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Comparative efficacy of penoxsulam and pyrazosulfuron ethyl for weed control in direct - seeded puddle rice (*Oryza sativa*)

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Weeds are the most threatening biological constraint for getting higher yield in direct- seeded rice (Rao *et al*. 2007). Rice yields are reduced up to 80 % or even a complete crop failure may occur due to heavy weed infestation (Gopinath and Kundu 2008). Manual weeding, though effective, is getting increasingly difficult due to labour scarcity, rising wages and its dependence on weather conditions. A weed free period for the first 30 to 45 DAS (days after sowing) is essential to avoid reduction in yield as the dry weight of weeds increases greatly from 30 DAS in direct-seeded rice (Singh and Singh 2010). Thus, the herbicide usage seems to be indispensable for weed management in direct-seeded rice. It offers selective and economical weed control right from beginning, giving the crop an advantage of good start and competitive superiority (Saha 2005). Continuous use of herbicides with similar mode of action might lead to development of resistance in certain weeds to the herbicides. Hence, evaluation of new herbicide molecules is imperative for the control of wide spectrum of weed flora. Recent trend in weed management is the use of low dose, high efficacy herbicides which not only reduces the total volume of herbicides but also facilitates easier and economic application (Kathiresan 2001). The present study was undertaken to evaluate the performance of new herbicide molecules, viz. penoxsulam and pyrazosulfuron ethyl to control weeds in direct-seeded rice under puddle condition.

Field experiments were conducted during the *kharif* 2010 and 2011 at the Rice Research Station, Moncompu, Kerala (geographically situated at 9º5´N latitude, 76º5´E longitude and an altitude 1 m below mean sea level). The soil was silty clay with pH 6.2, organic carbon 1.1%, available P 13.8 kg/ha and available K 142 kg/ha The total rainfall received during the cropping season (June-October) was 1781 mm and 1556 mm during 2010 and 2011, respectively. The experiment was laid out in randomized block design with six treatments and four replications. The treatments included the application of post emergence herbicide molecule penoxsulam 24 SC at 22.5 and 25 g ai /ha (15 to 20 DAS) and the early post emergence herbicide pyrazosulfuron ethyl 10 WP at 20 g ai/ha (4 to 7 DAS), weed free condition, hand weeding at 20 and 40 DAS and unweeded check. Herbicides were sprayed using knapsack sprayer fitted with flat-fan nozzle at 300 l/ha of spray volume. The medium duration rice variety Uma was sown on 1st June and 17th June, respectively, during 2010 and 2011. The crop was fertilized with 90, 45 and 45 kg/ha of N, P_2O_5 and K_2O, respectively. One third dose of N and K and half P was 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. Observations on weed density were recorded using 0.25 m^2 quadrat from two representative sites in each plot and weed samples were collected from the same area at 60 DAS for recording weed dry weight. These were subjected to square root transformation to normalize the distribution. Weed control efficiency (WCE) percentage was computed using the dry weight of weeds and weed index (WI) was computed using the grain yield of weed free check and yield of treated plot. Grain yield and other yield attributing characters like panicles per square metre, panicle weight (g) and 1000 grain weight (g) were recorded at harvest. 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.

The dominant weed species in weedy plots at 60 DAS were grassy weeds like *Echinochloa stagnina* (Retz.) P. Beauv. (Hippo grass) and *Echinochloa glabrescens* Munro ex Hook.f. (Barnyard grass), sedges like *Cyperus difformis* L. (Umbrella sedge), *Fimbristylis miliacea* (L.) Vahl (Globe fringerush) and *Schoenoplectus pungens* (Vahl) Palla (Three-square

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Table 1 Effect of weed control treatments on density and dry weight of weeds (pooled data of two years

Treatment	Weed density (No./m^2) at 60 DAS			Total weed dry weight (g/m^2) at 60 DAS	WCE (%)
	Grasses	Sedges	Broad-leaved weeds		
Penoxsulam 24 SC at 22.5 g ai/ha (15 to 20 DAS)	24 (4.95)	1.8 (1.52)	26.7 (5.22)	48.1 (6.97)	75.2
Penoxsulam 24 SC at 25 g ai/ha (15 to 20 DAS)	28.9 (5.42)	0.9 (1.19)	12.1 (3.55)	39.7 (6.34)	79.6
Pyrazosulfuron ethyl 10 WP at 20 g ai/ha (4 to 7 DAS)	54.4 (7.41)	0 (0.71)	0 (0.71)	59.7 (7.76)	69.2
Weed free	2.3 (1.66)	1.7 (1.47)	5.2 (2.39)	3.4 (1.98)	98.3
Hand weeding	2.3 (1.67)	1.7 (1.47)	8.5 (3.0)	5.2 (2.39)	97.3
Weedy check	84.7 (9.23)	32.6 (5.75)	44.9 (6.74)	194.1 (13.95)	
LSD (P=0.05)	1.23	1.29	0.74	1.47	

Figures in parentheses are transformed values

Bulrush) and broad-leaved weeds like *Monochoria vaginalis* (Burm. f.) (Pickerel weed), *Ludwigia perennis* L. (Water primrose) and *Sphenoclea zeylanica* Gaertn. (Chickenspike). The grassy weeds constituted 52.2%, sedges 20.1 % and broad-leaved weeds 27.7% of the total weed population under weedy conditions.

