Short communication

Efficacy of herbicide combinations for weed management in transplanted rice

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Abstract

An experiment was conducted in farmer's field at Alappad kole in Thrissur district to evaluate the bio efficacy of herbicide combinations for broad spectrum weed control. The treatments were : post-emergence application of bispyribac-sodium 25 g ha^{-1}, penoxsulam 24% SC 22.5 g ha^{-1}, bispyribac-sodium 25 g ha^{-1} + ethoxy sulfuron 18.75 g ha^{-1}, bispyribac-sodium 25 g ha^{-1} + premix of (chlorimuron-ethyl and metsulfuron-methyl) 4 g ha^{-1}, pre-emergence application of pretilachlor 750 g ha^{-1} followed by (*fb*) post-emergence application of ethoxy sulfuron 18.75 g ha^{-1}, pre-emergence application of pretilachlor 750 g ha^{-1} *fb* post-emergence application of premix of (chlorimuron-ethyl and metsulfuron-methyl) 4 g ha^{-1}, pre-emergence application of pyrazosulfuron ethyl 20 g ha^{-1} *fb* post-emergence application of premix of (chlorimuron-ethyl and metsulfuron-methyl) 4 g ha^{-1}, post-emergence application of premix of penoxsulam + cyahalofop-butyl 6% OD 135 g ha^{-1}, post-emergence application of premix of triafamone + ethoxy sulfuron 60 g ha^{-1}, pre-emergence application of pendimethalin 750 g ha^{-1} *fb* post-emergence application of bispyribac-sodium 25 g ha^{-1}, hand weeding at 25 and 45 DAT and weedy check. Hand weeding resulted in highest weed control and grain yield. Among the herbicide combinations, lowest weed dry matter production and weed control efficiency, and highest grain yield were recorded by triafamone combined with ethoxy sulfuron, and bispyribac-sodium combined with premix of (chlorimuron-ethyl + metsulfuron-methyl). All treatments were significantly superior to unweeded control.

Keywords: Ethoxy sulfuron, Herbicide combinations, Transplanted rice, Triafamone,

Weeds are the most important biotic constraint in rice production, their uncontrolled growth causing up to 33 to 45 per cent reduction in grain yield (Singh et al., 2007; Manhas et al., 2012). Delayed or inadequate weed control can reduce the productivity drastically. Though several herbicides are available and are widely used for weed control, their efficacy in reducing the population of all types of weeds is inadequate. Singh et al. (2004) have observed that whenever grasses have been effectively controlled by these herbicides, broad leaf weeds and sedges emerge at high densities, leading to substantial reduction in rice yields.

The kole area of Thrissur and Malappuram districts is a unique rice ecosystem which is characterized by high productivity. The area lies 0.5 to 1 m below sea level and cropping is done from September after dewatering the fields. The soil is highly acidic and has high organic carbon content. An environment suited to growth of rice is also highly conducive to the growth of several species of grasses, sedges and broad leaf weeds. Herbicide application is a regular practice in this area and the occurrence of a vast array of weeds require several rounds of sprays to manage them, consequently raising the cost of cultivation.

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Herbicide combinations are adopted to some extent, but their efficiency is limited. Evaluation of bio efficacy of herbicide combinations including new herbicides which are available in the market is essential for more efficient weed management. With this objective in view, an experiment was designed for the kole area of Thrissur district.

The experiment was conducted during the second crop season of 2014-2015, in a farmer's field at Alappad in Thrissur district, where weed problems are usually very severe. The soil was clay loam in texture, with a pH of 5.2. The organic carbon content was 1.4%, and the available N, P and K contents were 890, 22 and 281 kg ha^{-1} respectively. The rice variety Jyothi was transplanted with two seedlings per hill at a spacing of 20 x 10 cm on 10-11-14 and harvested on 20-02-15.

