon	2.2 (4.4)	1.8 (2.6)	1.0 (0.4)	4.5 (19.8)	4.3 (17.7)
LSD (P=0.05)	0.2	NS	0.1	0.1	0.2
Weed control methods					
Pretilachlor 0.75 PE kg/ha + 1 HW at 30 DAS	2.4 (5.5)	1.3 (1.2)	1.7 (2.3)	4.6 (20.8)	3.6 (12.2)
Pendimethalin 1.0 PE kg/ha + 1 HW at 30 DAS	1.8 (2.9)	1.2 (0.6)	1.3 (1.1)	4.09 (16.23)	3.2 (9.8)
Pretilachlor 0.75 kg/ha *fb* 2,4-D (0.5 kg/ha) *fb* fenoxaprop (0.07 kg/ha)	2.3 (4.9)	1.1 (0.6)	1.3 (1.1)	3.71 (13.3)	3.1 (8.9)
Pendimethalin 1.0 kg/ha *fb* 2,4-D (0.5 kg/ha) *fb* fenoxaprop (0.07 kg/ha)	2.0 (3.4)	1.3 (1.3)	1.0 (0.5)	4.0 (15.7)	4.7 (21.7)
Dhaincha+pretilachlor *fb* 2,4-D (0.5 kg/ha) *fb* fenoxaprop (0.07 kg/ha)	2.6 (6.5)	1.8 (2.6)	1.7 (2.5)	4.8 (22.2)	5.8 (32.6)
Dhaincha+pendimethalin *fb* 2,4-D (0.5 kg/ha) *fb* fenoxaprop (0.07)	1.9 (3.0)	1.5 (1.8)	1.2 (0.9)	4.4 (18.4)	5.8 (32.8)
Dhaincha +*fb* 2,4-D (0.5 kg/ha) *fb* fenoxaprop (0.07 kg/ha)	3.2 (9.4)	2.0 (3.6)	1.5 (1.7)	5.0 (24.1)	5.6 (31.2)
Hand weeding at 20 & 45 DAS	1.9 (4.1)	1.2 (0.9)	1.3 (1.1)	3.5 (12.0)	3.6 (12.2)
Weedy check	4.1 (15.9)	3.7 (13.5)	2.69 (6.7)	7.1 (50.1)	6.8 (45.6)
LSD (P=0.05)	0.2	0.3	0.3	0.2	0.2

Data subjected to square root transformation, Values in parentheses are original

Table 37. Effect of date of sowing and weed control methods on growth, yield attributes & yield of rice

Treatment	Plant population/m row length at 20 DAS	Plant height (cm)	No. of panicles/m row length	No. of grains/ panicle	1000-grain weight (g)	Grain yield (kg/ha)
Date of sowing						
Sowing before monsoon	44.50	63.0	72.7	143	28.4	3374
Sowing after first flush of monsoon	49.55	67.2	82.9	164	28.5	4547
LSD (P=0.05)	NS	1.5	0.6	3	NS	229
Weed control methods						
Pretilachlor 0.75 kg/ha + 1 HW at 30 DAS	53.66	64.9	80.8	153	28.1	4391
Pendimethalin 1.0 kg/ha + 1 HW at 30 DAS	51.33	69.6	84.5	185	29.5	4684
Pretilachlor 0.75 kg/ha *fb* 2,4-D (0.5 kg/ha) *fb* fenoxaprop (0.07 kg/ha)	49.16	69.8	83.5	157	29.5	4566
Pendimethalin 1.0 kg/ha *fb* 2,4-D (0.5 kg/ha) *fb* fenoxaprop (0.07 kg/ha)	47.17	66.9	77.5	153	29.8	4513
Dhaincha+pretilachlor *fb* 2,4-D (0.5 kg/ha) *fb* fenoxaprop (0.07 kg/ha)	41.66	61.0	78.0	142	27.6	3705
Dhaincha+pendimethalin *fb* 2,4-D (0.5 kg/ha) *fb* fenoxaprop (0.07 kg/ha)	40.50	65.6	82.3	149	27.7	3894
Dhaincha + 2,4-D (0.5 kg/ha) *fb* fenoxaprop (0.07 kg/ha)	39.83	62.2	77.8	142	26.80	3645
Hand weeding at 20 & 45 DAS	50.33	64.1	82.5	163	28.00	4619
Weedy check	49.16	61.5	53.2	137	28.79	1725
LSD (P=0.05)	2.90	1.3	2.6	4	2.53	241

Tillage and Weed management in rice-chickpea cropping system

J.S. Mishra, V.P. Singh, MBB Prasad Babu and Chandra Bhanu

Diversification of rice-wheat cropping system with greater inclusion of legumes is essential to alleviate declining factor productivity, input use efficiency and sustainability. Inclusion of chickpea during winter season may be an alternative to wheat because of its higher productivity as compared to other legumes. It is therefore necessary to see the effect of different rice cultures, tillage and herbicides on productivity, weed dynamics, microbial properties and soil physical properties in subsequent chickpea crop. Field experiment was initiated in *Kharif* 2006. Treatments consisted of four rice cultures *viz*., transplanting, puddle broadcasting, conventional direct seeded rice (DSR) and zero till DSR in main plots. The chickpea crop with two tillage (conventional and zero) as sub-plots and two weed control methods (pendimethalin 1.0 kg/ha as pre-em and weedy check) as sub-sub plots was grown in subsequent winter season. The experimental design was split-split plot with four replications.

E. colona, *Alternanthera sessilis*, *C. iria* and *Caesulia axillaris* were the dominant weeds in rice. In general, poor rice yields were obtained due to early withdrawal of monsoon resulting in moisture stress during reproductive phase. Transplanting of rice significantly reduced the population of almost all the weeds as compared to other methods of rice establishment (Table 38). However, maximum weed dry matter at harvest recorded in transplanted rice was due to vigrous growth of *A. sessilis* resulted in lower grain yield as compared to other establishment methods. Puddle broadcast rice (2875 kg/ha) being at par with ZT DSR (2775 kg/ha) yielded significantly better than transplanted rice (1891 kg/ha) due to higher number of panicles/m^2 (Table 39).

Table 38. Effect of rice establishment techniques on density and dry matter of weeds

Treatment (Rice cultures)	Weed density (No./m²) at 30 DAS					Weed biomass at harvest (g/m²)
	E. colona	*C. iria*	*C. axillaris*	*A. sessilis*	Total	
Transplanted	3.1	1.4	15.8	48.9	69.3	297
Puddle broadcast	5.2	11.1	26.4	43.5	86.9	203
Conventional DSR	6.2	12.6	21.1	87.9	128.4	242
ZT DSR	6.1	19.3	16.3	98.2	143.8	223
LSD (P=0.05)	0.8	1.8	2.8	19.0	19.5	78

Table 39. Effect of rice establishment techniques on growth, yield attributes and grain yield of rice.

Treatment (Rice cultures)	Plant height (cm)	No. of panicles/m²	Panicle length (cm)	No. of grains/panicle	1000-grain weight (g)	Grain yield (kg/ha)
Transplanted	58.2	199	17.7	106	19.8	1891
Puddle broadcast	57.6	321	18.2	109	22.5	2875
Conventional DSR	55.5	306	18.7	117	20.9	2657
ZT DSR	54.7	317	18.7	116	21.5	2775
LSD (P=0.05)	NS	67	NS	NS	2.6	655

Effect of tillage and weed management in direct seeded rice-wheat cropping system

J.S. Mishra, V.P. Singh, MBB Prasad Babu and Chandra Bhanu

Due to rising costs of labour and excessive water use in puddling for transplanting rice in the irrigated ecosystems, direct seeding of rice (DSR) with adequate weed management is gaining popularity in South East Asia. As the zero till DSR facilitates timely sowing of wheat, even a slight loss in rice productivity is compensated by increased wheat yields, implying no loss in system productivity. Since the ecological conditions for the growth and development of weeds are different in zero-till and conventional till conditions, there is a need to study changes in weed flora along with their management techniques in zero-till technology.

The field experiments were initiated during rainy season of 2006. The treatments consisted of 4 tillage *viz.*, zero-zero, zero-conventional, conventional-zero and conventional-conventional as main plots and 3 weed control methods viz., weedy check, recommended herbicide (pendimethalin 1.0 kg/ha as pre-em in rice and clodinafop fb 2,4-D in wheat) and herbicide + 1 hand weeding in sub plots. The experimental design was split-split plot with 4 replications.

The experimental field was infested mainly with *E. colona*, *Alternanthera sessilis*, *C. iria* and *Caesulia axillaris*. Variation in tillage did not influence the population of weeds except *C. iria* which was significantly lower in ZT as compared to CT (Table 41). In general, poor rice yields were obtained due to early withdrawal of monsoon resulting in moisture stress during reproductive phase. Conventional

Table 42. Effect of tillage and weed control methods on density of weeds.

Treatment	Weed density (No./m² at 60 DAS)*				
	E. colona	*A. sessilis*	*C. iria*	*C. axillaris*	Total
Tillage					
Zero	2.5 (5.8)	4.2 ()	5.3 (27.6)	5.2 (26.5)	10.0 (100)
Conventional	2.4 (5.3)	4.5 ()	6.7 (44.4)	5.7 (32.0)	11.0 (121)
LSD (P=0.05)	NS	NS	0.5	NS	0.6
Weed Control					
Weedy check	3.7 (13.2)	5.6 (30.9)	8.7 (75.2)	6.3 (39.2)	13.2 (174)
Pendimethalin 1.0 kg/ha as pre-em	1.7 (2.4)	4.1(16.3)	4.4 (18.9)	5.9 (34.6)	9.3 (86)
Pendimethalin + 1 HW at 30 DAS	1.8 (2.7)	4.8 (22.5)	4.7(21.6)	4.0 (16.0)	8.9 (79)
LSD (P=0.05)	0.4	0.9	0.8	0.6	1.6

* Data subjected to square root transformation, Values in parentheses are original

Table 43. Effect of tillage and weed control methods on dry matter of weeds

Treatment	Weed dry matter (g/m² at 60 DAS)*				
	E. colona	*A. sessilis*	*C. iria*	*C. axillaris*	Total
Tillage					
Zero	2.7 (6.8)	2.0 (3.5)	2.5 (5.8)	2.7 (6.8)	6.0 (35.5)
Conventional	2.6 (6.3)	1.8 (2.7)	3.2 (9.7)	3.4 (11.1)	5.8 (33.1)
LSD (P=0.05)	NS	0.16	0.2	0.23	NS
Weed Control					
Weedy check	5.0 (24.5)	2.5 (5.8)	4.5 (19.8)	4.1 (16.3)	8.7 (75.2)
Pendimethalin 1.0 kg/ha as pre-em	1.9 (3.1)	1.9 (3.1)	2.6 (6.3)	3.7 (13.2)	6.4 (40.5)
Pendimethalin + 1 HW at 30 DAS	1.1 (0.7)	1.4 (1.5)	1.5 ()	1.4 ()	2.7 (6.8)
LSD (P=0.05)	0.4	0.5	0.4	0.5	0.9

* Data subjected to square root transformation, Values in parentheses are original

Table 42. Effect of tillage and weed control methods on weed dry matter at harvest, growth, yield attributes and yield of rice.

Treatment	Weed biomass (g/m^2)	Plant height (cm)	No. of panicles/m^2	Panicle length (cm)	No. of grains/ panicle	1000-grain weight (g)	Grain yield (kg/ha)
Tillage							
Zero	15.6	51.3	212	18.1	103	20.0	1061
Conventional	16.1	51.7	215	18.3	102	20.9	1308
LSD (P=0.05)	NS	NS	NS	NS	NS	NS	175
Weed Control							
Weedy check	17.7	51.8	199	17.9	96	19.8	1062
Pendimethalin 1.0 kg/ha as pre-em	17.2	51.1	211	18.3	107	20.2	1091
Pendimethalin + 1 HW at 30 DAS	12.8	51.6	230	18.5	104	20.3	1401
LSD (P=0.05)	2.4	NS	26	NS	NS	NS	194

3401. Role of intercrops and cover crops in weed management

R. P. Dubey

Effect of sesbania intercropping for weed management in direct - seeded rice (*kharif* 2006)

A field experiment was conduced to find out the best method of sesbania intercropping and weed control practice in rice. The experiment was taken in split plot design with three replications. The treatments consisted of 4 intercropping systems in main plots and 4 weed control treatments in sub plots (Table 43).

The major weed flora observed in the experimental field consisted of *Echinochloa colona, Ammania baccifera, Commelina benghalensis* etc. Soil incorporation of Sesbania intercrop at 30 DAS was found better in managing weeds and producing higher rice yield (4049 kg/ha) as compared to broadcasted Sesbania intercrop (3191 kg rice /ha) which was killed by 2, 4-D 0.5 kg/ha.

Table 43: Effect of sesbania intercropping systems and weed control on weed dynamics at 60 DAS

Treatments	Weed density (no./m^2)				Weed biomass (g/m^2)
Intercropping system	*E. c.*	*A. b.*	*C. b.*	Total	
Rice sole 20 cm	2.2(4.3)	3.3(10.4)	1.4(1.5)	5.4(28.7)	3.8(13.9)
Rice + sesbania (line sown) fb 2,4 -D 0.5 kg/ha 30 DAS	2.2(4.3)	1.4(1.5)	1.2(0.9)	3.4(11.1)	3.5(11.7)
Rice + sesbania (incorporated at 30 DAS)	2.0(3.5)	1.1(0.7)	1.3 (1.2)	3.3 (10.4)	3.1 (9.1)
Rice + sesbania (broadcast in between rice rows) fb 2,4 -D 0.5 kg/ha 30 DAS	2.2(4.3)	1.2(0.9)	1.6 (2.1)	3.6 (12.5)	3.1 ()
LSD (P=0.05)	ns	1.5	ns	0.3	0.3
Weed Control					
Pendimethalin 1.0 kg/ha PE + 1 HW	2.1(13.9)	1.7(2.4)	1.1 (0.7)	3.7 (13.2)	2.8 (7.3)
Pendimethalin 1.0 kg/ha PE fb fenoxaprop 60 g/ha	1.6(2.1)	1.9 (3.1)	1.7 (2.4)	3.7 (13.2)	2.3 (4.8)
2 manual weeding	1.7(2.4)	1.5 (1.8)	0.9 (0.3)	3.2 (9.7)	2.5 (5.7)
iv. Unweeded	3.3(10.4)	2.0 (3.5)	1.9 (3.1)	5.1 (25.5)	6.0 (35.5)
LSD (P=0.05)	0.4	ns	0.5	0.3	0.3

Weed data transformed to v x+0.5; Figures in parenthesis are original values
E.c. Echinochloa colona, A.b. Ammania baccifera, C.b.- Commelina benghalensis

Table 44. Interaction effect of treatments on grain yield (kg/ha) of direct seeded rice

	Pendimethalin 1.0 kg/ha PE + 1 HW	Pendimethalin 1.0 kg/ha PE fb fenoxaprop 60 g/ha	2 hand weeding	Unweeded control	Mean
Rice sole 20 cm	4144	3968	4283	3166	3890
Rice + sesbania (line sown) fb 2,4-D 0.5 kg/ha 30 DAS	3838	4450	3999	3528	3959
Rice + sesbania (incorporated at 30 DAS)	4209	3949	4817	3419	4049
Rice + sesbania (broadcast in between rice rows) fb 2,4-D 0.5 kg/ha 30 DAS	3462	3252	3456	2592	3191
Mean	3918	3905	4139	3176	

LSD (P=0.05) 590 & 860 kg/ha

Effect of seed rate and stage of incorporation of Sesbania intercrop for weed management in direct - seeded rice (*kharif* 2006)

R.P. Dubey

A field experiment was carried out to find out the effective seed rate and stage of sesbania incorporation for weed control in rice. Twelve treatment combinations (Table 47) were taken in a RBD replicated thrice. Pendimethalin 1.0 kg/ha was applied pre-emergence to all the treatments except in manual weeding and unweeded control. Sesbania was killed by 2,4-D 0.5 kg/ha as per treatments.

The major weed flora observed in the experimental field consisted of *Echinochloa colona, Cyperus iria, Commelina benghalensisetc* etc. *Sesbania* as intercrop sown at 60 kg/ha seed rate and killed by 2,4-D 0.5 kg/ha at 45 DAS was effective in managing weeds and produced higher rice seed yield of 5079 kg/ha as compared to 3938 kg/ha under weedy check in direct-seeded rice.

Table 45. Effect of seed rate and stage of incorporation of Sesbania on weed dynamics (60 DAS) and yield of rice

Treatments	Weed density (no/m²)				Weed dry biomass (g/m²)	Grain yield (kg/ha)
	E. c.	*C. i.*	*C. b.*	Total		
Sesbania (30 kg/ha and 25 DAS)	1.6(2.1)	0.8(0.1)	1.8(2.7)	2.4(5.3)	1.9(3.1)	4358
Sesbania (30 kg/ha and 35DAS)	1.6(2.1)	0.7(0.0)	1.3(1.2)	2.1(3.9)	1.8(2.7)	4383
Sesbania (30 kg/ha and 45 DAS)	1.3(1.2)	0.7(0.0)	0.9(0.3)	1.5(1.8)	1.6(2.1)	4408
Sesbania (45 kg/ha and 25 DAS)	1.5(1.8)	1.2(0.9)	1.0(0.5)	2.1(3.9)	1.6(2.1)	4298
Sesbania (45 kg/ha and 35 DAS)	1.3(1.2)	1.1(0.7)	1.3(1.2)	2.2(4.3)	1.5(1.8)	4271
Sesbania (45 kg/ha and 45 DAS)	1.6(2.1)	0.7(0.0)	0.9(0.3)	1.7(2.4)	1.5(1.8)	4344
Sesbania (60 kg/ha and 25 DAS)	1.9(3.1)	0.9(0.3)	0.8(0.1)	2.4(5.3)	1.4(1.5)	4802
Sesbania (60kg/ha and 35 DAS)	1.9(3.1)	1.3(0.2)	1.3(1.2)	2.6(6.3)	1.4(1.5)	4913
Sesbania (60 kg/ha and 45 DAS)	1.5(1.8)	0.7(0.0)	0.7(0.0)	1.6(2.1)	1.4(1.5)	5079
Pendimethalin 1.0 kg/ha + 1 HW 20 DAS	1.8(2.7)	2.5(5.8)	2.1(3.9)	4.1(16.3)	2.8(7.3)	4140
2 hand weeding 20 & 40 DAS	1.4(1.5)	2.8(7.3)	0.7(0.0)	2.6(6.3)	1.8(2.7)	4422
Unweeded	3.2(9.7)	3.2(9.7)	2.4(5.3)	5.7(32.0)	7.0(48.5)	3938
LSD (P=0.05)	1.0	0.7	0.6	0.4	0.4	113

Weed data transformed to v x+0.5; Figures in parenthesis are original values
E.c. Echinochloa colona, C.i.. Cyperus iria, C.b.- Commelina benghalensis

Influence of berseem as intercrop on weed management and productivity of mustard (*rabi* 2005-06)

R. P. Dubey

A field experiment was conducted to find out the best intercropping combination of irrigated mustard and berseem for weed suppression. Three intercropping systems as main plot treatments were taken along with five weed control treatments in sub plots in a split plot design replicated thrice. The major weed flora of the field was *Avena sp, Medicago denticulata, Chenopodium album, Physalis minima, Phalaris minor, Vicia sativa, Cichorium intybus* and *Rumex dentatus*

The results indicated that intercropping of berseem either in between two rows of mustard at 45 cm or as paired rows of 30/60 cm reduced the weeds effectively. The seed yield of mustard did not differ due to intercropping systems. Among the weed control treatments fluchloralin 1.0 kg/ha+ one hand weeding and two hand weeding performed the best.

Table 46: Effect of mustard+berseem intercropping and weed control treatments on weed dynamics (60 DAS) and crop yield of mustard and berseem

Treatments	Weed density (No./m2)	Weed dry biomass (g/m2)	Mustard seed yield (kg/ha)	Berseem fodder yield (t/ha)	Berseem seed yield (kg/ha)
Intercropping system					
Mustard sole 45 cm	20.2(407)	7.4(54)	1882	-	-
Mustard + berseem 45cm	11.5(132)	3.8(14)	2304	10.2	119
Mustard+ Berseem (30/60 cm)	11.4(131)	3.2(10)	2030	10.8	102
LSD (P=0.05)	1.7	1.4	504		
Weed control					
1 HW	15.6(243)	5.2(26)	2111		
2HW	11.8(139)	2.2(4)	2282		
Fluchloralin 1.0 kg/ha	13.1(171)	6.1(37)	1985		
Fluchloralin 1.0 kg/ha+1HW	12.7(161)	3.4(11)	2348		
Unweeded control	18.3(343)	7.2 (51)	1645		
LSD (P=0.05)	2.5	1.3	288		

Weed data transformed to v x+0.5 ; Figures in parenthesis are original values

Unweeded

Mustard + Berseem 45 cm 1 HW

Fig. 10: Effect of intercropping in mustard on weeds

3501. Nutrient and plant residue management on weeds in rice-wheat system

P. J. Khankhane and K. K. Barman

Effect of crop residue management on weed dynamics in rice-wheat system

The mechanical method of harvesting rice and wheat crop leave significant amount of residues in the field. In order to facilitate the seed bed preparation for the next crop, the residue is either burnt or removed, the former is generally preferred by the farmers. Hence the present investigation was undertaken to study the effect of crop residue management on weed dynamics in rice-wheat system. The field experiment was conducted with 18 treatment combinations consisting of three-crop residue management (removal, burning and incorporation), two weed management practices (weedy and herbicide) and thee nitrogen levels (60, 120 and 180 kg N/ha) using split-split plot design with three replications.

