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Effect of herbicide and nitrogen on yield of scented rice (*Oryza sativa*) under different rice cultures

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ABSTRACT

An experiment was conducted to find out the effect of herbicides and nitrogen on yield of scented rice (*Oryza sativa* L.) under different rice cultures. Under transplanted rice, weed population and their dry weight were significantly lower, whereas effective tilleres/m^2, grains/panicle and grain yield of rice were significantly higher than under direct-seeded puddled rice. Application of 120 kg N/ha significantly increased the yield attributes and yield as well as weed population and their dry weight compared with 60 kg N/ha. Under both transplanted and direct-seeded puddled rice cultures hand-weeding caused maximum decrease in weed population and their dry weight and increase in yield attributes and yield. However, effect of herbicide treatments was not alike. Herbicides were found more effective under transplanted rice. Butachlor (1.0 kg/ha), anilofos (0.5 kg/ha) and clorimuron ethyl (0.012 kg/ha) caused almost identical decrease in weed population and their dry weight and resulted in significant increase in yield attributes and yield of rice compared with weedy check. Chlorimuron ethyl was found more effective against broad-leaved weeds. Effect of herbicides under direct-seeded puddled rice was not as palpable as in transplanted rice. Neither herbicides nor nitrogen caused noticeable change in the grain-quality characters, viz. hulling, milling and head-rice recovery (%), grain length, breadth and length : breadth ratio, before and after cooking in any year.

In recent past area under scented rice (*Oryza sativa* L.) has increased many fold owing to its remunerative price in international market. But its average productivity is very low (8.5 q/ha). There is urgent need to increase its productivity. Nitrogen and weed management are pivotal to realize higher yield potential (Ishizuka, 1989; Singh, 1990). In non conventional rice-growing area in light coarse-textured soils, nitrogen loss is greater due to deep percolation (Bajwa and Pasricha, 1995). Frequent aerobic condition of these soils and higher temperature favour the growth of grassy weeds (Sharma *et al.*, 1995). These weeds being more virulent pose severe problem (De Datta, 1979). However, the quantum of decrease in crop yield varies with type and density of weed species (De Datta, 1979) and rice cultures (Pande *et al.*, 1981; Shah *et al.*, 1990). Thus it is of utmost importance to control the emerging weeds to save the waste full loss of applied nitrogen as well as other nutrients. One of the potent means of controlling weeds is use of herbicides (Pandey *et al.*, 1991). Information on the effect of commonly used herbicides on the agronomic characteristics of high-yielding rice varieties is available (Pandey and Shukla, 1990-not cited). However, a very little work has been done on the effect of sulfonyl urea herbicides on agronomic characteristics and quality of scented rice. The aim of the study was to evaluate the effect of sulfonyl urea herbi-

cide along with butachlor and anilofos under different rice cultures and nitrogen levels on weeds, yield and quality of scented rice.

MATERIALS AND METHODS

A field experiment having 2 rice cultures (transplanting, and direct-seeding under puddled corditions) as main-plot treatments and 2 nitrogen levels (60 and 120 kg/ha) and 5 weed-control treatments (weedy check, hand-weeding, butachlor @ 1.0 kg/ha, anilofos @ 0.5 kg/ha and chlorimuron ethyl @ 0.012 kg/ha) as subplot treatments was conducted in split-plot design with 3 replications at Indian Agricultural Research Institute, New Delhi, during the rainy season (*kharif*) of 1993 and 1994 respectively. Scented rice cultivar 'Pusa Basmati 1' was grown. The soil was sandy clay-loam (Inceptisol) with pH 8.05–8.10 and organic carbon 0.61–0.63%. The available N, P and K in 1993 were 160, 19.5 and 284.0 kg/ha, whereas in 1994 these were 175, 21.1 and 296.0 kg/ha respectively.

Under direct-seeded, puddled rice culture sprouted seeds of rice were broadcast @ 100 kg/ha. For transplanted rice, seeds were sown on the same day in nursery. Seedlings of 28 days were transplanted at a spacing of 20 cm x 20 cm. Nitrogen was applied in 3 equal splits at sowing or transplanting, maximum tillering [45 days after sowing (DAS) and 20 days after transplanting (DAT)] and panicle-initiation stage (70 DAS and 40 DAT).

