Indian Journal of Weed Science **45**(3): 159–162, 2013

Chemical management of non-grassy weeds in direct-seeded rice

Sheeja K. Raj*, Nimmy Jose, Reena Mathew and S. Leenakumary
Rice Research Station, Kerala Agricultural University, Moncompu, Alappuzha, Kerala 688 503

Received: 3 July 2013; Revised: 16 September 2013

ABSTRACT

Field experiments were conducted during *Rabi* 2011-12, *Kharif* 2012 and *Rabi* 2012-13 to evaluate the bioefficacy of carfentrazone-ethyl at 20 and 25 g/ha on 15-20 DAS with 2,4-D Na salt 800 g/ha on 20-25 DAS, weed free situation and un-weeded check as treatments in randomized block design replicated four times. *Fimbristylis miliacea, Cyperus difformis, Cyperus iria, Schenoplectus pungens* were the major sedges and *Monochoria vaginalis, Ludwigia perennis* and *Sphenoclea zeylanica* were the dominant broad-leaved weed species. Application of carfentrazone-ethyl 20 g/ha on 15-20 DAS proved effective in controlling sedges and broad-leaved weeds in direct-seeded rice. Carfentrazone-ethyl 40 DF 20 g/ha recorded higher grain yield (3.68 t/ha) with weed control efficiency of 90.7% and weed index of 9.5. It was comparable with 2,4-D Na salt 800 g/ha (3.65 t/ha) with weed control efficiency of 96.7% and weed index of 10.5. There was 72% reduction in grain yield due to the infestation of non-grassy weeds in direct-seeded rice. Weed free situation recorded the highest grain yield (4.07 t/ha) but its B: C ratio was lower than carfentrazone-ethyl 20 g/ha and 2,4-D Na salt 800 g/ha. Carfentrazone-ethyl, both at 20 and 25 g/ha did not exhibit any phytotoxic effect in rice plant.

Key words: Broad-leaved weeds, Carfentrazone-ethyl, Chemical control, Sedges, Weed control efficiency, Weed index

Weed infestation is one of the major reasons for poor productivity in direct-seeded rice. Weeds interfere with normal crop growth by competing for available nutrients, light and water. Uncontrolled weeds reduce the grain yield by 96% in dry direct-seeded rice and 61% in wet direct-seeded rice (Maity and Mukerjee 2008). In direct-seeded rice, initial 30 to 40 days of crop growth is critical. The yield decrease in direct-seeded rice increases with the increase in competition duration during the initial period. Manual and mechanical methods are not effective in controlling sedges and broad-leaved weeds in direct-seeded rice because of the high labour cost, scarcity of labour during the critical period of weed competition and unfavorable weather at weeding time. Hence usage of herbicides is becoming increasingly popular as a viable alternative to hand weeding. There is a shift in weed flora from grassy weeds to sedges and broad-leaved weeds and from annuals to perennials due to the continuous use of herbicides for the control of annual grassy weeds (Rajkhowa *et al.* 2006). To avoid undesirable weed shift and herbicide resistance in weeds, the continuous use of herbicides with similar mode of action has to be restricted. Hence, it is imperative to identify alternative herbicides for effective control of sedges and broad-leaved weeds. Therefore the present study was undertaken to evaluate the bio efficacy of carfentrazone-ethyl, a new low dose post-emergent contact herbicide which kills weed by desiccation of leaves for the control of sedges and broad-leaved weeds in direct-seeded rice.

***Corresponding author:** sheejakraj70@gmail.com

MATERIALS AND METHODS

Field experiments were conducted during *Rabi* 2011-12 (December 2011-April 2012), *Kharif* 2012 (June 2012-October 2012) and *Rabi* 2012-13 (December 2012-April 2013) at the experimental farm of Rice Research Station, Moncompu, Alappuzha, Kerala (geographically situated at 9º 5´ N latitude and 76º 5´E longitude and at an altitude 1 m below MSL). The soil of the experimental site was silty clay in texture with pH 6.17 (wet), organic Carbon 1.59%, available P 49.28 kg/ha and available K 51.33 kg/ha. The experiment was laid out in randomized block design with five treatments, *viz.* carfentrazone-ethyl 40 DF 20 g/ha on 15- 20 days after sowing (DAS), carfentrazone-ethyl 40 DF 25 g/ha on 15-20 DAS, 2,4-D Na 80 WP 800 g/ha on 20-25 DAS, weed free situation and un-weeded check in four replications. In all the treatments, grassy weeds were controlled by the application of cyhalofop-butyl at 0.08 kg/ha on 18 DAS. The total rainfall received during the cropping season was 387 mm, 1150.6 mm and 217.1 mm respectively, during *Rabi* 2011-12, *Kharif* 2012 and *Rabi* 2012-13.

