Efficacy of different herbicides alone and with follow up application of 2,4-D with regard to weeds and yield of zero tillage direct seeded rice

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ABSTRACT: ***Fimbristylis miliacea*** **was most dominant weed in zero tilled condition with average contribution of 55.3 per cent at 60 days stage. Higher dry weight was observed during the second year of experiment. Anilofos 0.4 kg ha^{-1} as early post emergence application followed by 2,4-D at 0.5 kg ha^{-1} reduced density and total dry weight of weeds at 60 days stage resulting in highest weed control efficiency (91.5 and 55.1 per cent respectively during 2001 and 2002) among herbicidal treatments. Weeds caused complete destruction of rice crop in weedy check plots. Owing to better control of weeds pendimethalin at 1.0 kg ha^{-1} followed by 2,4-D at 0.5 kg ha^{-1} and anilofos 0.4 kg ha^{-1} as early post emergence application followed by 2,4-D at 0.5 kg ha^{-1} recorded significantly higher number of panicles m^{-2} and thus grain yield.**

Key words: Zero tillage, direct seeding, herbicides, rice

Transplanting rice seedlings on puddled soils is widespread in irrigated ecosystems. However, several constraints i.e. late rice planting, drudgery to farm workers, high production costs, high water use and restricted root systems, non availability of labour in time often result in shortages and increasing labour costs (Hobbs *et al.*, 2002). Due to these production obstacles rice production system is undergoing various shifts and most prominent of them is inclination of farmers towards direct seeding. The main driving force for the same is the rising wage rates, scarcity of water and at the same time availability of advanced technologies of weed management (Singh and Singh, 2004). Despite several advantages various production constraints are also encountered in direct seeded rice and heavy weed infestation is most prominent of them. Weeds cause heavy damage to direct seeded crop, which can be to the tune of 5-100 per cent (Moody and Mian, 1979). Notwithstanding the labour scarcity and increasing labour costs weeding in rice under moist conditions is the last choice of agricultural labourers which has given momentum to the herbicides for weed management in rice. But, the crop faces the problem of highly competitive weeds mostly grasses at the early stages of crop growth. Later on broad leaf and some other aquatic weeds tolerant to stagnant water condition dominate after submergence (Moorthy and Saha, 2003). Research results from various locations suggested that herbicides alone did not provide effective control under such situations unless these were supplemented with hand weeding or some other cultural methods (Jena *et al.*, 2002). Therefore, present investigation was undertaken to study the relative efficiency of different herbicide alone and in combination with 2, 4-D in direct seeded zero tillage rice and also to check the extent of weed infestation in rice in zero tilled condition.

MATERIALS AND METHODS

Field experiment was conducted in randomized block design with four replications during *Kharif* season of 2001 and 2002 at Crop Research Station of G. B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar (Uttarakhand). The soil of the experiment at site was silty clay loam in texture, high in organic carbon (0.9 per cent), medium in available phosphorus (19 kg P ha^{-1}) and high in available potassium (225 kg K ha^{-1}) with pH 7.65. Treatments consisted of three herbicides alone i.e. pendimethalin 1.0 kg ha^{-1}, anilofos 0.4 kg ha^{-1} and pretilachlor 0.75 kg ha^{-1} and again application of these three herbicides in combination with 2,4-D at 0.5 kg ha^{-1}. Two treatments consisted of anilofos 0.4 kg ha^{-1} as early post emergence and anilofos early post emergence at 0.4 kg ha^{-1} followed by 2,4-D at 0.5 kg ha^{-1}.

