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Spacing and weed management in transplanted basmati rice

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Abstract: A field investigation was carried out at the Instructional farm, College of Agriculture, Vellayani during 2000-2001 to assess the effect of spacing and weed management practices on the performance of basmati rice. The treatments comprised of three spacings (15x15, 20x10 and 15x10 cm) and five weed control treatments (weed free check, unweeded control, hand weeding twice at 20 and 40 DAT, anilofos+2,4-DEE (readymix) 0.40+0.53 kg ha^{-1} at 6 DAT supplemented with hand weeding at 20 DAT and anilofos+2,4-DEE (readymix) 0.40+0.53 kg ha^{-1} at 6 DAT supplemented with 2,4-D sodium salt 1 kg ha^{-1} at 20 DAT). Grasses were the predominant weed species observed in the experimental field. Unchecked weed competition reduced grain yield to the tune of 46%. Herbicides were most effective in controlling the weeds. The results revealed that with 20x1 Ocm spacing (50 hills m^{-2}), pre-emergence application of anilofos+2,4-DEE (readymix) 0.40+0.53 kg ha^{-1} supplemented with 2,4-D sodium salt 1 kg ha^{-1} could result in maximum grain yield and minimum weed competition.

Keywords: **Spacing, weed control, basmati rice, readymix, anilofos, 2,4-D ethyl ester and 2,4-D sodium salt.**

Introduction

There had been a steady but progressive increase in exports of basmati rice all through the post-liberalisation period. From just 2,32,412 tonnes in 1990-91, India's basmati exports went up almost four-folds to touch 8,47,458 tonnes in 2000-2001. Plant spacing is an important factor that can be used to exploit the potential of the high yielding improved rice varieties (Paraye *et al.* 1996). Among the problems encountered in cultivation of scented rice, control of weeds is of utmost importance. Scented rice varieties are inherently poor competitors of weeds due to their initial slow growth (Chander and Pandey, 2001). The most critical period of weed competition is between 20 and 45 days after transplanting rice for a medium duration rice variety like Pusa Basmai-1 with a duration of 130 days. Traditional hand weeding is time consuming, labourious and expensive. So, herbicides are required for weed control in situations where labour is scarce and expensive. Herbicide combinations will broaden the spectrum of herbicidal action for controlling different weeds. Hence, the present investigation was conducted to evaluate the different weed control practices in transplanted scented rice.

Materials and Methods

The field experiment was carried out during winter 2001 at the Instructional Farm, College of Agriculture, Vellayani on sandy clay loam soils. The experiment with 15 treatment combinations replicated three times, was laid out in a randomised block design. The treatments comprised of three spacings (15x15, 20x10 and 15x10 cm) and five weed control treatments (weed free check, unweeded control, hand weeding twice at 20 and 40 DAT, anilofos+2,4-DEE 0.40+0.53 kg ha^{-1} at 6 DAT supplemented with hand weeding at 20 DAT and anilofos+2,4-DEE 0.40+0.53 kg ha^{-1} at 6 DAT supplemented with 2,4-D sodium salt 1 kg ha^{-1} at 20 DAT).

Table 1. Weed density (No m^{-2}), weed control efficiency (%) and weed index (%) as influenced by different spacing and weed control practices

Treatments	Weed density (No m^{-2})		Weed control efficiency (%)		Weed Index
	40 DAT	60 DAT	40 DAT	60 DAT	(%)
Spacing (cm)					
S_1 - 15x15	6.08 (36.47)	7.68 (58.48)	83.51	82.42	18.88
S_2 - 20x10	5.62(31.08)	7.29 (52.64)	83.50	82.36	13.83
S_3 - 15x10	6.31 (39.32)	8.03 (63.98)	82.84	83.67	21.62
CD (P=0.05)	0.087	0.130	NS	NS	
Weed control					
W_1 - Anilofos+2,4-DEE fb HW	4.90(23.51)	8.16(66.09)	86.50	76.57	14.85
W_2 - Anilofos+2,4-DEE fb 2,4-DNa salt	3.32(10.99)	5.28(27.38)	88.96	89.18	8.06
W_3 - HW twice at 20 and 40 DAT	8.83 (78.00)	9.19(83.96)	57.68	65.51	21.31
W_4 - Weed free check	0.71 (0.00)	0.71 (0.00)	100.00	100.00	0.00
W_5 - Unweeded control	12.15(147.12)	14.98(223.90)	0.00	0.00	46.30
CD (P=0.05)	0.112	0.168	2.090	1.494	

Values in parenthesis indicate original values, fb- followed by, NS - not significant HW - hand weeding, DAT - days after transplanting.

Required dose of herbicides as per treatments were mixed with water, 500 lha^{-1} and sprayed uniformly using knapsack sprayer with flat fan type nozzle. FYM @ 5 tonnes ha^{-1} was applied uniformly to the field at the time of field preparation and incorporated. A fertilizer dose of 90:45:45 kg N, P_2O_5 and K_2O ha^{-1} was applied. Half N and K_2O and full P_2O_5 were applied as basal. The remaining half N and K_2O were applied in two equal splits at active tillering and flowering stages, respectively. Twenty four day old seedlings of rice variety 'Pusa Basmati 1' (130 days duration) were transplanted using 3 seedlings/hill, during third week of October.