The experiment was laid out in randomized block design and replicated thrice with twelve treatments, viz.,

T_1 - bispyribac-sodium 25 g ha^{-1} 25 days after transplanting (DAT)
T_2 - penoxsulam 24% SC 22.5 g ha^{-1} 15 DAT
T_3 - bispyribac-sodium 25 g ha^{-1} + ethoxy sulfuron 18.75 g ha^{-1} 25 DAT
T_4 - bispyribac-sodium 25 g ha^{-1} + premix of (chlorimuron-ethyl and metsulfuron-methyl) 4 g ha^{-1} 25 DAT
T_5 - pretilachlor 750 g ha^{-1} 3 DAT followed by (*fb*) ethoxy sulfuron 18.75 g ha^{-1} 25 DAT
T_6 - pretilachlor 750 g ha^{-1} 3 DAT *fb* premix of (chlorimuron-ethyl and metsulfuron-methyl) 4 g ha^{-1} 25 DAT
T_7 - pyrazosulfuron ethyl 20 g ha^{-1} 3 DAT *fb* premix of (chlorimuron-ethyl and metsulfuron-methyl) 4 g ha^{-1} 25 DAT
T_8- premix of penoxsulam + cyahalofop-butyl 6% OD 135 g ha^{-1} 15 DAT
T_9 - premix of triafamone + ethoxy sulfuron 60 g ha^{-1} 15 DAT
T_{10} - pendimethalin 750 g ha^{-1} 3 DAT *fb* bispyribac-sodium 25 g ha^{-1} 25 DAT
T_{11} - hand weeding at 25 and 45 DAT and,
T_{12} - unweeded control

Spraying was done at a spray volume of 500 l ha^{-1}, using a flood jet nozzle.

All the plots (5 m x 4 m) were fertilized with 110 kg N, 45 kg P, 45 kg K ha^{-1} through urea, factumphos and muriate of potash. Full dose of P and half doses of N and K were applied uniformly as basal at the time of transplanting. Remaining half doses of N and K were top dressed at active tillering stage [30-35 days after transplanting (DAT)]. The gross plot size was 20 sq.m (5m x 4m) and the net plot size was 14.40 sq. m (4 m x 3.6 m). Grain and straw yields from the net plots were expressed on per hectare basis.
Species-wise weed density and biomass were recorded at 60 DAT by placing a quadrat of 50 x 50 cm from the marked sampling area in each plot. Significant differences between treatments were compared by critical difference at 5% level of probability. The data on weed density and biomass were subjected to square root transformation for comparison.

Weed flora and major weeds

A wide array of weeds was seen in the field. The grass species included *Echinochloa crusgalli* (L.) Beauv., *E. stagnina* (Retz.) P. Beauv., and *Leptochloa chinensis* (L.) Nees., while the sedges observed were *Cyperus iria* L., *C. difformis* L. and *Fimbristylis miliacea* (L.) Vahl. The prominent broad leaf weeds were *Ludwigia parviflora* L., *Lindernia crustacea* (L.) F.v. Muell. and *Eclipta alba* L. Weedy rice (*Oryza sativa* f. *spontanea*) also occurred in moderate numbers in the field. The weeds recorded in the study were *Echinochloa* spp., *Leptochloa chinensis* and *Ludwigia parviflora*, as the other weeds occurred in very small numbers in the experimental area.

Weed population and dry matter at 60 DAT

Effect of treatments on population and dry matter

Table 1. Effect of the treatments on weed count, dry matter production and WCE of grass weed and broad leaf weeds at 60 DAT

Treatments		Weed count (no. m^2)			Dry weight of weeds (g m^{-2})	WCE (%)
		Grass weeds		Broad leaved weeds		
		Echinochloa spp.	*Leptochloa chinensis*	*Ludwigia parviflora*		
T_1	Bispyribac sodium	1.82^{de*} (3.0)[£]	4.83^{a} (24.0)	3.33^{a} (10.7)	11.35^{def*} (131.57)[£]	53.25
T_2	Penoxsulam	0.70^{f} (0.0)	3.32^{bc} (10.7)	3.57^{a} (13.3)	11.45^{def} (130.81)	53.52
T_3	Bispyribac-sodium + ethoxy sulfuron	0.70^{f} (0.0)	4.51^{ab} (20.0)	3.24^{a} (10.7)	13.85^{abcd} (191.96)	31.79
T_4	Bispyribac-sodium + (chlorimuron-ethyl + metsulfuron-methyl)	0.70^{f} (0.0)	5.06^{a} (25.3)	3.97^{a} (16.0)	10.33^{ef} (114.67)	59.25
T_5	Pretilachlor *fb* ethoxy sulfuron	3.66^{ab} (13.3)	3.80^{abc} (14.7)	3.33^{a} (10.7)	12.80^{bcde} (170.71)	39.34
T_6	Pretilachlor *fb* (chlorimuron-ethyl + metsulfuron-methyl)	4.13^{a} (17.3)	4.46^{ab} (20.0)	1.18^{b} (1.3)	15.61^{ab} (247.76)	11.96
T_7	Pyrazosulfuron ethyl *fb* (chlorimuron-ethyl + metsulfuron-methyl)	2.65^{cd} (6.7)	4.66^{a} (21.3)	0.70^{b} (0.0)	15.15^{abc} (229.48)	18.46
T_8	Penoxsulam + cyhalofop butyl	0.70^{f} (0.0)	2.59^{c} (6.7)	$.66^{a}$ 3(13.3)	11.94^{cde} (144.19)	48.76
T_9	Triafamone + ethoxy sulfuron	2.85^{bc} (8.0)	3.03^{c} (9.3)	0.71^{b} (0.0)	8.44^{f} (71.32)	74.65
T_{10}	Pendimethalin + bispyribac-sodium	1.17^{ef} (1.3)	5.01^{a} (25.3)	3.03^{a} (9.3)	14.13^{abcd} (200.53)	28.74
T_{11}	Hand weeding	0.70^{f} (0.0)	0.70^{d} (0.0)	0.71^{b} (0.0)	0.71^{g} (0.00)	100.00
T_{12}	Unweeded control	3.71^{ab} (13.3)	4.52^{ab} (20.0)	3.12^{a} (9.3)	16.78^{a} (281.44)	0.00
		CD (0.05)	0.937	1.270	1.230	3.208

