Short communication

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Weed control in wet-seeded rice by post-emergence herbicides

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Crop-weed competition is one of the prime yield limiting biotic constraints resulting in yield reduction in rice. Among the various systems of cultivation of rice, direct- seeding of sprouted seeds in puddled soil (wet-seeded rice) offers a good alternative stand establishment practice to transplanting system. It reduces labour cost and give yield similar to transplanting, making it more economical. But weed problems are more critical in direct seeding (Moorthy and Saha 2002) contributing to a yield loss of 40 to 100% (Choubey *et al.* 2001). Among the various weed control measures, use of chemical herbicides is the most common practice as it is easier, time and labour saving, and economical compared to hand weeding (Rekha *et al.* 2003). For controlling mixed flora of weeds emerging during the early stages of crop growth, application of herbicides are needed. Hence a viable recommendation would be a single application of a broad spectrum herbicide or a herbicide combination. Continuous use of same herbicide may lead to herbicide resistance in weeds and so the rotational use of different herbicides are essential for effective weed control. Therefor, the present study was conducted to evaluate the efficacy of various new post-emergence herbicides and herbicide combinations for weed control in wet-seeded rice, to find out the most effective herbicide or herbicide combination for cost effective weed control and to assess the response of rice and its major weeds to new herbicides.

A field experiment was conducted during *Mundakan* season (2011 to 2012) in a farmer's field at Alappad in the Kole lands (10^0 31' N latitude and $76^0$13' E longitude and 1m below mean Sea level) of Thrissur district using the rice variety *'Jyothi'*. The soil was clayey with pH 5.5, organic content 2.1%, available P and K 26 and 281 kg/ha, respectively. The experiment comprised of 13 treatments, *viz.* post-emergence spray of metamifop, metamifop with a follow up spray of carfentrazone ethyl, metamifop with a follow up spray of chlorimuron-ethyl +metsulfuron methyl, cyhalofop-butyl, cyhalofop-butyl with a follow up spray of chlorimuron-ethyl + metsulfuron-methyl, fenoxaprop-p-ethyl, fenoxaprop-p-ethyl with a follow up spray of chlorimuron-ethyl + metsulfuron-methyl, fenoxaprop-p-ethyl with a follow up spray of ethoxysulfuron, bispyribac-sodium, penoxsulam, azimsulfuron, unweeded control and hand weeded checks. The trial was laid out in randomized block design with three replications.

All herbicides were sprayed at 20 days after sowing (DAS) with follow up spray on next day using knapsack sprayer. Data on weed biomass and N, P and K content of weeds (at 30 DAS, 60 DAS and harvest) and yield attributes were recorded. Weed control efficiency (WCE), weed index (WI) and economics of production were also calculated. Data on weed biomass, which showed wide variation, was subjected to square root transformation ($\sqrt{x+0.5}$) to make the analysis of variance valid (Gomez and Gomez, 1984). Multiple comparisons among treatment means, where the F-test was significant (at 5% level) were done with Duncan's Multiple Range Test (DMRT).

Major weed species found in experimental plot were grasses which comprised of *Echinochloa colona, Echinochloa crusgalli, Echinochloa stagnina* and *Leptochloa chinensis. Ludwigia perennis, Lindernia crustacea, Monochoria vaginalis, Sphaeranthes indicus* and *Alternanthera* sp. were the broad-leaved weeds and *Fimbristylis mileacea, Cyperus iria* and *Cyperus difformis* were the sedges present.

A weed biomass of 33-38 kg/ha was registered in plots sprayed with fenoxaprop p-ethyl, metamifop and cyhalofop-butyl at 30 DAS. The highest weed biomass of 350 kg/ha was recorded in unweeded control. By 60 DAS, weed biomass quadrupled in unweeded control with 1300 kg/ha and the lowest weed biomass (43 kg/ha) was noticed in hand weeded plots followed by bispyribac -sodium (129 kg/ha) (Table 1). There was an increase in dry weight from 1300 to 2280 kg/ha in unweeded plot.

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Very low N uptake of 1.5 kg/ha was noticed in bispyribac-sodium sprayed plots at 60 DAS which was only one-twelfth of the uptake registered in unweeded control. A maximum uptake of 41 kg/ha was observed in unweeded control at the harvesting stage of the crop which was double compared to uptake at 60 DAS. Minimum uptake of 0.6 kg/ha was noticed in hand weeded plot followed by 1.6 kg/ha in bispyribac-sodium.

At 30 DAS, the highest number of tillers was in hand weeded plot which was at par with penoxsulam, fenoxaprop p-ethyl + chlorimuron-ethyl+ metsulfuron methyl, cyhalofop-butyl, fenoxaprop-p-ethyl + ethoxysulfuron and metamifop + carfentrazone-ethyl. However at 60 DAS, tiller count in hand weeded control ($592/m^2$) was significantly superior to all other treatments (Table 2).