Weed flora infesting experimental site were identified and enlisted category wise. Weed count was recorded at different stages of crop growth in a randomly selected area of 100 cm x 100 cm quadrant and were classified into 3 groups *viz.* grasses, sedges and broadleaved weeds. The dry weight of weeds, nutrient uptake by crop and weeds, yield and yield attributing characters were recorded and statistically analysed. Data on weed density showed high variation and was subjected to square root transformation ($\sqrt{x+0.5}$) (Little and Hills, 1977). Data on weed control efficiency was not subjected to transformation, as the variation is not large. Gross and net returns (Rs ha^{-1}) and profitability (B : C ratio) were also calculated.

Results and Discussion

Weed flora

The predominant weed species observed in the field were *Echinochloa colona, Echinochloa, crus-galli* and

Table 2. Nutrient uptake by crop and weeds as influenced by different spacing and weed control practices

Treatments	Nutrient uptake by crop (kg ha^{-1})			Nutrient removal by weeds (kg ha^{-1})		
	N	P	K	N	P	K
Spacing (cm)						
S_1 - 15x 15	142.71	72.40	132.98	16.04	4.81	11.89
S_2 - 20x 10	154.06	78.30	142.68	15.60	4.55	11.42
S_3 - 15x10	130.84	67.14	121.32	14.41	4.16	10.44
CD (P=0.05)	4.358	1.888	3.528	0.500	0.176	0.413
Weed control						
W_1 - Anilofos+2,4-DEE fb HW	146.34	74.15	135.00	6.91	2.66	7.65
W_2 - Anilofos+2,4-DEE fb 2,4-DNa salt	157.03	79.37	147.61	2.51	1.03	3.04
W_3 - HW twice at 20 and 40 DAT	140.25	70.57	129.13	10.84	3.38	9.52
W_4 - Weed free check	174.20	91.76	168.43	0.00	0.00	0.00
W_5 - Unweeded control	94.86	47.22	81.45	41.14	10.95	24.78
CD (P=0.05)	5.627	2.437	4.555	0.577	0.203	0.477

fb- followed by, HW-hand weeding, DAT- days after transplanting.

Leersia hexandra among grasses, *Cyperus iria* and *Cyperus difformis* among sedges and *Ludwigia parviflora* and *Monochoria vaginalis* among broad leaf weeds.

Weed Density

At all the stages, the maximum number of weeds was observed under weedy check (Table 1). Pre-emergence application of anilofos+2,4-D EE supplemented with 2,4-D sodium drastically reduced the weed density which was superior to anilofos+2,4-D EE supplemented with hand weeding. Rao (1995) reported similar results. Treatments involving pre-emergence herbicides followed by post-emergence herbicides proved to be better than treatments involving one hand weeding in addition to pre-emergence herbicides. Grassy weeds were predominant (63.81% at 40 DAT and 68.81% at 60 DAT) followed by sedges (18.24% at 40 DAT and 15.80% at 60 DAT) and broad leaf weeds (17.94% at 40 DAT and 15.39% at 60 DAT). Treatments involving herbicides supplemented with hand weeding showed a predominance of grasses (51.60%) followed by broad leaf weeds (26.45%) and sedges (21.95%).

Weed dry matter

Minimum weed biomass of 37.58 g m^{2} was noted with 15x10 cm which was followed in an increasing order by 20x10 cm (40.71gm^{-2}) and 15x15 cm (40.99 gm^{-2}) at 60 DAT. Weed free check reduced the dry matter of the weeds to a significantly lower level at all stages of observation. Anilofos+2,4-D EE supplemented with 2,4-D sodium (12.22 gm^{-2} at 40 DAT and 17.52 gm^{-2} at 60 DAT) was superior to anilofos+2,4-D EE supplemented

Table 3. Yield attributes, yield and economics as influenced by different spacing and weed control practices

Treatments	Effective tillers hill^{-1}	Filled Grains per panicle	Sterility percentage	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Benefit-cost ratio
Spacing (cm)						
S_1 - 15x15	8.89	113.25	16.55	3509	6325	1.36
S_2 - 20x10	9.25	120.15	15.32	3991	7008	1.69
S_3 - 15x10	8.12	95.11	18.89	3014	5435	0.98
CD (P=0.05)	0.207	3.213	1.415	69.0	120.1	
Weed control						
W_1 - Anilofos+2,4-DEE fb HW	9.00	115.37	15.94	3645	6493	1.77
W_2 - Anilofos+2,4-DEE fb 2,4-DNa salt	9.40	119.95	15.15	3928	6861	2.07
W_3 - HW twice at 20 and 40 DAT	8.36	104.95	17.62	3378	6102	1.54
W_4 - Weed free check	10.03	127.46	13.56	4267	7370	0.42
W_5 - Un weeded control	6.86	79.76	22.31	2305	4455	0.93
CD (P=0.05)	0.267	4.148	1.826	89.1	155.1	

fb > followed by, HW-hand weeding, DAT- days after transplanting.

with hand weeding (14.97 gm^{-2} at 40 DAT and 38.10 g m^{-2} at 60 DAT) and caused significant decrease in the dry matter of weeds. This might be due to better and prolonged weed control due to sequential application of herbicides. The maximum dry matter of weeds was found in weedy check (111.55 g m^{-2} at 40 DAT and 162.84 gm^{-2} at 60 DAT). Rao (1995) also reported lower weed dry weight in rice with pre-emergence application of aniofos+2,4-D EE supplemented with 2,4-D sodium, which supports the present investigation.