The major weed species found on the experimental site were *Ehinochloa colona*, *Cyperus iria, Commelina communis* in transplanted rice and *Medicago hispida* in wheat. Among the residue management treatments, burning of wheat residue significantly reduced weed dry weight in transplanted rice whereas burning and incorporation treatments were at par in wheat. Removal of residue showed highest weed dry weight in both rice and wheat crop. Tank mix application of isoproturon at 1 Kg/ha and 2, 4-D at 0.5 kg/ha as post emergence application controlled the weeds effectively resulting in lower weed dry weight in wheat. However, the pre emergence application of butachlor at 1.5 Kg/ha showed no effect on weed dry weight in rice. Higher pooled yield with an increase of 17.4 % was recorded under burning with higher net monetary return of Rs. 25247/-ha/year and benefit/cost ratio of 3.39 as compared to removal (Rs 18530/ha/yr and B: C ratio 2.41). Lower yield was registered under incorporation of residues in rice. On the contrary an increase of 10.8 % of yield was recorded under incorporation over burning treatment in wheat with net monetary returns of Rs 57781/ha/yr and higher cost/ benefit ratio of 6.79 as compared to removal.

The incorporation of residue increased the organic carbon content in soil over residue burning after harvest of rice but phosphorus and potassium was found at par with burning. The microbial population i.e. bacteria and fungi in soil was affected by burning treatment at the early stage six days after sowing (DAS) however it was recovered at 90 DAS. The soil reaction, electrical conductivity and available nitrogen did not differ significantly between crop residue management and N levels treatments. Therefore, it may be concluded that under the situation where consistently higher weed intensity occurs and residue incorporation does not improve yield, the burning of previous crop residue (wheat) is the option for reducing weeds in transplanted rice whereas in wheat incorporation of residue proved better in terms of weed reduction and increase in yield.

Table 47. Effect of residue management on weed dry matter and yield of transplanted rice

	Dry weight (g/m^2)		Pooled Yield Kg/ha (3 years)	Net monetary Returns (Rs/ha/yr)	Benefit : cost ratio
	30 DAS	60 DAS			
Management					
Removal	4.5 (20.6)	5.7 (32.9)	4769	18530	2.41
Burning	3.6 (13.0)	4.9 (24.4)	5152	25247	3.39
Incorporation	4.0 (16.3)	5.4 (28.9)	4389	20197	3.00
LSD (P=0.05)	0.67	0.45	595	-	-
Weed control					
Weedy	4.1 (17.0)	5.4 (29.3)	4680	21339	2.99
Herbicide	3.9 (16.3)	5.3 (28.2)	4860	21310	2.89
LSD (P=0.05)	NS	NS	NS	-	-
N levels					
60	3.7(14.3)	5.0 (25.9)	4260	19032	2.78
120	3.9(15.4)	5.3 (28.7)	4878	22477	2.93
180	4.4(20.3)	5.6 (31.6)	5172	22465	3.08
LSD (P=0.05)	NS	NS	445	-	-

Table 48. Effect of crop residue management on weed dry weight and yield of wheat

Crop residue management	Dry weight (g/m^2)	Pooled Yield Kg/ha (3 years)	Net monetary Returns (Rs/ha/yr)	Benefit: Cost ratio
Management				
Removal	7.5 (58.3)	4771	48081	3.86
Burning	5.7 (35.2)	4699	51440	6.19
Incorporation	6.2 (39.6)	5205	57781	6.79
LSD (P=0.05)	1.3	-	-	-
Weed control				
Weedy	7.2 (54.3)	4693	51445	6.24
Herbicide	5.7 (34.48)	5072	55792	6.43
LSD (P=0.05)	1.2	-	-	-
N levels				
60	6.3 (42.6)	4285	45300	5.06
120	6.6 (47.5)	5196	56598	5.90
180	6.4 (43.1)	5387	58192	5.68
LSD (P=0.05)	NS	-	-	-

Table 49. Effect of crop residue management on soil properties in rice-wheat sequence

Treatments	After harvest of rice						During wheat growing period			
	*pH	*EC	Organic C (%)	Available nutrients (Kg/ha)			Bacteria ($CFU \times 10^{-5}/g$)		Fungi ($CFU \times 10^{-5}/g$)	
							Days after sowing of wheat			
				N	P	K	60	90	6	90
Management										
Removal	6.8	0.30	0.61	231	29.80	267	18.01	8.63	10.46	8.07
Burning	6.9	0.34	0.61	239	32.20	316	16.13	8.99	9.10	6.54
Incorporation	6.8	0.28	0.64	244	36.92	304	19.87	8.58	14.15	7.37
LSD (P=0.05)	NS	NS	0.03	NS	5.36	31.6	2.09	NS	2.30	NS
Weed control										
Weedy	6.9	0.31	0.60	229	33.48	291	18.70	8.41	12.27	7.18
Herbicide	6.8	0.31	0.64	247	32.50	300	17.30	8.99	10.21	7.48
LSD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	1.96	NS
N levels										
60	6.9	0.27	0.62	217	32.00	282	-	8.21	-	7.73
120	6.8	0.35	0.63	240	31.72	288	-	9.07	-	7.32
180	6.8	0.32	0.61	256	35.24	317	-	8.82	-	6.94
LSD (P=0.05)	NS	NS	NS	29.8	3.14	NS	-	NS	-	NS

*pH (1:2.5 soil water ratio), Electrical conductivity (EC) as $d S m^{-1}$

D. BIO-PESTICIDES AND BIOCONTROL OF WEEDS

4101. Herbicidal activity of plants and their constituents

D. K. Pandey

Phytotoxicity of *Solanum viarum* Dunal plant parts on aquatic weeds

Phytotoxicity of *Solanum viarum* plant parts residue was investigated to generate preliminary information for selection of the plant parts for isolation and screening of the constituents for evaluation for herbicidal activity.

The *Solanum viarum* leaf residue was lethal to different aquatic weeds at 0.1-2.0 % except for spirodella (*Spirodella polyrhiza* L. Schleid) and lemna (*Lemna pausicostata* Hegelm.) depending on the species. The root residue was lethal to different weeds at 0.5-2.0% except for water hyacinth (*Eichhornia crassipes* Mart Solms.), pistia (*Pistia stratiotes* L.), spirodella (*Spirodella polyrhiza* L. Schleid) lemna (*Lemna pausicostata*), najas (*Najas graminea* Del.), aponogeton (*Aponogeton minor*) and potamogeton (*Potamogeton crispus* L.). Green (unripe) fruit pulp of the species was lethal to different aquatic weeds at 0.1-2.0%. Yellow (ripe) fruit pulp of the species was lethal to different aquatic weeds at 0.1-2.0%. Seed residue of the species was lethal to different aquatic weeds at 0.1-0.5%. However, the stem residue was not at all lethal to the aquatic weeds included in the study upto 2.0%.

Glycoalkaloid constituents were isolated from the seed residue. The constituent mixture was verified by specific alkaloid test (reaction with platinum chloride reagent). Studies are underway for standardization of methods for obtaining individual constituents and for purification of the constituents of the mixture.

Phytotoxicity of p-hydroxybenzoic acid on representative crops and their major weeds and on aquatic weeds

The p-hydroxybenzoic acid, which is a phenolic constituent of several toxic obnoxious weeds like parthenium, lantana, etc. was investigated on representative crops, their major weeds and on aquatic weeds.

Phytotoxicity of p-hydroxybenzoic acid on aquatic weeds

The chemical was inhibitory to the floating aquatic weeds water hyacinth, pistia, azolla, spirodella and lemna at 0.5 - 5 mM. At 5 mM all floating aquatic weeds were killed. The lethal level of the p-hydroxybenzoic acid for submerged aquatic weed hydrilla and ceratophyllum was 5 mM. The submerged aquatic weed najas was killed at 1 mM. However, the green musk chara appeared to be the most sensitive, among all the aquatic weeds tested, to p-hydroxybenzoic acid. The weed was killed at as low as 0.1 mM.

Phytotoxicity of p-hydroxybenzoic acid to rice and barnyard grass (*Echinochloa crus-galli* L. Beauv.) during germination and early seedling growth

The p-hydroxybenzoic acid at 0.05 mM inhibited germination of rice seeds. The germination took place even at 5 mM though only 20% seeds showed germination at this concentration. There was no germination at 10 mM. The p-hydroxybenzoic acids affected the seedling growth as reflected by root and shoot lengths and fresh weights 8 days after initiation of the treatments in the dark at 0.1 mM. Root and shoot lengths were affected much more than their fresh weights.

Table 50. Effect of p-hydroxybenzoic acid on germination in the dark at 30°C and early seedling growth (8 days after initiation of imbibition) of rice (*Oryza sativa* L. var. Kranti)

Treatment (mM)	Germination (%)	Seedling growth			
		Length (cm)		Fresh weight (mg)	
		Shoot	Root	Shoot	Root
Control	88.6 ± 6.1	3.7 ± 0.2	4.2 ± 0.3	51.8 ± 10.7	10.1 ± 0.3
0.01	89.3 ± 6.1	3.5 ± 0.4	4.1 ± 0.3	44.7 ± 7.1	9.8 ± 0.7
0.05	74.6 ± 6.1	3.4 ± 0.5	4.3 ± 0.4	61.2 ± 5.5	8.2 ± 0.8
0.10	74.7 ± 10.1	2.3 ± 0.2	3.9 ± 0.3	30.5 ± 8.9	6.1 ± 0.6
0.50	69.3 ± 8.3	2.4 ± 0.4	3.9 ± 0.2	41.0 ± 10.9	10.8 ± 0.4
1.00	69.3 ± 10.1	2.1 ± 0.3	3.2 ± 0.3	42.4 ± 4.9	11.7 ± 1.7
5.00	20.0 ± 10.6	1.4 ± 0.4	1.5 ± 0.4	30.7 ± 5.8	6.0 ± 1.4
10.00	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
LSD at P<0.05	13.62	0.57	0.52	13.01	1.55

The values are means of three replications ± SD.

However, the p-hydroxybenzoic acid was less phytotoxic to the barnyard grass. The germination, and shoot and root lengths and fresh weights were much less affected at the concentration of p-hydroxybenzoic acid, at which the rice seeds showed profound inhibition of the attributes. Strangely, the weed seed germination was not fully inhibited by the p-hydroxybenzoic acid even at 10 mM.

Table 51. Effect of p-hydroxybenzoic acid on germination in the dark at 30°C and early seedling growth (8 days after initiation of imbibition) of barnyard grass (*Echinochloa crus-galli* L. Beauv.)

Treatment (mM)	Germination (%)	Seedling growth			
		Length (cm)		Fresh weight (mg)	
		Shoot	Root	Shoot	Root
Control	88.0 ± 8.0	6.6 ± 0.4	4.3 ± 0.3	64.1 ± 4.9	11.5 ± 0.4
0.01	80.0 ± 4.0	6.2 ± 0.7	4.1 ± 0.7	51.9 ± 13.2	10.5 ± 0.6
0.05	74.6 ± 6.1	6.3 ± 0.9	5.2 ± 0.7	62.8 ± 5.8	11.6 ± 0.6
0.10	73.3 ± 8.3	5.7 ± 0.2	4.2 ± 0.5	49.0 ± 2.0	8.9 ± 1.5
0.50	73.3 ± 6.1	5.3 ± 0.2	4.5 ± 1.0	38.9 ± 1.5	9.4 ± 0.5
1.00	76.0 ± 4.0	4.9 ± 0.9	4.6 ± 1.0	32.1 ± 1.8	7.5 ± 0.6
5.00	32.0 ± 4.0	2.6 ± 0.5	1.4 ± 0.3	22.9 ± 4.2	1.9 ± 0.2
10.00	26.6 ± 6.1	1.8 ± 0.3	0.8 ± 0.3	17.2 ± 2.0	1.1 ± 0.2
LSD at P<0.05	10.48	0.97	1.14	9.94	1.24

The values are means of three replications ± SD.

Phytotoxicity of p-hydroxybenzoic acid to wheat and little seeded canary grass (Phalaris minor Retz.) during germination and early seedling growth

The p-hydroxybenzoic acid inhibited the germination and seedling growth of wheat considerably at 10 and 1 mM respectively.

The germination of little seeded canary grass was much more sensitive to the p-hydroxybenzoic acid. The germination was reduced almost to 50% by 0.1 mM p-hydroxybenzoic acid. The seedlings growth was considerably reduced at 1 and 5 mM.

Table 52.Effect of p-hydroxybenzoic acid on germination in the dark at 18°C and early seedling growth (8 days after initiation of imbibition) of wheat (*Triticum aestivum* L.) var. WH 147

Treatment (mM)	Germination (%)	Seedling growth			
		Length (cm)		Fresh weight (mg)	
		Shoot	Root	Shoot	Root
Control	91.0 ± 6.6	11.4 ± 0.8	12.7 ± 0.7	381.6 ± 31.5	133.1 ± 6.2
0.01	89.0 ± 5.6	9.5 ± 1.3	11.8 ± 1.5	409.5 ± 6.7	113.2 ± 24.6
0.05	83.3 ± 9.5	10.6 ± 1.7	12.6 ± 1.0	364.5 ± 34.7	109.2 ± 22.1
0.10	90.6 ± 6.1	10.4 ± 1.5	11.7 ± 1.3	346.2 ± 52.5	66.3 ± 32.2
0.50	74.6 ± 6.1	11.0 ± 1.5	12.8 ± 1.1	272.7 ± 97.8	69.7 ± 29.6
1.00	76.0 ± 6.9	9.3 ± 1.3	9.7 ± 1.5	49.3 ± 7.6	11.6 ± 2.1
5.00	76.0 ± 4.0	2.4 ± 0.3	1.9 ± 0.2	26.2 ± 7.7	8.2 ± 2.0
10.00	40.0 ± 8.0	1.6 ± 0.4	0.9 ± 0.1	0.0 ± 0.0	0.0 ± 0.0
LSD at P<0.05	11.70	2.08	1.86	74.28	34.72

The values are means of three replications ± SD.

Table 53.Effect of p-hydroxybenzoic acid on germination in the dark at 18°C and early seedling growth (8 days after initiation of imbibition) of little seeded canarygrass (*Phalaris minor* Retz.)

Treatment (mM)	Germination (%)	Seedling growth			
		Length (cm)		Fresh weight (mg)	
		Shoot	Root	Shoot	Root
Control	69.3 ± 10.1	10.8 ± 0.7	4.7 ± 0.5	15.7 ± 2.9	3.8 ± 0.6
0.01	57.3 ± 19.7	10.8 ± 1.3	4.6 ± 0.4	14.6 ± 4.1	3.1 ± 1.0
0.05	48.0 ± 8.0	11.3 ± 0.9	4.3 ± 0.4	14.0 ± 5.0	2.0 ± 0.1
0.10	32.0 ± 4.0	11.1 ± 0.7	4.7 ± 0.3	20.2 ± 0.9	2.7 ± 0.2
0.50	29.3 ± 12.2	10.3 ± 0.7	4.3 ± 0.5	21.9 ± 2.7	2.6 ± 0.4
1.00	24.0 ± 4.0	8.2 ± 1.6	3.6 ± 0.5	14.4 ± 5.7	2.1 ± 0.8
5.00	13.3 ± 3.2	6.4 ± 1.2	3.5 ± 0.4	14.1 ± 2.5	1.6 ± 0.3
10.00	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
LSD at P<0.05	16.71	1.73	0.73	6.02	0.91

The values are means of three replications ± SD.

Mechanism of herbicidal activity of p-hydroxybenzoic acid on green musk chara

The p-hydroxybenzoic acid showed highest phytotoxicity to the submerged aquatic weed green musk chara as the plants were killed at as low as 0.1 mM (13.8 ppm). The mechanism of action of herbicidal activity of the constituent chemical was studied on this weed. Among the first visual symptoms of toxicity was dull green appearance of the treated plants. Acquisition of flaccid texture and fragmentation of the plants followed this. There appeared slight turbidity in the medium after a few days. This could be due to the excessive growth of microbes in the medium as a consequence of availability of cellular constituents leaked out of the treated plants.

The treatment resulted in loss of cellular membrane integrity as evidenced by excessive leakage of electrolytes, UV absorbing substance, and phosphorus from the treated plants.

There was concurrent reduction in sugar and starch with the progression of the treatment. This might be due to sustained use of the reserves and decline in their synthesis due to reduced photosynthetic activities as reported with other phenolic constituent. Similarly, reduction in amino acids with progression of the treatment appears to be due to use of the existing contents and reduction in their synthesis due to disruption in metabolism by p-hydroxybenzoic acid.

The chlorophyll a, chlorophyll b, total chlorophyll and carotenoids declined drastically in response to p-hydroxybenzoic acid phytotoxicity. This might be due to damage to the existing molecules and /or stalled synthesis of newer molecules. Decline in protein in the treated plants might be due to stalled or reduced *de novo* synthesis and /or breakdown of the preexisting proteins, except those whose synthesis was stimulated or enhanced (e.g., oxidative stress enzymes) by the p-hydroxybenzoic acid.

Among the enzymes of oxidative stress studied, guaiacol peroxidase and glutathione reductase showed marked increase initially and drastically declined with the treatment duration at the lethal concentration of the p-hydroxybenzoic acid. The glutathione reductase plays a key role in hydrogen peroxide scavenging pathway by generating reduced glutathione from oxidized glutathione, sustaining its role of redox buffer. Para-hydroxybenzoic acid induced glutathione reductase. Stimulation of glutathione reductase is a common response of oxidative stresses generated by a wide range of factors, including physical ones such as heat and drought and pollutants such as pesticides or ozone. The increased activity of the guaiacol peroxidase imply damage to key macromolecules following p-hydroxybenzoic acid toxicity and activation of defence mechanism to quell effects of oxidative stresses due to action of the chemicals. Similarly, there was loss of activity of catalase, glutathione-*S*-transferase, ascorbate peroxidase, and pyrogallol peroxidase with p-hydroxybenzoic acid phytotoxicity.

Ascorbate peroxidase catalyses the reduction of hydrogen peroxide to water using ascorbic acid as a donor of electron. Pyrogallol peroxidase is a common response to oxidative stresses caused by biotic or abiotic agents. The stimulation evoked the capacity of peroxidases to reduce hydrogen peroxide using phenolic compounds or flavonoids as donor of electrons.

Para-hydroxybenzoic acid toxicity derived oxidative stresses ensuing reactive oxygen resulted in short term induction of antioxidant enzymes as a short of defense against the oxidative stresses. Since p-hydroxybenzoic acid was at lethal concentration, the damage to the cell structure and function inflicted by the phytotoxin appears to be too severe to sustain and support synthesis of the induced antioxidative enzymes (guaiacol peroxidase, glutathione reductase and pyrogallol peroxidase) for long and to allow synthesis of other antioxidative enzymes (ascorbate peroxidase, glutathione-S-transferase, and catalase) which did not show induction at all. That induction of the antioxidative enzymes in response to p-hydroxybenzoic acid might be a cellular adaptation process to coupe with a possible perturbation of the redox state of the cell generated by the reactive oxygen species.

4201. Survey, surveillance and impact evaluation of prominent agents and herbicides with other methods for integrated management of some important weeds

Sushilkumar

Survey of weeds for bio-agents

Survey is one of the imperative steps to find out the occurrence and abundance of insects and to carry out biological studies on the bio-agents for control of weeds

During survey, reoccurrence of water hyacinth in two ponds was noticed. It was completely controlled by the water hyacinth weevil *Neochetina* spp in all the 5 ponds where biological studies were carried out earlier. The weevil attacked reoccurrence of water hyacinth. in Mahanadda pond which was earlier completely controlled by the weevil and which was devoid of water hyacinth for about three years. Likewise, reoccurrence of water hyacinth was observed in another pond namely "Ranital" which was also earlier controlled by the weevils. In this pond, the intensity of water hyacinth was low on the bank side. Although the population of weevil was not very high but its presence in low numbers indicates that the bioagent has started to buildup for the control of water hyacinth in future. Thus biological control was found to work on a sustainable basis.

Survey of insect fauna for biological control of *Trianthema portulacastrum*

Trianthema portulacastrum. Linn. (Aizoaceae), a common weed associated with dryland crops, plantation crops, vegetables and pastures was surveyed in Pantnagar area in Uttaranchal in search of potential bioagents for biological control. Two species of lepidopteron insects were collected and identified as *Spodoptera litura* (Lepidoptera: Noctuidae) and *Hymenia recurvalis* (Fabricius). Experiments were conducted to find out the host range, life cycle and biotic potential of these insects

Host preference study of insects collected on *T. portulacastrum*

A culture of *S. litura* and *Hymenia recurvalis* was maintained on *T. portulacastrum* leaves at 26 ± 2^0C, 70 ± 5^0 RH. The adults were reared in well aerated plastic jars and were provided with *T. portulacastrum* twigs in the form of bouquet and cotton soaked in 10% sucrose solution. In each experiment, 10 larvae were placed on bouquet of various crop plants and weeds in well aerated containers. All the experiments were replicated thrice. The feeding preference was visually monitored by giving ranks viz., no feeding (-) nibbling (+), moderate feeding (++), voracious feeding (+++). The weed plants obtaining a score of +++ were selected and life cycle of insect was studied on these weeds.

