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Crop-weed competition and weed management studies in direct seeded rice (*Oryza sativa*)

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ABSTRACT

Field experiments were conducted during 2006-07 and 2007-08 at Krishi Vigyan Kendra, Madurai, Tamil Nadu under the Zonal Project Directorate, Bangalore to study the critical period of crop weed competition and develop an integrated and effective weed control practices, combining chemical, manual and mechanical methods, for direct seeded rice (*Oryza sativa* L.). It was found that first 40 days after sowing was the most critical period for crop weed competition. The crop grown under weed free condition for 40 days after sowing gave the maximum grain yield (2.93 t/ha). Hand-weeding followed by foliar application of urea was significantly superior to rest of the treatments and gave maximum grain (4.33 t/ha) and straw yields (8.17 t/ha). Post-emergence application of propanil @ 3.8 kg/ha at 20 days after sowing and soil application of urea was most effective in increasing the crop yield and minimizing the crop weed competition. Highest weed control efficiency of 88.1% was recorded in crop given propanil @ 3.8 kg/ha + hand weeding within rows and hoeing at 40 DAS and it closely followed by the application of butachlor @ 2.5 kg/ha + hand weeding within rows and hoeing at 40 DAS. In the integrated approach, post-emergence application of propanil @ 3.8 kg/ha at 20 days after sowing followed by hoeing between the rows and hand weeding within rows at 40 days after sowing minimized crop weed competition, increased uptake of N, P and K by crop and maximized grain yield and economical returns significantly.

Key words : Critical period, Crop-weed competition, Direct-seeded rice, Integrated weed management

India is the world's second largest producer of rice after China, accounting for 20% of world rice production. Rice is the staple food of the people of the eastern and southern parts of the country. Direct-seeded culture has become increasingly important in rice cultivation due to scarcity of rural labour and higher water requirement and production costs of transplanted rice (Azmi and Baki, 2007). Direct-seeded rice needs only 34% of the total labour requirement and saves 27% of the total cost of the transplanted crop (Mishra and Singh, 2011). Irrespective of the method of rice establishment, weeds are a major impediment to rice production through their ability to compete for resources and their impact on product quality. Weeds are responsible for heavy rice yield losses, to the extent of complete crop loss under extreme conditions. Out of the losses due to various biotic stresses, weeds are known to account for nearly one third. Weed competition would be less severe under transplanting than those under direct-seeding (Singh *et al*., 2005; Savary *et al*., 2005; Rao and Nagamani, 2007; Rao *et al*., 2007). Uncontrolled weeds reduced the grain yield by 75.8, 70.6 and 62.6% under dry-seeded rice, wet-seeded rice and transplanted rice, respectively (Singh *et al*., 2005). Proper weed management technologies can result in an additional rice production. Thus, weed management would continue to play a key role to meet the growing food demands of increasing population in India. As the weed problems are multi-pronged, a holistic multi-disciplinary integrated approach would be imperative. In this context, integrated weed management may provide a more sustainable approach to rice production. Spraying herbicide-fertilizer mixtures saves application time and gives better results with smaller doses. A 3% urea solution mixed with propanil @ 3 litres a.i./ha in 600 liters of water controlled weeds better and increased rice yield more than when urea and propanil were sprayed separately (Mukhopadhyay and Rooj, 1969). In order to find out crop-weed competition, compatibility of herbicide fertilizer mixture for simultaneous foliar nutrition and weed control and effective and economically feasible method of weed control, systematic studies were planned.