Table 1: Effect of treatments on different weed species (No. m^{-2}) at 60 DAS

Treatments	Dose (kg ha^{-1})	*E. colona*		*C. rotundus*		*F. miliacea*		*C. benghalensis*		*C. axillaris*		*P. maxicum*	
		2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Pendimethalin	1.0	2.33 (9.5)	3.05 (21.0)	3.38 (33.5)	2.08 (12.5)	4.34 (78.0)	4.53 (94.0)	3.78 (47.0)	3.48 (36.0)	3.42 (30.5)	1.98 (11.0)	1.24 (5.5)	0.48 (1.5)
Pendimethalin fb 2,4-D	1.0, 0.5	1.78 (8.5)	2.03 (7.0)	3.04 (20.5)	1.65 (17.0)	4.21 (67.5)	4.40 (81.0)	2.26 (8.0)	0.59 (2.5)	1.74 (7.0)	0.0 (0.0)	0.48 (1.5)	0.0 (0.0)
Anilofos kg ha^{-1}	0.4	2.54 (12.0)	2.84 (17.0)	2.34 (17.5)	3.34 (36.0)	4.47 (87.0)	4.65 (105.2)	3.48 (36.0)	2.58 (22.0)	4.12 (64.0)	1.31 (4.5)	1.93 (1.0)	1.0 (7.0)
Anilofos fb 2,4-D	0.4	2.07 (9.5)	2.60 (13.5)	1.99 (10.0)	1.83 (19.0)	4.22 (68.0)	4.41 (82.2)	0.97 (3.0)	1.22 (3.5)	2.67 (14.0)	0.0 (0.0)	0.0 (0.0)	0.48 (1.5)
Anilofos e.p.e	0.4	1.00 (3.5)	2.07 (7.5)	3.35 (29.5)	3.45 (35.5)	4.64 (104.5)	4.83 (126.4)	3.72 (41.5)	3.19 (32.5)	4.14 (66.0)	2.16 (13.0)	1.50 (10.0)	0.0 (0.0)
Anilofos e.p.e fb 2,4-D	0.4, 0.5	0.67 (3.5)	2.64 (14.0)	2.68 (27.5)	3.52 (44.0)	3.79 (47.5)	3.97 (57.4)	2.12 (8.0)	0.98 (1.5)	1.79 (7.5)	0.0 (0.0	1.24 (6.5)	0.0 (0.0)
Pretilachlor	0.75	3.06 (22.0)	2.49 (11.5)	2.31 (16.0)	3.11 (29.5)	4.53 (95.0)	4.72 (114.9)	3.18 (23.5)	3.76 (44.5)	3.46 (32.5)	2.06 (9.5)	2.30 (11.0)	0.0 (0.0)
Pretilachlor fb 2,4-D	0.75, 0.5	2.52 (12.0)	2.39 (10.5)	0.85 (7.5)	2.49 (26.5)	4.39 (84.5)	4.58 (102.3)	1.53 (5.5)	0.73 (4.5)	1.99 (10.0)	0.40 (1.0)	1.33 (7.0)	0.0 (0.0)
Weed free		0.00 (0.0)	0.0 (0.0)	0.00 (0.0)	0.0 (0.0)	0.00 (0.0)	0.0 (0.0)	0.00 (0.0)	0.0 (0.0)	0.00 (0.0)	0.0 (0.0)	0.00 (0.0)	0.0 (0.0)
Weedy		3.66 (43.0)	3.21 (25.5)	3.58 (39.5)	0.87 (8.0)	5.12 (172.5)	5.3 (208.7)	4.01 (60.0)	3.98 (56.0)	4.19 (68.0)	2.67 (16.0)	2.79 (16.0)	0.0 (0.0)
L.S.D. (P=0.5)		1.19	0.51	1.51	2.08	0.35	0.36	0.87	0.98	1.22	1.22	1.62	NS

Values in parenthesis are original
e.p.e. = Early Post Emergence, fb = Followed by
DAS = Days After Sowing

Weedy and weed free were also kept for comparison. All the pre emergence herbicides were applied three days after sowing (DAS), early post emergence herbicides were applied 7 DAS whereas 2,4-D was applied 35 DAS.

Rice variety Sarjoo-52 was sown at spacing of 20 cm between rows. The experiment was conducted adopting recommended package of practices. Weed data were analyzed using log (x+1) transformation.

