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Short communication

Performance of transplanted scented rice (*Oryza sativa* L.) under different spacing and weed management regimes in southern Kerala

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Abstract

A field experiment to study the effects of spacing and weed management practices on transplanted scented rice (‘Pusa Basmati 1’) in the sandy clay loam soil of Vellayani during the winter season of 2001-’02 showed that adoption of 20 x 10 cm spacing and pre-emergence application of anilofos+2,4-D ethyl ester (0.40+0.53 kg ai ha^{-1}) at six days after transplanting supplemented with 2,4-D Na salt (1.0 kg ai ha^{-1}) at 20 days after transplanting generally favoured increased yield and net income. The benefit-cost ratio for anilofos+2,4-D ethyl ester was 2.07 as against 0.93 for unweeded check. In addition, the weed flora consisting of *Echinochloa colona*, *Echinochloa crus-galli* and *Leersia hexandra* (grasses); *Cyperus iria*, *Cyperus difformis* and *Fimbristylis miliaceae* (sedges); and *Ludwigia parviflora* and *Monochoria vaginalis* (broad-leaf weeds), had considerably lower NPK uptake in the weed management treatments compared to unweeded plots.

Keywords: Productivity, profitability, nutrient uptake, economics, *basmati*, plant population density

Scented rice (*Oryza sativa* L.) cultivation is emerging as a new economic pursuit for the paddy farmers in some localities of Kerala. Being a relatively recent introduction into southern Kerala, adequate information on the spacing and weed management aspects of this crop are not locally available. Furthermore, weed competition is severe in scented paddy culture, in view of its early slow growth rates (Chander and Pandey, 2001) and it may be exacerbated by sub-optimal population densities. Maintenance of optimal population density is, therefore, critical for optimizing crop productivity. In view of this, an investigation was undertaken to determine the effective spacing and weed management practice that would maximize the productivity and profitability of scented rice crop in southern Kerala.

The field experiment was conducted during the winter season of 2001-’02 at Vellayani. The treatments included three spacings (15 x 15, 20 x 10 and 15 x 10 cm) and five weed management practices [anilofos+2,4-D-ethyl ester (EE) at six days after transplanting (DAT) followed by hand weeding at 20 DAT, anilofos+2,4-D EE at six DAT followed by 2,4-D sodium salt at 20 DAT, hand weeding twice at 20 and 40 DAT, weed free check and unweeded control]. The trial was laid out in a randomised block design with three replications (plot size: 6.0 x 3.6 m). The soil of the experimental site was sandy clay loam with 327, 27 and 175 kg ha^{-1} of N, available P and K respectively, and a pH of 5.4. Twenty four-day-old seedlings of rice variety ‘Pusa Basmati 1’ were transplanted (3 seedlings $hill^{-1}$) during the third week of October 2001. The herbicides were applied with a flat fan nozzle using 500 L of water ha^{-1}. Fertilizers were applied at the rate of 90 kg N, 45 kg P_2O_5 and 45 kg K_2O ha^{-1}. Full dose of P_2O_5 and half dose of N and K_2O were applied basally after puddling and the balance N and K_2O were top-dressed in two split doses at maximum tillering and panicle initiation

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stages. Observations on weed flora, weed biomass and nutrient uptake of both crop and weeds were recorded along with grain yield and yield attributes. Economics was worked out using the prevailing market rates for produce and inputs.

Highest grain yield of 3991 kg ha^{-1} was recorded in the 20x10 cm spacing, which was significantly superior to all other spacing treatments, implying that 50 hills per m^2 probably represent the optimum population density for 'Pusa Basmati 1' under the eco-climatic conditions of southern Kerala (Table 1). Among the weed management treatments (except weed-free check), the highest yield of 3928 kg ha^{-1} was obtained for anilofos+2,4-D EE supplemented with 2,4-D sodium salt, which was superior to anilofos+2,4-D EE+hand weeding (3645 kgha^{-1}) and hand weeding twice (3378 kg ha^{-1}). Anilofos+2,4-D EE with 2,4-D sodium salt also had the second highest plant height and filled grains per panicle after the weed-free check (data not shown). Number of productive tillers hill^{-1} also followed a similar trend (Table 1). Grain yield (2305 kg ha^{-1}) was lowest in weedy check, which may be due to a drastic reduction in productive tillers hill^{-1}. Positive correlation between productive tillers hill^{-1} and filled grains panicle^{-1} *vs*. grain yield (r = 0.94 and 0.96, respectively) and negative correlation between weed biomass and grain yield (r = -0.82) were also noted.

A comparison of the data in Table 2 also indicates that 15 x 10 cm spacing showed the lowest weed biomass (38 g m^{-2}), which was significantly lower than that of 20 x 10 and 15 x 15 cm (41 g m^{-2} each). All weed management practices showed significantly lower weed biomass than the weedy check. This is in conformity with the results of Rao (1995), who reported lower weed dry weight in rice with pre-emergence application of anilofos+2,4-D EE supplemented with 2,4-D sodium salt. Incidentally, the weed flora at our experimental site was dominated by *Echinochloa colona* (L.) Link, *Echinochloa crus-galli* (L.) Beauv. and *Leersia hexandra* S. W. among grasses; *Cyperus iria* L., *Cyperus difformis* L. and *Fimbristylis miliaceae* (L.) Vahl., among sedges; and *Ludwigia parviflora* Roxb. and *Monochoria vaginalis* (Burm. F.) Kunth., among the broad leaved species. Anilofos+2,4-D EE with 2,4-D sodium salt suppressed all weeds and it had the highest weed control efficiency of 89%. Weed index of unweeded control indicated that there was a loss of yield to the tune of 46% owing to weed infestation (Table 2).