Host range and feeding preference study of *Spodoptera litura* and *Hymenia recurvalis*

None of the insects was found host specific. The host range of *S. litura* was wide while host range of *H. recurvalis* was narrow. No choice feeding test study conducted on various plant species showed that the larvae of *H. recurvalis* could feed well on *Alternanthera philoxeroides*, *Sorghum vulgare*, *Lycopersicon esculentum*, *Amaranthus viridis* and *Chenopodium album* other than *Trianthema portulacastrum*. While no feeding was observed on other 38 plant species tested (Table 54, 55).

Table 56. Feeding preference of *S. litura* and *H. recurvalis* on crop plants

S.No.	Common name	Botanical name	Feeding preference	
			S. litura	*H. recurvalis*
1.	Amaranth (chaulai)	*Amaranthus viridis*	++	+++
2.	Bathua, goosefoot	*Chenopodium album*	+++	+++
3.	Cabbage	*Brassica oleracea var. capitata*	+++	-
4.	Cauliflower	*Brassica oleracea var. botrytis*	+++	-
5.	Egyptian clove (Barseem)	*Trifolium alexandrinum*	+++	-
6.	Gram	*Cicer ariartinum.*	++	-
7.	Linseed	*Linum usitatissimum*	+	-
8.	Marigold	*Tagetes erecta*	+	-
9.	Masoor, Lentil	*Lens esculenta*	++	-
10.	Moong, Mung bean	*Vigna radiata*	+	-
11.	Paddy	*Oryza sativa*	-	-
12.	Pea	*Pisum sativum*	+	-
13.	Rahar, Pigeon Pea	*Cajanus cajan*	+++	-
14.	Rai	*Brassica campestris*	+	-
15.	Soybean	*Glycine max.*	++	-
16.	Spinach	*Spinacea oleracea*	+++	-
17	Tomato	*Lycopersicon esculentum*	+++	+++
18.	Wheat	*Triticum aestivum*	++	-
19.	Jowar	*Sorghum vulgare*	Not tested	+++
20.	Maize	*Zea mays*	++	-

Table 57. Feeding preference of *S. litura* and *H. recurvalis* on weed plants

S. no.	Common name	Botanical name	Feeding preference	
			S. litura	*H. recurvalis*
1.	Alligator weed	*Alternanthera philoxeroides*	+++	+++
2.	Wetland amaranth	*Alternanthera sessilis*	++	-
3.	Cut leaf false oxtongue	*Blumea lacera*	Not tested	-
4.	Para grass	*Brachiaria mutica*	++	-
5.	Ghrilla	*Caesulia axillaris*	-	-
6.	Asian Pennywort	*Centrella asiatica*	-	
7.	Chicory	*Cichorium intybus*	+++	-
8.	Tropical Spiderwort	*Commelina benghalensis*	++	-
9.	Field bind weed	*Convolvulus arvensis*	-	-
10.	Podrush	*Corchorus aestuans*	+	
11.	Indian Doab	*Cynodon dactylon*	-	-
12.	Rice foot sedge	*Cyprus iria*	-	
13.	Waterhyacinth	*Eichhornia crassipes*	+++	-
14.	Asthma weed	*Euphorbia hirta.*	+++	-
15.	Wild spikenard	*Hyptis suaveolens* Poit	+	-
16.	Morning Glory	*Ipomoea carnea*	+++	-
17	Lantana	*Lantana camara*	-	-
18.	Carrot grass	*Parthenium hysterophorus*	+++	-
19.	Wild gooseberry	*Physalis minima*	++	-
20.	Water lettuce	*Pistia stratiotes*	++	-
21.	Broad-leaved Dock	*Rumex obtusifolius*	+++	-
22.	Perennial Sow thistle	*Sonchus arvensis*	-	-
23.	Horse-purslane	*Trianthema portulacastrum*	+++	+++
24.	Wild daisy	*Tridax procumbens*	++	-
25.	Medick	*Medicago polymorpha*		-
26.	Common Fanpetals	*Sida acuta*	-	-
27.	Rice foot sedge	*Cyperus iria*	Not tested	-
28.	Common vetch	*Vicia sativa*	Not tested	-

Life cycle study of *S. litura* on different host weeds

There was a differential response of *S. litura* to different host plants (Fig. 11& 12) with respect to incubation period of eggs, larval period, larval weight, pupal period, pupal weight, adult longevity, pre-oviposition period *etc.* Minimum larval period of 16.6 days was noticed in those larvae that were reared on *Trianthema* leaves closely followed by *Rumex* (17.0 days) and *Cichorium* intybus (19.2 days). Maximum larval period of 32.2 days was observed on larvae reared on *Parthenium* leaves followed by (27 days) (Table-56, 57).

Table 58. Influence of different host on development of *S. Litura*

Weeds	Incubation period of eggs (days)		Larval period (days)		Larval weight (gm)		Pupal period (days)		Pupal weight (gm)	
	Mean	*Range*	*Mean*	*Range*	*Mean*	*Range*	*Mean*	*Range*	*Mean*	*Range*
A. philoxeroides	3.7	3-4	26.2	24-29	0.1	0.19-0.85	15.2	15-16	0.27	0.17-0.31
E. hirta	5.0	4-6	26.6	26-27	0.1	0.04-0.09	16.4	15-18	0.25	0.19-0.33
T. portulacastrum	2.3	2-3	16.6	16-17	0.9	0.64-1.08	10.4	10-11	0.34	0.31-0.38
P. hysterophorus	5.3	5-6	32.2	31-33	0.1	0.03-0.08	12.2	12-13	0.20	0.16-0.25
R. obtusifolius	2.7	2-3	17.0	17	1.1	0.73-2.02	10.0	10	0.31	0.25-0.33
C. intybus	2.3	2-3	19.2	17-21	1.0	0.67-1.23	12.6	12	0.32	0.22-0.40
I. fistulosa	4.0	3-5	23.6	22-26	0.4	0.21-0.67	14.8	14-15	0.28	0.21-0.37
E. crassipes	3.3	3-4	27.0	27	0.2	0.18-0.25	12.2	11-16	0.21	0.19-0.24
SEm	0.4		0.54		0.1		0.48		0.02	
LSD (P=0.05)	1.2		1.58		0.2		1.38		0.07	

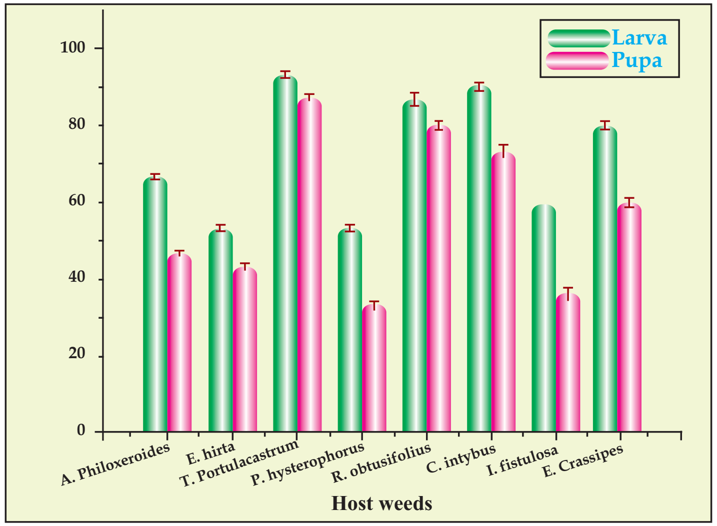


Fig. 11: Per cent survival of larvae and pupae of *S. litura* reared on different weed hosts. (Vertical bars indicate standard error)

Table 59. Influence of larval feeding on different host on adult biology of *S. Litura*

Weeds	Adult longevity (days)		Pre-oviposition period (days)		No. of batches of eggs laid	
	Mean	*Range*	*Mean*	*Range*	*Mean*	*Range*
A. philoxeroides	11.0	10-12	3.0	3	3.3	3-4
E. hirta	9.4	5-15	5.3	5-6	1.7	1-2
T. portulacastrum	11.2	6-15	2.3	2-3	4.7	4-5
P. hysterophorus	6.0	5-7	3.0	3	2.3	2-3
R. obtusifolius	8.6	8-10	2.7	2-3	4.7	4-5
C. intybus	8.6	9-10	2.7	2-3	4.3	4-5
I. fistulosa	7.2	5-9	3.7	3-5	4.0	2-5
E. crassipes	5.0	4-6	4.7	4-5	4.0	3-5
SEm ±	0.9		0.4		0.5	
LSD (P=0.05)	2.67		1.05		1.5	

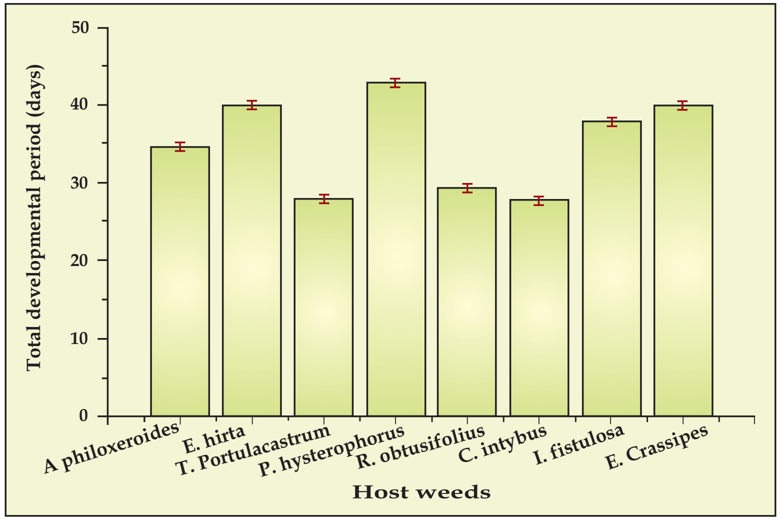


Fig. 12: Total developmental period of *S. litura* reared on different hosts. Vertical bars indicate standard error.

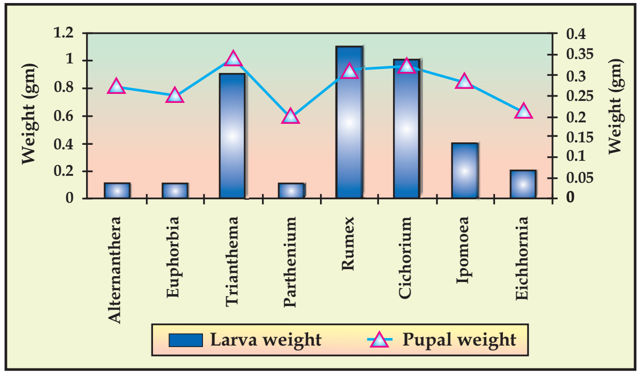


Fig. 13: Larval and pupal weight of *Spodoptera litura* reared on different weeds

Life cycle study of *H. recurvalis* on *Trianthema*

Moths obtained in previous generations were fed glucose solution and life cycle study was done on the eggs. Larvae of *H. recurvalis* were fed on leaves of *T. portulacastrum* regularly. Mean incubation period of eggs was 2.3 on *Trianthema*. Larval period was recorded 5.5 days while larva weight 0.41 g fed on *Trianthema*. Further pupal period of 12.1 days was obtained on *Trianthema* while pupal weight of 0.4 g was observed on both weeds. Adult longevity was recorded 12.9 days while pre-oviposition period on the weeds was 3.5 days (Fig. 14).

Table-. Life cycle study of *Hymenia recurvalis* on *T. Portulacastrum*

Incubation period of eggs (days)		*Larval period (days)*		*Larval weight (gm)*		*Pupal period (days)*		*Pupal weight (gm)*		*Adult longevity (days)*		*Pre-oviposition period (days)*	
Mean	*Range*	*Mean*	*Range*	*Mean*	*Range*	*Mean*	*Range*	*Mean*	*Range*	*Mean*	*Range*	*Mean*	*Range*
3.4	2-4	15.5	13-16	0.41	0.45-0.49	12.1	10-16	0.4	0.37-0.45	12.9	6-19	3.5	3-7

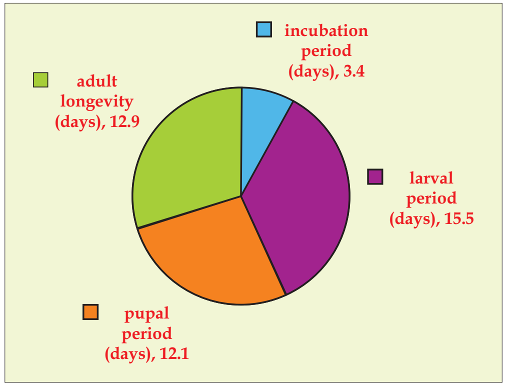


Fig 14: Life cycle of *Hymenia recurvalis* on *T. Portulacastrum*

Fig. 15. Rearing of Mexican beetle in Poly cages in winter season

Mass rearing of Mexican beetle was successfully done in net house covered with 50-75% agro-net during summer season when its population becomes negligible in nature. Mass rearing during summer season yielded about 2000 Mexican beetles in 60 days duration in a net house having area of 2x3 metre. Mass multiplication was easily done during rainy season in simple net house covered by mosquito net or iron mesh. Excellent egg laying by female and congenial weather conditions were responsible for good population build up. In a net house of about 10x30 m^2 about 50000 beetles were reared between July to September 2006.

About 1.25 lakh adult beetles were supplied during 2006-07 as a nucleus culture to different KVKs in the states of Assam, Nagaland, Himachal Pradesh, Chhatisgarh, Madhya Pradesh, Haryana, Punjab, Orissa, Bihar, West Bengal, Uttaranchal, and Jharkhand; 14 centres of All India Coordinated Project on Weed Control, many farmers and NGOs. Beetles were packed in a special packing (Fig.16) developed at NRCWS and supplied through speed post and courier services. There was overwhelming demand from all the stakeholders for the culture of Mexican beetle


Fig. 16: Sending of Mexican beetle in special packing.

Impact evaluation of Mexican beetle at Jabalpur

Samples were taken from *Zygogramma bicolorata* exposed and protected sites. Bioagents from the protected site were excluded by spraying insecticides at fortnightly interval. Study revealed that Mexican beetle had a negative impact on plant height, flower production and fresh and dry biomass. The level of defoliation by the beetle was only up to 5 and 25% by July and August, respectively which increased up to 95% by September-October. Samples of soil taken from the beetles's exposed sites and protected sites revealed reduction in seed germination at both the sites.

Impact evaluation of *Neochetina* spp. and glyphosate on water quality and fish mortality for integrated management of water hyacinth

Sushilkumar & Shobha Sondhia

Water hyacinth plants were collected from infested ponds and established for one month in the large water tubs at our farm. 20 fingerlings of fish were released in each tub after their acclimatization in one water pool for one week. Water hyacinth weevil *Neochetina* spp. was released in 10-30 pairs alone and in combination with glyphosate (2 kg/ha). Herbicide was sprayed in 25, 50 and 100% area of water hyacinth surface in different treatments with the bioagents. Glyphosate was also sprayed only on water surface without the weed or weevil. In control, only water hyacinth was kept without any treatment. Observations were taken for fish mortality, water hyacinth population, bio-agent population and water quality parameters like pH, dissolve oxygen and BOD.

No fish mortality was observed after herbicide spray up to one week however 5% mortality occurred after 20 days correlated with the decomposition of water hyacinth due to herbicides. In all the herbicide treated tanks, water hyacinth was killed corresponding to treated area but after 25 days onwards regrowth started (Fig. 17) from the left plants or part of the left plants and water tanks were full of water hyacinth after 45 days of herbicide spray as were before the treatment.

Fig. 17: Regrowth of water hyacinth after herbicide control

Meanwhile egg laying started by the released females which subsequently lead grub development. Due to feeding of weevils, height of plants (35 cm) in weevil treated tanks was less than control tanks (48 cm). However no significant reduction in water hyacinth density was observed either in weevil treated or herbicide + weevil treated tanks. Nevertheless, flower production was totally inhibited in the weevil treated tanks while in control tanks flower production increased about 156/tank in comparison to 29/tank in 100% herbicide treatment.

Fig. 18: Flower production in control and herbicide treated tanks

Herbicide was found to affect the water quality after spray. pH increased from 7.4 to 9 after herbicide treatment corresponding to area of treatment. No change in dissolved oxygen (DO) was observed up to 5 days in tanks treated with herbicide but afterwards it decreased corresponding to area of tank treatment. Maximum decrease in DO was observed between 25 to 35 days in tanks where 100% area of water hyacinth surface was treated with herbicide. There was increase in DO in the same time after 45 days. There was no decrease in DO in herbicide treated tank without weed which suggests that decline in DO is correlated with decomposition of water hyacinth. BOD increased in weed tank treated with herbicide after 20 days till 45 days. There was increase in Ca, Mg, Na, Fe, Nitrite between 20 to 35 days in herbicide treated tank with maximum increase in 100% glyphosate treated tank.

4301. Collection, characterization and evaluation of plant pathogens for weed management

Chandra Bhanu and J.S. Mishra

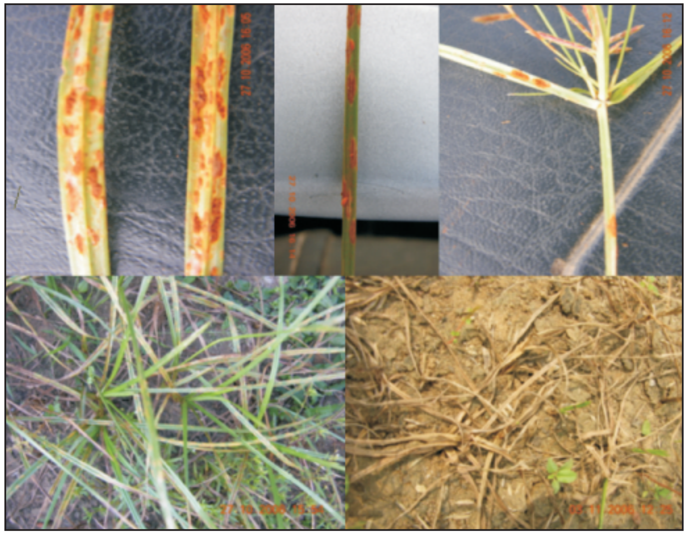
Survey for diseases of *Cyperus rotundus* (collaborative project with PDBC, Bangalore)

Surveys were conducted during 2006 in Jabalpur for the collection of promising weed pathogens against *Cyperus rotundus*. Two leaf spot diseases were observed in the month of August and one rust disease was observed from September to February. Maximum damage of *Cyperus rotundus* due to rust disease in nature was noticed in the months of September-October. Two fungi were isolated from leaf spot, out of which one was identified as *Colletotrichum dematium* and another is yet to be identified. The pathogenicity was proved for both the leaf spot fungi.

The rust fungus was identified as a species of *Puccinia*. On artificial inoculation in pot culture *Cyperus rotundus* plants, it successfully produced the disease symptoms. The damage potential of rust pathogen was tested in earthen pots (30 cm dia.). The control pots were maintained by spraying tilt (systemic fungicide). Inoculation was done by spraying spore suspension (added with 0.2% CMC) in the month of November at 3-4-leaf stage of weed. Observations on damage of *Cyperus rotundus* were recorded at four months after inoculation. Disease appeared as minute, brown coloured uredinia after 8 days of inoculation. Inoculation of rust significantly reduced the tiller number, fresh weight of tillers and roots, and number, fresh and dry weight of nuts. The damage potential was recorded in the months which were less favourable to disease development and much more damage of *Cyperus rotundus* is expected in favourable months i.e. September-October when 100% damage was observed in natural conditions due to rust disease.

Table 59. Biomass reduction of *Cyperus rotundus* due to rust inoculation

Sl. No.	Parameter	% reduction
1.	Tiller number	25
2.	Fresh weight of shoot	32
3.	Fresh weight of root	12
4.	Number of nuts	18
5.	Fresh weight of nuts	26
6.	Dry weight of nuts	25



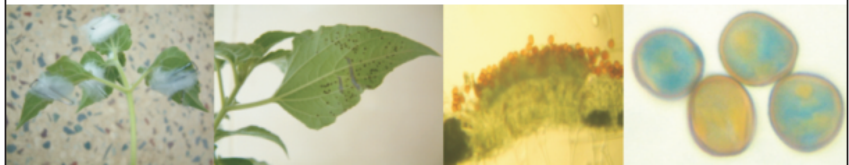
Damage potential of rust

Fig. 19: Symptoms and natural incidence of rust disease on *Cyperus rotundus*

Rust Disease of *Lagascea mollis*

A rust disease on *Lagascea mollis* was first observed in June 2006 at Hyderabad and subsequently at Jabalpur and Bhopal during rainy season of 2006. Maximum incidence of disease was noticed during July to September and heavily infected plants got defoliated and died before flowering and fruiting. The pathogen produced only uredial stage on *L. mollis.* Uredinia were maroon brown to blackish brown in colour on both sides of leaves (most frequent on lower side) and also on sepals at advance stage of the disease. Variable shapes uredospores quickly fall down from the pedicle and rarely seen attached with pedicle. Telia and teleutospores were not observed. The identification of pathogen is under progress. Under artificial inoculation conditions fungus successfully produced heavy disease on inoculated *L. mollis* plants. Symptoms appeared at 6 days after inoculation and progressed very fast and covered entire leaves.