*Values followed by same alphabets do not differ significantly in DMRT

[£]"x+0.5 transformed values. Original values are given in parentheses.

production of two major grass weeds, *Echinochloa spp.* and *Leptochloa chinensis,* and a broad leaf weed, *Ludwigia parviflora* at 60 DAT are presented in Table 1. Combinations involving the pre emergence herbicides pretilachlor and pyrazosulfuron ethyl (T_6 and T_7) were found to be less effective against grasses. However (chlorimuron-ethyl + metsulfuron-methyl) in combination with these two herbicides effectively controlled *Ludwigia parviflora*, and was on par with hand weeding (T_{11}). The pre emergence herbicide pendimethalin along with bispyribac sodium (T_{10}) was seen to be effective against grasses, while the effect on broad leaf weeds was less. The combinations including the post emergence herbicides bispyribac-sodium and penoxsulam (T_4 and T_8) were effective against *Echinochloa* spp., but were ineffective against *Leptochloa chinensis.* Of the herbicide combinations, triafamone + ethoxy sulfuron (T_9) was found to be relatively more

effective against *Leptochloa chinensis* and *Ludwigia parviflora*, though not so effective against *Echinochloa* spp. Triafamone, penoxsulam and ethoxy sulfuron are relatively new herbicides with broad spectrum activity. Deivasigamani (2016) reported that triafamone + ethoxy sulfuron recorded least weed count and weed dry matter at 42 days after application, followed by ethoxy sulfuron in direct seeded rice. Penoxsulam applied post emergence was also reported to satisfactorily control weeds in transplanted rice, so as to produce grain yield on par with hand weeded control (Bir et al., 2008).

The efficacy of triafamone + ethoxy sulfuron (T_9) was further confirmed in the weed dry matter production, which was lowest (8.44 g m^{-2}) after T_{11} i.e., hand weeding (0.71 g m^{-2}). The treatment bispyribac-sodium + (chlorimuron-ethyl + metsulfuron-methyl) (T_4) was on par with this (10.33 g m^{-2}). Lower efficacy of pre emergence herbicides pretilachlor and pyrazosulfuron ethyl followed by ethoxy sulfuron and (chlorimuron ethyl + metsulfuron methyl) (T_5 and T_7) was reflected in higher weed dry matter production (Table 1). Post emergence herbicides bispyribac-sodium (T_1) and penoxsulam (T_2) were found to be effective in reducing weed dry matter production and were next to triafamone + ethoxy sulfuron (T_9) in efficacy. An exception was seen in the case of the treatment pendimethalin + bispyribac-sodium (T_{10}), which could be due to higher infestation of *Leptochloa chinensis*. Abeysekhara and Wickrama (2004) have reported that bispyribac-sodium,

