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Research Paper

Response of wheat (*Triticum aestivum*) to rice (*Oryza sativa*) residue and weed-management practices

B.L. MEENA[1] AND R.K. SINGH[2]

Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh 221 005

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ABSTRACT

A field experiment was carried out during the winter seasons of 2009–11 at Varanasi, to evaluate the effect of rice (*Oryza sativa* L.) residue management practices and weed-control measures on the weed infestation and wheat [*Triticum aestivum* (L.) emend. Fiori & Paol.] yield. Treatments included application of sulfosulfuron alone and tank-mix sulfosulfuron 25g/ha + metsulfuron 4 g/ha and isoproturon 1.0 kg/ha + metsulfuron 4 g/ha. Rice residue mulching treatment reduced weeds density and dry weight, resulting in 19.4 % and 11.1% higher yield over rice residue retained and residue incorporated treatment respectively. Application of sulfosulfuron 25 g/ha + metsulfuron 4 g/ha recorded 9.6% and 2.7% higher yield over sulfosulfuron at 25 g/ha and isoproturon 1.0 kg/ha + metsulfuron 4 g/ha respectively. It was concluded that rice residue mulching management was the best among the given residue management practices and tank-mix sulfosulfuron 25 g/ha + metsulfuron 4 g/ha was better among the herbicides in terms of weed growth reduction and increased wheat yield.

Key words **:** Crop protection, Herbicide, Metsulfuron, Rice residue management, Sulfosulfuron, Weed growth, Wheat

Wheat stands second in grain production in the world and most widely cultivated food crop. In India, it is second important staple food crop cultivated over an area of 29.90 million ha with a total production of 90.9 million tonnes and total productivity of 2.91 t/ha (DWR, 2012).

Weed infestation is a major problem in the productivity of rice-based cropping systems, depending on their types and intensity, 20–50% or even gather losses in grain yields of wheat are common due to competition from the weeds. Among grassy weeds, *Phalaris minor* (L.) Retz. and among broad leaf weeds *Rumex denticulate* L. are of major concern in irrigated wheat under rice–wheat cropping system in India (Balyan and Malik, 2000). Besides the crop rotation (Anderson and Beck, 2007), tillage also influences the type of weed flora. Crop residues left on the surface can suppress weed seed germination and or seedling growth and complement the effects of herbicide (Dyck and Liebman, 1994). The overall effect of residues on herbicide performance probably depends on many interacting factors, such as environmental and management factors, and amount of residues remaining in the soil (Mills and Witt, 1989).

Herbicide mixtures, may besides providing broad-spectrum weed control, also be one of the options for management or delay of cross resistance development against herbicides (Yadav and Malik, 2005; Dhawan *et al.*, 2009). Keeping in the view the facts, an investigation was planned to study on the response of herbicides under rice residue management practices in wheat.

MATERIALS AND METHODS

A field study was conducted during winter seasons of 2009–11 at the Agricultural Research Farm, Varanasi .The Eastern Indo- Gangetic soil was sandy clay loam in texture having soil pH 7.8 and moderately fertile with 0.43% organic carbon, 205.14 kg/ha available N, 17.46 kg/ha available P and 237.34 kg/ha available K .

The treatment comprised 3 rice residue management practices, viz. rice residue retained to a height of 30 cm from surface (R_0), rice residue mulches between crop rows at 4.0 t/ha. (R_1) and rice residue incorporation before sowing (R_2) in main plots and 5 weed control treatments, viz. W_0, weedy check; W_1, weed free; W_2, sulfosulfuron 25 g/ha alone; W_3, sulfosulfuron 25 g/ha + metsulfuron 4 g/ha; and W_4, isoproturon 1.0 kg/ha + metsulfuron 4 g/ha in

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Corresponding author Email: agromeena@gmail.com

[1]Research Scholar, [2]Professor, Department of Agronomy, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh 221 005

subplots. The experiment was laid out in spilt-plot design (SPD) with 4 replications. Wheat 'HUW 234' was sown with the help of zero-till seed cum ferti-drill on 2–3 December during 2009 and 2010. A uniform nutrient dose of 120:60:40 kg/ha N:P_2O_5:K_2O/ha was applied in the form of urea, single superphosphate and muriate of potash respectively. One-third nitrogen and full dose of phosphorus and potassium was applied basal and remaining two-thirds N was applied in 2 equal splits at crown-root initiation and tillering stages**.** Existing weed species were destroyed by application of glyphosate at 1.0 kg ha (3 days before sowing). Herbicides were applied as post-emergence at 32 days after sowing (DAS) with the help of hand-operated knapsack sprayer, fitted with flat-fan nozzle with water as carrier at 600 l/ha. Weed density and weed dry weight data were recorded at 45 and 60 days stage of crop growth. Weed count was recorded randomly from 2 places in each plot using 0.25 m^2 quadrate. Weeds were cut at ground level, washed with tap-water, sun-dried and thereafter oven-dried at 65^{o}C for 48 hr and they weighed. Weed-control index was calculated at maximum weed-growth stage using weed dry weight recorded 60 days after sowing. Grain yield and its attributes were also recorded during the course of investigation. The data recorded on weeds were subjected to square root transformation $\sqrt{x+0.5}$.

