

Efficacy of herbicides in transplanted, medium-duration rice (*Oryza sativa*) under sub-tropical conditions of Jammu

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ABSTRACT

A field experiment was conducted during the rainy season of 2001 and 2002 on sandy-loam soils of Jammu, to test the efficacy of different herbicides in transplanted, medium-duration 'PC 19' ('Tawi') rice. Herbicide combinations, viz. anilophos + ethoxy sulfuron (0.312 + 0.015 kg/ha) applied 10 days after transplanting (DAT) or metsulfuron-methyl + chlornimuron ethyl + butachlor (0.004 + 0.938 kg/ha applied 3 DAT) or butachlor followed by (fb) metsulfuron-methyl + chlornimuron ethyl (0.938+0.004 kg/ha applied 3 DAT fb 21 DAT) with a mean grain yield of 48.1, 44.3 and 45.6 q/ha, respectively, remained at par with 2 hand-weedings (20 and 40 DAT). However, through improvement in weed-control efficiency corresponding mean values being 69.6, 60.8 and 61.5%, enhanced the grain yield significantly by 67.6, 54.4 and 58.9%, respectively, over control. Among the herbicides, combination of anilophos and ethoxysulfuron proved most profitable with net returns of Rs 14,268/ha and benefit : cost ratio of 1:97.

Key words : Benefit : cost ratio, Herbicides, N-use efficiency, Rice, Weed-control efficiency, Yield

In Jammu region, rice is cultivated over an area of 109.6 thousand hectares, of which 88.18% falls in the sub-tropical agro-climatic zone. The productivity in the region is 16.68 q/ha (DESPPD, 2002–03) which is far below than harvestable potential of various rice varieties cultivated in the region. The dominance of rice–wheat cropping system in the region and continuous use of the same single herbicide, i.e. Butachlor, year after year in rice has not shown desired results in controlling various weed species and thereby resulting yield reduction 25 to 53% due to weed infestation (Mukherjee and Singh, 2004). Hence it necessitates to either determine the efficacy of alternative herbicides for effective control of weeds in transplanted rice or to apply the admixture of Butachlor with any synergistic herbicide. Therefore a field experiment was conducted to study the performance of various herbicides in transplanted, medium-duration rice under sub-tropical conditions of Jammu province.

MATERIALS AND METHODS

The field experiment was conducted during rainy season (*kharif*) of 2001 and 2002 on sandy-loam soils of Chatha Campus of the University, Jammu. The experimental site with pH 7.14 had 0.60% organic carbon and 174.5, 15.2 and 140.0 kg available N, P and K/ha respectively. The treatments comprising butachlor [50 EC @ 1.5 kg/ha

3–5 days after transplanting (DAT)], anilophos + ethoxysulfuron (0.312+0.015 kg/ha 10 DAT), (metsulfuron-methyl + chlornimuron ethyl) + butachlor (20 WP +50 EC @ 0.004+0.38 kg/ha 3 DAT), butachlor + (metsulfuron-methyl+chlornimuron ethyl) (50 EC fb 20 WP) @ 0.938+0.004 kg/ha 3 fb 21 and 25 DAT), 2 hand-weedings (20 and 40 DAT) and weedy check were tried in randomized block design with 4 replications. Two seedlings-hill of 'PC 19' ('Tawi') rice of 30 days age were transplanted in puddled field at a spacing of 20 cm × 10 cm in the second fortnight of June during both the years. Crop was supplied with nutrients, i.e. 120, 60, 25 and 20 kg N, P₂O₅, K₂O and ZnSO₄/ha respectively. Full quantity of P₂O₅ and K₂O through diammonium phosphate and muriate of potash, respectively, along with full ZnSO₄ and one-third of N through urea was applied as basal dose at the time of puddling. Remaining N was top-dressed 25 and 40 DAT in equal splits.

RESULTS AND DISCUSSION

Weed flora

The most dominant weed species found in weedy check throughout the crop growth in the rice–wheat ecosystem of Jammu were grasses: *Echinochloa crus-galli*, *Echinochloa colonum* and *Ischaemum regosum*; sedges: *Cyperus rotundus*, *Cyperus iria* and *Fimbristylis miliacea*;

and broad-leaf ones : *Ammania baccifera*, *Ludwigia parviflora*, *Eclipta alba* and *Monochoria vaginalis*.