RESULTS AND DISCUSSION

Effect on weeds

The major weeds found in the experimental plot were *Echinochloa colona, Cyperus rotundus, Fimbristylis miliacea, Commelina benghalensis, Caesulia axillaris* and *Panicum maxicum* with their population being 9.9, 6.8, 55.3, 12.5, 10.4 and 4.6 per cent, respectively (Table 3). Considerably high dry weight of weeds was found during second year of experiment (Table 2). It was probably due to accumulation of large number of weed seeds in the seed bank during the second year. All the herbicides reduced density and dry weight of all the weeds species compared to weedy check at 60 days crop stage. Reduced density and dry weight was observed in all those treatments where all the pre-emergence herbicides were followed by 2,4-D compared to those treatments where these were used alone. This could be due to better control of both grassy and broad leaved weeds by herbicide combinations at 60 days stage. Anilofos 0.4 kg ha^{-1} followed by 2,4-D was most effective treatment, which was statistically comparable to pendimethalin 1.0 kg ha^{-1} followed by 2,4-D 0.5 kg ha^{-1} in reducing density and dry weight of weeds. Anilofos was not found effective as pre-emergence compared to early post emergence herbicide. Weed control efficiency at 60 days was also highest in anilofos 0.4 kg ha^{-1} followed by 2,4-D during both the years (Fig. 1) among herbicidal treatments. Among all treatments though, highest weed control efficiency was found in weed free treatment owing to complete control of weeds.

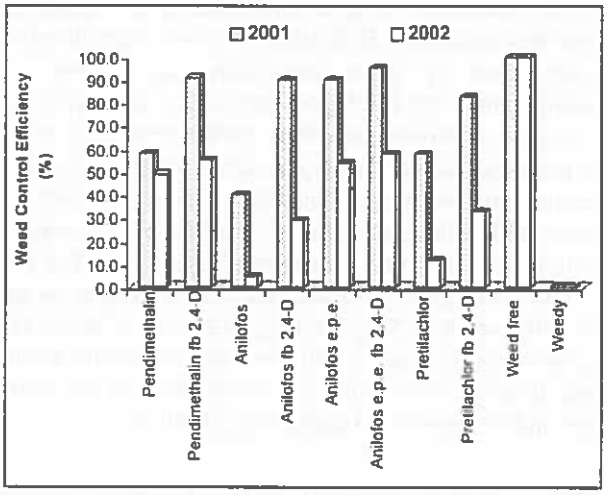

Fig. 1: Weed Control Efficiency (%) as influenced by treatments

Table 2: Effect of treatments on total dry weight (g m^{-2}) at 60 DAS

Treatments	Dose (kg ha^{-1})	2001	2002
Pendimethalin	1.0	5.10 (165.4)	5.73 (309.1)
Pendimethalin fb 2,4-D	1.0, 0.5	3.83 (46.6)	5.60 (271.8)
Anilofos	0.4	5.35 (224.6)	6.29 (540.7)
Anilofos fb 2,4-D	0.4	3.88 (49.2)	6.03 (417.0)
Anilofos e.p.e	0.4	5.32 (28.7)	5.98 (298.8)
Anilofos e.p.e fb 2,4-D	0.4, 0.5	3.81 (48.2)	5.59 (271.6)
Pretilachlor	0.75	5.00 (155.4)	6.20 (501.3)
Pretilachlor fb 2,4-D	0.75, 0.5	4.13 (68.3)	5.93 (377.0)
Weed free	-	0.00 (0.0)	0.00 (0.0)
Weedy		5.86 (353.1)	6.32 (559.6)
L.S.D. (P=0.5)		0.40	0.18

Values in parenthesis are original
e.p.e. = Early Post Emergence, fb = Followed by
DAS = Days After Sowing