Results revealed that the application of penoxsulam 24 SC at 22.5 and 25g ai/ha at 15 to 20 DAS was significantly more effective in controlling grassy weeds compared to pyrazosulfuron ethyl 10% WP 20 g/ha applied at 4 to7 DAS (Table 1). Pyrazosulfuron ethyl gave very good control of sedges and broad-leaved weeds. Significant reduction in weed dry matter accumulation at 60 DAS was observed due to application of herbicides compared to weedy check. Lowest total weed dry weight (3.4 g/m^2) was recorded in weed free situation and it was on par with hand weeding at 20 and 40 DAS (5.2 g/m^2). All the herbicides were equally and significantly effective in reducing weed dry matter as compared to weedy check. Pal *et al*. (2009) reported that penoxsulam 24 SC applied at 22.5g ai/ha on 8 to12 days after transplanting was most effective in reducing weed dry matter.

Infestation of weeds caused 65 % reduction in grain yield of rice (Table 2). Sultana (2000) observed that weed density of 100 to 200 weeds/m^2 reduced paddy yield by 51 to 64% compared to weed free conditions. All the herbicide treated plots recorded significantly higher grain yield than weedy check. Highest grain yield (5 148 kg/ha) was recorded in the weed free situation and it was on a par with hand weeding twice at 20 and 40 DAS (4 780 kg/ha). Among the herbicides, penoxsulam 24 SC applied at 22.5 g ai /ha recorded the lowest grain yield of 3 268 kg/ha and highest weed index 36.5%. Penoxsulam 25 g ai/ha being on a par with pyrazosulfuron ethyl 20 g ai/ha recorded higher grain yield (4 272 kg/ha) due to more number of panicles/m^2 and better

Table 2 Effect of weed control treatments on yield attributes, grain yield and weed index (pooled data of two years)

Treatment	Panicles (No./m^2)	Panicle weight (g)	1000 grain weight (g)	Grain yield (kg/ha)			Weed index (%)
				kharif 2010	*kharif* 2011	Pooled Mean	
Penoxsulam 24 SC at 22.5 g ai/ha (15 to 20 DAS)	192	2.59	25.43	3710	2826	3268	36.5
Penoxsulam 24 SC at 25 g ai/ha (15 to 20 DAS)	238	2.44	25.19	3760	4784	4272	17.0
Pyrazosulfuron ethyl 10 WP at 20 g ai/ha (4 to 7 DAS)	186	3.14	25.06	4000	4226	4113	20.1
Weed free	220	3.25	25.50	4350	5946	5148	–
Hand weeding	216	2.89	25.49	4490	5070	4780	7.2
Weedy check	96	2.25	23.45	1780	1823	1801	65.0
LSD (P=0.05)	30.9	0.23	0.41	400	809	676	

weed control efficiency compared to other herbicides.

It can be concluded that penoxsulam 25 g ai/ha at 15 to 20 DAS and pyrazosulfuron ethyl 20 g ai/ha at 4 to 7 DAS were effective for broad spectrum weed control and higher grain yield in direct-seeded puddle rice.

SUMMARY

A field experiment was conducted at Rice Research Station, Moncompu during rainy (*kharif*) seasons of 2010 and 2011 to evaluate the efficacy of new herbicide molecules for broad spectrum weed control in direct-seeded rice. The field was dominated by grassy weeds like *Echinochloa stagnina* (Retz.) P. Beauv. (Hippo grass) and *Echinochloa glabrescens* Munro ex Hook. f. (Barnyard grass), sedges like *Cyperus difformis* L. (Umbrella sedge), *Fimbristylis miliacea* (L.) Vahl (Globe fringerush) and *Schoenoplectus pungens* (Vahl) Palla (Three-square Bulrush) and broad-leaved weeds like *Monochoria vaginalis* (Burm. f.) (Pickerel weed), *Ludwigia perennis* L. (Water primrose) and *Sphenoclea zeylanica* Gaertn. (Chickenspike). The weed flora in weedy plots at 60 DAS constituted grasses 52.2 %, broad-leaved weeds 27.7% and sedges 20.1%. The reduction in grain yield was 65% in weedy plots. The application of post emergence herbicide molecule, penoxsulam 24 SC at 22.5 and 25 g ai/ha (15 to 20 DAS) and the early post emergence herbicide pyrazosulfuron ethyl 10 WP at 20 g ai/ha (4 to 7 DAS) were compared with weed free situation and hand weeding twice. Pooled analysis of the two year data on weed density of different treatments indicated the positive effect of herbicides in arresting the weed population up to 60 DAS. Lowest weed dry weight (3.4 g/m^2) was recorded in weed free situation and it was on par with hand weeding at 20 and 40 DAS (5.2 g/m^2). All the herbicides were equally and significantly effective in reducing weed dry matter as compared to weedy check. Among the herbicides, the lowest weed dry weight was observed in penoxsulam 24 SC applied at 25 g ai/ha (15 to 20 DAS) with highest weed control efficiency. The highest grain yield was recorded in weed free check which was significantly superior to all the other treatments. The grain yield obtained for penoxsulam 24 SC applied at 25 g ai /ha on 15 to 20 DAS and pyrazosulfuron ethyl 10 WP applied at 20 g ai /ha on 4 to7 DAS were on par with hand weeding twice (20 and 40 DAS). The weed control efficiency recorded for these herbicides were 79.6% and 69.2 %, respectively.

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