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MATERIALS AND METHODS

On-farm experiments were conducted at Krishi Vigyan Kendra in Madurai (latitude 9.58 N, longitude 78.10 E with an altitude of 101 m above mean sea level) district of Tamil Nadu during the year 2006-07 and 2007-08. The soil of the experimental field was sandy clay loam in texture with pH of 6.8.The nutrient status of the soil was low in available nitrogen (218.4 kg/ha), phosphorus (7.5 kg/ha) and medium in available potassium (265.6 kg/ha). Dry seeding was done in rows 20 cm apart at the rate of 100 kg/ha. The experiments were laid out in randomized block design with three replications. In the first experiment on crop weed competition, the rice variety 'IR 20' (medium duration) was grown as test crop. Weed free condition for different periods of 10, 20, 30, 40, 50 and 60 days after seeding (DAS), weed free check and un-weeded check formed the treatments as per detail in table 1. In the second experiment on compatibility of herbicide fertilizer mixture for simultaneous foliar nutrition and weed control, 'Pusa 3-33' (medium duration) variety was grown as the test crop. Nitrogen was applied through soil as well as foliar spray as per treatments detail in table 2. The herbicides butachlor (2.5 kg/ha), nitrofen (3.0 kg/ha) and propanil (3.8 kg/ha) were applied as post- emergence at 20 DAS. Hand weeding was done on 20 and 40 DAS. In the third experiment on different methods of weed control, rice variety 'CO 37' (medium duration) was used as test crop. Butachlor (2.5 kg/ha) was applied as per-emergence at 3 DAS, whereas, MCPA (2.0 kg/ha) and propanil (3.8 kg/ha) were applied as post-emergence at 20 DAS as per treatment detail in table 3. Herbicides were sprayed using spray volume of 600 litres/ha with the help of Knapsack sprayer fitted with flat fan nozzle. Hand weeding and hoeing were done either alone or in combination at 20 and 40 DAS according to the treatments. Hoeing was done with the help of finger weeder. In all the experiments, the crop was fertilized with 60 kg N + 30 kg P + 30 kg K/ha. Half dose of N and full dose of P and K was applied at sowing and remaining nitrogen was applied in the form of urea as foliar spray/through soil as per treatments. Weeds were collected from three places in each plot, by placing a quadrate of 0.50 m × 0.50 m. Growth attributes, yield parameters and yield were recorded during the course of investigation. The N, P and K uptake by crop and weeds was determined in the third experiment using methods given by Jackson (1973). The trend of results was similar during both the years hence, data were subjected to pooled analysis for results and discussion.

RESULTS AND DISCUSSION

Weed growth

The weeds observed in the fields included *Borreria laevis* (Lam.) Griseb., *Cassia tora* (L.), *Commelina benghalensis* (L.), *Cynodon dactylon* Pers., *Cyperus iria* (L.), *Cyperus rotrundus* L., *Digitaria sanguinalis* (L.) Scop., *Echinochloa colona* (L.) Link, *Echinochloa crusgalli* (L.) Beauv., *Fimbristylis miliacea* (L.) Vahl., *Oxalis acetosella* (L.), *Phyllanthus niruri* (L.) and *Setaria glauca* (L.) Beauv. In general, grassy weeds and sedges were predominant throughout the growing period of the crop. The post-emergence application of Propanil @ 3.8 kg/ha + hand weeding within rows and hoeing at 40 DAS caused significant reductions in total weed dry weight followed by other treatments compared to un-weeded control (Table 3). The better performance of propanil could be ascribed to its preferential absorption by *Echinochloa* sp. which was dominant weed flora (Singh *et al*., 2007). Highest weed control efficiency of 88.1% was recorded in crop given propanil @ 3.8 kg/ha + hand weeding within rows and hoeing at 40 DAS and it was closely followed by the application of butachlor @ 2.5 kg/ha + hand weeding within rows and hoeing at 40 DAS. Jaya Suria *et al.*

Table 1. Effect of crop–weed competition on rice, dry matter of weeds and weed control efficiency (Pooled data of two years)