The pre-germinated seeds of medium duration rice variety '*Uma*' were sown on 21 December 2011, 6 June, 2012 and 13 December 2012. The seed rate adopted for sowing was 100 kg/ha. The crop was fertilized with 90, 45, 45 of N, P_2O_5, K_2O kg/ha. One third dose of N and K and half P were applied at 15 DAS, one third dose of N and K and half P at 35 DAS and remaining one third N and K at 55 DAS. All other agronomic measures were adopted as per the package of practice recommendations of Kerala Agricultural University (KAU 2011). Herbicides were applied with the help of a hand operated knapsack sprayer fitted with flat fan nozzle at a spray volume of 300 l/ha. Observations on density of broad-leaved weeds and sedges were recorded with the help of a quadrate (0.25 x 0.25 m) placed randomly at two representative sites in each plot at 30 DAS and 60 DAS. Broad-leaved weeds and sedges were collected separately from the same area at 60 DAS for recording the weed dry weight of sedges and broad-leaved weeds and their total weed dry weight. Weed samples were sun dried before oven drying at 65^0C until constant weight was attained. The data on weed density and weed dry weight were subjected to square root transformation ($\sqrt{x+0.5}$) to normalize their distribution. Weed control efficiency (WCE) was computed using the total dry weight of weeds and weed index (WI) was computed using the grain yield of weed free check and yield of treated plots. Yield attributing characters like panicles/m^2, panicle weight, fertile grains per panicle and 1000 grain weight were recorded at harvest from 10 randomly selected hills. Number of panicles was recorded by placing a quadrate (0.25 x 0.25 m) at two spots in each plot. The grain yield was recorded at 13% moisture. The cost of cultivation was worked out based on the labour and input cost incurred towards rice cultivation in different treatments. Economics of cultivation was worked out based on the minimum support price for rice (₹17/kg) given by the Government of Kerala during 2012 and straw one rupee per kilogram. The data except WCE and WI were analyzed using ANOVA and the least significant difference (LSD) values at 5% level of significance were calculated and used to test significant difference between treatment means.

RESULTS AND DISCUSSION

Weed flora and density

The observations made on the weed flora at different stages indicated that sedges were the predominant non-grassy weeds present in the experimental field. *Fimbristylis miliacea, Cyperus difformis, Cyperus iria, Schenoplectus pungens* were the major sedges and *Monochoria vaginalis, Ludwigia perennis* and *Sphenoclea zeylanica* were the dominant broad-leaved weed species present in the field. On an average, total non-grassy weed population at 30 DAS comprised of broad-leaved weeds (9.69%) and sedges 90.31%. At 60 DAS, total non-grassy weed population comprised of broad-leaved weeds (13.22%) and sedges (86.78%) (Table 1.). There was a decline in the population of sedges in the unweeded check as the crop advanced in its age which may be due to slight increase in the population of broad-leaved weeds and consequent intraspecific competition.

The density of broad-leaved weeds and sedges under herbicidal treatments was significantly lower than the unweeded control (Table.1). Data on weed density at 30 and 60 DAS indicated that the lowest population of sedges and broad-leaved weeds were recorded in 2, 4-D Na salt applied at 800 g/ha on 20-25 DAS. Among the different dosages of carfentrazone-ethyl tested, 20 g/ha applied on 15-20 DAS recorded lower density of broad-leaved weeds at 30 DAS, while the density of sedges was lower in higher concentration of 25 g/ha. This was statistically at par with 2,4-D Na salt and significantly superior to weed free situation. The findings were in conformity with that of Yaduraju and Mishra (2008) who reported that hand weeding failed to control sedges due to regeneration or escape of weeds. The data at 60 DAS revealed that carfentrazone-ethyl applied at 20 g/ha was better than its higher concentration in reducing the density of broad-leaved weeds as well as sedges.

Weed dry matter and weed control efficiency

The dry matter accumulation by weed varied in accordance with the weed population recorded under the different treatments. Significant reduction in weed dry weight of broad-leaved weeds and sedges was observed due to weed control measures (Table 1). Among the herbicides tested, 2,4-D Na salt recorded the lowest dry weight of broad-leaved weeds and sedges and total weed dry weight. Among the different doses of carfentrazone-ethyl tested, both doses were statistically at par in reducing the dry weight of sedges and broad-leaved weeds. However, lower dose of 20 g/ha was better in reducing the dry weight of broad-leaved weeds and higher dose of 25 g/ha was found to be better in reducing the dry matter of sedges. Among the different weed control measures, 2,4-D Na salt recorded the highest weed control efficiency (96.7%). Carfentrazone-ethyl applied at 20 g/ha registered 90.7% weed control efficiency which was higher than its higher dose which registered a weed control efficiency of 88.8%. This was due to better reduction in the population and dry matter of broad-leaved weeds.