The maximum number of productive tillers was also recorded in hand weeded treatment ($215/m^2$) and minimum was noticed in unweeded control with $156/m^2$. Maximum grains/panicle of 112 was recorded in hand weeded treatment as well as in cyhalofop-butyl + chlorimuron-ethyl + metsulfuron-methyl (Table 2). There was no significant difference between treatments for 1000 grain weight (test weight) of grains.

The highest grain yield of 6.13 t/ha was recorded in hand weeded plot which was at par with cyhalofop-butyl + chlorimuron-ethyl + metsulfuron-methyl and fenoxaprop + chlorimuron-ethyl + metsulfuron-methyl (5.8 t/ha) and lowest yield of 4.03 t/ha was obtained in unweeded control (Table 2). Abraham *et al.* (2012) also reported about the efficacy of fenoxaprop in direct-seeded rice. In the case of straw, the highest yield was obtained in hand weeding with 5.83 t/ha and lowest in unweeded control with 4.37 t/ha.

Regarding economics of production, among different treatments, maximum B: C ratio of 1.8 was obtained in cyhalofop-butyl + chlorimuron-ethyl+ metsulfuron-methyl, fenoxaprop-p-ethyl + chlorimuron-ethyl + metsulfuron-methyl, bispyribac-sodium and fenoxaprop-p-ethyl alone. Although hand weeded treatment resulted in a net profit of ` 63,075/ha, but B:C ratio was reduced to 1.4 due to high cost of cultivation (` 45,825/ha) and the least B:C ratio of 1.2 was noted in unweeded control.

The treatment bispyribac-sodium showed highest weed index of 6.1 compared to other treatments followed by cyhalofop-butyl + chlorimuron-ethyl + metsulfuron-methyl and fenoxaprop-p-ethyl +

Table 1. Effect of various post-emergence herbicides on weed biomass and nutrient uptake (kg/ha) by weeds