Treatment	Height at maturity (cm)	No. of panicles/ m^2	Panicle length (cm)	No. of gains/ panicle	Grain weight/ panicle (g)	Grain yield (t/ha)	Straw yield (t/ha)	Dry matter of weeds (kg/ha)	WCE (%)
Un-weeded control	58.6	38.0	18.9	24.4	21.0	0.48	0.54	382.6	00.0
Weed free up to 10 DAS	59.5	42.3	17.4	15.8	21.1	0.60	0.86	369.8	03.4
Weed free up to 20 DAS	60.0	58.3	17.8	57.4	21.3	1.47	2.48	205.6	46.2
Weed free up to 30 DAS	57.9	89.6	18.7	59.7	21.2	2.77	2.95	66.7	82.6
Weed free up to 40 DAS	60.0	84.6	19.5	64.8	21.1	2.93	3.33	30.8	91.9
Weed free up to 50 DAS	58.0	77.0	19.8	58.0	21.0	2.34	2.52	16.8	95.6
Weed free up to 60 DAS	60.4	95.0	19.1	58.5	20.6	2.46	2.80	10.7	97.2
Weed free	60.1	89.0	18.5	59.9	21.5	2.72	3.20	-	100.0
SEm±	0.9	7.8	0.6	4.5	0.5	0.26	0.29	9.5	-
CD (P=0.05)	NS	23.8	NS	13.9	NS	0.81	0.87	28.9	-

(2011) also reported highest (95.62%) weed control efficiency with propanil in rice.

Nutrient uptake

Nutrient uptake by crop was more in all weed control treatment compared to one hand weeding at 20 DAS and un-weeded control. Weeds depleted more N, P and K under weedy condition. Propanil @ 3.8 kg/ha followed by hand weeding within rows and hoeing at 40 DAS recorded significantly highest uptake of N, P and K by crop and lowest uptake by weeds (Table 4). However, all other herbicide treatments proved equally effective in reducing the N, P and K removal by weeds. The results are in conformity with Kolhe and Tripathi (1998).

Crop-weed competition

Dry matter production of weeds was significantly low when weed free condition was maintained for 30 DAS or longer periods. In other words, the crop-weed competition reduced considerably when the weed free period was up to 30 DAS or more. By reducing the weed free period from 30 to 20 or 10 DAS, there was considerable increase in dry matter of weeds. In fact, weed free period for 10 DAS was comparable to un-weeded control which recorded maximum dry matter of weeds. This revealed that reducing the period of weed free condition increases weed growth causing greater crop-weed competition ultimately affecting the grain yield adversely (Table 1).

Grain yield remained almost at par with each other under all the treatments where weed free condition was maintained for at least 30 DAS. The weeds which appeared after 30 days of weed free period could not compete with the crop, hence the growth and yield of crop remained unaffected. On the contrary, there was significant reduction in yield when weeding was terminated after 10 and 20 DAS. This was due to severe weed competition at later stages of crop growth as apparent from the dry matter of weeds at harvest under these two treatments. The yield attributes, mainly number of panicles/m^2 and number of grains per panicle were affected most by crop weed competition as evident from negative correlation observed between weed dry matter and these yield components. Therefore, it is imperative to maintain a weed free condition at least up to 30 DAS.

Compatibility of herbicide fertilizer mixture

Hand weeding followed by foliar application of urea was significantly superior in reducing the dry matter of weeds to a minimum level and it was found to be at par with hand weeding followed by soil application of urea, propanil @ 3.8 kg/ha followed by soil application of urea and butachlor @ 2.5 kg/ha followed by foliar application of urea. Among the herbicide treatments, post-emergence application of propanil @ 3.8 kg/ha followed by soil application of urea was found to be most effective. Un-weeded control recorded the maximum dry matter of weeds indicating severe weed competition.

Hand-weeding followed by foliar application of urea was significantly superior to rest of the treatments and gave maximum grain and straw yields. This treatment also recorded maximum number of panicles/unit area, length of panicle and 1,000-grain weight. This was due to less crop-weed competition with added advantage to the crop by the foliar application of urea. Two hand weedings followed by soil application of urea was the next best treatment for increasing grain yield. Among the herbicidal treatments, post-emergence application of propanil @ 3.8 kg/ha followed by soil application of urea recorded the maximum grain yield which was associated with the maximum number of panicles/unit area, length of panicle and 1,000-grain

Table 2. Effect of different weed control treatments on various characters of paddy, dry matter of weeds and weed control efficiency (Pooled data of two years)