Table 2. Effect of treatments on yield and yield attributes

	Treatments	Panicle no. /hill	No. of filled grains/ panicle	Percentage of filled grain	1000 grain weight (g)	Grain yield (dry) Kg ha^{-1}	Straw yield (dry) Kg ha^{-1}
T_1	Bispyribac-sodium	11.3	303.67^{abc}	84.77^{abc}	29.30	4438^{e*}	8752^{abcd}
T_2	Penoxsulam	10.3	293.33^{bc}	87.60^{ab}	29.30	3252^{ef}	6667^{cde}
T_3	Bispyribac-sodium + ethoxysulfuron	10.9	250.00^{e}	80.43^{cde}	28.23	4298^{cd}	9833^{ab}
T_4	Bispyribac-sodium + (chlorimuron-ethyl + metsulfuron-methyl)	12.1	300.00^{abc}	82.73^{bcd}	29.60	5692^{b}	11292^{a}
T_5	Pretilachlor *fb* ethoxy sulfuron	9.5	320.33^{ab}	87.97^{ab}	28.60	4417^{c}	7083^{bcde}
T_6	Pretilachlor *fb* (chlorimuron-ethyl + metsulfuron-methyl)	10.1	224.00^{e}	88.17^{a}	28.67	2542^{f}	4417^{ef}
T_7	Pyrazosulfuron ethyl *fb* (chlorimuron-ethyl + metsulfuron-methyl)x	12.5	284.00^{cd}	78.57^{de}	29.23	3583^{cde}	5875^{def}
T_8	Penoxsulam + cyhalofop butyl	11.1	259.33^{de}	76.67^{e}	28.60	3375^{def}	6625^{cde}
T_9	Triafamone + ethoxy sulfuron	10.5	305.33^{abc}	87.30^{ab}	29.33	5958^{ab}	9125^{abc}
T_{10}	Pendimethalin + bispyribac-sodium	10.3	289.67^{c}	76.47^{e}	28.80	3808^{cde}	6500^{cde}
T_{11}	Hand weeding	12.8	302.67^{abc}	85.90^{ab}	28.80	6917^{a}	11083^{a}
T_{12}	Unweeded control	8.7	156.33^{f}	69.20^{f}	28.00	1292^{g}	3000^{f}
	CD(0.05)	NS	29.97	5.34	NS	994.303	2948.491

*Values followed by same alphabets do not differ significantly in DMRT

though very effective against grasses, broad leaf weeds and sedges, does not control *Leptochloa chinensis*. Weed control efficiency (WCE) followed the exact trend of weed dry matter production with triafamone + ethoxy sulfuron (T_9) recording the highest value of 74.65% followed by bispyribac-sodium + (chlorimuron-ethyl + metsulfuron-methyl) (T_4) recording 59.25%. Following closely were the post emergence herbicides penoxsulam (T_2) and bispyribac-sodium (T_1) recording values of 53.52% and 53.25% respectively. All other herbicides recorded values below 50%.

Grain and straw yield

Treatment effects on plant height and tiller number were non significant. Competition from weeds resulted in lowest number of filled grains per panicle, percentage of filled grain, grain yield and straw yield in unweeded control. Singh et al. (2005) have reported that uncontrolled weeds caused, on an average, a reduction of 62.6% in grain yield in transplanted rice. Grain weight of rice followed the trend of weed dry matter production at 60 DAS, with the best treatment being hand weeding (T_{11}) (6917 kg ha^{-1}), followed by triafamone combined with ethoxy sulfuron (T_9) (5958 kg ha^{-1}) and bispyribac-sodium combined with (chlorimuron-ethyl + metsulfuron-methyl) (T_4) (5692 kg ha^{-1}), which were on par with hand weeding (Table 2). The treatments bispyribac-sodium (T_1), and pretilachlor followed by ethoxy sulfuron (T_5) came next. All treatments were significantly superior to unweeded control (T_{12}) (1292 kg ha^{-1}). Considering straw yield, the treatment bispyribac-sodium combined with (chlorimuron-ethyl + metsulfuron-methyl) (T_4) was the best (11292 kg ha^{-1}), superior even to hand weeding (T_{11}) (11083 kg ha^{-1}). All other treatments were inferior to these two treatments, with unweeded control (T_{12}) recording only 3000 kg ha^{-1}.

Combinations of triafamone with ethoxy sulfuron (T_9), bispyribac-sodium + (chlorimuron ethyl + metsulfuron methyl) (T_4) and pretilachlor *fb* ethoxy sulfuron (T_5), as well as bispyribac-sodium alone (T_1) were found to be effective in obtaining high grain yield. The combination of the new herbicides triafamone with ethoxy sulfuron (T_9) especially showed promise in broad spectrum weed control.

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