Treatment	Weed biomas			N uptake			P uptake			K uptake		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
Metamifop	*6.09^{b} (36.67)	17.94^{d} (321.33)	18.22^{d} (332.00)	*1.19^{bc} (0.93)	2.02^{d} (3.59)	2.21^{fg} (4.43)	*0.76^{c} (0.09)	1.20^{b} (0.96)	1.22^{e} (1.0)	*1.30^{b} (1.19)	2.28^{de} (4.71)	2.19^{g} (4.30)
Metamifop + carfentrazone-ethyl	0.71^{c} (0)	18.35^{cd} (336.33)	21.44^{c} (459.33)	0.71^{d} (0)	2.17^{bc} (4.24)	2.57^{cd} (6.15)	0.71^{c} (0)	1.14^{d} (0.80)	1.35^{c} (1.33)	0.71^{c} (0)	2.42^{bc} (5.37)	2.79^{de} (7.30)
Metamifop + chlorimuron ethyl+ metsulfuron methyl	0.71^{c} (0)	18.59^{c} (345.00)	21.11^{c} (445.33)	0.71^{d} (0)	1.93^{e} (3.23)	2.67^{bc} (6.68)	0.71^{c} (0)	1.08^{f} (0.67)	1.35^{c} (1.33)	0.71^{c} (0)	2.22^{e} (4.45)	2.67^{e} (6.67)
Cyhalofop-butyl	6.25^{b} (38.67)	18.59^{c} (345.00)	19.24^{d} (370.00)	1.21^{b} (0.97)	2.16^{c} (4.17)	2.35^{cf} (5.05)	0.92^{b} (0.38)	1.10^{e} (0.72)	1.27^{d} (1.13)	1.32^{b} (1.23)	2.45^{b} (5.51)	2.67^{e} (6.64)
Cyhalofop-butyl + chlorimuron ethyl+ metsulfuron-methyl	0.71^{c} (0)	13.24^{f} (175.00)	16.5^{e} (272.00)	0.71^{d} (0)	1.76^{f} (2.62)	1.98^{h} (3.45)	0.71^{c} (0)	0.85^{j} (0.22)	1.14^{f} (0.81)	0.71^{c} (0)	1.61^{g} (2.09)	2.50^{f} (5.77)
Fenoxaprop p-ethyl	5.81^{b} (33.33)	15.38^{e} (236.00)	18.22^{d} (332.00)	1.11^{c} (0.74)	1.75^{f} (2.58)	2.12^{gh} (4.0)	0.77^{c} (0.10)	0.98^{g} (0.47)	1.21^{e} (0.93)	1.27^{b} (1.12)	1.85^{f} (2.93)	2.46^{f} (5.60)
Fenoxaprop-p-ethyl + chlorimuron-ethyl + metsulfuron-methyl	0.71^{c} (0)	12.46^{g} (155.00)	15.08^{f} (227.33)	0.71^{d} (0)	1.58^{g} (2.0)	1.94^{h} (3.27)	0.71^{c} (0)	0.90^{h} (0.31)	1.07^{g} (0.65)	0.71^{c} (0)	1.51^{h} (1.81)	2.28^{g} (4.73)
Fenoxaprop-p-ethyl + ethoxysulfuron	0.71^{c} (0)	19.56^{b} (382.00)	21.73^{c} (472.00)	0.71^{d} (0)	2.25^{b} (4.58)	2.48^{de} (5.66)	0.71^{c} (0)	1.17^{c} (0.87)	1.39^{c} (1.43)	0.71^{c} (0)	2.41^{bc} (5.33)	2.91^{cd} (8.0)
Bispyribac-sodium	0.71^{c} (0)	11.39^{h} (129.33)	12.07^{g} (146.00)	0.71^{d} (0)	1.40^{h} (1.48)	1.46^{i} (1.66)	0.71^{c} (0)	0.87^{i} (0.26)	0.94^{h} (0.40)	0.71^{c} (0)	1.45^{h} (1.63)	1.53^{h} (1.86)
Penoxsulam	0.71^{c} (0)	19.56^{b} (382.00)	23.23^{b} (539.33)	0.71^{d} (0)	2.25^{b} (4.58)	2.74^{bc} (7.03)	0.71^{c} (0)	1.12^{e} (0.76)	1.44^{b} (1.60)	0.71^{c} (0)	2.24^{e} (4.55)	2.93^{c} (8.10)
Azimsulfuron	0.71^{c} (0)	18.31^{cd} (335.00)	23.35^{b} (544.67)	0.71^{d} (0)	2.20^{bc} (4.37)	2.84^{b} (7.60)	0.71^{c} (0)	1.15^{d} (0.83)	1.46^{b} (1.63)	0.71^{c} (0)	2.34^{cd} (5.01)	3.11^{b} (9.23)
Unweeded control	18.71^{a} (350.00)	36.06^{a} (1300.00)	47.75^{a} (2280.00)	2.99^{a} (8.50)	4.32^{a} (18.20)	6.44^{a} (41.04)	1.09^{a} (0.70)	1.93^{a} (3.25)	2.70^{a} (6.84)	2.96^{a} (8.23)	4.17^{a} (16.90)	6.62^{a} (43.33)
Handweeded control	0.71^{c} (0)	6.59^{i} (43.00)	8.11^{h} (65.33)	0.71^{d} (0)	0.98^{i} (0.47)	1.05^{j} (0.61)	0.71^{c} (0)	0.76^{k} (0.08)	0.78^{i} (0.11)	0.71^{c} (0)	1.00^{i} (0.51)	1.08^{i} (0.68)

* $\sqrt{x + 0.5}$ transformed values, Original values in parentheses. In a column, means followed by common letters do not differ significantly at 5% level by DMRT. DAS – Days after sowing

Table 2. Effect of various post-emergence herbicides treatments on tiller count, yield attributes, yield, economics of cultivation, weed index (WI) and weed control efficiency (WCE)