Full dose of P and K (50 kg each of P_2O_5 and K_2O/ha) were applied at the time of sowing or transplanting. Herbicides were applied 5 DAS/DAT as pre-emergence with the help of knap-sack sprayer fitted with flat-fan nozzle. The data on weed population and their dry weight were subjected to square-root transformation $\sqrt{(X + 0.5)}$ to normalise their distribution.

RESULTS AND DISCUSSION

Weed population and dry weight

The predominant weed species that infested the field were *Echinochloa colonum* (L.) Link, *E. crus-galli* (L.) Beauv. and *Leptochloa chinensis* (L.) Nees among grassy weeds; and *Eclipta alba* (L.) Hassk and *Commelina benghalensis* L. among dicot weeds. In both the years weed population and dry weight were significantly lower under transplanted rice culture than direct-seeded, puddled rice culture (Table 1). Superiority of the former may be attributed to frequent burrying of weeds while ploughing to achieve puddled conditions and high soil-moisture content, depth of submergence and greater crop canopy. But under direct-seeded, puddled rice, higher total weed population and dry weight may be attributed to failure to maintain flooded condition (lower redox potential) in field owng to deep percolation of water in coarse-textured light soil in non-conventional rice-growing area, lower rainfall, less number of rainy days, higher evaporation owing to high temperature in June and July, and concomitant germination of weeds and keen competition between crop and weeds for growth factors. Bajwa and Pasricha (1995) observed frequent aerobic soil environment for major period of crop growth and development due to deep percolation of water in direct-seeded rice. Sharma *et al.* (1995) reported that higher temperature favours growth of graminaceous weeds. Pande *et al.* (1981) and Shah *et al.* (1990) found decreased weed competition in transplanted rice as compared to direct-seeded, puddled rice.

Higher nitrogen dose (120 kg/ha) caused a significant increase in total weed population and dry weight than lower dose (60 kg/

Table 1. Effect of rice cultures, nitrogen and weed-control treatments on weed population and dry matter and yield attributes and yield of scented rice

Treatment	Weed population (plants/m²) 100 DAS or DAT				Weed dry matter (g/m²) at 100 DAS or DAT		Effective tillers/m²		Grains/ panicle		Grain yield (q/ha)	
	1993		1994		1993	1994	1993	1994	1993	1994	1993	1994
Rice culture												
Transplanted	3.86	(16.6)	3.90	(16.8)	5.98 (39.8)	6.16 (42.5)	218.1	244.5	143.5	147.3	31.57	37.59
Direct-seeded (puddled)	10.2	(120.0)	11.41	(141.2)	15.56 (271.1)	15.35 (261.9)	99.6	121.8	71.1	83.6	13.04	13.45
CD (P = 0.05)	1.07		1.58		0.51	0.93	7.3	10.4	8.2	15.8	3.92	1.02
N (kg/ha)												
60	6.78	(62.6)	7.30	(75.0)	10.14 (137.2)	10.15 (134.5)	145.3	171.0	104.2	110.6	19.93	23.26
120	7.38	(74.0)	8.01	(83.0)	11.40 (173.7)	11.36 (169.9)	172.4	195.2	110.4	120.3	24.68	27.78
CD (P = 0.05)	0.38		0.54		0.69	0.67	5.9	6.3	4.7	5.0	1.55	0.96
Weed control												
Weedy check	11.85	(168.6)	11.72	(164.5)	17.00 (343.6)	16.61 (321.1)	127.0	142.5	89.6	98.3	15.48	18.29
Hand-weeding	4.27	(20.6)	4.81	(26.6)	6.03 (40.8)	5.75 (36.8)	191.0	234.5	132.3	152.9	33.31	35.94
Butachlor	6.27	(46.3)	7.36	(71.6)	10.14 (126.3)	10.34 (131.0)	151.8	184.2	106.5	109.3	20.14	23.38
Anilofos	6.08	(46.0)	6.77	(59.0)	9.32 (105.5)	9.95 (122.8)	163.3	174.4	106.2	108.7	22.11	25.49
Chlorimuron ethyl	6.98	(59.6)	7.60	(73.1)	11.34 (161.0)	11.13 (149.1)	161.2	180.1	101.9	103.0	20.49	24.52
CD (P = 0.05)	0.60		0.85		1.10	1.06	9.4	9.9	7.5	7.9	2.46	1.52

DAS or DAT, Days after sowing or transplanting
Figures in parentheses original values

ha), perhaps owing to higher depletion of applied nitrogen (Rao *et al.*, 1993 b). Warington (1924) observed higher weed densities in plots rich in nitrogen than the plots poor in available N. Singh and Thakur (1988) reported similar increase due to higher nitrogen level.