Symptoms on Leaves | *Heavily infected plant* | *Defoliated plant due to rust*



Artificial inoculation | *Symptoms on artificially inoculated plants* | *Uredinia* | *Uredospores*

Fig.20: Rust disease of *Lagascea mollis*

Isolation and evaluation of herbicide degrading bacteria

Sulfosulfuron is a moderately persistent herbicide with phytotoxic effect on majority of crops, onion and reddish being most susceptible species. Likewise application of metribuzin may have detrimental effect on succeeding sensitive crops. Hence management of residues of sulfosulfuron and metribuzin in the soil is necessary to reduce the losses in the succeeding crop yield. Keeping the above facts in view, the present study was planned to isolate some plant growth promoting rhizobacteria (PGPR) and evaluation of their herbicide degradation potential under laboratory conditions.

Rhizospheric soils of soybean and field pea treated with higher doses of metribuzin were selected for the isolation of metribuzin degrading bacteria on various selective media. Similarly, rhizospheric soil of wheat (treated with sulfosulfuron at 100 g/ha as PO) was used for isolation of sulfosulfuron degrading bacteria. Isolated bacteria were then transferred to their specific media containing 50, 100, 500, 1000-ppm concentration of herbicides. The bacteria having better growth in these higher concentrations of herbicides were treated as herbicide degrading bacteria. The isolated bacteria were identified as *Pseudomonas fluorescens* on the basis of their cultural, morphological and biochemical characteristics. The herbicide degradation abilities of selected bacteria are given as below:

Growth of metribuzin degrading bacteria *in vitro*

A laboratory experiment was conducted to know the growth of metribuzin degrading bacterial isolates M.B-I and M.B-II on metribuzin (0, 50, 100, 500, 1000 ppm). All the concentrations of metribuzin significantly increased the bacterial population (optical density). Whereas, the survival (c.f.u.) of M.B-I was negatively affected by metribuzin, being least at higher and maximum at lower concentration. The population and survival of isolate M.B-II increased at higher concentrations (500 and 1000 ppm) while increased population and decreased survival was noticed at lower concentrations (50 and 100 ppm) of metribuzin. It was concluded that isolate M.B-II has greater capability to multiply and survive with higher concentrations of metribuzin.

Table 60. OD and c.f.u. of metribuzin degrading bacterial isolates

Treatment	O.D. 660 nm.	C.F.U. ($x10^{12}$)/ml
M.B I 50 ppm	1.30	0.77
M.B.I 100 ppm	1.2	0.2
M.B I 500 ppm	1.30	1.68
M.B I 1000 ppm	1.41	2.23
M.B II 50 ppm	1.55	2.45
M.B II 100 ppm	1.26	2.73
M.B II 500 ppm	1.95	8.18
M.B II 1000 ppm	2.18	5.07
M.B I 0 ppm	1.16	2.62
M.B II 0 ppm	1.06	3.12
$LSD_{(P=0.05)}$	0.03	0.28
C.V. %	1.60	5.66

Growth of sulfosulfuron degrading bacteria in vitro

Four different concentrations of sulfosulfuron i.e. 50, 100, 500, 1000 ppm along with 0 ppm control were tested against sulfosulfuron degrading bacterial isolate S.W and S.PN. Isolate S.PN showed significantly increased c.f.u. counts at 100, 500, and 1000 ppm concentrations of sulfosulfuron as compared to its respective control (0 ppm). Isolate S.W showed significantly higher c.f.u. counts at 500 ppm concentration of sulfosulfuron but significantly decreased c.f.u. counts at other concentrations as compare to its respective control (0 ppm). It was concluded that both the isolates S.W and S.PN showed greater multiplication and survival at 500 ppm. of sulfosulfuron but variable multiplication and survival at other concentrations.

Table 61. Effect of sulfosulfuron in vitro

Treatment	O.D. 660nm.	C.F.U. ($x10^{12}$)
S.W 50 ppm	0.96	2.58
S.W 100 ppm	1.79	3.10
S.W 500 ppm	1.22	5.03
S.W 1000 ppm	1.34	2.93
S.PN 50 ppm	0.99	2.37
S.PN 100 ppm	1.20	3.08
S.PN 500 ppm	1.13	4.47
S.PN 1000 ppm	0.77	3.51
S.W 0 ppm	0.93	4.07
S.PN 0 ppm	0.81	2.70
$LSD_{(P=0.05)}$	0.13	0.05
C.V. %	6.84	9.03

Effect of herbicide degradation bacteria on various crops

Effect of metribuzin

Metribuzin degrading bacterial isolates M.B-I and M.B-II were applied through seed treatment on soybean, chickpea and field pea under pot experiment. Metribuzin was applied as pre emergence at 500 g/ ha. The observations on germination% and plant dry weight/plant at 15 days after showing were taken. In general isolate M.B-II was found most efficient for growth promotion in soybean, chick pea and field pea and produced higher plant dry weight as compared to control.

Table 62. Effect of metribuzin degrading bacteria on soybean

Treatment	Germination (%)	Dry weight (mg)/plant
M.B I +metribuzin	95.00	121.60
M.B II+ metribuzin	96.60	140.30
Metribuzin	88.30	118.60
Uninoculated control	90.00	127.00
$LSD_{(P=0.05)}$	7.60	13.00
C.V. %	4.40	5.45

Table 63. Effect of metribuzin degrading bacteria on chickpea

Treatment	Germination (%)	Dry weight (mg)/plant
M.B I +metribuzin	93	135
M.B II+ metribuzin	100	139
Metribuzin	86	115
Uninoculated control	95	124
LSD$_{(P=0.05)}$	13.00	10.63
C.V. %	7.63	4.39

Table 64. Effect of metribuzin degrading bacteria on pea

Treatment	Germination (%)	Dry weight (mg)/plant
M.B I +metribuzin	95	153
M.B II+ metribuzin	97	181
Metribuzin	93	136
Uninoculated control	91	173
LSD$_{(P=0.05)}$	NS	22.23
C.V. %	-	7.33

Effect of sulfosulfuron degrading PGPR

The effect of sulfosulfuron degrading bacterial isolates S.W and S.PN were tested in pot experiments at recommended rate on wheat. Bioagents were applied through seed treatment and herbicide was applies as post-emergence at 15 DAS. The observations on percentage germination and plant dry weight of wheat were recorded at 25 DAS. Maximum Germination (96.6%) and dry weight per plant (75.33 mg) were observed with isolate S.W whereas; isolate S.PN produced at par germination and plant dry weight as compared to uninoculated control.

Table 65. Effect of sulfosulfuron degrading bacteria on wheat

Treatment	Germination (%)	Dry Weight (mg)/plant
S.W+ Sulfosulfuron	85	103
S.PN+ Sulfosulfuron	91	80
Sulfosulfuron	80	77
Control	81	72
LSD$_{(P=0.05)}$	NS	18.82
C.V. %	-	12.01

Degradation of herbicides in culture media

Degradation of metribuzin

Metribuzin degrading isolate were grown in specific liquid culture media containing 0, 50,100, 500 and 1000 ppm metribuzin. After 20 days of incubation, each set of treatment was analyzed through gas chromatography in CHEMITO GC.

Table 66. Degradation of metribuzin by metribuzin degradation PGPR

S.No.	Metribuzin con.(ppm.) in media at inoculation	% degradation of metribuzin by PGPR isolate	
		M.B- I	M.B- II
1	100 ppm	83.43	90.11
2	500 ppm	69.93	77.07
3	1000 ppm	49.43	71.88

Both the isolates of PGPR have greater capability to degrade metribuzin. Isolate M.B.-II showed more degradation of metribuzin than the M.B.-I. In general, higher degradation was found with lower concentrations of metribuzin with both the isolates. The plant growth promoting capability along with good metribuzin degradation ability of isolate M.B.-II may be exploited in the crop production.

Degradation of sulfosulfuron

Sulfosulfuron degrading bacterial isolates were grown is specific liquid culture media containing 0, and 500 ppm of sulfosulfuron. After 20 days of incubation the culture media were analyzed in SHIMADZU by HPLC chromatograph.

Table 67. Degradation of sulfosulfuron by sulfosulfuron degradation PGPR

S.No.	Bacterial isolates	% Degradation of sulfosulfuron
1	S.W	62.76
2	S.PN	13.85

Isolate S.W. showed greater degradation (62.76 %) of sulfosulfuron while isolate S.PN exhibited very low degradation (13.85 %). The greater sulfosulfuron degrading activity of isolate S.W. may be a good indication for management of sulfosulfuron residues in wheat field.

4401- Evaluation of bioagents and herbicides alone or in combination on water quality and fish mortality for integratedmanagement of some aquatic weeds

Sushilkumar

Bioagents along with herbicides spray in 25% and 50% area caused suppression of water hyacinth in various intensity. There was quicker control of one cycle of water hyacinth in the treatments applied only with herbicides in 100% area but in these treatments water quality was affected adversely. There was increase in weevil population in all the treatments where it was released in different numbers. The population of water hyacinth along with height of the plant was found increased in the treatments where no *Neochetina* was released. There was least mortality of fish in all the treatments irrespective of herbicides spray.

4501- Isolation and identification of root exudates of linseed and marigold and their growth inhibitory effect on few weeds

Shobha Sondhia and Jay G. Varshney

Allelopathic substances, if present in crop varieties, may reduce the need for weed management, particularly herbicide use. Allelopathy alone may not be a perfect weed management technology but it may be a supplementary tool for weed control. Hence an attempt was made to isolate root exudates from marigold plants, which were grown in five kg capacity plastic pots for 4 months. Root exudates of marigold plats were collected every 3-4 days interval and stored in dark. Approximately 40 litres of root exudates were collected and evaporated at low temperature and partitioned with various solvents of increasing polarity. This process yielded white crystal of chemical compound, which was non-polar in nature and insoluble in methanol.

Phytotoxic effect of concentrated root leachates (aqueous) and isolated compound at concentrations of 1, 10, 50, 100 and 1000 ppm on some weed *viz Vicia sativa, Lathyrus sativa, Parthenium hysterophorus*, *Phalaris minor, Avena ludoviciana, Convolvulus arvensis* was evaluated in petridishes bioassay and shoot and root length were measured.

Root and shoot growth of all the tested weeds reduced as the concentration of isolated compound increased. The aqueous extract was more phytotoxic in reducing the growth of all the weeds as compared to isolated compound alone.

Phytotoxic effect of root leachates of marigold plants was at par with the 10 and 1000 ppm of isolated compound in the case of *Parthenium histerophorus* and *Lathyrus sativa* respectively; however the phytotoxic effect was even more in case of *Phalaris minor* and *Avena ludoviciana* as compared to control (Fig 21, 25 and 26). The phytotoxic effect of root leachates was in the order of *Lathyrus sativa*> *Phalaris minor*> *Parthenium hysterophorus*> *Avena ludoviciana*> *Vicia sativa*> *Convolvulus arvensis* (Fig 21-26). The root growth of all the weeds was more severely affected as compared to shoot growth by leachates of marigold.

Germination of *Phalaris minor, Avena ludoviciana, Vicia sativa* and *Lathyrus sativa* was less affected by the root leachates and various concentrations of isolated compound as compared to shoot and root growth. However, more than 67 and 51% reduction in germination of *Parthenium hysterophorus* and *Convolvulus arvensis* was noticed by aqueous root exudates (Fig 24 and 25).

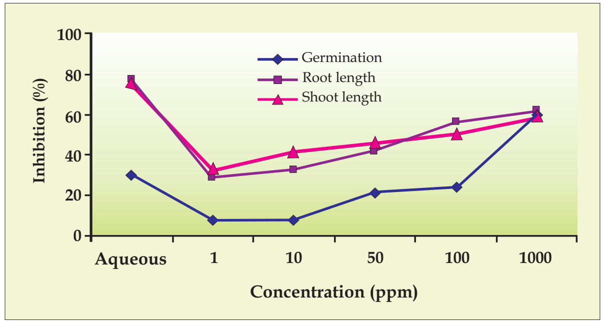


Fig. 21: Effect of isolated compound from marigold root leachates on the growth of *Avena ludoviciana*

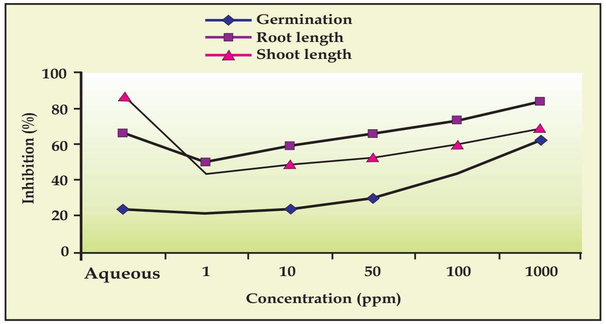


Fig. 22: Effect of isolated compound from marigold root leachates on the growth of *Vicia sativa*

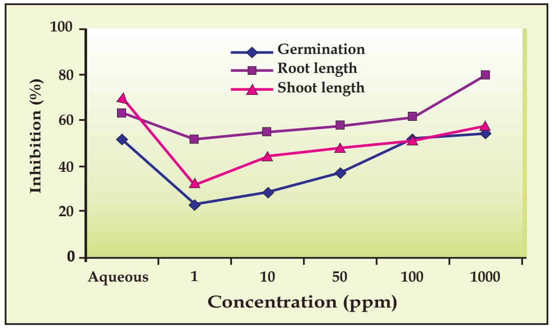


Fig. 23: Effect of isolated compound from marigold root leachates on the growth of *Convolvulus arvensis*.

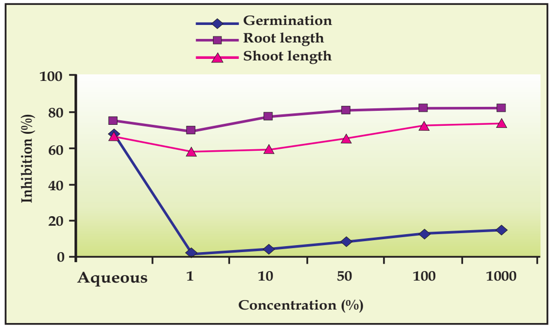


Fig. 24: Effect of isolated compound from marigold root leachates on the growth of *Parthenium hysterophorus*.

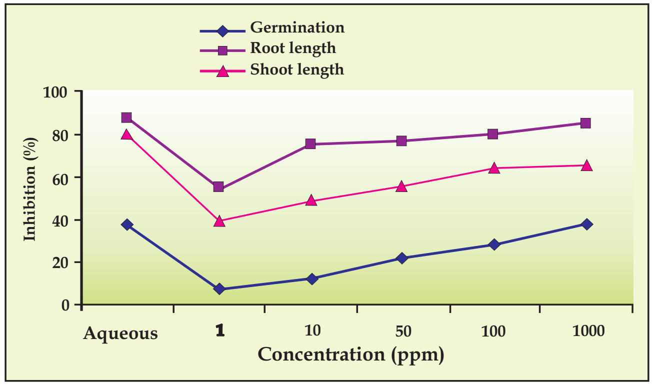


Fig. 25: Effect of isolated compound from marigold root leachates on the growth of *Lathyrus sativa*

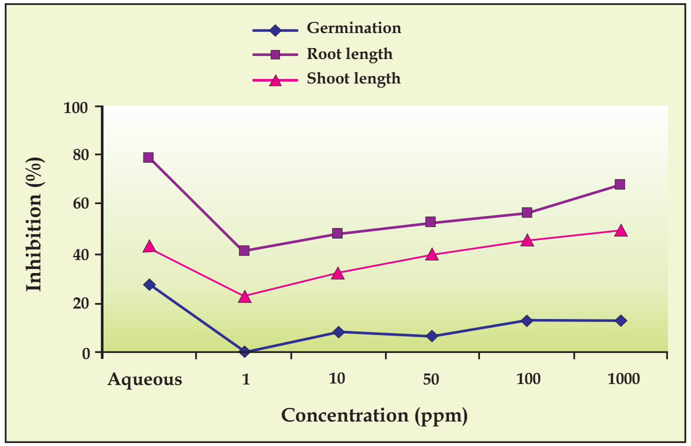


Fig. 26: Effect of isolated compound from marigold root leachates on the growth of *Phalaris minor*

E. EXTERNALLY FUNDED PROJECTS

At present, eleven externally funded projects from various funding agencies like Department of Biotechnology (DBT), Indian Council of Agricultural Research (ICAR), Department of Science and Technology (DST), Indian Space Research organization (ISRO) including multinational private concerns like Monsanto and Syngenta India Limited are running at the Centre. The major achievements of these projects are as under:

1. Large-scale demonstration on management of *Parthenium hysterophorus* through integrated approach

PI-Dr. Sushilkumar, Sr. Scientist

Funding agency: DBT, New Delhi

Cassia tora was found to be the most competitive plant in suppressing *Parthenium* besides some other plant species like *Hyptis suaveolens, Amaranthus spinosus*, *Achyranthus aspera*, *Sida acuta*, *Xanthium strumanium etc*. About 1 quintal seeds of *Cassia tora* was collected during OctoberNovember for large scale demonstration to replace parthenium by *Cassia tora*. Integrated use of herbicide like 2,4-D, glyphosate and metribuzin was found effective in controlling *Parthenium* in combination with bioagent *Z. bicolorata* and *C. tora*. Spray of herbicides on early flush of parthenium brought quick suppression of *Parthenium* on the site. Regeneration and germination of new flush of the weed on the same site in later days was controlled by *Z. bicolorata* due to good population buildup. Study revealed drastic reduction in *Parthenium* density in the demonstrated as well as other sites throughout the Jabalpur. No germination of *Parthenium* seeds as noticed in the compost prepared by conventional pit method with treatment of dung and urea in layers. *Parthenium* compost was found superior than FYM. *Parthenium* compost treated plots gave yield equivalent to Farm Yard Manure when applied at half of recommended dose of fertilizer.

2. Herbicidal property of invasive and noxious weed Lantana (*Lantana camara* L) constituents

PI-Dr. D.K. Pandey, Sr. Scientist

Funding agency: DST, New Delhi

Evaluation of the lantana plant parts residue for herbicidal activity

The aquatic weeds included in the study were mostly components of composite natural ecosystems in water bodies in the country including floating weeds - water hyacinth (*Eichhornia crassipes* Mart Solms.), pistia (*Pistia stratiotes* L.), salvinia (*Salvinia molesta* DS Mitchell.), lemna (*Lemna pausicostata* Hegelm.), azolla (*Azolla nilotica* Decne.) and spirodella (*Spirodella polyrhiza* L. Schleid), and four submerged aquatic weeds - hydrilla (*Hydrilla verticillata* L. f. Royle), ceratophyllum (*Ceratophyllum demersum* L.), najas (*Najas graminea* Del.) and green musk chara (*Chara zeylanica* willd.). The submerged aquatic weeds aponogeton (*Aponogeton minor*) and potamogeton (*Potamogeton crispus* L.).

Lantana plant parts were dried in shade, powdered and suspended in water at different levels from 0.01-2.0% (w/v). Preweighed aquatic plants were placed in the suspension and toxicity and biomass were monitored. The plant parts of lantana used in the study include leaf, stem, root, flower, fruit pulp and seed.

The lantana plant parts residue showed varying levels of phytotoxicity. The lantana root residue was not lethal to the floating and submerged aquatic weeds included in the studies at levels up to 1 - 2% (dry weight / volume, though it inhibited many species at 0.05 - 2%. The leaf residue was lethal to floating weed azolla at 0.5%. It was lethal to submerged weed hydrilla, aponogeton and ceratophyllum at 0.5%. The leaf residue was most phytotoxic to green musk chara, which was killed at the level of 0.1%. The leaf residue was inhibitory to most of the weeds at 0.1 - 2.0%. The stem residue was inhibitory at 0.05 - 2%. The stem residue was lethal to azolla and green musk chara at 0.5 and 1%, respectively. The lantana flower residue was toxic at 0.1 - 1%. It was lethal to green musk chara at 0.25%, and was lethal to ceratophyllum at 0.5%. However, it was lethal to other weeds at 1 - 2%. Lantana fruit pulp residue too had considerable herbicidal activity. This was inhibitory to different weeds at 0.1 - 2%. The fruit pulp residue was lethal to different weeds at 0.25 - 2%. Interestingly, lantana seed residue too showed phytotoxic property. The residue was inhibitory at 0.1 - 2% and lethal at 0.25 - 2%. The leaf and fruit pulp residue appear to be the most phytotoxic components.

3. Feasibility of increasing persistence of some rice herbicide and its consequences in soil environment

PI-Dr. K.K. Barman, Sr. Scientist

Funding agency: ICAR, New Delhi

Degradation pattern of starch- and alginate- based controlled release formulations (CRF) of butachlor in soil was studied under laboratory condition. Compared to EC formulation, the degradation of butachlor was slower in the soil that received CRFs. This indicated that persistence of butachlor applied through CRFs increased over its commercially available EC formulation.

The release pattern of buatchlor from different formulations was studied under laboratory condition. The result showed relatively lower concentration of buatchlor in solution that received CRFs than the commercial EC formulation. This indicated that while the release of butachlor was instantaneous in case of EC formulation, it was restricted by the CRFs.