Treatment	Height at maturity (cm)	No. of panicles/ m^2	Panicle length (cm)	1,000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Dry matter of weeds (g/m^2)	WCE (%)
Un-weeded control	42.3	115.6	14.6	19.7	1.54	2.52	300.6	00.0
Hand weeding + soil application of urea	60.0	529.6	21.1	21.7	4.12	7.78	162.9	45.8
Hand weeding + foliar application of urea	70.5	582.3	21.6	21.9	4.33	8.17	153.1	49.0
Propanil + foliar application of urea	63.7	421.3	18.9	21.3	3.58	6.81	206.1	31.4
Propanil + soil application of urea	66.0	459.3	19.2	21.7	3.77	6.46	184.9	38.5
Butachlor + foliar application of urea	51.4	281.3	17.2	20.4	2.85	4.58	193.5	35.6
Butachlor + soil application of urea	54.9	307.6	17.1	20.5	2.99	4.67	236.4	21.4
Nitrofen + foliar application of urea	58.2	345.3	17.2	20.8	3.22	5.30	213.1	29.1
Nitrofen + soil application of urea	60.1	368.6	17.7	20.0	3.32	5.93	241.7	19.6
SEm ±	0.8	7.5	0.1	0.3	0.05	0.08	14.5	-
CD (P=0.05)	2.5	22.5	0.5	0.9	0.15	0.25	43.2	-

weight (Table 2). This justifies the superiority of herbicide application with soil application of urea as compared to other treatments in the direct seeded rice.

Comparative efficiency of weed control methods

The herbicides butachlor @ 2.5 kg/ha and propanil @ 3.8 kg/ha alone or in combination with hand weeding within rows and hoeing were effective in reducing the weed competition in terms of dry matter of weeds and significantly superior to un-weeded control where the dry matter of weeds was maximum. However, pre-emergence application of butachlor @ 2.5 kg/ha in combination with hand weeding within rows and hoeing recorded the minimum dry matter of weeds and was at par with pre-emergence application of butachlor @ 2.5 kg/ha, post-emergence application of propanil @ 3.8 kg/ha alone and in combination with hand weeding with in rows and/or hoeing (Table 3).

While comparing the treatments where weeds within rows were controlled in one and not in the other, there was difference in grain yield. This difference in yield was observed in spite of removal of weeds between the rows. This justified the necessity of controlling weeds with in rows either manually or chemically. The data pertaining to yield and its attributes revealed that post-emergence application of propanil @ 3.8 kg/ha in combination with hand weeding within rows and hoeing was the best treatment and gave maximum grain (2.55 t/ha) and straw (4.60 t/ha) yields. This was due to low crop weed competition and better uptake and utilization of nutrients by the crop (Table 4). Greater uptake of nitrogen by the crop helped in increasing the yield by increasing the number of panicles/m^2 and 1,000-grain weight (Fageria and Baligar, 2001). This treatment further provides scope in economizing the use of herbicide which may be required to kill the weeds within rows and not between rows. Comparable crop yield was also obtained under the treatments of pre-emergence application of butachlor @ 2.5 kg/ha alone or in combination with handweeding within rows, hoeing and two weedings. Post-emergence application of MCPA @ 2.0 kg/ha alone or in combination with hand weeding within rows and or hoeing was least effective in controlling weeds and reduced the yield considerably (Table 3). This was due to heavy infestation of grassy weeds and sedges against which MCPA is ineffective (Ahmad and Bhuiyan, 2010). Post-emergence application of propanil @3.8 kg/ha in

Table 3. Effect of different weed control treatments on weed growth, weed control efficiency, yield component, yield and economics (Pooled data of two years)