Table 1. Effect of treatments on density and dry matter of broad-leaved weeds and sedges (pooled data of three seasons)

Treatment	Dose (g/ha)	Weed density (no./m^2)				Weed dry weight at 60 DAS (g/m^2)		Total weed dry weight at 60 DAS (g/m^2)	WCE (%)
		30 DAS		60 DAS					
		BLW	Sedges	BLW	Sedges	BLW	Sedges		
Carfentrazon-ethyl	20	6.21 (2.59)	8.38 (2.98)	13.04 (3.68)	16.81 (4.16)	5.75 (2.50)	4.93 (2.33)	22.93 (4.84)	90.6
Carfentrazone-ethyl	25	10.19 (3.27)	3.70 (2.05)	22.16 (4.76)	19.04 (4.42)	9.93 (3.23)	3.74 (2.06)	27.48 (5.29)	88.8
2,4-D Na salt	800	2.60 (1.76)	2.89 (1.84)	3.15 (1.91)	4.84 (2.31)	1.09 (1.26)	2.26 (1.66)	8.08 (2.93)	96.7
Weed-free		22.93 (4.84)	81.95 (9.09)	28.77 (5.41)	16.64 (4.14)	1.75 (1.50)	3.15 (1.91)	11.13 (3.41)	95.4
Unweeded		42.93 (6.59)	399.9 (20.01)	51.34 (7.20)	336.9 (18.37)	16.81 (4.16)	131.9 (11.51)	245.3 (15.68)	
LSD (P=0.05)		1.2	1.55	1.45	2.87	0.75	0.99	1.18	

Figures in parentheses are transformed values; BLW- Broad-leaved weeds, WCE- weed control efficiency; DAS - Days after sowing

Table 2. Effect of treatments on yield attributes and yield of direct-seeded rice (pooled data of three seasons)

Treatment	Dose (g/ha)	Panicles /m^2	Panicle weight (g)	Fertile grains/ panicle	1000-grain weight (g)	Grain yield (t/ha)	Weed index
Carfentrazone-ethyl	20	290	2.39	86.9	24.02	3.68	9.5
Carfentrazone-ethyl	25	272	2.28	91.0	23.38	3.32	18.5
2,4-D Na salt	800	282	2.28	91.6	24.28	3.65	10.3
Weed-free		330	2.43	104.0	25.19	4.07	-
Unweeded		147	1.55	56.2	22.74	1.14	72.0
LSD (P=0.05)		19	0.18	7.4	0.44	0.30	

Yield attributes and yield

The yield attributing characters were significantly influenced by the weed control treatments (Table 2). Weed free situation recorded significantly higher number of panicles/m^2, fertile grains per panicles and test weight compared to other treatments. Data on panicles/m^2 revealed that tested herbicides did not exhibit any phytotoxic effect in crop plants. Among the herbicide treatments, carfentrazone applied at 20 g/ha recorded higher number of panicle/m^2, panicle weight and test weight compared to others. Reduction in the weed population provided a competition free environment for rice, enhancing the uptake of nutrients and translocation of photosynthates to sink which in turn influenced the yield attributes positively. Un-weeded check recorded the lowest number of panicles/ m^2, panicle weight, fertile grains per panicle and test weight. This was due to severe weed competition exerted by sedges and broad-leaved weeds for space, light and nutrients throughout the growth period. The results are in conformity with the findings of Gopinath and Kundu (2008) and Saha (2009).

Adoption of different weed management measures increased the grain yield from 3.32 - 4.07 t/ha (Table 2). The increase ranged from 65.6% - 71.91% over un-weeded control. Among the weed control treatments, weed free situation recorded the highest grain yield of 4.07 t/ha. This might be due to the competition free environment maintained by the manual removal of associated weeds. Among the different herbicides tested, carfentrazone-ethyl 20 g/ha recorded higher grain yield which was at par with 2,4-D Na salt applied at 800 g/ha due to better control of sedges and broad-leaved weeds and also due to the improved yield attributes. Paswan *et al.* (2012) reported that application of carfentrazone-ethyl 20 g/ha recorded maximum grain yield in wheat compared to 2,4-D Na salt at 750 g/ha. Un-weeded check recorded the lowest grain yield (1.14 t/ha) due to the negative impact on yield attributes imposed by competition by weeds. Mohan *et al.* (2010) has also reported similar results.