RESULTS AND DISCUSSION

Weed

The experimental field was dominated with broad leaf weeds, namely *Chenopodium album* L., *Rumex dentatus* L.*, Melilotus alba, Anagallis arvensis, Vicia sativa* L. and sedge, viz. *Cyperus rotundas.* Relative composition of narrow and broad leaf weed in weedy check recoded at 60 days stage of growth revealed that average weed population of broad leaf species was more than narrow leaf weed species during both years. Relatively more number of broad leaf weeds were also observed under zero till system (Chhokar *et al.,* 2007).

Rice residue management caused significant variations in weed density at 60 days in both the years. Rice residue mulch practices significantly reduced weed density and dry matter of weeds at 60 days in comparison to rice residue retained and it was at par with rice residue incorporated (Table 1). Among the varying rice residue management, rice residue mulch had the maximum weed-control efficiency, followed by rice residue incorporated and rice residue retained during both the years. Placement of rice residues on the soil surface creates mechanical hindrance which does not allow the weed seeds to germinate and as a result reduced dry weight of weeds is observed under residue placement

Table 1. Effect of rice residue and weed management on weed population, dry weight, weed control efficiency in wheat at 60 days after sowing and weed control index at harvest (pooled data over 2 years).

Treatment	Weed population (No./m^2)							Weed dry weight (g/m^2)	Weed-control efficiency (%)	Weed-control index (%)
	Phalaris minor	*Cynodon dactylon*	*Vicia sativa*	*Chenopodium album*	*Rumex dentatus*	*Melilotus* spp.	*Cyperus rotundus*			
Residue management										
Rice residue retained	6.8 (40.1)	6.1 (31.5)	5.1 (21.9)	6.3 (34.4)	5.0 (20.7)	6.2 (32.6)	6.4 (35.1)	6.2 (32.6)	66.8	20.1
Rice residue mulches	5.4 (24.8)	5.6 (26.7)	4.7 (18.1)	5.8 (28.3)	4.5 (16.6)	5.9 (29.3)	6.0 (30.5)	5.8 (28.4)	71.0	4.5
Rice residue incorporated	5.9 (29.4)	5.7 (27.9)	7.8 (18.6)	5.9 (29.4)	4.6 (17.6)	6.0 (30.3)	6.0 (31.1)	6.0 (31.0)	68.3	14.1
SEm±	0.78	0.79	0.73	0.81	0.75	0.75	0.78	0.79	-	-
CD (P=0.05)	1.02	1.04	1.23	1.08	0.96	0.96	1.01	1.02		-
Herbicides										
Weedy check	7.0 (42.4)	6.7(38.5)	5.7 (27.7)	7.4 (48.1)	5.4 (24.4)	6.8 (40.7)	7.1 (43.9)	10.3 (97.9)	0.0	37.1
Weed free	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	100.0	0.0
Sulfosulfuron 25 g/ha	6.7 (39.0)	6.5 (36.3)	5.3 (23.8)	6.4 (35.8)	5.2 (22.8)	6.7 (39.0)	6.8 (40.5)	4.8 (19.0)	80.6	13.8
Sulfosulfuron 25 g/ha + metsulfuron 4.0 g/ha	6.6 (37.5)	6.2 (33.4)	5.2 (22.9)	6.2 (32.9)	5.1 (21.7)	6.5 (36.7)	6.6 (37.3)	4.7 (18.0)	81.7	5.5
Isoproturon 1.0 kg/ha + metsulfuron 4.0 g/ha	6.6 (38.3)	6.4 (35.2)	5.3 (23.5)	6.4 (35.2)	5.2 (22.6)	6.5 (37.2)	6.7 (39.4)	4.7 (18.5)	81.2	8.0
SEm±	0.75	0.76	0.72	0.79	0.72	0.72	0.75	0.76	-	-
CD (P=0.05)	0.94	0.95	0.88	0.98	0.89	0.88	0.92	0.95	-	-

Data were subjected to $\sqrt{x+0.05}$ transformation and value with in the parentheses are original value.

treatments (Rahman *et al.,* 2005).

All the weed-control treatments registered significantly lower number of weeds and weed dry matter than weedy at 60 days stage (Table 1). Tank-mix application of sulfosulfuron 25 g/ha+ metsulfuron 4.0 g/ha was most effective in controlling weeds, but remained at par with isoproturon 1.0 kg/ha + metsulfuron 4.0 g/ha and significantly superior to sulfosulfuron 25.0 g/ha applied alone. The better efficiency of herbicide mixture compared to alone application of sulfosulfuron might be due to presence of grassy and broad leaf herbicides controlling complex weed flora in wheat. Among the herbicides, sulfosulfuron 25.0 g/ha showed the highest weed-control index owing to more weed growth and poor yield in the treatment. Whereas, sulfosulfuron 25 g/ha+ metsulfuron 4.0 g/ha recorded the lowest weed-control index due to minimum weed growth and higher yield in this treatment. Of the herbicides, sulfosulfuron 25 g/ha and metsulfuron methyl 4 g/ha application had the highest weed control efficiency, followed by isoproturon 1.0 kg/ha and metsulfuron methyl 4 g/ha and sulfosulfuron 25 g/ha alone in both years.