Treatment	Height at maturity (cm)	No. of panicles/ m^2	No. of grains/ panicle	1,000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Dry matter of weeds (kg/ha)			WCE (%)	Additional returns over un-weeded (×10^3 ₹/ha)
							Broad leaved	Narrow leaved + sedges	Total		
Butachlor	53.0	43.6	77.2	18.2	2.09	4.37	15.8	29.9	45.7	84.3	9.20
Butachlor + HWwithin rows and hoeing at 40 DAS	52.7	51.0	62.1	18.4	2.31	4.03	13.0	22.7	35.7	87.9	1.71
Butachlor + Hoeing at 40 DAS	52.5	33.0	76.6	18.0	1.74	4.25	22.4	15.5	38.3	87.1	3.15
Propanil	50.3	46.0	63.3	18.7	2.20	4.01	10.3	60.4	70.7	76.1	9.98
Propanil + HW within rows and hoeing at 40 DAS	51.1	47.0	67.2	20.2	2.55	4.59	6.3	28.8	35.1	88.1	10.77
Propanil + Hoeing at 40 DAS	50.6	44.6	63.9	18.5	2.18	3.57	3.6	59.9	63.6	78.6	6.47
MCPA	40.3	32.6	59.5	16.3	1.34	3.13	0.0	83.3	83.3	71.9	(-)1.52
MCPA + HW within rows and hoeing at 40 DAS	44.6	30.0	70.1	17.7	1.80	3.32	0.0	75.1	75.1	74.6	(-)2.40
MCPA + Hoeing at 40 DAS	42.6	33.3	69.1	17.7	1.60	3.27	0.0	123.6	123.6	58.3	(-)9.10
HW at 20 DAS	51.0	42.0	54.6	18.8	2.08	3.92	6.2	81.4	87.7	70.4	6.87
HW at 20 and 40 DAS	50.5	49.0	65.7	19.2	2.21	3.81	0.0	83.0	83.0	72.0	5.01
HW within rows and hoeing at 20 DAS	51.0	40.6	66.5	18.4	1.90	3.85	0.0	90.5	90.5	69.5	4.08
HW within rows and hoeing at 20 and 40 DAS	49.6	43.6	64.5	18.6	2.13	3.61	4.5	80.3	84.8	71.4	2.33
Hoeing at 20 and 40 DAS	50.8	38.0	59.5	17.8	1.78	3.59	6.2	132.9	139.1	53.0	1.65
Un-weeded control	43.6	25.3	52.0	17.8	1.28	2.92	34.0	262.6	296.7	00.0	-
SEm ±	2.7	4.8	6.2	0.5	0.23	0.25	2.38	14.8	16.7	-	-
CD (P= 0.05)	7.8	10.1	NS	1.5	0.67	0.72	6.89	43.0	40.3	-	-

Table 4. Effect of weed control treatments on N, P and K uptake by crop and weeds

Treatment	Nutrient uptake (kg/ha) by crop			Nutrient uptake (kg/ha) by weeds		
	N	P	K	N	P	K
Butachlor	69.7	16.3	61.2	4.6	0.8	3.4
Butachlor + HWwithin rows and hoeing at 40 DAS	82.4	18.6	65.6	2.5	0.4	2.2
Butachlor + Hoeing at 40 DAS	79.0	18.0	64.9	2.6	0.4	2.2
Propanil	73.0	17.1	62.2	3.1	0.6	3.0
Propanil + HW within rows and hoeing at 40 DAS	84.1	18.7	66.4	1.7	0.3	1.8
Propanil + Hoeing at 40 DAS	77.5	17.8	64.0	2.8	0.5	1.9
MCPA	62.3	15.4	58.1	6.8	1.3	5.1
MCPA + HW within rows and hoeing at 40 DAS	81.8	18.5	65.1	2.5	0.5	1.9
MCPA + Hoeing at 40 DAS	66.1	15.9	59.8	5.9	0.9	4.2
HW at 20 DAS	51.0	10.2	45.6	11.4	3.2	10.4
HW at 20 and 40 DAS	56.1	11.8	52.1	8.2	1.9	6.1
HW within rows and hoeing at 20 DAS	54.2	10.8	50.3	8.9	2.1	7.2
HW within rows and hoeing at 20 and 40 DAS	58.2	14.9	56.0	7.1	1.2	5.6
Hoeing at 20 and 40 DAS	52.0	10.0	49.8	9.2	2.7	8.2
Un-weeded control	49.9	9.3	39.9	14.4	4.3	12.6
SEm ±	4.4	1.2	2.9	0.3	0.0	0.3
CD (P=0.05)	5.7	3.6	8.5	1.1	0.2	0.9

combination with hand weeding within rows and hoeing was most effective in minimizing the crop-weed competition and increasing the crop yield. In addition, this treatment gave highest additional return (Table 3) and also proved economically most profitable. These findings are in line with the results of Thakur *et al*. (1967).