Weed index is the measure of reduction in grain yield due to crop- weed competition compared to weed free situation. In the present study 72% reduction in grain yield

Table 3. Effect of treatments on economics of rice (pooled data of three seasons)

Treatment	Dose (g/ha)	Grain yield (t/ha)	Straw yield (t/ha)	Gross returns (x10³ `/ha)	Cost of cultivation (x10³ `/ha)	Net returns (x10³ `/ha)	B:C ratio
Carfentrazone-ethyl	20	3.68	4.72	81.63	34.62	47.01	2.36
Carfentrazone ethyl	25	3.32	4.45	74.28	34.74	39.54	2.14
2,4-D Na salt	800	3.65	4.82	81.43	34.48	46.95	2.36
Weed-free		4.07	5.38	90.75	39.20	51.55	2.32
Unweeded		1.14	1.72	26.27	31.38	-5.11	0.84
LSD (P=0.05)		0.30	0.29				

was noticed due to the infestation of broad-leaved weeds and sedges in direct-seeded rice. Among herbicides, application of carfentrazone-ethyl 20 g/ha on 15-20 DAS recorded the lowest weed index (9.5) followed by 2, 4-D Na salt applied at 800 g/ha on 20-25 DAS (10.5). The lower weed indices recorded in these treatments indicated lesser grain yield reduction due to minimum crop-weed competition at critical stages.

Even though manual weeding required high labour cost compared to herbicide treatments, weed free situation registered high gross returns and net returns due to high grain and straw yield. Among the herbicide treatments, carfentrazone-ethyl applied at 20 g/ha recorded higher gross returns and net returns due to higher grain yield followed by 2,4-D Na salt applied at 800 g/ha. However the B:C ratio recorded was same in the two treatments (2.36) due to the low cost of 2,4-D compared to carfentrazone-ethyl and high straw yield (Table 3). Weed free situation recorded lesser B: C ratio than carfentrazone ethyl 40 DF applied at 20 g/ha and 2, 4-D Na salt applied 800 g/ha due to high cost of labour with resultant increase in cost of cultivation. Yaduraju and Mishra (2008) reported that manual and mechanical method used to control sedges could not find much place among farmers because of high labour cost, scarcity of labour during the critical period of weed competition and un-favourable weather at weeding time. The lowest B: C ratio was recorded in carfentrazone-ethyl applied at 25 g/ha.

It can be concluded that application of carfentrazone-ethyl 20 g/ha on 15-20 DAS can be recommended for the control of broad-leaved and sedges (non-grassy weeds) in direct-seeded rice with higher grain yield, gross returns, net returns and B: C ratio. It can be used as an alternative to 2,4-D Na salt, a popular herbicide for controlling non - grassy weeds in rice.

REFERENCES

Gopinath KA and Kundu S. 2008. Evaluation of metsulfuron-methyl and chlorimuron-ethyl for weed control in direct-seeded rice (*Oryza sativa). Indian Journal of Agricultural Sciences* **78** (5): 466-469.

KAU, 2011. Package of Practices Recommendations. pp. 12-37. In: *Crops 2011*, 14th edition. Kerala Agricultural University, Thrissur.

Maity SK and Mukerjee PK. 2008. Integrated weed management in dry-seeded rice (*Oryza sativa*). *Indian Journal of Agronomy* **53** (2): 116-120.

Mohan KS, Muniyappa TV, Kalyana Murthy KN, Ramesh YM and Savitha HR. 2010. Effect of chemical weed control on growth and yield of direct seeded puddle rice (*Oryza sativa* L.). *International Journal of Agricultural Sciences* **6**(2): 471-474.

Paswan AK, Kumar R, Kumar P and Singh RK. 2012. Influence of metsulfuron–methyl and carfentrazone-ethyl either alone or in combination on weed flora, crop growth and yield in wheat (*Triticum aestivum*). *Madras Agricultural Journal* **99**(7-9): 560-562.

Rajkhowa DJ, Borah N, Barua IC and Deka NC. 2006. Effect of pyrazosulfuron-ethyl on weeds and productivity of transplanted rice during rainy season. *Indian Journal of Weed Science* **38**(1 &2): 25-28.

Saha Sanjoy. 2009. Efficacy of bensulfuron-methyl for controlling sedges and non-grassy weeds in transplanted rice (*Oryza sativa*). *Indian Journal of Agricultural Science***s 79**(4): 313-316.

Yaduraju NT and Mishra JS. 2008. Sedges in rice culture and their management, pp. 191-203. In: *Direct Seeding of Rice and Weed Management in the Irrigated Rice-Wheat Cropping System of the Indo -Gangetic Plains*, (Eds. Singh Y, Singh V P, Chauhan B, Orr A, Mortimer A M, Johnson D E and Hardy B.) IRRI, Los Banos, Philippines.