Yield attributes and grain yield

All the weed-control treatments significantly outnumbered and out-weighted the weedy check in respect to yield attributes, viz. panicles/m², panicle weight (g) and grains/panicle except 1,000-grain weight (Table 1). Among the weed-control measures, hand-weeding recorded the lowest weed count and weed dry weight and the highest values of panicles/m², panicle weight and grain/panicles and grain yield (Table 2). An increase of 61.1 and 97.9% over the weedy check treatment was observed during 2001 and 2002, respectively, mainly owing to manual removal of associated weed flora. Better control of weeds facilitated the crop for better absorption of nutrients, as evident from N uptake by crop and weeds (Table 1). The weed-control measures also reduced the weed biomass substantially, which in turn caused better N uptake by crop (Table 2) and might have helped in realizing higher grain yield of rice. Rao (1995) and Jacob and Syriac (2005) also reported similar findings. Among the herbicidal treatments, maximum yield and its attributes were obtained with the application of anilophos + ethoxysulfuron (0.312 + 0.015 kg/ha) at 10 DAT, thereby realized an increase of 67.3% yield over weedy check but was at par with hand-weeding treatment. Mukherjee and Singh (2004) also reported similar results.

Weed dry matter

The weed-control measures registered a significant reduction in weed dry matter from the weedy check throughout the crop growth (Table 2). Hand-weeding recorded the lowest dry matter of weeds probably due to effective control of the first flush of weeds during 20–40 days and second flush of weeds from 40 days onwards. Among the herbicides, anilophos + ethoxysulfuron (0.312 + 0.015 kg/ha) reduced total dry matter significantly by 70.09 and 69.29% compared to weedy check in 2001 and 2002 respectively. It remained at par with butachlor (1.5 kg/ha), metsulfuron-methyl + butachlor (0.004 + 0.938 kg/ha) and butachlor followed by (metsulfuron-methyl + chlornimuron ethyl) (0.938 + 0.004 kg/ha) in 2002. The weed count in the weed-control treatments was markedly reduced compared to weedy check (Table 2). The beneficial effect of anilophos + ethoxysulfuron (0.312 + 0.015 kg/ha) might be attributed to significant reduction of grasses, sedges and broad-leaf weeds. Similar observations were recorded by Narwal *et al.* (2002).

Weed-control efficiency

As regards weed-control efficiency, hand-weeding twice was found superior to the other treatments with

Table 1. Yield, yield attributes and nitrogen uptake, N-use efficiency and economics of transplanted rice under different weed-control treatments

Treatment	Panicles/ m ²		Panicle weight (g)		Grains/ panicle		Grain yield (q/ha)		N uptake (kg/ha)		N-use efficiency (kg grain/ kg N applied)	Net returns (Rs/ha)	Benefit : cost ratio
	2001	2002	2001	2002	2001	2002	2001	2002	Crop	Weeds			
Butachlor (50 ec) @ 1.5 kg/ha 3–5 DAT	226	193	2.83	2.79	81.5	84.5	42.2	39.8	80.8	30.4	34.16	9,935	1.67
Anilophos + Ethoxysulfuron (21 SC+1SC) @ 0.312 + 0.015 kg/ha 10 DAT	246	240	3.01	2.99	88.3	86.2	49.1	47.0	104.5	16.3	40.08	14,268	1.97
Metsulfuron-methyl + Chlornimuron ethyl + Butachlor (20 WP+50 EC) @ 0.004 + 0.938 kg/ha 3 DAT	236	203	2.85	3.14	86.2	85.4	46.3	42.3	97.8	17.1	36.91	11,940	1.81
Butachlor fb Metsulfuron-methyl + Chlornimuron ethyl (50 EC fb 20 WP) + @ 9.938 + 0.004 kg/ha 3 DAT fb 21–25 DAT	236	213	2.85	3.20	87.1	87.8	46.7	45.6	91.5	18.5	38.00	12,722	1.86
2 hand-weedings (20 and 40 DAT)	263	234	3.09	3.27	90.2	92.3	52.2	49.3	109.3	15.9	42.33	13,805	1.82
Weedy check	178	133	2.24	2.56	43.0	46.5	32.4	24.9	51.8	55.7	23.83	2,817	1.19
CD (P=0.05)	14	12	0.14	NS	5.2	5.8	4.5	6.2	1.8				