Treatment	Tiller count 60 DAS (no./m^2)	Panicles (no./m^2)	Filled grains/ panicle (no.)	Grain yield (t/ha)	Straw yield (t/ha)	Total cost (x10^3 `/ha)	Net profit (x10^3 `/ha)	B:C ratio	WI	WCE (%)
Metamifop	530.0^{de}	187.00^{de}	102.00^{abc}	5.13^{ef}	5.60^{abcd}	36.15	57.15	1.6	16.3^{bc}	85.4^{e}
Metamifop+ carfentrazone ethyl	541.7^{cd}	187.33^{de}	109.00^{ab}	5.20^{def}	5.37^{def}	37.89	56.31	1.5	15^{bcd}	79.8^{f}
Metamifop + chlorimuron-ethyl + metsulfuron-methyl	554.0^{bc}	189.00^{d}	102.00^{abc}	5.50^{bcd}	5.20^{ef}	37.47	60.62	1.6	9.9^{def}	80.5^{f}
Cyhalofop-butyl	524.7^{de}	191.33^{cd}	101.67^{bc}	5.37^{cde}	5.47^{cde}	35.68	61.81	1.7	12.3^{cde}	83.8^{e}
Cyhalofop-butyl +chlorimuron-ethyl + metsulfuron-methyl	556.0^{bc}	196.33^{bc}	112.00^{a}	5.80^{ab}	5.67^{abc}	37.01	67.09	1.8	5.2^{fg}	88^{d}
Fenoxaprop p-ethyl	527.0^{de}	191.00^{cd}	105.00^{abc}	5.60^{bc}	5.17^{f}	35.35	64.25	1.8	8.4^{ef}	85.4^{e}
Fenoxaprop p-ethyl + chlorimuron-ethyl + metsulfuron-methyl	554.7^{bc}	198.33^{b}	110.00^{ab}	5.80^{ab}	5.10^{f}	36.67	65.63	1.8	5.2^{fg}	90^{c}
Fenoxaprop-p-ethyl + ethoxysulfuron	509.7^{e}	182.33^{e}	96.00^{cd}	5.10^{ef}	5.80^{ab}	36.91	56.99	1.5	16.6^{bc}	79.3^{f}
Bispyribac-sodium	564.3^{b}	191.00^{cd}	105.67^{abc}	5.73^{b}	5.37^{def}	36.14	65.56	1.8	6.1^{f}	93.6^{b}
Penoxsulam	554.3^{bc}	190.67^{cd}	100.00^{bcd}	5.33^{cde}	5.50^{cd}	35.89	60.10	1.7	12.9^{cde}	76.3^{g}
Azimsulfuron	517.3^{e}	175.33^{f}	100.33^{bcd}	4.90^{f}	5.53^{bcd}	35.07	54.92	1.6	19.9^{b}	76.1^{g}
Unweeded control	394.0^{f}	156.67^{g}	91.00^{d}	4.03^{g}	4.37^{g}	32.82	40.37	1.2	33.8^{a}	-
Handweeded control	592.0^{a}	215.00^{a}	112.00^{a}	6.13^{a}	5.83^{a}	45.82	63.07	1.4	-	97.1^{a}

In a column, means followed by common letters do not differ significantly at 5% level by DMRT

chlorimuron-ethyl + metsulfuron-methyl (5.2). Maximum weed control efficiency of 97.1% was obtained in hand weeded plots followed by bispyribac-sodium (93.6%) and fenoxaprop p-ethyl + chlorimuron ethyl+ metsulfuron-methyl (90%). Ramachandiran and Balasubramanian (2012) also reported about the higher weed control efficiency of fenoxaprop-p-ethyl + chlorimuron-ethyl + metsulfuron-methyl in aerobic rice.

SUMMARY

An experiment was conducted at Kole lands in Thrissur district, Kerala to study the efficacy of various post-emergence herbicides in wet-seeded rice. The results showed that cyhalofop-butyl + chlorimuron-ethyl+ metsulfuron-methyl, fenoxaprop-p-ethyl + chlorimuron-ethyl+ metsulfuron-methyl and bispyribac-sodium were best treatments with a lower weed biomass as well as high grain yield and B:C ratio. Maximum weed control efficiency of 97.1% was obtained in hand weeded plots followed by bispyribac-sodium (93.6%). The highest grain yield of 6.13 t/ha was recorded in hand weeded plot which was at par with cyhalofop-butyl + chlorimuron-ethyl + metsulfuron-methyl and fenoxaprop + chlorimuron ethyl+ metsulfuron-methyl (5.8 t/ha). From this study it can be concluded that, cyhalofop-butyl with a follow up spray of chlorimuron-ethyl + metsulfuron-methyl or fenoxaprop-p-ethyl with a follow up spray of chlorimuron-ethyl + metsulfuron methyl or bispyribac sodium alone can be recommended for effective post emergence weed control and higher yield in wet seeded rice. If grasses are the predominant weeds, cyhalofop-butyl or fenoxaprop-p-ethyl alone without follow up spray of chlorimuron-ethyl + metsulfuron-methyl can also be recommended.

REFERENCES

Abraham CT, Prameela P and Laxmi MP. 2012. Bioefficacy testing of fenoxaprop-p-ethyl against weeds in direct-seeded rice. *Indian Journal of Weed Science* **44**(2): 92-94.

Choubey NK, Kolhe SS and Tripathi RS. 2001. Relative performance of cyhalofop-butyl for weed control in direct seeded rice. *Indian Journal of Weed Science* **33**: 132-135.

Gomez AK and Gomez AA. 1984. *Statistical Procedures for Agricultural Research* (2nd edition). John Wiley and Sons, New York: 657p.

Moorthy BTS and Saha S. 2002. Bio-efficacy of certain new herbicide formulations in puddle-seeded rice. *Indian Journal of Weed Science.* **34:** 46-49.

Ramachandiran K and Balasubramanian R. 2012. Efficacy of herbicides for weed control in aerobic rice. *Indian Journal of Weed Science* **44**(2): 118-121.

Rekha BK, Raju MS and Reddy MD. 2003. Effect of herbicides on weed growth, grain yield and nutrient uptake in rainfed lowland rice. *Indian Journal of Weed Science.* **35**: 121-122.