It is concluded that first 30 days after sowing was the most critical period for crop weed competition in direct seeded rice. Post-emergence application of propanil @ 3.8 kg/ha at 20 days after sowing followed by hoeing between the rows and hand weeding within rows at 40 days after sowing minimized crop weed competition and maximized grain yield and economical return significantly.

REFERENCES

Ahmad, G.J.U. and Bhuiyan, M.K.A. 2010. Performance of weed management practices for different establishment methods of rice in dry season. *Pakistan Journal of Weed Science Research* **16**(4): 393–402.

Azmi, M. and Baki, B. 2007. Weed flora landscapes and innovative management in direct seeded culture. Science, technology and trade for peace and prosperity. (*In*): Proceedings of the 26th International Rice Research Conference, 9-12 October, 2006, New Delhi, India. pp 401–09.

Fageria, N.K. and Baligar, V.C. 2001. Lowland rice response to nitrogen fertilization. *Communications in Soil Science and Plant Analysis* **32**(9): 1405–29.

Jackson, M.L. 1973. 'Soil chemical analysis-advanced course'. A manual of methods useful for instruction and research in soil chemistry, physical chemistry, soil fertility and soil genesis. 2nd edition Madison US.

Jaya Suria, A.S.M., Juraimi, A.S., Rahman, M., Man, A.B. and Selamat, A. 2011. Efficacy and economics of different herbicides in aerobic rice system. *African Journal of Biotechnology* **10**(41): 8007–22.

Kolhe, S.S. and Tripathi, R.S. 1998. Integrated weed management in direct seeded rice. *Indian Journal of Weed Science* **30**(1–2): 51–53.

Mishra, J.S. and Singh, V.P. 2011. Cultivar competitiveness and weed control in zero-till dry seeded irrigated rice (*Oryza sativa*). *Indian Journal of Agricultural Sciences* **81**(10): 976–78.

Mukhopadhyay, S.K. and Rooj, S. 1969. Studies on combined spray of herbicides and nitrogenous fertilizers on rice crop. (*In*): *Proceedings, 57th Indian Science Congress*, 3–7 January, 1970, Kharagpur, India. p. 605

Rao, A.N. and Nagamani, A. 2007. Available technologies and future research challenges for managing weeds in dry-seeded rice in India. (*In*): *Proceedings of the 21st Asian Pacific Weed Science Society Conference* 2 to 6th October 2007, Colombo, Sri Lanka, pp.513–17

Rao, A.N., Johnson, D.E., Sivaprasad, B., Ladha, J.K. and A.M. Mortimer 2007. Weed management in direct-seeded rice. *Advances in Agronomy* **93**: 155–257.

Savary, S., Castilla, N.P., Elazegui, F.A., Teng, P.S. 2005. Multiple effects of two drivers of agricultural change, labour shortage and water scarcity, on rice pest profiles in tropical Asia. *Field Crops Research* **91**: 263–71.

Singh, S., Singh, G., Singh, V.P. and Singh, A.P. 2005. Effect of establishment methods and weed management practices on weeds and rice in rice–wheat cropping system. *Indian Journal of Weed Science* **37**: 51–57.

Singh, S., Ladha, J.K., Gupta, R.K., Lav Bhushan, Rao, A.N., Sivaprasad, B. and Singh, P.P. 2007. Evaluation of mulching, intercropping with *Sesbania* and herbicide use for weed management in dry-seeded rice (*Oryza sativa* L.). *Crop Protection* **26**: 518–24.

Thakur, R.N., Nizamuddin, S., Agarwal, K.N., Sharma, N.N. and Akhtar, M. 1967. Effect of Nitrofen, Agroxone–3 and Spontox with and without cultural practices on the control of rice weeds. *Madras Agricultural Journal* **54**: 415–20.