Crop

Data on crop growth attributes (Table 2) revealed that plant height and dry matter accumulation (g/m row) in rice residue mulch was the highest and significantly different from rice residue incorporated and rice residue retained during both the years, Among weed-control treatments, weed-free and weedy recorded the highest and lowest plant height and dry matter, respectively, in comparison with herbicidal treatments in both the years. Combination of sulfosulfuron 25 g/ha + metsulfuron 4.0 g/ha recorded more plant dry matter which was at par with isoproturon 1.0 kg/ha + metsulfuron 4.0 g/ha and significantly superior to sulfosulfuron 25 g/ha, which had the lowest dry matter amongst herbicidal treatments.

The study revealed that yield attributes, viz. ears/m^2 and test weight remained significantly higher than rice residue retained treatment, but comparable to rice residue incorporated treatment. The increase in yield attributes under rice residue mulch treatment can be attributed to maximum crop dry-matter accumulation and its translocation to develop yield component in the treatment. The maximum number of yield attributes in rice residue mulch treatment, led to significantly higher grain yield over rice residue incorporated and rice residue retained treatments. A similar trained was observed in straw yield of the crop (Table 2). Application of herbicides recorded significant variation in yield attributes and yield of wheat over untreated crop. Singh *et al*. (2003) also observed significant improvement in yield attributes and wheat yield in herbicide-treated than untreated crop. Tank-mix application of sulfosulfuron 25 g/ha + metsulfuron 4 g/ha had significantly higher number of ears and test weight than alone application of sulfosulfuron at 25 g/ha, but was comparable to weed-free and isoproturon 1.0 kg/ha + metsulfuron 4 g/ha. Among herbicides, significant increase in yield components resulted in highest grain yield in sulfosulfuron + metsulfuron treatment. Increased grain yield in herbicide mixture could be ascribed to poor weed growth, higher crop dry matter and more number of ears and test weight when compared with alone application of sulfosulfuron and untreated treatment. The findings of Yadav *et al*. (2010) supports the

Table 2. Effect of rice residue and weed management on crop growth, yield attributes, yield and economics in wheat (pooled data over 2 years).

Treatment	Plant height (cm)	Dry matter (g/m)	Ear heads (No./m^2)	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Gross returns (× 10^3 ₹/ha)	Net returns (× 10^3 ₹/ha)	Benefit: cost ratio
Residue management									
Rice residue retained	70.5	351.5	319.2	40.6	3.7	5.7	63.8	36.0	1.3
Rice residue mulches	74.3	365.0	326.6	42.7	4.4	6.5	75.7	45.0	1.5
Rice residue incorporated	73.6	363.5	325.1	41.8	4.0	6.1	68.3	39.2	1.4
SEm±	0.43	0.53	1.1	0.30	0.07	0.09	-	-	-
CD (P=0.05)	1.55	1.82	3.7	1.03	0.25	0.32	-	-	-
Herbicides									
Weedy check	71.6	359.9	316.8	40.5	2.9	4.9	51.6	25.4	1.0
Weed free	74.8	366.6	328.2	42.8	4.7	6.7	78.7	42.5	1.2
Sulfosulfuron 25 g/ha	71.9	361.5	320.8	41.3	4.1	6.0	68.3	41.0	1.5
Sulfosulfuron 25 g/ha + metsulfuron 4.0 g/ha	73.4	364.9	327.3	42.2	4.4	6.5	74.5	46.0	1.6
Isoproturon 1.0 kg/ha + metsulfuron 4.0 g/ha	72.5	363.7	325.2	41.9	4.3	6.3	72.8	45.4	1.7
SEm±	0.4	0.5	0.8	0.22	0.05	0.06	-	-	-
CD (P=0.05)	1.2	1.5	2.4	0.66	0.15	0.18	-	-	-

superiority of herbicide mixture over their alone application in improving wheat yield components and yield.

Economics

The highest net return and benefit: cost ratio were recorded for rice residue mulch treatment which was followed by rice residue incorporation treatment. Among weed-control treatments, the maximum net returns were obtained in sulfosulfuron 25 g/ha + metsulfuron 4 g/ha, but the benefit: cost ratio was marginally high in isoproturon 1.0 kg/ha + metsulfuron 4 g/ha treatment. This might be due to lower cost of isoproturon 1.0 kg/ha + metsulfuron 4 g/ha compared to sulfosulfuron 25 g/ha + metsulfuron 4 g/ha herbicide. The minimum net return and benefit: cost ratio was associated with untreated treatment followed by weed-free treatment. The lower crop yields in untreated and higher cost of weed-free treatment are the reasons for lower net return in these treatments.

The present study indicated that rice residue mulch and post-emergence application of herbicide mixture appeared to be most productive and profitable in wheat under rice–wheat cropping system of Eastern Indo Gangetic Plains.

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