Bioassay study conducted under laboratory condition showed that *Echinocloa* root growth was significantly decreased in presence of butachlor and effect was in general similar for all the formulations used. This indicated that the release rate of butachlor in water from its CRFs was sufficient enough to affect Echinocloa growth and equally effective as that of its EC formulation.

The effect of different formulations of butachlor on microbial population in soil was studied. Compared to control, microbial population in soil reduced significantly on the day of butachlor application through its EC formulation. However, in case of CRFs significant reduction in microbial population was also indicated, but after 1-2 weeks of their application.

4. Augmentation and activity enhancement of Mexican beetle for biological control of parthenium

PI-Dr. Sushilkumar, Sr. Scientist

Funding agency: ICAR, New Delhi

Augmentation of beetle in early June resulted higher population build-up than the non-augmented sites. Augmentation of Mexican beetle in the wheat crop infested with parthenium brought good control of parthenium even during winter season. Beetles ceased egg laying at $40^{0}C$ after 2 days of their release. There was only 20% survival after 7 days Survived beetles also become dead within 22 days when kept at room temperature. The beetles exposed at $32^{0}C$ resulted higher survival of progeny along with good fecundity in the females. Diapause in Mexican beetle varied collection to collection. About 4-10 % beetle did not go in diapause. Mating of non-diapaused field collected beetles resulted higher percentage of non-diapaused beetled in subsequent generation. But there was high rate of mortality in the beetles of subsequent generation. Exposure of Mexican beetle to 40^{0}C caused aversion of diapause. Likewise, exposure of low temperature also resulted aversion in diapause behaviour in Mexican beetle. Activity enhancement of Mexican beetle by spraying parthenium leaf extract and Parthenin in different concentrations : Mexican beetle were congregated in higher number on the site treated with parthenium leaf extract or parthenin spray. This attribute can be utilised for activity enhancement of Mexican beetle at the desired site.

5. Bio-efficacy and Long-term residue trial of pinoxaden for the control of grasses in wheat

PI-Dr. Anil Dixit, Sr. Scientist

Funding agency: Syngenta India limited, Mumbai

Bio-efficacy of NOA-407 (Pinoxaden) in wheat with special reference to *Avena* and *Phalaris*

Phalaris minor and *Avena ludoviciana* are dominating weeds for the wheat crop particularly in rice-wheat cropping syatem due to favorable ecological conditions created by this system. Isoproturon, clodinafop and fenoxaprop are being used successfully for control of these grassy weeds. However, continuous use of these herbicides may result in development of resistant biotypes. This calls for use of other competitive herbicide for its management to avoid perceptible change in the weed flora. Therefore, the present investigation was undertaken to find out the bioefficacy of Pinoxaden (NOA-407) in wheat.

A field experiment was conducted to study the effect of various doses of pinoxaden on wheat and associated weeds during winter seasons. Fifteen treatments consisting of pinoxaden 35g+ Surfactant(A) 2.0 L/ha, pinoxadin 35 g+ Surfactant(A).5L/ha, pinoxaden 35g+ Surfactant(A)1.0L/ha, pinoxaden 40g+ Surfactant(A)0.5L/ha, pinoxaden 40g+ Surfactant(A)1.0L/ha, pinoxaden 35g+ Surfactant(H) 1.0 L/ha, pinoxaden 35g+ Surfactant(H) 0.5 L/ha, pinoxaden 40g+ Surfactant(H) 1.0 L/ha, pinoxaden 40g+ Surfactant(H) 0.5 L/ha, pinoxaden 40g, Pinoxadin 80g/ha, sulfosulfuron 25 g,clodinafop 60g/ha ,weedy and weed free with three replications were laid out in randomized block design.

The experimental field was predominantly infested with *Avena ludoviciana* (45%), *Phalaris minor* (12%) and broad-leaved weeds (43%). All the pinoxaden treatments irrespective of doses and surfactant caused significant reduction in the density and dry weight of *Avena ludoviciana* and *Phalaris minor* over weedy check. Weed control efficiency of pinoxadin at all the doses was higher as compared to weedy check. The efficiency of the clodinafop at 60 g/ha was almost similar to that of application of pinoxaden(NOA-407) for the reduction in the density of *Phalaris minor* and *Avena ludoviciana.*

Uncontrolled weeds, on an average, caused 54% reduction in grain yield of wheat when compared with weed-free plots. All the treatments produced significantly more grain yield than weedy check. At all the doses of pinoxaden irrespective of surfactant produced higher grain yield than sulfosulfuron at 25 g/ha. Pinoxaden at 35 and 40 g/ha as post emergence produced almost similar grain yield of wheat to that of clodinafop at 60g/ha. The higher yield under these treatments can be attributed to effective control of weeds and more value of yield attributes. There was no phytotoxicity of NOA-407 (pinoxaden) on wheat crop.

Table 70. Effect of doses of pinoxaden (NOA-407) on weed density in wheat

Treatments	Weed population (species wise)				Weed dry Weight (g/m^2)	Yield (Kg/ha)
	Avena ludoviciana	*Phalaris minor*	*Medicago*	Other broadleavd weeds		
NOA 407 + A12127R(35+2.0)	4	3	33	43	24	3842
NOA 407 + A12127R(35+0.5)	5	4	33	40	27	3877
NOA 407 + A12127R(35+1.0)	6	6	30	42	22	3841
NOA 407 + A12127R(40+0.5)	6	7	38	46	24	3822
NOA 407 + A12127R(40+1.0)	3	6	32	44	23	3879
NOA 407 + H (35+1.0)	3	5	34	34	27	3870
NOA 407 + H (35+0.5)	3	6	33	44	25	3818
NOA 407 + H (40+1.0)	2	4	34	43	20	3940
NOA 407 + H (40+0.5)	2	6	37	41	21	3966
NOA 407 40	6	7	35	41	23	3890
NOA 407 80	2	3	30	43	20	3982
Clodinafop 60	6	5	33	40	22	3950
Sulfosulfuron 25	29	8	14	22	28	3800
Weed free	-	-	-	-	-	4270
Weedy	84	22	37	42	81	2310
LSD(P=0.05)	-	-	-	-	4.6	208

Bio-efficacy of pinoxaden 5% EC in wheat with special reference to grassy weeds

Anil Dixit

Phalaris minor and *Avena ludoviciana* are dominating weeds for the wheat crop particularly in rice-wheat cropping system due to favorable ecological conditions created by this system. Isoproturon, clodinafop and fenoxaprop are being used successfully for control of these grassy weeds. However, continuous use of these herbicides may result in development of resistant biotypes. This calls for use of other competitive herbicide for its management to avoid perceptible change in the weed flora. Therefore, the present investigation was undertaken to find out the bioefficacy of Pinoxaden 5%EC in wheat.

A field experiment was conducted to study the effect of various doses of pinoxaden on wheat and associated weeds. Nine treatments consisting of pinoxaden 5 EC at 35g, pinoxaden40g, pinoxaden 45g and pinoxaden 50g, pinoxaden 10EC 40g+ Surfactant (A)2.0L/ha, sulfosulfuron 25 g, clodinafop 60g/ha ,weedy and weed free with three replications were laid out in randomized block design.

The experimental field was predominantly infested with *Avena ludoviciana Phalaris minor*, and other broad-leaved weeds like *Medicago* and *Chenopodium album.*

All the pinoxaden treatments irrespective of dose caused significant reduction in the density and dry weight of *Avena ludoviciana* and *Phalaris minor* over weedy check. Weed control efficiency of pinoxaden at all the doses was higher as compared to weedy check. The efficiency of the clodinafop at 60 g/ha was almost similar to that of application of pinoxaden 5%EC for the reduction in the density of *Phalaris minor* and *Avena ludoviciana* There was no phytotoxicity of pinoxaden 5% EC on wheat crop at any stage of crop.

Table 71. Effect of pinoxaden on weeds and yield of wheat

Treatments (g a.i./ha)	Weed population* at 60 DAS (No/m²)	Weed dry weight (g/m²)	Yield (kg/ha)
Pinoxaden 5%EC 35	2.21	11	3630
Pinoxaden 40	1.58	8	3642
Pinoxaden 45	0.87	6	3784
Pinoxaden 50	0.99	6	3873
Pinoxaden +A 12127 (35+2LH)	0.71	-	3911
Clodinafop 60	1.35	7	3878
Sulfosulfuron 25	4.23	33	3683
Weed free	0.71	-	4022
Weedy check	6.38	59	2180
LSD (P=0.05)	0.59	6.1	307

* Weed count subject to square root transformation.

Effect of elevated atmospheric carbon di-oxide (CO_2) on crop-weed interactions

PI-Dr. V.S.G.R. Naidu, Scientist

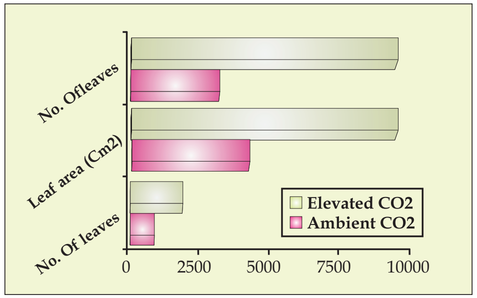
Funding agency: ICAR, New Delhi

Growth and Biomass partitioning in two weed species, *Parthenium hysterophorus* (C_3) and *Amaranthus viridis* (C_4), under elevated CO_2.

A pot culture experiment was conducted to study the growth response of *Parthenium hysterophorus* (C_3) and *Amaranthus viridis* (C_4) to CO_2 enrichment. The experiment was conducted in open top chambers (OTC) where in the CO_2 concentration was maintained at two levels i.e. ambient (36020 ppm) and elevated (55030 ppm). The elevated CO_2 concentration was maintained by continuous supply of commercial grade CO_2 from the cylinders and the concentration was monitored with the use of ë-T CO_2 monitor/controller (ADC make).

The elevated CO_2 enhanced the growth and biomass production in both the weed species. In case of *P. hysterophorus*, the increase in plant height at elevated CO_2 was more than 100%, with more number of primary branches and leaves. The leaf area increase was 49% even though the number of leaves was 291% more than that of ambient conditions. This was due to the production of more number of smaller sized leaves on the branches under elevated CO_2 (Fig.27). There was an increase in root length by 56% increase and root biomass by 700% due to profuse branching at the upper portion as well as the sturdy growth of the taproot. Under ambient CO_2 conditions about 87% of the biomass was allocated to stem (44%) and leaves (43%) and rest of the 13% was almost equally allocated root and flowers (Fig.28). Whereas under elevated CO_2 conditions 71% of the biomass was accumulated in the stem and the rest in leaves (12%), flowers (9.4%) and root (7.6%).

In case of *A. viridis,* the growth enhancement under elevated CO_2 started after 60 DAS and continued till the end. The enhanced biomass production under elevated CO_2 was mainly due to profuse branching and production of large number of leaves and flower heads. Most of the biomass (93%) was accumulated in stem and inflorescence under elevated CO_2 . The tremendous growth response of *Amaranthus* is in contrast to the generalized opinion that C_4 plants show little response to CO_2 enrichment.



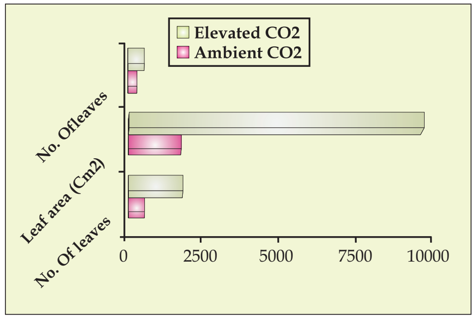
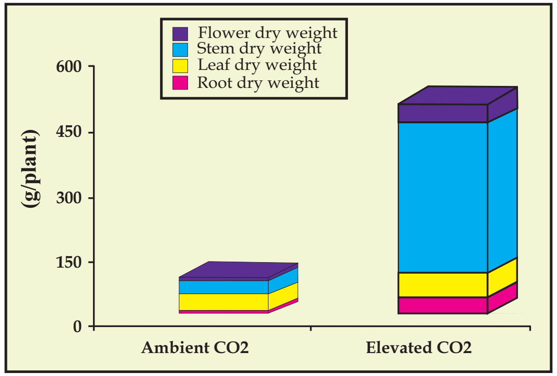


Fig. 27: Leaf and flower production in *P. hysterophorus* (Fig. A) and *A. viridis* (Fig. B) under ambient and elevated CO_2 conditions.



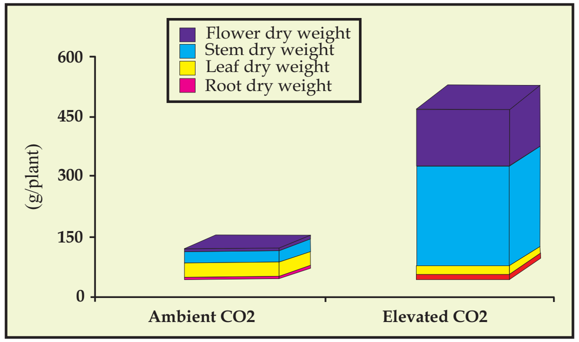


Fig. 28: Biomass partitioning in *Parthenium hysterophorus* (Fig. A) and *Amaranthus viridis* (Fig. B) under ambient and elevated CO_2 conditions

Effect of elevated CO_2 on the efficacy of different herbicides

The effect of different post-emergence herbicides on the mortality of selected weeds was tested under ambient (36020 ppm) and elevated (55030 ppm) CO_2 conditions. The CO_2 enrichment decreased the efficacy of the herbicides as and the time taken for the complete mortality of the weeds was prolonged at elevated levels of CO_2 (Table 72). Variability of efficacy among the herbicides under high CO_2 was observed. The impact of high CO_2 on the efficacy was more on isoproturon (mortality was delayed by 9 days) followed by clodinafop (7 days), 2,4-D (5 days) and glyphosate (3 days). The sulfosulfuron slightly retarded the growth of *Lathyrus sativus* for short period but did not cause death under both the conditions.

Table 72. Effect of elevated CO_2 on the efficacy of different herbicides

Weed Species	Herbicide	Dose (Kg/ha)	No. of days taken for complete mortality		Mortality delayed by (Days)
			Ambient	Elevated	
Chenopodium album	Glyphosate	2.0	7	10	3
Phalaris minor	Isoproturon	1.5	6	15	9
Avena fatua	Clodinafop	0.06	8	15	7
Amaranthus viridis	2,4-D	0.5	8	13	5
Lathyrus sativus	Sulfosulfuron	0.03	No visible symptoms of death		

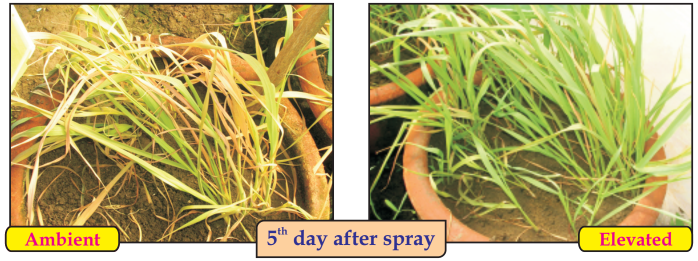


Fig. 29: Effect of clodinafop on the mortality of wild oat under ambient and elevated CO_2

Interactive effect of elevated CO_2 and herbicides on the rhizosphere microbial populations

Observations on the effect of elevated CO_2 and herbicides on the rhizosphere microbial (Bacteria, fungi and actinomycetes) populations revealed that the application of herbicides reduced the microbial population and the CO_2 enrichment alleviated the herbicide effect to some extent. The toxic effect of 2,4-D and isoproturon was high on bacterial population even under elevated CO_2. There was significant reduction in the impact of glyphosate (Fig. 30), sulfosulfuron and clodinafop on bacterial population due to CO_2 enrichment. The toxic effect of 2, 4-D and glyphosate was high on fungi even under high CO_2 and effect of other herbicides on fungi was decreased by high CO_2. The effect of all the herbicides on actinomycetes was reduced by CO_2 enrichment.

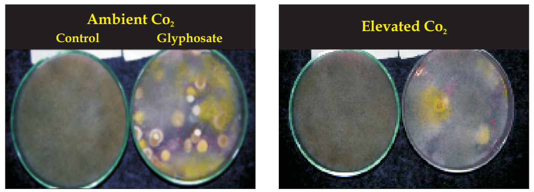


Fig. 30: Interactive effect of elevated CO_2 and glyphosate on rhizospheric fungal population from the rhizosphere of *Chenopodium album*.

3 TRANSFER OF TECHNOLOGY

For sustenance of agriculture, transfer of technology is also an important tool as that of technology development. Low adoption level of weed management technologies has been a major constraint in achieving the goal. The Centre is regularly carrying out its extension activities with a view to demonstrate the performance and profitability of proven weed management technologies among farming community throughout the year.

3601. Evaluation/ demonstration of improved weed control technologies on farmers' fields

P.K. Singh

Surveys were made to search and identify the farmers, villages and public places for carrying out the demonstrations on cropped and non-cropped situations at Jabalpur and location specific improved weed management technologies programme were undertaken through on-farm trial/ field demonstrations under transfer of technology. to identify the location specific weed problem under transfer of technology programme were undertaken through on farm trial/ field demonstration on improved weed management technologies.

Field demonstration/ OFT were conducted in major crops/ problem weeds of Jabalpur during *kharif* and *rabi* season 2006-07 below:

Table 73. Number of field demonstrations in cropped and non-cropped situations

Season/Crop	Number
Kharif	
Rice	16
Soybean	06
Rabi	
Wheat	25
Mustard	02
Chickpea	04
Zero tillage	05
Soil solarization (Vegetable nursery)	02
Non-cropped situations	
Ipomoea carnea	02
Parthenium hysterophorus	02

Kharif

In rice, 16 on farm trials demonstration and refinement of the weed management technology on farmers' fields were conducted during *kharif* 2006. The fields were mainly infested with major weed i.e. *Echinochloa colona*. Pre-emergence herbicides butachlor/ anilophos are in use for its control, which are not very effective. OFT results revealed that fenoxaprop 60 g/ha applied at 30 DAS was quite effective against this weed. Application of 2,4-D (0.5 kg/ha) one week after fenoxaprop resulted in broad-spectrum weed control and highest grain yield as compared to farmers practice. Maximum benefit was recorded with fenoxaprop+2,4-D (Rs. 7400/ha) *fb* fenoxaprop alone (Rs. 5700/ha).

In soybean, six field demonstrations were conducted to show the performance and profitability of recommended herbicides viz metribuzin @ 500 g/ha (PE), imazethapyr @ 100 g/ha(PO), quizalofop+chrorimuron @ 40+ 8 g/ha (PO) at 25 DAS. Results revealed that tank mix application of chlorimuron + quizalofop gave broad-spectrum weed control. The adoption of integration of weed management technologies in soybean increased its yield by 50% with a benefit of Rs. 9860/ha over farmer's practice.

Untreated

Treated

Fig. 31: Field demonstration on weed management technology in Rice during *Kharif*, 2006

Rabi

In wheat, 25 field demonstrations were laid out on framer's fields nearby Jabalpur. Tank mix application of 2,4-D+isoproturon at 500+500 g/ha as post-emergence effectively controlled mixed weed flora except wild oat, whereas, clodinafop *fb* metsulfuron controlled very effectively the mixed weed flora including wild oat and P. minor. The treated fields were almost free from weeds. The treatment resulted in WCE of over 60% and an increase in the yield of wheat by 25% as compared to farmer's practice. The maximum benefit (Rs. 8031/ha) was obtained with the treatment of clodinafop+metsulfuron.

Phalaris infestation

Wild oat infestation

treated

Fig. 32: Field demonstration on weed management technology in wheat crop

Zero tillage (ZT) in wheat was demonstrated with integration of herbicides in 5 farmers' fields. Results revealed that ZT reduced the infestation of *Phalaris minor*. The WCE of 2,4-D+isoproturon was higher (94%) in ZT as compared to conventional Tillage (CT). Grain yield of wheat and benefit due to treatment were higher under ZT than CT. In addition to this, ZT also saved around Rs. 2000/ha on account of land preparation and around 15 hrs time. Farmers of the adopted village and near by villages were highly convinced and appreciative of the technology.

Fig. 33: Demonstration of zero tillage technology on farmers' field s

In chickpea, four on-farm trials were conducted on the farmers fields. The herbicides tested were clodinafop (PO), pendimethalin (PE) besides one hoeing at 30 DAS. The fields were infested with mixed weed flora. The results showed that clodinafop 60 g/ha (PO) effectively controlled grassy weeds (WCE 96%) and increased the yield over farmers practice by about 85%. The maximum benefit of Rs. 7864/ha was recorded with pendimethalin.

Similarly in mustard, two OFTs were conducted in Jabalpur district with pendimethalin (PE) and one hoeing. A marked increase in yield was noted with the use of pendimethalin (47%) compared to farmers practice.

Field demonstrations on soil solarization in vegetable nursery

The demonstrations were conducted in vegetable nursery of brinjal, cabbage and cauliflower using soil solarization technique at Amkhera village of Jabalpur to show the performance of non-chemical technique. They were also appraised with the profitability of the technique especially in vegetables. The farmers of demonstrated sites showed high interest in soil solarization technique for better and safe weed management in vegetable nursery.