Table 1. Effect of treatments on yield and nutrient uptake by transplanted scented rice

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Productive tillers hill^{-1}	Nutrient uptake by crop (kg ha^{-1})			Net income (Rs ha^{-1})	Benefit-cost ratio
				N	P	K		
Spacing (cm)								
15 x 15 (44 hills m^{-2})	3509^a	6325^a	8.9^a	142.7^a	72.41^a	132.9^a	41853^a	1.36^a
20 x 10 (50 hills m^{-2})	3991^b	7008^b	9.3^b	154.1^b	78.30^b	142.7^b	52009^b	1.69^b
15 x 10 (67 hills m^{-2})	3014^c	5435^c	8.1^c	130.8^c	67.14^c	121.3^c	30418^c	0.98^c
CD (0.05)	69.0	120.1	0.21	4.36	1.89	3.53	1485	0.05
Weed management practices								
Anilofos+2,4-D EE with HW (0.40+0.53 kg ai ha^{-1})	3645^d	6493^d	9.0^d	146.3^d	74.15^d	135.0^d	51371^d	1.77^d
Anilofos+2,4-DEE with 2,4-D Na salt (0.40, 0.53 & 1 kg ai ha^{-1})	3928^e	6861^e	9.4^e	157.0^e	79.37^e	147.6^e	58209^e	2.07^e
HW twice at 20 and 40 DAT	3378^f	6102^f	8.4	140.3^f	70.57^f	129.1^f	45277^f	1.54^f
Weed free check	4267^g	7370^g	10.0^g	174.2^g	91.76^g	168.4^g	27508^g	0.42^g
Unweeded control	2305^h	4455^h	6.9^h	94.9^h	47.22^h	81.5^h	24770^h	0.93^h
CD (0.05)	89.1	155.1	0.27	5.63	2.44	4.56	1917	0.06

EE- ethyl ester; HW- hand weeding; DAT- days after transplanting; means followed by the same superscripts do not differ significantly

Table 2. Effect of treatments on dry weight and nutrient uptake by weeds

Treatment	Weed biomass at 60 DAT (g m^{-2})	Weed control efficiency at 60 DAT	Weed index (%)	Nutrient uptake by weeds (kg ha^{-1})		
				N	P	K
Spacing (cm)						
15 x 15 (44 hills m^{-2})	6.48^{a} (40.99)	8.73 (76.27)	18.88^{a}	16.0^{a}	4.8^{a}	11.9^{a}
20 x 10 (50 hills m^{-2})	6.46^{a} (40.71)	8.73 (76.14)	13.83^{b}	15.6^{a}	4.6	11.4^{b}
15 x 10 (67 hills m^{-2})	6.21^{b} (37.58)	8.83 (77.92)	21.62^{c}	14.4^{b}	4.2^{c}	10.4^{c}
CD (0.05)	0.149	NS	0.577	0.499	0.18	0.41
Weed management practices						
Anilofos+2,4-D EE with HW (0.40+0.53 kg ai ha^{-1})	6.25^{c} (38.10)	8.75^{a}(76.56)	14.85^{d}	6.9^{c}	2.7^{d}	7.7^{d}
Anilofos+2,4-D EE with 2,4-D Na salt (0.40, 0.53 & 1 kg ai ha^{-1})	4.30^{d} (17.52)	9.44^{b}(89.17)	8.06^{e}	2.5^{d}	1.0^{e}	3.0^{e}
HW twice at 20 and 40 DAT	7.56^{e} (56.11)	8.09^{c}(65.50)	21.31^{f}	10.8^{e}	3.4^{f}	9.5^{f}
Weed free check	1.00^{f} (0.00)	-	0.00^{g}	-	-	-
Unweeded control	12.80^{g}(162.84)	-	46.30^{h}	41.4^{f}	11.0^{g}	24.8^{g}
CD (0.05)	0.19	0.10	0.75	0.58	0.20	0.48

Data given in parenthesis indicate retransformed values. EE- ethyl ester; HW- hand weeding; DAT- days after transplanting; NS- not significant; means followed by the same superscripts do not differ significantly

As expected, the weed-free check recorded the maximum uptake of nutrients by crop (174 kg N, 91 kg P_2O_5 and 168 kg K_2O ha^{-1}). This was followed by anilofos+2,4-D EE with 2,4-D sodium salt and anilofos+2,4-D EE with hand weeding (157 kg N, 79 kg P_2O_5 and 148 kg K_2O ha^{-1}. Conversely, the maximum nutrient uptake of weeds was observed in the weedy check (41 kg N, 11 kg P_2O_5 and 25 kg K_2O ha^{-1}). Presumably, the excessive weed growth prevented rice plants from absorbing nutrients. Both crop and weeds together could use only 136, 58 and 106 kg ha^{-1} N, P_2O_5 and K_2O in the unweeded check. Similar results were reported by Rajan (2000) previously.

In summary, of the various spacings and weed management practices, 20x10 cm spacing and anilofos+2, 4-D EE supplemented with 2,4-D Na salt appear to be the most economical for scented rice ('Pusa Basmati 1') cultivation. Although yield levels were highest in the weed-free check, the weed management treatments were superior in respect of benefit-cost ratio (Table 2). Combination of anilofos+2,4-DEE with 2,4-D sodium salt also resulted in the highest net income (Rs 58,209 ha^{-1}) and benefit-cost ratio (2.07). Thus, adoption of 20x10 cm plant spacing and resorting to pre-emergence application of anilofos+2,4-DEE with 2,4-D sodium could achieve higher productivity in *basmati* rice.

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