Effect on crop

Heavy weed infestation caused reduction in yield attributes and yield of rice. Practically no yield was obtained in weedy plots during first year, and during second year also there was severe reduction in yield. Highest yield attributes and yields were obtained in weed free treatment. Effect of 2,4-D was evident in the experiment in terms of yield and yield attributes as all those treatments where it was applied, produced significantly higher number of panicles m^{-2} as well as number of grains per panicle. However, anilofos early post emergence 0.4 kg ha^{-1} followed by 0.5 kg 2,4-D and pendimethalin at 1.0 kg ha^{-1} followed by 0.5 kg 2,4-D were best treatments. Both treatments were significantly better than all other herbicides alone and in combinations. The 1000-grain weight was unaffected by treatments. However, in weedy plots, since there were no panicles, mean of weedy check regarding 1000-grain weight came out to be very less. Results obtained in grain yields reflect infestation of weeds at 60 days stage. Anilofos as early post emergence herbicide @ 0.4 kg ha^{-1} followed by 0.5 kg 2,4-D and pendimethalin 1.0 kg ha^{-1} followed by 0.5 kg 2,4-D gave 3.21 t ha^{-1} and 3.38 kg ha^{-1} average grain yield respectively. Grain yield reduction in these two treatments was however, 46.2 per cent and 38.3 per cent, respectively (Table 3).

Above results (Table 4) showed that where herbicide were used alone, net return came out to be negative irrespective of herbicide used. Both grain yield and net return showed superiority in hand weeding over use of herbicides (Table 4). Thus, in zero tillage direct seeded rice, hand weeding is must to obtain better yield

Table 4: Net return (Rs. ha^{-1}) of various treatments.

Treatments	Dose (kg ha^{-1})	Net return (Rs. ha^{-1})
Pendimethalin	1.0	-5750
Pendimethalin fb 2,4-D	1.0, 0.5	5963
Anilofos kg ha^{-1}	0.4	-6083
Anilofos fb 2,4-D	0.4	5188
Anilofos e.p.e.	0.4	-5915
Anilofos e.p.e. fb 2,4-D	0.4, 0.5	4936
Pretilachlor	0.75	-5482
Pretilachlor fb 2,4-D	0.75, 0.5	1379
Weed free	–	16838
Weedy	1.0	-12342

Table 3: Effect of treatments on yield attributing characters and grain yield of rice.

Treatments	Dose (kg ha^{-1})	No. of panicle m^{-2}		No. of grains $panicle^{-1}$		1000-grain wt. (g)		Grain yield (t ha^{-1})	
		2001	2002	2001	2002	2001	2002	2001	2002
Pendimethalin	1.0	88	60	122	128	22.0	24.6	1.35	1.23
Pendimethalin fb 2,4-D	1.0, 0.5	261	162	140	132	22.9	25.1	4.17	2.59
Anilofos kg ha^{-1}	0.4	169	84	128	133	23.0	25.0	1.47	0.90
Anilofos fb 2,4-D	0.4	243	144	144	139	24.5	25.4	3.90	2.52
Anilofos e.p.e.	0.4	157	81	118	110	24.3	24.6	1.65	0.78
Anilofos e.p.e. fb 2,4-D	0.4, 0.5	210	101	131	113	24.6	24.8	3.55	2.78
Pretilachlor	0.75	226	52	125	117	22.5	25.1	1.82	0.92
Pretilachlor fb 2,4-D	0.75, 0.5	222	55	133	128	23.2	23.8	2.25	2.00
Weed free	–	321	307	140	131	23.9	23.9	6.30	5.64
Weedy	1.0	0.0	3.7	0.0	24	0.0	25.1	0.0	0.09
L.S.D. (P=0.5)		38.5	25.8	16.4	26.5	1.64	7.0	0.39	0.63

e.p.e. = Early Post Emergence, fb = Followed by
DAS = Days After Sowing

and economics. Also it is not recommended in the light of data to adopt zero tillage rice consecutively as there was drastic decrease in yield in second year compared to first year.

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