Non-solarized gobhi

Solarized gobhi

Field demonstration on soil solarization

Non-cropped situation

On-farm evaluation of promising herbicides were carried out for the control of *Parthenium hysterophorus* and *Ipomoea cornea* each in two locations in large plots of $500\ m^2$. Glyphosate (1 and 1.5%), metribuzin (0.3 and 0.5%) on *Parthenium* and glyphosate (1 and 1.5%), 2,4-D (0.5 & 0.75 kg/ha) on *Ipomoea cornea* were sprayed on active foliage. Results revealed that glyphosate controlled *Parthenium* effectively, whereas 2,4-D 0.75 kg/ha was found most economical and the best among all other treatments for control *of Ipomoea cornea.*

Training

NRCWS organised several training programmes for farmers/agriculture officials with the help of Gram Panchayat, progressive farmers, block samiti at different places during the year (on campus and off campus).

During the programmes farmers were briefed about the importance of weed management. Scientists of the Centre explained the chemical and biological control of weeds in crop and non- crop situations, use of mechanical tools and implements for weed control in field crops etc.

Problems faced by the farmers were solved by the scientists during the scientist-farmers interface.

Participation in Kisan Mela/exhibitions

The Centre has put up an excellent stall at JNKVV, Jabalpur and NRC-Soybean during *Kisan Mela*. Photographs and charts depicting pertaining to latest research findings and achievements of NRCWS were displayed. A large number of dignitaries, Scientists, farmers, NGO's, govt. officials, students and other entrepreneurs of different places visited the stall and acquired technical know-how on weed management. The extension handouts and other publications were distributed among the visitors.

places visited the stall and acquired technical know-how on weed management. The extension handouts and other publications were distributed among the visitors.

4 EDUCATION AND TRAINING

Training received

Training programmes attended by the scientists and other staff

Participants	Title of the programme	Venue and period
Dr. Shobha Sondhia	Agriculture Resource management for eco friendly environment, sustainable production system and better soil health	JNKVV, Jabalpur 26 December to 15 January 2007

5 AWARDS AND RECOGNITION

Dr. Varshney Joins as Director, NRCWS

Dr. Jay G. Varshney has taken over as Director NRCWS, Jabalpur on 10 May 2006. Prior to joining this post, he was working as Principal Scientist (Weed Science) at Indian Institute of Pulses Research, Kanpur (IIPR). He held various important positions like National project coordinator of All India Coordinated Research Project on improvement of prominent grain legume crops (mungbean, urdbean, lentil, lathyrus, French beans and field peas); Head, Division of Crop Production at Indian Institute of Pulses Research, Kanpur and founder Head of Regional Center of Directorate of Pulses Research at Gwalior (M.P.). Dr. Varshney has vast experience of working in the field of weed management on different crops in different parts of the country. He was one of the pioneer worker who worked in depth on problem of nutsedge. He also worked as Editor, Indian Journal of Pulse Research for long time. He has more than 60 research papers and 7 book chapters to his credit and also presented over 100 research papers in various National/International conferences.

Dr. Varshney becomes the Secretary, ISWS

Dr. Varshney, Director, NRCWS was declared elected as the Secretary of Indian Society of Weed Science (IWSS) during a meeting of the Society's executives held on 26 March 2007 at CCSHAU, Hisar.

Dr. A.K. Gogoi Joins as ADG

Dr. A.K. Gogoi, took over as Assistant Director General (Agronomy), ICAR, New Delhi on 18 May, 2006. Dr. Gogoi, with wide range of experience in the field of weed science served in various capacities as Assoc. Professor, AAU, Jorhat and Principal Scientist and I/C AICRP-WC at NRCWS, Jabalpur.

Personnel

Sh. Apresh Mukherjee, Assistant from Indian Institute of Sugarcane Research (IISR), Lucknow, joined as AAO on 1 March 2007 on deputation.

Promotions

Name	Promoted	w.e.f
Dr. Shobha Sondhia	Scientist (SS)	11 December 2003
Dr. M.B.B. Prasad Babu	Sr. Scientist	05 July 2005
Dr. P.J. Khankhane	Sr. Scientist	14 August 2005
Sh. Veer Singh	SSG-IV	17 July 2006
Sh. Raju Prasad	SSG-IV	
Sh. Naresh Singh	SSG-III	
Sh. Jamna Prasad	SSG-III	
Sh. Ashwani Tiwari	SSG-II	
Sh. S.K. Patel	SSG-II	
Sh. J.P. Kori	Assistant	11 August 2006
Sh. R. K. Hadge	Assistant	
Sh. T. Lakhera	Assistant	06 November 2006

Awards and honours

Dr. Anil Dixit, Sr. Scientist, received best paper (oral presentation) award in National Symposium on conservation and Management of Agro-resources in accelerating the food production for 21st Century organized by ISA held at IGKV, Raipur from14-15 December 2006. He has been nominated as Honorary advisor of Rural Society (Village, society and farmers): www.ruralsociety.com magazine.

Dr. (Mrs.) Shobha Sondhia received the "Best Participant Award" during the 21-day training programme on "Agricultural resource management for eco-friendly environment, sustainable production system and better soil health" organized at Centre for Advanced Studies (CAS), Department of Soil Science and Agricultural chemistry, JNKVV Jabalpur from 26 December to 15 January 2007.

Dr. P.K. Singh, Sr. Scientist (Agril Ext), NRCWS, Jabalpur received the best appreciation award of the Society of Extension Education, Agra for his outstanding contribution made in the field of Extension Education during fourth Extension education congress held at JNKVV, Jabalpur from 9-11 March 2007.

6 AICRP - WEED CONTROL

NRC-Weed Science coordinates the network research with State Agricultural Universities for generating location specific technologies for weed management in different crops, cropping and farming systems and also non-crop situations through its All India Coordinated Research Project on Weed Control (AICRP-WC) operating at 22 Centres spread through out the country. The yearly achievements of AICRP-WC are published separately in its annual report. The summary of salient research achievements of the programme during the current year is presented below:

Weed survey and surveillance

Weed survey and surveillance in crops and cropping system

- In Bangalore, new weeds *Smallantus* sp, of Asteraceae family in eastern dry and southern transition zones; *Eriocaulon cuspidatum* (Eriocaulaceae) and *Sphaeranthus indicus* in coastal zone, *Polygala chinensis* in eastern dry zone of Southern Karnataka have been observed.
- In Pantnagar, *Leptochloa chinensis* has been observed as new weed. *Lathyrus aphaca*, *Medicago denticulata* and *Melilotus* spp. were increased in wheat fields due to continuous use of isoproturon.
- In Gujarat, the infestation of *Phalaris minor* was recorded first time in Ahmedabad district in the year 1996. The weed has now spread in 6 districts *viz.* Banasankantha, Sabarakantha, Mahesana, Gandhinagar, Ahmedabad and Kheda with varying densities (15-35 plants m^{-2}).
- In Coimbatore, *Cyperus rotundus* which was dominant in summer was replaced by *Cyperus iria* and *Cyperus difformis* in *kharif* and *Cyperus difformis* alone was observed in *rabi*.
- In West Bengal, *Parthenium* was found to invade rice fields in some places of the district. *Ludwigia, Alternanthera, Oldenlandia* and *Eclipta* were observed in all the *kharif* crops. In road sides, *Parthenium* was replaced by *Xanthium.*
- In Orissa, *Parthenium hysterophorus*, previously confined to the roadside areas, are now observed in all major canal embankments in the coastal command areas. *Orobanche* infestation was observed in brinjal crop under vegetable tract of Khurda district.
- In Hyderabad, *Parthenium hysterophorus* was highly observed in tomato, carrot, brinjal, sugarcane, groundnut, wheat, cluster bean, chillies, banana and sweet orange.
- In North-eastern Haryana, weed flora in wheat has shifted towards broadleaf weeds such as *Medicago denticulata, C. album and Rumex retroflexus* due to continuous use of clodinafop by the farmers every year. Infestation of parasitic weed *Orobanche aegyptiaca* is increasing every year.
- In Pusa (Bihar), *Dendrophthoe falcata* (l.f.) Ettingsh (Syn. *Loranthus falcatus* (c.f.) of *Lorantheaceae* family locally known as *Banda* was observed a fast spreading parasitic weed on mango and litchi.

Studies on cross resistance in *P. minor*

- In Punjab, cross/ multiple resistance in *Phalaris minor* indicated that clodinafop induced significantly higher mortality than isoproturon and control indicating the rotation of herbicide might delay the development of resistance.

- At Hisar, the possibility of evolution of cross resistance against alternate herbicides fenoxaprop, sulfosulfuron and clodinafop as GR_{50} of biotypes of *P. minor* collected from permanent sites is increasing every year.

Monitoring of butachlor resistance of *Echinochloa* spp.

- At Sriniketan, no resistance against butachlor has developed in *Echinochloa* sp.

Weed management in crops and cropping systems

Integrated weed management in direct-seeded rice

At Pusa and Bhubaneswar, maximum reduction in weed population was observed in the treatment *Dhaincha* + pendimethalin 1.0 kg/ha *fb* 2,4-D 0.5 kg/ha. At Raipur, Pre-emergence application of pendimethalin 1.0 kg/ha + one hand weeding and hand weeding twice at 30 and 45 DAS gave the comparable and highest yield of direct seeded rice.

Weed management in maize

At Pusa, pendimethalin 1.0 kg/ha PE + intercropping of cowpea gave better yield followed by atrazine 0.5 kg/ha PE *fb* one mechanical weeding (30 DAS) and atrazine alone 1.0 kg/ha PE. At Anand, pre-emergence application of pendimethalin 0.25 kg/ha with atrazine 0.50 kg/ha or pre emergence of atrazine 1.0 kg/ha is the substitute of two hand weeding and inter culture in *kharif* maize crop.

Integrated weed management studies in sugarcane ratoon

At Pantnagar, the highest cane yield of ratoon was recorded with three hoeings at 30, 60 & 90 DAH treatment, which was closely followed by atrazine at 1.5 or 2.0 kg/ha supplemented with hoeings at 60 and 90 DAH. At Dharwad, atrazine 2.0 kg/ha pre-emergence on 3 DAH + 2,4-D 1.25 kg/ha post-emergence on 90 DAH + directed spray of glyphosate 1.0 kg/ha on 150 DAH was recorded highest sugarcane yield and weed control efficiency. At Pusa, metribuzin 0.88 kg/ha (pre-em) *fb* one hoeing at 45 DAS *fb* 2,4-D (Na salt 2.5 kg/ha) at 90 DAS have observed more weed suppressing ability followed by atrazine 2.0 kg/ha PE on 3 DAP + 2,4-D 1.25 kg/ha as POE on 90 DAP and atrazine 2.0 kg/ha PE on 3 DAP.

IWM in sugarcane intercropping systems

At Jorhat, metolachlor 1.0 kg/ha recorded significantly lower weed population in sugarcane + cowpea intercropping system followed by the treatment receiving pendimethalin 1.0 kg/ha at 60 DAP while, at 120 DAP, both the herbicides were at par and recorded significantly lower weed density over farmers practice.

Integrated weed management in rice-rice system

At Bangalore, in summer rice, use of butachlor 1.25 kg/ha + Almix 20 WP at 4 g/ha at 3 DAP lowered the weeds and gave the higher rice yield. Whereas in *kharif* rice, Use of pretilachlor lowered the density of weeds and gave 5% more paddy yield than hand weeding. The use of herbicide was cheaper and saved weeding cost to an extent of Rs. 3950/ha for managing the weeds similar to that of hand weeding. At Bhubaneswar, Application of butachlor 1.25 kg/ha and almix 4 g/ha at 3 DAP were found to be superior to other weed control measures in reducing weed density and weed biomass during the entire crop cycle of rice.

IWM in maize groundnut system

In Bangalore, use of pendimethalin 1.0 kg/ha 3 DAS gave groundnut yield comparable to hand weeding, besides being economical in managing weeds and saving the weeding cost by Rs. 4600/ha (over hand weeding). Whereas, in maize, use of atrazine 1.0 kg/ha 3 DAS followed by mechanical weeding of passing Junior hoe with two tynes (3 weeks after sowing) gave yield comparable (6749 kg/ha) to hand weeding (6539/ha).

At Hyderabad, either application of atrazine fb mechanical weeding or farmer's method of weed management is better for getting higher yield in maize-groundnut cropping system.

At Anand, the higher grain yield of maize (4086 kg/ha) was obtained under HW + inter cultivation (IC) at 20 & 40 DAS which was at par with lower dose of atrazine (0.5 kg/ha) as PE with IC at 3 WAS and application of atrazine 1.0 kg/ha as pre-emergence. In groundnut, significantly higher pod yield (1519 kg/ha) recorded from application of atrazine which was at par with rest of the treatments.

Long- term trial on tillage in different cropping system

- At Ludhiana, in maize-wheat system, similar wheat yield was obtained under both tillage system of zero and conventional. At Palampur, combination of zero tillage in maize and conventional tillage in wheat or zero tillage in both the crops resulted in significantly higher grain yield of wheat.
- At Gwalior in pearlmillet-wheat cropping system, minimum tillage proved most economic treatment in wheat crop. Whereas in peralmillet, minimum tillage proved more economical and efficient treatment by providing higher net income.
- At Pantnagar in rice-wheat system, zero tillage sown wheat produced significantly higher yield than reduced tillage and conventional tillage, which was comparable to each other. Grain yield of rice planted after wheat also did not differ significantly with each other owing to different wheat establishment methods. At Hisar, grain yield were significantly more when wheat was sown by ZT method. At Pusa in rice lower weed indices were recorded in conventional and bed system which were significantly superior with zero tillage. In wheat, zero tillage treatment found significantly lower weed count and weed dry weight than the reduced and conventional system. At Raipur, dry matter of weed g/m^2 as well as the grain yield of direct seeded rice was not influenced significantly due to zero and conventional tillage methods and produced similar dry matter of weeds and grain yield.
- In Soybean- wheat system at Parbhani, highest grain yield of wheat was recorded in Bed-Bed system which was at par with all other treatments and significantly superior over Zero-Zero tillage. Significantly highest grain yield of soybean was recorded in conventional zero treatments which was at par with zero-conventional and bed-bed tillage system.
- In maize-sunflower system at Bangalore, zero tillage for sunflower in summer gave yields similar to that of conservation tillage, while for maize conservation tillage was better than zero tillage during *kharif*. At Coimbatore continuous -conventional tillage combined with hand weeding at 20 and 40 DAS recorded the higher gross and net returns of sunflower and maize,

respectively. At Hyderabad, maximum sunflower yield was obtained with Zero conventional method of cultivation which was significantly superior to zero-zero tillage and conventional-zero tillage. Maximum grain yield of maize was recorded with conventional-conventional method.

Long- term studies on weed management in rice-chickpea cropping system

At Pantnagar, butachlor supplemented with one hand weeding was found to be effective and recorded the higher grain yield. At Pusa, application of anilophos produced higher grain yield fb butachlor. In Faizabad, hand weeding 20 and 40 DAS provided significantly higher grain yield than butachlor or anilofos each coupled with one hand weeding.

Long- term studies on weed management in rice-wheat cropping system

At Pantnagar, Pusa, Dharwad and Jorhat anilofos at 0.5 kg ha^{-1} applied at 3-4 days after transplanting being on par with mechanical weedings at 30 & 60 DAT and butachlor 1.5 kg/ha produced grain yield of rice significantly higher to that of weedy check.

Long-term studies on weed management in maize-chickpea/lentil/pea cropping system

At Ludhiana, the grain yield of maize was significantly more in different weed control treatments as compared with unweeded control. At Palampur, application of atrazine 1.0 kg ha^{-1} in integration with one HW resulted in significantly higher grain yield of maize. At Hisar, highest grain yield of maize was recorded in mechanical weeded plots which was at par with atrazine 0.75 kg/ha *fb* 2,4-D 0.5 kg/ha and atrazine at 1.0 kg/ha as pre-emergence. At Pusa and Pantnagar, atrazine 0.75 kg/ha *fb* 2,4-D 0.5 kg/ha provided the highest WCE and maximum grain yield of maize. At Dharwad, grain yield was highest in mechanical weeding treatment followed by atrazine application coupled with hand weeding.

Weed seed bank studies in different cropping system

At Ludhiana, seed of *P. minor* and *R. dentatus* increased in 2005-06 as compared to previous season in the long-term study in wheat. At Gwalior in bajra-wheat system, accumulation of total and broad leaved weeds were maximum under weedy check plots followed by atrazine. At Pantnagar in rice-chickpea system, the highest percentage (79.4%) of *P. minor* was found in 5-10 cm soil depth. At Palampur in transplanted rice-wheat sequence, weed seed bank was more in 0-10 cm layer than in 10-20 cm soil layer. At Jorhat, the accumulation of weed seeds was highly reduced due to continuous application of herbicides. At Coimbatore, Highest total weed density was recorded in no fertilizer or manure (control) applied treatment and lowest in 100% NPK + manual weeding. At Sriniketan, combined effect of reduced tillage *fb* zero tillage utera showed minimum emergence of weed seed. At Bhubaneswar in groundnut- fallow system, there was a shift (16%) from grasses to broadleaf weeds during the later stages of crop growth (60 DAS). At Hyderabad in continuous Zero tillage system in maize-sunflower in weedy check plot maximum number of weeds ($657m^{-2}$) emerged from soil collected from 0-15 cm depth. At Hisar in rice, emergence of weeds in green manured plots was more than non-green manured plots.

Management of parasitic/invasive/problematic/aquatic weeds

Management of *Cuscuta*

At Coimbatore in green vegetable (*Amaranthus* spp.), post-emergence directed application of either paraquat 0.80 kg/ha or glufosinate 0.40 kg/ha on 20 days after sowing, reduced the *Cuscuta* weed coverage and dry weight of both *Cuscuta* sp. and other weeds at 25 days after sowing. At Hyderabad, pendimethalin at 0.5 kg ha^{-1} as post- emergence resulted in control of *Cuscuta* and other weeds to a greater extent and aided in a higher fodder yield in four cuts of Lucerne.

Management of *Orobanche* sp. in different crops

At Bikaner, application of neem cake at 200 kg/ha + pendimethalin at 0.5 kg/ha as pre-emergence followed by a hand weeding 30 days after sowing produced significantly higher seed of mustard. At Gwalior, the yield of mustard was higher with the application of trifluralin 1.5 kg/ha ppi, soybean oil 2 drops per shoot, neem cake 200 kg/ha in furrows +1 hand weeding and glyphosate 0.5 kg/ha POE.

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

- At Pusa in tobacco, *Orobanche* infestation under non solarized and non chemical treatment condition showed emergence at 57 days while chemical treatments delayed the infestation duration from 57 to 76 days. Solarized plot treatment showed higher value of crop growth indices than the non solarized condition.
- At Bhubaneswar in brinjal, the parasite produces around 4750 seeds / floret and there were 60 florets per shoot.

Herbicide testing, leaching behaviour, persistence, residues and toxicity

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

- At Ludhiana, isoproturon, 2, 4-D, butachlor, anilophos, clodinafop and sulfosulfuron over the years in rice-wheat cropping systems did not leave any residues in soil, grain and straw.
- At Palampur, the initial deposits of atrazine in soil were found to be 0.54 and 1.22 μgg^{-1} for atrazine 1.5 kg ha^{-1} and atrazine 3.0 kg ha^{-1} which after 60 days of herbicide application reached to non-detectable.
- At Bangalore, the residues of butachlor and pendimethalin were below detectable level in soil after the harvest of finger millet and ground nut in long term trial.
- At Gwalior, sulfosulfuron applied to Isabgol persisted in soil upto 45 DAA and leaving no residue in post harvest soil
- At Anand, pendimethalin residues were detected at the time of harvest in sandy loam soil under soybean crop.
- At Coimbatore, application of pendimethalin 1 kg and 2 kg/ha did not leave any residue in the post harvest soil samples.
- At Faizabad, butachlor applied as 1.5 kg/ha pre-emergence in rice under rice-wheat cropping system did not leave its residues in the post harvested soil.

- At Bhubaneswar, the residues of butachlor in rice-rice cropping system were maximum at 0 days after application at both the doses. At 15 days, the residues were decreased to 50% and the residues could not be detected in the soils after 30 days of application.
- At Hyderabad, the half life of pretilachlor ranged from 11.9 days to 16.9 days at 1.0 and 2.0 kg application respectively. Residues were not detected in both rice grain and soil samples at harvest time.

WS 4.2: Studies on herbicide persistence in water

- At Ludhiana, the degradation of paraquat 38.9 to 47 %, 2,4-D 21.3 to 26.7 % and glyphosate 27.5 to 32.0 % was recorded after 5th day of spray.
- At Hyderabad, survival of the fish was not affected on application of paraquat or 2,4-D at recommended or double the recommended rate.
- At Bangalore, glyphosate, 2,4-D and paraquat were effective in controlling water hyacinth without affecting the fish mortality both at recommended and double the recommended days upto 35th day.
- At Jorhat, no fish mortality was observed at both recommended and double the recommended doses of glyphosate.
- At Coimbatore, paraquat residue content in water showed a declining trend with time 78.03-84.77% of paraquat degraded within 10 days after herbicide application.

WS 4.3 : Characterization of leaching behaviour of herbicide in soil.