Weed control efficiency (WCE)

Weed control treatments recorded higher weed control efficiency at all stages of crop growth except unweeded control (Table 1). Anilofos+2,4-D EE supplemented with 2,4-D sodium recorded highest WCE of 88.96 and 89.18 per cent at 40 and 60 DAT respectively which was superior to anilofos+2,4-D EE supplemented with hand weeding (86.50% at 40 DAT and 76.57% at 60 DAT). This might be due to effective control of weeds up to the critical stage of crop weed competition. This was followed by hand weeding twice (57.68% at 40 DAT and 65.51% at 60 DAT). This is in conformity with the results obtained by Rao and Singh (1997).

Weed index

The lower dry weight and lesser weed density resulted in lower weed index with treatment combination of 20x10 cm spacing and anilifos+2,4-D EE supplemented with 2,4-D sodium. This might be due to weed free condition achieved during most of the crop growth period. Weed index of unweeded control indicated that there was a yield loss of 46.30 per cent due to heavy infestation of weeds.

Nutrient uptake by crop and weeds

Weed free check recorded maximum uptake of nutrients by crop (174.20 kg N, 91.16 kg P_2O_5 and 168.43 kg K_2O ha^{-1}). Chaudhary *et al.* (1995) reported similar results. Apart from weed free check, maximum uptake of nutrients by crop (157.03 kg N, 79.37 kg P_2O_5 and 147.61 kg K_2O ha^{-1}) was recorded in anilofos+2,4-D EE supplemented with 2,4-D sodium and was followed by anilofos+2,4-D EE supplemented with hand weeding (146.34 kg N, 74.15 kg P_2O_5 and 135.00 kg K_2O ha^{-1}) and hand weeding twice (140.25 kg N, 70.57 kg P_2O_5 and 129.13 kg K_2O ha^{-1}) (Table 2). This might be due to weed free environment during most of the crop growth period which resulted in lesser competition of weeds and there by increased availability of nutrients (NPK) to the crop. Maximum nutrient uptake of weeds was observed in weedy check (41.14 kg N, 10.95 kg P_2O_5 and 24.78 kg K_2O ha^{-1}) which might be due to heavy weed infestation that made the plants weak and unhealthy and thereby reduced the growth and development of crop resulting in higher nutrient uptake by weeds.

Apart from failing to utilize the available nutrients, weeds prevented rice plants from utilizing these nutrients because both crop and weeds together could use only 136.00, 58.17 and 106.23 kg ha^{-1} N, P_2O_5 and K_2O in unweeded check thus clearly showing that some amount of nutrients remained unabsorbed in soil due to weed competition. Similar results regarding nutrient uptake was reported by Rajan (2000) in rice.

Yield and yield attributes

Higher grain yield of 3991 kg ha^{-1} was recorded in 20x10 cm spacing, which was significantly superior to all other spacings. Lourduraj (1999) had reported that for medium duration rice cultivars, 20x10 cm is optimum plant spacing for achieving maximum yield. Highest yield of 3928 kg ha^{-1} was recorded with anilofos+2,4-D EE supplemented with 2,4-D sodium and was superior to anilofos+2,4-D EE supplemented with hand weeding (3645 kg ha^{-1}) and hand weeding twice (3378 kg ha^{-1}) (Table 3). This might be due to the better expression of yield attributes *viz.* more number of effective tillers $hill^{-1}$ (9.4) and maximum filled grains per panicle (119.95). Lowest yield (2305 kg ha^{-1}) obtained from weedy check might be due to heavy weed infestation which has reduced effective tillers $hill^{-1}$ and filled grains per panicle. Positive correlation between effective tillers $hill^{-1}$ and filled grains $panicle^{-1}$ vs grain yield ($r = 0.94$ and 0.96, respectively) and negative correlations between weed biomass and grain yield ($r = -0.82$) further confirmed the result.

Economics

Of the various spacings and weed management practices, 20x10 cm spacing and anilofos+2,4-D EE supplemented with hand weeding was most economical for rice (Table 3). All weed management practices proved their superiority over the controls (weed free and unweeded) by registering a benefit : cost ratio of more than 1.00. Combination of anilofos + 2,4-DEE supplemented with 2,4-D sodium 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 supplemented with 2,4-D sodium could achieve higher productivity in basmati rice.

References

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