Table 2. Weed dry weight, weed count and weed-control efficiency of transplanted rice under different weed control treatments (mean data of 2 years)

Treatment	Weed dry weight (g/m ²)		Weed count/m ²			Weed-control efficiency (%)
	2001	2002	B	G	S	
Butachlor (50 EC) @ 1.5 kg/ha 3–5 DAT	31.07	29.31	27.2	23.1	27.5	58.2
Anilophos + Ethoxysulfuron (21 SC + 1 SC) @ 0.312+0.015 kg/ha 10 DAT	19.77	24.93	12.7	18.5	11.9	69.7
(Metsulfuron-methyl+Chlonimuron ethyl) + Butachlor (20 WP + 50 EC) @ 0.004 + 0.938 kg/ha 3 DAT	30.00	26.74	14.2	21.2	15.6	60.9
Butachlor fb Metsulfuron-methyl + Chlonimuron ethyl (50 EC fb 20 WP) @ 0.938 + 0.004 kg/ha 3fb 21 and 25 DAT	32.03	23.05	20.7	28.5	18.4	61.6
2 hand-weedings (20 and 40 DAT)	7.43	4.92	10.5	17.2	8.7	91.3
Weed check	66.10	81.19	67.2	41.5	40.2	
CD (P=0.05)	9.57	9.50				

B=Broad-leaf weeds; G=grassy weeds; S, sedges

88.7 and 93.9% control of weeds in 2001 and 2002 respectively (Table 2). Among the herbicidal treatments, on the basis of mean of 2 years, the highest weed-control efficiency was achieved with anilophos + ethoxysulfuron (0.312 + 0.015 kg/ha), followed by butachlor followed by metsulfuron-methyl + chlonimuron ethyle (0.938 + 0.004 kg/ha) whereas other herbicides or herbicide combinations were not found effective and efficient in controlling weeds and therefore weed control efficiency was quite low.

Nitrogen-use efficiency

Based on mean of 2 years data, the highest N-use efficiency, which is the efficiency of N-utilization by rice (kg grain/kg N applied), was recorded with 2 hand-weedings at 20 and 40 DAT (Table 1). Among the chemical treatments, anilophos + ethoxysulfuron (0.312 + 0.015 kg/ha) recorded the highest N-use efficiency (40.1 kg grain/kg N applied) followed by the treatment butachlor followed by (metsulfuron-methyl+chlonimuron ethyl) (0.93 + 0.004 kg/ha). Crop exhibited improvement in N uptake with the adoption of weed-control measures. Highest uptake was recorded with 2 hand-weedings followed by the treatment involving use of anilophos in combination with ethoxysulfuron (Table 1). Lowest uptake was under the weedy check. The N uptake by weeds followed the reverse trend. Effective weed control reduced the weed biomass which in turn might have reduced weed competition and thereby resulted in the improvement of N uptake by crop.

Economics

On basis of 2 years mean, the maximum net return and

benefit : cost ratio were obtained with anilophos + ethoxysulfuron (0.312 + 0.015 kg/ha) application followed by 2 hand-weedings at 20 and 40 DAT (Table 1). The corresponding values being Rs 14,268 and 1.97 and Rs 13,805 and 1.86 respectively. Though hand-weeding increased the yield of rice, but it had lower net returns and benefit : cost ratio on account of higher cost involved.

Therefore an application of anilophos + ethoxysulfuron @ 0.312 and 0.015 kg/ha at 10 day after transplanting may be a suitable and profitable alternative to the existing recommendation of butachlor application in medium-duration rice under sub-tropical conditions of Jammu.

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