- At Ludhiana, results showed that movement of the herbicides (pendimethalin and oxyfluorfen) is observed upto 30-40 cm soil depth.
- At Anand, fluchloralin did not move beyond 15 cm soil depth. Most of the applied fluchloralin remain in the top layer and only negligible amount leached to the lower (7.5 to 15.0 cm) depth.
- At Hyderabad, oxadiargyl applied at recommended rate move upto 10 cm depth with major portion of the herbicide remaining in the top 0-5 cm depth.
- At Bangalore, pyrazosulfuron in soil showed movement up to 60 cm in sandy loam soil.
- At Coimbatore, movement of butachlor was seen upto 20 cm in sandy loam soil and upto 15 cm in clay loam soil. Similarly movement of pendimethalin was seen upto 10 cm soil depth.

Transfer of Technology

Parthenium management by *Zygogramma* beetles

At Ludhiana, the damage on *Parthenium* varied from minor effect to almost complete eating of leaves by the beetel. At Bangalore, the damage to parthenium was more in areas with good rainfall distribution in Ananthapura and Bandikodigehally. Population of the beetles could not survive in Gwalior and Jorhat. At Parbhani, the damage to the Parthenium plant was to the extent of 87 % and average 1.67 larva and 3.27 adult were recorded on each plant. Up to 60 % defoliation of leaves was recoded due to this insect in Ambala, Kalka, Yamuna Nagar and Kurukshetra districts of Hariyana. At Raipur, damaged the *Parthenium* plants by 69.7 to 84.5 % whereas, at Dharwad, 55 to 83 % damage in three sites.

Yield loss estimation

At Ludhiana, yield loss under farmers practice in maize varied up to 3 per cent, in rice 1-5 per cent and in wheat up to 7 per cent due to weeds over recommended practice. Uncontrolled weeds caused 25- 45, 8-11 and 40 % loss of yield over farmers practice in rice at Bangalore, Sriniketan and Dharwad, respectively. Whereas, in wheat 20%, 6% and 6-12% yield loss over farmers practice was observed at Anand, Sriniketan and Hisar,

On- farm trials (OFTs)

- At Ludhiana, in wheat, clodinafop 0.6 kg/ha, sulfosulfuron 0.025 kg/ha. In rice, butachlor 1.5 kh/ha and anilophos 0.375 kg/ha were tested at 4 districts of Punjab.
- At Bangalore in transplanted rice, use of pyrazosulfuron ethyl at 25 g ai/ha 3 DAP, clomazone 20 EC 250 g + 2,4-D EE 30 EC 375 g/ha (a ready mix) 3 DAP and pretilachlor 0.75 kg/ha 3 DAP gave 4.5%, 4.3 and 4.3% more yield than hand weeding twice.
- At Gwalior in wheat, sulfosulfuron 20 g/ha, isoproturon 1.0 /ha and 2,4-D Na salt 0.5 kg/ha, all as post emergence, were tested and gave the higher yield.
- At Pantnagar in wheat, sulfosulfuron and atlantis, was better than Isoproturon and Isoproturon + metsulfuron methyl. Whereas in rice, combined application of butachlor followed by Almix depicted highest weed control efficiency.
- At Palampur, ninety three on farm trials were conducted in maize, rice & wheat, application of isoproturon and atrazine was superior to their broadcast application in wheat and maize, respectively.
- At Jorhat , application of butachlor 1.0 kg ha^{-1} followed by paddy weeder at 30 DAT resulted in highest grain yield of *boro* rice. Similarly in wheat, application of isoproturon 1.0 kg ha^{-1} + metsulfuron methyl 4 g ha^{-1} at 30 DAS resulted in highest grain yield and lowest weed dry weight.
- At Parbhani, twenty on farm trials on sorghum, soybean and cotton were conducted, recommended weed management technology was compared with farmer's practices. Results indicated 32.8 %, 16.30 % and 17.48 % increase in seed cotton yield, grain yield of soybean and sorghum, respectively.
- At Coimbatore, yield of transplanted rice could be maximized by the pre-emergence application of butachlor 0.75 $kgha^{-1}$ + bensulfuon methyl 50 g ha^{-1} on 3 DAT + HW on 45 DAT.
- At Faizabad, pendimethalin 1.0 kg/ha as pre-emergence was highly effective to control almost all the weed spp. and recorded significantly higher grain yield.
- At Ranchi in direct seeded upland rice, combined use of butachlor + 2,4-D increased the yield by 42.3 % over the untreated plot.

- At Bhubaneswar in *kharif* groundnut, highest pod yield was obtained in the plots applied with oxyfluorfen 0.03 kg /ha.
- At Hyderabad in maize + redgram, use of pendimethalin at 1.25 kg/acre reduced weeds in initial stages of the crop i.e. up to 15 DAS and helped to save on hand weeding.
- At Pusa, in transplanted rice, an increase of 14.2, 11.5% and 12.5% in yield was observed over farmers practice from anilofos 0.4 kg/ha, thiobencarb 1.5 kg/ha, pyrazosulfuron 30 g/ha, respectively.
- At Raipur, application of fenoxaprop-p-ethyl 56.25 g/ha + chlorimuron + metsuluron 4.0 g/ha at 20-25 DAT gave the highest yield of transplanted rice.
- At Dharwad in maize + soybean inter cropping system, pre-emergence application of butachlor1.5 kg/ha + 1 intercultivation at 20 DAS was found most effective and increased the yield by 2-27% and 6-9% in maize and soybean, respectively.

Impact analysis on weed management

- At Ludhiana, farmers were adopting different weed management technologies to increase crop productivity.
- At Bangalore, the 80 per cent farmers considered the chemical weed management as worth and would lower the cost of cultivation.
- At Gwalior, about 85 per cent of the farmers due to lack of technical know-how, could not get higher productivity of the crops.
- At Parbhani, majority of the farmers of this region were adopting the weed management by means of cultural method (75 to 80 %) because ninety percent cropped area comes under rainfed situation.
- At Coimbatore, adoption of integrated weed management increased the yield of sugarcane and thereby increasing the farm income of the growers.
- At Hyderabad, most of the farmers were not aware of herbicide usage in inter crop like maize + redgram and vegetable crops. Economic conditions, small land holdings, lack of equipment and lack of knowledge about right chemical, its rate, method and time of application are some of the constraints for herbicide use.
- At Hisar, level of satisfaction was 80% in wheat crop and 100% in rice.
- At Pusa, 67 percent farmers were fully satisfied with the impact of recommended methods of weed management.

7 PUBLICATIONS

Research Papers

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6. Mishra, J.S. and Chandra Bhanu, 2006. Effect of herbicides on weeds, nodulation and growth of *Rhizobium* in summer blackgram. *Indian J. Weed Sci. Indian J. of Weed Sci.* 38 (1&2): 150-153.
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12. Shobha Sondhia and R. P. Dubey 2006. Determination of terminal residues of butachlor and pendimethalin in onion. *Pesticide Res. J.* 18: 85-86.
13. Singh, V.P., J.S Mishra., Anil Dixit and P.K. Singh 2006. Comparative efficacy of herbicides against spurge (*Euphorbia geniculata*) in soybean. *Indian J. Agric.l Sci.* 76 (7):380-382.
14. Sondhia Shobha and Anil Dixit 2007. Determination of terminal residues of oxyfluorfen in onion. *Annals of Plant Protection Sciences* 15: 232-234.

15. Sondhia Shobha, Benu Singhai and V. P. Singh 2007. Degradation of sulfosulfuron in sandy clay loam soil and detection of its residues in wheat grains and straw. *Geobios* 34: 74-76.

16. Sondhia Shobha and V.P. Singh 2005. Persistence of isoproturon in soil and detection of its residues in wheat grain and straw. *Geobios* 33: 209-211

17. Sushilkumar, Ranu Diwedi and Kamlesh Vishwakarma 2007 Biochemical and developmental basis of host preference in spotted leaf beetle, *Henosepilachna vigintioctopunctata* (Fabr.) (Coccienellidae: Coleoptera) on weed and vegetable plants. *Journal of Entomological Research* 31(2):1-4.

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Shri Kantilal Bhuria, Hon'ble minister of State for Agriculture, GOI during his visit released three publications *viz*., Biology and management of *Cuscuta*, Weed management in pulse based intercropping systems and Methods of herbicide residue analysis in soil, water and food chain, developed by the Centre.

New arrivals

Title of publication	Author (s)
Biology and management of *Cuscuta*	Dr(s). J.S. Mishra, BTS Moorthy and A.K. Gogoi
Weed management in pulse based intercropping systems	Dr(s). A.N. Tewari, J.S. Mishra, and A.K. Gogoi
Methods of herbicide residue analysis in soil, water and food chain,	Dr. Shobha Sondhia and Dr. A.K. Gogoi

8 APPROVED RESEARCH PROJECTS

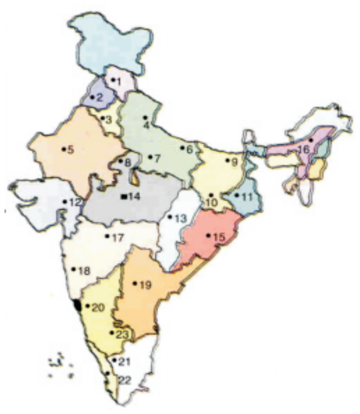
Code	Projects	Principal Investigators
A	**Herbicide as a tool in weed management**	
1101	Testing of new molecules	Dr. Anil Dixit
1201	Long-term effects of herbicides in cropping systems	Dr. V.P. Singh
1301	Influence of herbicides on soil micro-flora, soil fertility and productivity	Dr. K.K. Barman
1401	Efficient weed management through herbicide use	Dr. Anil Dixit
1601	Herbicide residues in soil and food chain	Dr. Shobha Sondhia
1701	Studies herbicide residue in long-term herbicide trial in soybean-wheat cropping system	Dr. Shobha Sondhia
1801	Studies herbicide residue in long-term herbicide trial in rice-wheat cropping system	Dr. Shobha Sondhia
B	**Weed biology and eco-physiology**	
2201	Weed flora shift in cropping systems	Dr. V.P. Singh
2501	Effect of nutrient supply on crop-weed competition	Dr. M.B.B.P. Babu
2601	Germination, dormancy and ageing of weed seeds	Dr. D.K. Pandey
2701	Evaluation of Methods of Breaking Weed Seed Dormancy	Dr. VSGR Naidu
2801	Physiological and biochemical basis for weed suppressing ability of different crop varieties.	Dr. D. Subrahmanyam
C	**Development and evaluation of integrated weed management techniques /practices**	
3101	Role of weed competitive crop cultivars in IWM	Dr. BTS Moorthy
3201	Design, development and evaluation of mechanical weeding tool as a component of integrated weed management techniques and practices	Er. H.S. Bisen
3401	Role of intercrops and cover crops in weed management	Dr. R.P. Dubey
3501	Studies on effect of crop residue management on weeds in rice-wheat cropping system	Dr. P.J. Khankhane
3601	Evaluation of improved weed control technologies on farmers fields	Dr. P.K. Singh
3701	Integrated management of *Cuscuta* in berseem and lucerne	Dr. J.S. Mishra
3801	Effect of tillage and weed control measures on weed dynamics in rice based cropping systems	Dr. J.S. Mishra

Code	Projects	Principal Investigators
D	**Bio-pesticides and biocontrol of weeds**	
4101	Herbicidal activity of plants and their constituents	Dr. D.K. Pandey
4201	Survey, surveillance and impact evaluation of bio-agents and herbicides with other methods for integrated management of some important weeds	Dr. Sushilkumar
4301	Collection, characterization and evaluation of plant pathogens for weed management	Sh. Chandrabhanu
4401	Evaluation of bioagants and herbicides alone or in combination on water quality and fish mortality for integrated management of some aquatic weed	Dr. Sushilkumar
4501	Isolation and identification of root exudates of linseed and marigold and their growth inhibitory effect on few weeds	Dr. Shobha Sondhia

8 LINKAGES AND COLLABORATION IN INDIA AND ABROAD INCLUDING EXTERNALLY FUNDED PROJECTS

NRCWS, a nodal agency for research and training in the field of Weed Science and a repository of information in Weed Science in the country, offered research and training to the research scholars and provided expertise and consultancy to the staff and students of SAUs, ICAR Institutes, NGOs, herbicide industries, etc.

NRCWS acts as the Project Coordinating Cell for the AICRP on Weed Control, which is currently operating at 22 SAU's located at different agro-climatic zones of the country. The NRCWS also collaborates with several other educational and research institutions. A MoU was signed with Jawaharlal Nehru Krishi Vishva Vidyalaya (JNKVV), Jabalpur enabling better collaboration in the area of research, teaching and extension. It has also been recognized by Rani Durgawati Vishva Vidyalaya (RDVV), Jabalpur as a post-graduate research centre for their students. In addition, the centre is open to several educational institutions all over the country for their research and training activities. The overall programme of NRCWS and AICRP on Weed Control is being coordinated and monitored by the Director, NRCWS. Programme for linkages with agencies like NBSS&LUP, CIAE, SAUs, IIBAT, IARI, IASRI, NCAP, IIT, DBT, DST, ISRO, CSIR are mainly for data generation, sharing, joint research, HRD, technology dissemination and impact analysis -wise linkages with other partners and collaborators and their role are given below



AICRP-Weed Control Centres

1 HPKV, Palampur
2 PAU, Ludhiana
3 CCSHAU, Hisar
4 GBPUA&T, Pantnagar
5 RAU, Bikaner
6 NDUA&T, Faizabad
7 CSAUA&T, Kanpur
8 JNKVV, Gwalior
9 RAU, Pusa
10 BAU, Ranchi
11 VB, Sriniketan
12 GAU, Anand
13 IGKV, Raipur
14 HQ, NRCWS, JBP
15 OUAT, Bhubaneswar
16 AAU, Jorhat
17 MAU, Parbhani
18 DBSKKV, Dapoli
19 ANGRAU, Hyderabad
20 UAS, Dharwad
21 TNAU, Coimbatore
22 KAU, Thrissur
23 UAS, Bangalore

Externally-funded projects

Project Title	Funding Agency	Duration	
Large scale demonstration on management of *Parthenium hysterophorus* through integrated approach (Net work project with 7 cooperating centres)	DBT	2004	2007
Herbicidal property of Invasive and noxious weed-lantana (*Lantana camara* L.) constituents	DST	2005	2008
Feasibility of increasing persistence of some rice herbicide and its consequence in soil environment	ICAR	2005	2008
Augmentation and activity enhancement of Mexican beetle for biological control of parthenium	ICAR	2005	2008
Detection of weeds for precision crop management using remote sensing technique	ISRO	2004	2007
Structural behavior of different of cropping conditions - identification and quantification sulfonylurea herbicides in sub-soil under the influence of potential metabolites responsible for the toxicity and their bio-accumulation in fish (In collaboration with IIBAT, Padappai and PAU, Ludhiana)	ICAR	2005	2008
Effect of elevated atmospheric carbon di-oxide (CO_2) on crop-weed interactions	ICAR	2004	2007
Determination of the role of weeds in epidemic and perpetuation of economically important plant viruses (In collaboration with IARI)	ICAR	2004	2007

8 QRT, RAC, IMC AND IRCMEETINGS

Quinquennial Review Team (QRT) meeting

The QRT meeting of NRCWS and AICRP-Weed Control was held during 29-31 January 2007 under the chairmanship of Dr. G.B. Singh, former DDG (NRM), ICAR, New Delhi and former DG, Uttar Pradesh Council of Agricultural research (UPCAR), Lucknow. Members who attended the meeting were Dr. David N. Sen, Retired Professor, University of Jodhpur; Dr. D.C. Uprety, National Fellow and Principal Scientist, Division of Plant Physiology, IARI, New Delhi; Dr. RJ Rabindra, Project Director, PDBC, Bangalore; Dr. Jamaluddin, Group Coordinator (Research), TFRI, Jabalpur; Dr. Jay G. Varshney, Director, NRCWS and Dr. D. Subrahmanyam, Principal Scientist, NRCWS and Member Secretary. The QRT reviewed the research achievements of the past five years and made valuable suggestions for future improvement. The team was shown the various on-going field and laboratory experiments.

RAC meeting

The XI[th] RAC meeting of the Centre was held during 22-23 February 2007 under the Chairmanship of Dr. Ambika Singh. The members present were Dr. A.K. Gogoi, ADG (Agronomy), ICAR, New Delhi; Dr. U.C. Sharma, former Joint Director, ICAR Research Complex for NEH Region, Barapani; Dr. G.L. Bansal, Professor & Head, Departrment of Plant Physiology, CSKHPKVV, Palampur; Dr. Hamid Kazi, MLA, Burhanpur, M.P.; Dr. Jay G. Varshney, Director, NRCWS and Er. H.S. Bisen, Principal Scientist, NRCWS and Member Secretary. The research achievements of the last year were presented by the scientists, which were critically reviewed and valuable suggestions for improvement in the coming year were made by the committee. The members of the RAC also visited the field and laboratory experiments.

IMC meeting

The XVII[th] Institute Management Committee meeting of the Centre was held on 23 March 2007 under the Chairmanship of Dr. Jay G. Varshney, Director. The meeting was attended by Dr. V.S. Tomar, Director-Research Services (DRS), JNKVV; Dr. V.V Singh, Principal scientist, CIAE, Bhopal; Sh. Hamid Quazi, MLA, Burhanpur, M.P.; Sh Tota Ram Kayande, Ex. MLA, M.P.; Sh. B.B. Mishra, Joint Director (Agriculture), Dept. of Agriculture, Bhopal; Sh. S.K. Hemraj, Joint Director, Department of Agriculture, Chattisgarh; Dr. M.S. Raghuvanshi, Technical Officer; Sh A.K. Shrivastava, AF&AO; Sh. Apresh Mukherjee, AAO and Dr. P K Singh, Sr. Scientist & HO, NRCWS. The progress of research/ developmental activities and infrastructure build-up were reviewed during the meeting. Approval was accorded for various new items to be executed/ procured during the financial year.

Institute Research Committee (IRC)

The Institute Research Committee (IRC) meeting was convened on 20-21 June 2006 under the chairmanship of Dr. Jay G. Varshney, Director to review the results of on-going projects and to consider new project proposals. Dr. R.P. Dubey, member Secretary, IRC presented the action taken report on the previous IRC proceedings. At the outset, the Chairman discussed the action taken on the previous IRC proceeding, research programmes and the recommendations of Research Advisory Committee (RAC) and emphasized that suggestions made by the RAC should be kept in mind while preparing the new proposals. Scientists presented their research achievements of 2005-06 and discussed new proposals for the coming year.

11 PARTICIPATION OF SCIENTISTS AND STAFF IN SEMINARS, SYMPOSIA ETC.

Participants	Conference / Symposium	Venue & Date
Drs. Jay G. Varshney, K.K. Barman, V.P. Singh, J.S. Mishra, R.P. Dubey, Sushilkumar, Anil Dixit, MBB Prasad Babu, Shobha Sondhia, VSGR Naidu, Chandra Bhanu, M.S. Raghuvanshi, Mr. A.K. Srivastava, Mr. Sandeep Dhagat, Mr. O.N. Tiwari and Mr. Pankaj Shukla	Biennial workshop of AICRP-WC	Acharya N.G. Ranga Agricultural University, Hyderabad from 1-3 June 2006
Drs. Jay G. Varshney , V.P. Singh, R.P. Dubey, P.K. Singh, Anil Dixit, MBB Prasad Babu, Shobha Sondhia, Chandra Bhanu	2nd International Rice Congress 2006	New Delhi from 9-13 October 2006
Dr. (s) Jay G. Varshney J.S. Mishra	National Symposium on Conservation Agriculture and Environment	BHU, Varanasi from 26-28 October 2006
Dr. Anil Dixit	National Symposium on conservation and Management of Agro-resources in accelerating the food production for 21st Century	IGKV, Raipur from 14-15 December 2006
Drs. Jay G. Varshney R.P Dubey V.P Singh J.S. Mishra M.B.B Prasad Babu Shobha Sondhia Chandra Bhanu	International Conference on Sustainable Agriculture for Food, Bio-energy and Livelihood Security	JNKVV, Jabalpur on 14-16 February 2007
Dr. Jay G. Varshney Dr. K. K. Barman	International Conference on 21st Century Challenges to Sustainable Agri-Food systems: Biotechnology, Nutrition, Trade and Policy	GKVK, Bangalore on 15-17 March 2007
Dr. Jay G. Varshney Sh. Chandra Bhanu	59th Annual Meeting of Indian Phytopathological Society	RDVV, Jabalpur on 16-18 January 2007

12 WORKSHOPS, SEMINARS, TRAINING PROGRAMMES ORGANISED

XVII Biennial Workshop of AICRP on Weed Control

The XVII Biennial Workshop of All India Coordinated Research Project on Weed Control was held during 01-03, June 2006 at Acharya N.G. Ranga Agricultural University, Hyderabad in collaboration with National Research Centre for Weed Science, Jabalpur. The workshop was inaugurated by Dr. S. Raghu Vardhan Reddy, Vice-Chancellor, ANGRAU, Hyderabad. The Vice-Chancellor in his address thanked ICAR for setting up of residue laboratories and sanctioning the post of microbiologists at some centres. He stressed on judicious mix of available technologies. Dr. G.B. Singh, Ex. DDG, ICAR expressed his concern on declining trend in food production. He opined that weed research should be more focused than other areas. Dr. A.K. Gogoi, ADG (Agronomy), ICAR, outlined in detail various issues of weed research. He also indicated that ICAR might set up an International Institute on Pest Management of which weed management would be an important component. Dr. Jay G. Varshney, Director, NRCWS presented the salient research findings of the weed control programme conducted during 2005-06. In subsequent technical sessions, the technical programme was thoroughly discussed. It was decided that whole research programme would be covered under five major programmes such as Weed survey and surveillance, Weed management in crops and cropping systems, Management of parasitic/ invasive/ problematic/ aquatic weeds, Herbicide testing, leaching behaviour, persistence, residues and toxicity and Transfer of Technology.

On this occasion, publications in the form of video CDs on alien invasive and parasitic weeds, weed management in tea, weed utilization and two bulletins on Weed management in rice and *Parthenium* management (In Assamese language) developed by different Centres of AICRP WC were released by the dignitaries.

Public Participatory Approach in *Parthenium* Management

The Public Participatory Approach in *Parthenium* Management, organized by National Research Centre for Weed Science, Jabalpur in collaboration with CIAE, Bhopal was inaugurated by His Excellency Dr. Balram Jakhar, Governor, Madhya Pradesh at CIAE, Bhopal 2006 on 06.09.2006. Shri Kantilal Bhuria, MOS for Agriculture, Government of India was the guest of honour. Dr. J.S. Samra, Deputy Director General (Natural Resources Management), ICAR, New Delhi chaired the function. The Directors of NRC-

Weed Science, IISS and CIAE, Bhopal were the convener. In addition to the above dignitaries, the program was attended by a large number of farmers, representatives from NGOs, officials from different government departments and scientists of ICAR and other research organizations. Director of the Centre made a brief presentation on the introduction of *parthenium* into the country, its spread, losses caused, ill effects on human beings and animals, biodiversity and ways to control the weed and its further utilization. He also highlighted the successful control of *parthenium* by Mexican beetle, *Zygogramma bicolorata* in and around Jabalpur- self-sustainable approach. He appealed the farmers to take immediate steps to eradicate and control *parthenium,* as it would be highly difficult to rein this weed in future as it spreads and establishes rapidly.

On this occasion, three publications on *parthenium* management including one video film were also released. An exhibition showing different aspects of *parthenium* control was also arranged at the venue. Thousands of Mexican beetles were released in Nabi Bagh area for the control of *parthenium.*

Review meeting of the DBT sponsored project on *Parthenium* management held

The Co-principal investigators' meeting of the DBT sponsored project on 'Large scale demonstration on management of *Parthenium* through integrated approach' was held on 23-24 August 2006 at UAS, Bangalore, in which Dr. Jay G. Varshney, Director, NRCWS and Principal Investigator of the project reviewed the progress.

Lectures delivered

- Dr. Sushilkumar delivered a lecture on integrated management of Lantana and Parthenium from 15 - 16 February 2006 in a training programme at Kerala Forest Research Institute, Peechi, Kerala.
- Dr. MBB Prasad Babu, Sr. Scientist delivered a lectuire on Alien invasive weeds and their management on 28 April 2006 at State Forst Research Institute, Jabalpur
- Drs. VP Singh, Anil Dixit and Sushilkumar delivered lectures on soil solarization, weed management through chemicals and biocontrol of weeds respectively during training programmes on Agril. resource management for eco-friendly environment, sustainable production system and better soil health during 26 December- 15 January 2007 at CAS, Division of SSAC, JNKVV, Jabalpur
- Sh. Basant Mishra, Sr. Photographer delivered a lecture on 'Wildlife Photography' in the First International Workshop on Wildlife Photography, Masai Mara, Nairobi and Digital writing and web journalism on 3-12 September 2006 and 8 February 2007 at Mata Gujari Mahavidhyalaya, Jabalpur.

Radio Talk

- Dr. J.S. Mishra delivered radio talk on "Biological control of *Parthenium*" on 29 June 2006 at AIR Jabalpur.

- Dr. Jay G. Varshney, Director, NRCWS delivered a radio talk on 'Losses due to *Parthenium* and ways to manage it'.
- Dr. P.K.Singh, Sr. Scientist delivered a radio talk on "Management of Kans in cropped and non-cropped situation" and *yantriki vidhi dwara kharpatwar niyantran* on 28 October 2006 and 22 March 2007, respectively.
- Dr. M.S. Raghuvanshi, Technical Officer delivered radio talk on *Rabi ki faslon mein kharpatwar niyantran* on 28.02.2007.

13 हिन्दी राजभाषा कार्यान्वयन

राजभाषा कार्यान्वयन समिति द्वारा वर्ष 2006–2007 में किये गये कार्यों का विवरण

संस्थान में राजभाषा कार्यान्वयन समिति की स्थापना भारत सरकार की राजभाषा नीति के अनुरूप सरकारी काम–काज में हिन्दी के प्रयोग को बढ़ावा देने व इसके प्रसार व प्रचार के लिए वर्ष 1999 में की गई। समिति अपने सीमित साधनों के बावजूद अपने दायित्व को पूरा करने के लिए सतत् प्रयत्नशील है। समिति के प्रयासों के परिणामस्वरूप ही संस्थान के विभागों/अनुभागों में हिन्दी में कार्य करने के प्रतिशत में आशातीत वृद्धि हो रही है और अधिकारियों व कर्मचारियों में हिन्दी में कार्य करने के लिए जो उत्साह पैदा हुआ है वह निः सन्देह राष्ट्रीय गौरव एवं स्वाभिमान का विषय है। समिति द्वारा वर्ष 2006–2007 के दौरान किये गये कार्यों का संक्षिप्त विवरण नीचे दिया जा रहा है :–

राजभाषा वार्षिक कार्यक्रम पर क्रियान्वयन

भारत सरकार की राजभाषा नीति के अनुसार संस्थान द्वारा संपादित कार्यों में हिन्दी का क्रियान्वयन सुनिश्चित करने के लिए गृह मंत्रालय, राजभाषा विभाग द्वारा जारी वर्षिक कार्यक्रम में दिये गये निर्देशों/आदेशों के अनुसार कार्यवाही की गई और संस्थान के सभी विभागों/अनुभागों को राजभाषा सम्बन्धी नियमों/निर्देशों से अवगत कराया गया तथा इन नियमों के अनुसार कार्यवाही सुनिश्चित करने का अनुरोध किया गया।

तिमाही हिन्दी रिपोर्ट का संकलन

भारत सरकार के राजभाषा विभाग, गृह मंत्रालय द्वारा निर्धारित त्रैमासिक रिर्पोट के प्रोफार्मा में संस्थान के विभागों/अनुभागों से उनके द्वारा किये जा रहे हिन्दी कार्यों की प्रगति के आंकड़े हर त्रैमास की समाप्ति पर मंगाये गए और उनको समेकित कर समेकित रिपोर्ट को क्षेत्रीय कार्यान्वयन कार्यालय भोपाल, भारतीय षि अनुसंधान परिषद तथा, नगर राजभाषा कार्यान्वयन समिति को प्रेषित किया गया। वहां से प्राप्त समीक्षा के अनुसार उठाये गये बिन्दुओं पर कार्यवाही की गई।

हिन्दी प्रोत्साहन योजनाओं का क्रियान्वयन

राजभाषा विभाग द्वारा जारी निर्देशों के अनुरूप संस्थान में विभिन्न प्रोत्साहन योजनाएं जैसे–सरकारी कामकाज मूलरूप से हिन्दी में करने की योजना, जिसके अंतर्गत प्रतिवर्ष सितंबर मास में 20,000 शब्दों से अधिक शब्द लिखने वाले संस्थान के अधि./कर्म. को नगद पुरस्कार प्रदान किया जाता है एवं सर्वाधिक हिन्दी में कार्य करने वाले अनुभागों को चलित शील्ड एवं ट्राफी से सम्मानित किया जाता है।

त्रैमासिक बैठकों का आयोजन

संस्थान राजभाषा कार्यान्वयन समिति की त्रैमासिक बैठकों का नियमित आयोजन किया गया। बैठकों में राजभाषा वार्षिक कार्यक्रम में निर्धारित किये गये लक्ष्यों को प्राप्त करने, समय–समय पर राजभाषा विभाग एवं भारतीय षि अनुसंधान परिषद से प्राप्त निर्देशों/आदेशों के अनुपालन पर चर्चा की गई और इन बैठकों में लिए गए निर्णयों को लागू करने क लिए कार्यवाही की गई।

नगर राजभाषा कार्यान्वयन समिति की बैठकों में संस्थान का प्रतिनिधित्व करना।

नगर राजभाषा कार्यान्वयन समिति द्वारा समय–समय पर आयोजित की जाने वाली बैठकों में निदेशक महोदय द्वारा मनोनीत वरिष्ठ अधिकारियों के साथ नियमित रूप से सहभागिता की गई। इन बैठकों में संस्थान में राजभाषा क्रियान्वयन हेतु किये जा रहे कार्यों की जानकारी दी गई।

राष्ट्रीय कृषि अनुसंधान प्रबन्ध अकादमी द्वारा आयोजित हिन्दी कार्यशालाओं में वैज्ञानिकों/अधिकारियों/कर्मचारियों को हिन्दी के प्रशिक्षण हेतु भेजना।

संस्थान के वैज्ञानिकों, अधिकारियों एवं कर्मचारियों को हिन्दी प्रशिक्षण के लिए नाम हैदराबाद द्वारा आयोजित गहन हिन्दी प्रशिक्षण कार्यशालाओं में भेजने की कार्यवाही की गई।

तृण सन्देश पत्रिका का प्रकाशन

संस्थान द्वारा प्रकाशित की जाने वाली हिन्दी राजभाषा पत्रिका ''तृण सन्देश'' के प्रकाशन के लिए कार्यवाही की गई। इसके लिए शोध लेख/पापुलर लेख मंगाने के लिए अन्य संस्थानों से पत्राचार किया गया। पत्रिका का द्वितीय अंक प्रकाशित कराया गया।

दो दिवसीय कार्यशाला का आयोजन

राजभाषा कार्यान्वयन समिति द्वारा दिनॉंक 22 अगस्त से 23 अगस्त, 2006 एक दो दिवसीय हिन्दी कार्यशाला का आयोजन तकनीकी वर्ग के अधिकारियों/कर्मचारियों के लिए किया गया था। जिसमें अतिथि वक्ता के रूप में डी. एस. सिह को बुलाया गया। दिनॉंक 29 मार्च, 2007 को एक दिवसीय कार्यशाला का आयोजन प्रशासनिक वर्ग के सभी अधिकारियों/कर्मचारियों के लिए किया गया था। इस अवसर पर समिति द्वारा कार्यशाला के आयोजन में महती भूमिका निभाई गई।

राजभाषा विषयक निरीक्षण

इस वर्ष संस्थान में परिषद मुख्यालय से निरीक्षण दल दिनॉंक 22/01/07 को आया था जिसके केन्द्र में राजभाषा क्रियान्वयन की प्रगति की जानकारी लेने हेतु निरीक्षण किया गया तथा निरीक्षण के अवसर पर इन परिसरों में राजभाषा क्रियान्वयन में आने वाली कठिनाइयों का निराकरण किया गया और कुछ सुझाव भी दिए गए।

हिन्दी पखवाड़ा समारोह का आयोजन

केन्द्र में 14 सितम्बर, 2006 हिन्दी दिवस के उपलक्ष्य में दिनॉंक 14/09/2006 से 30/09/2006 तक हिन्दी पखवाड़ा का आयोजन किया गया। कार्यक्रम का उद्घाटन डॉ. जय. जी. वार्ष्णेय, निदेशक महोदय ने दीप प्रज्जवलित कर पखवाड़े के शुभारंभ की घोषणा की। इस अवसर पर उन्होंने कार्यालय का अधिक से अधिक कार्य हिन्दी में करने हेतु सभी अधिकारियों/कर्मचारियों को संकल्पित किया। उन्होंने ने अपने वक्तव्य में कहा कि हमारा देश षि प्रधान देश है अगर हमारे द्वारा की गई खोज एवं शोध पत्र हिन्दी में प्रकाशित किये जायेगें, तो इससे अधिक से अधिक किसान भाई एंव जनसाधारण को फायदा पहुँच सकेगा। हिन्दी दिवस के साथ ही 14 सितंबर 2006 से हिन्दी पखवाड़े का शुभारंभ हुआ इस दौरान केन्द्र में विभिन्न प्रतियोगिताएँ संपन्न कराई गई। जैसे टंकण प्रतियोगिता, निबंध प्रतियोगिता, खुली लेख प्रतियोगिता, हिन्दी आलेखन एवं टिप्पण प्रतियोगिता, शुद्ध लेखन प्रतियोगिता, वाद–विवाद प्रतियोगिता आदि।

दिनॉंक 30/09/2006 को हिन्दी पखवाडे का समापन एंव पुरस्कार वितरण समारोह भव्यता के साथ अपरान्ह 3.30 बजे प्रारंभ हुआ। समारोह की अध्यक्षता केन्द्र के निदेशक डॉ. जय. जी. वार्ष्णेय ने की तथा मुख्य अतिथि श्री एस. सी. गुप्ता, वरिष्ठ महाप्रबंधक जी. आई. एफ. फैक्टरी थे, कार्यान्वयन समिति की ओर से समिति के अध्यक्ष डॉ. व्ही. पी. सिंह ने स्वागत उद्बोधन में हिन्दी को कार्यालयीन कार्य का मुख्य अंग बताते हुए अधिक से अधिक कार्य हिन्दी में संपन्न कराने पर बल दिया।



स्वागत उद्‌गार के पश्चात समारोह के मुख्य अतिथि श्री एस.सी. गुप्ता वरि. महाप्रबंधक जी,, आई. एफ. फैक्टरी एंव निदेशक महोदय ने सभी विजयी प्रतियोगियों को पुरस्कार वितरण किये। इस अवसर पर, मुख्य अतिथि श्री गुप्ता जी ने हिन्दी पखवाड़े के दौरान किये गये सम्पूर्ण आयोजन की सराहना करते हुये कहा कि विश्व भर में सबसे अधिक समझी जाने वाली भाषाओं में हिन्दी का प्रथम स्थान है। जिस देश की तकनीकी शिक्षा का साहित्य उस देश में समझी व बोली जाने वाली भाषा में होगा तो उस देश की प्रगति दुगनी होगी। यदि हिन्दी का कार्य दृढ़ विश्वास एंव मन लगाकर किया जाये तो हर वर्ष हिन्दी दिवस व हिन्दी पखवाड़ा मनाने की आवश्यकता नहीं होगी।

अंत में श्री जी. आर. डोंगरे सचिव ने सभी का आभार प्रर्दशन किया, इस अवसर पर केन्द्र के सभी अधिकारियों/कर्मचारियों ने कार्यक्रम में उपस्थित होकर कार्यक्रम को सफल बनाया।

धारा 3(3) का शत प्रतिशत अनुपालन

वर्ष के दौरान धारा3(3) के अंदर आने वाले समस्त कागजातों जैसे परिपत्र और कार्यालय आदेश आदि लगभग 90% से 95% अनुपालन सुनिश्चित किया गया।

हिन्दी में प्राप्त पत्रों या हिन्दी में हस्ताक्षरित पत्रों का केवल हिन्दी में जवाब

हिन्दी में प्राप्त पत्रों या हिन्दी में हस्ताक्षरित पत्रों का जहाँ कहीं उत्तर देना अपेक्षित समझा गया, केवल हिन्दी में उत्तर दिया गया।

हिन्दी मूल पत्राचार की स्थिति

हिन्दी मूल पत्राचार के तहत निर्धारित किए गए लक्ष्यों की प्राप्ति की दिशा में सतत प्रयास की ओर अग्रसर है, तथापि वर्तमान में औसतन 32% से 35% के बीच में है लक्ष्य–प्रप्ति हेतु प्रयास जारी किए है।

शीर्षस्थ प्रशासनिक बैठकों में वार्तालाप हिन्दी में

शीर्षस्थ प्रशासनिक बैठकों में वार्तालाप हिन्दी में करने पर जोर दिया गया।

14 DISTINGUISHED VISITORS

Dr. Satyabatra Maiti, Director, NRC -Medicinal and Aromatic Plants, Anand	08.02.2007
Dr. PP Reddy, Former Director, IIHR, Bangalore	08.02.2007
Dr. Gautam Kalloo, DDG (Crop Science), ICAR, New Delhi	22.05.2006
Sh Kantilal Bhuria, Minister of State for Agriculture, GOI, New Delhi	13.06.2006
Dr. D.P. Singh, Vice Chancellor, JNKVV, Jabalpur	13.06.2006
Dr. Amerika Singh, Director, NCIPM, New Delhi	19.01.2007
Dr. M. Mahadevappa, fsormer Chairman, ASRB, New Delhi	15.01.2007
Dr. GB Singh, Ex-Director General, UPCAR, Lucknow	29-31.01.2007
Dr. DC Uprety, National Fellow, Division of Plant Physiology, IARI, New Delhi	29-31.01.2007
Dr. RJ Ravindra, Project Director, Project Directorate of Biological Control, Bangalore	29-31.01.2007
Dr. Jamaluddin, Group Coordinator (Research), Tropical Forest Research Institute, Jabalpur	29-31.01.2007
Dr. David N. Sen, Retd. Prof. Univ. of Jodhpur, Jodhpur	29-31.01.2007
Dr. Ambika Singh, Assistant Director General (Retd.) Varanasi	22-23.02.2007
Dr. AK Gogoi, Asstt Director General (Agro), Indian Council of Agricultural Research (ICAR) New Delhi	22-23.02.2007
Dr. UC Sharma, Ex -Joint Director, ICAR Research Complex fotr NEH Region, Barapani	22-23.02.2007
Dr. GL Bansal, Prof & Head, Deptt of Plant Physiology, College of Basic Sciences, Ch. Sarwan Kumar HPKV, Palampur	22-23.02.2007
Shri Hamid Kazi, MLA, Burhanpur	23.032007
Dr. V. V. Singh, Head AMD, Central Instt. of Agricultural Engineering, Bhopal	23.032007
Dr. V.S. Tomar, Director Research Services, JNKVV, Jabalpur	23.032007

Dr. Kalloo interacting with the scientists in the laboratory

Minister for State For Agriculture releasing the publications

15 PERSONALIA

Directors

Dr. Jay G. Varshney (w.e.f. 10.05.2006)

Dr. AK Gogoi (upto 09.05.2006) (Acting)

Scientific

Dr. B.T.S. Moorthy	Pr. Scientist (Agronomy) **(Demised on 17.11.2006)**
Er. H.S. Bisen	Pr. Scientist (Agricultural Engineering)
Dr. A.K. Gogoi	Pr. Scientist (Agronomy) **(Till 17.05.2006)**
Dr. D. Subrahmanyam	Pr. Scientist (Plant Physiology)
Dr. D.K. Pandey	Sr. Scientist (Plant Physiology)
Dr. K.K. Barman	Sr. Scientist (Soil Science)
Dr. P.K. Singh	Sr. Scientist (Agricultural Extension)
Dr. V.P. Singh	Sr. Scientist (Agronomy)
Dr. J.S. Mishra	Sr. Scientist (Agronomy)
Dr. Sushilkumar	Sr. Scientist (Entomology)
Dr. R.P. Dubey	Sr. Scientist (Agronomy)
Dr. Anil Dixit	Sr. Scientist (Agronomy)
Dr. M.B.B.Prasad Babu	Sr. Scientist (Soil Science)
Dr. P.J. Khankhane	Sr. Scientist (Soil Science)
Dr. Shobha Sondhia	Scientist (SS) (Organic Chemistry)
Dr. V.S.G.R. Naidu	Scientist (Economic Botany)
Sh. Chandra Bhanu	Scientist (Plant Pathology)

Technical

Dr. M.S. Raghuwanshi	T-6 (Technical Officer)
Sh. R.S. Upadhyay	T-6 (Farm Manager)
Sh Mukesh Bhatt	T-6 (Artist-cum-Photographer)
Sh. S. Dhagat	T-5 (Technical Officer)
Sh B. Mishra	T-5 (Photographer)
Sh V.K.S. Meshram	T-5 (Artist)
Sh G.R. Dongre	T-5 (Draftsman)

Administration, Finance and Accounts

Sh. Balwant Rai	Assistant Administrative Officer (Till 31.01.2007)
Sh. A.K. Shrivastava	Assistant Finance and Accounts Officer

Our New Colleague

Dr. Varshney Joins as Director, NRCWS

Dr. Jay G. Varshney has taken over as Director NRCWS, Jabalpur on 10-5-2006. Prior to joining this post, he was working as Principal Scientist (Agronomy) at Indian Institute of Pulses Research, Kanpur.

Sh. Apresh Mukherjee, Assistant from Indian Institute of Sugarcane Research (IISR), Lucknow, joined as AAO on 1 March 2007 on deputation.

Farewell to Dr. A.K. Gogoi

Dr. AK Gogoi took over as Assistant Director General (Agro), ICAR, New Delhi on 18 May 2006.

Obituary

Dr. B.T.S. Moorthy, Principal scientist of this Centre has passed away on 17 November 2006, after rendering 29 years of service. Born on 01 July 1948 at Boppudy village, Andhra Pradesh, Dr. Moorthy started his career in 1977 as a Scientist at CRRI, Cuttack and later shifted to this Centre as Principal Scientist in 2001.

The Director and Staff of NRCWS deeply condole the death of Dr. B.T.S. Moorthy.

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