In both the years, weed-control treatments significantly decreased weed population and dry weight compared with weedy check. Hand-weeding caused maximum decrease and proved statistically superior to all other weed-control treatments. This may be attributed to frequent removal of weeds. Paliwal *et al.* (1994) found hand-weeding better than herbicide treatments. Anilofos, butachlor and chlorimuron ethyl caused almost identical decrease in both weed population and dry weight and proved superior to weedy check. However, former resulted in slightly better control of grassy weeds whereas the latter of broad-leaved weeds. The finding confirms the result of Pandey *et al.* (1991).

In both the years, under both cultural conditions hand-weeding significantly decreased the weed population and dry weight compared with herbicide treatment (Table 2). Under direct-seeded puddled rice culture latter, treatments resulted in decrease but effect was not conspicuous whereas their effect was palpable under transplanted culture. The lower efficacy under direct-seeded puddled rice culture may be due to initial failure of flooding owing to deep percolation. Soil environment provides equal opportunity to rice and germinating weeds, latter being more virulent might have escaped the restricted range of herbicide selectivity. Under transplanted rice culture, effect of anilofos was conspicuous. This is in accord with the result of Singh *et al.* (1987).

Table 2. Weed population and dry-matter accumulation as affected by interaction between rice cultures and weed-control treatments

Rice culture	Weed population (plants/m^2) at 100 DAS or DAT					Weed dry-matter accumulation (g/m^2) at 100 DAS or DAT				
	Weedy check	Hand-weeding	Buta-chlor	Anil-ofos	Chlori-muron ethyl	Weedy check	Hand-weeding	Buta-chlor	anil-ofos	Chlori-muron ethyl
1993										
Transplanted	6.57 (43.3)	2.65 (6.7)	3.41 (11.3)	2.99 (8.7)	3.70 (13.3)	9.80 (96.7)	3.97 (15.6)	5.35 (28.7)	5.01 (25.0)	5.74 (33.0)
Direct-seeded (puddled)	17.14 (294.0)	5.89 (34.7)	9.00 (81.3)	9.16 (84.0)	10.26 (106.0)	24.21 (590.6)	8.08 (66.0)	14.93 (224.0)	13.63 (186.0)	16.94 (289.0)
CD (P = 0.05)		0.85					1.56			
1994										
Transplanted	6.59 (43.3)	2.89 (8.0)	3.18 (10.0)	3.12 (9.3)	3.70 (13.7)	10.14 (103.0)	3.90 (15.0)	5.45 (29.3)	5.10 (26.0)	6.22 (39.0)
Direct-seeded (puddled)	16.85 (285.6)	6.74 (45.3)	11.55 (133.3)	10.42 (108.7)	11.51 (133.0)	23.09 (539.3)	7.61 (58.7)	15.23 (232.7)	14.80 (219.7)	16.04 (259.3)
CD (P = 0.05)		1.21					1.50			

DAS or DAT, Days after sowing or days after transplanting

Table 3. Grain yield of rice as affected by interaction between rice cultures and weed-control treatments

Rice culture	Weed-control treatment				
	Weedy check	Hand-weeding	Butachlor	Anilofos	Chlorimuron ethyl
1993					
Transplanted	23.61	41.47	29.99	33.61	29.17
Direct-seeded (puddled)	7.36	25.14	10.28	10.61	11.81
CD (P = 0.05)	3.48				
1994					
Transplanted	35.61	47.72	42.78	46.22	45.72
Direct-seeded (puddled)	6.58	29.42	10.44	11.50	11.36
CD (P = 0.05)	3.20				

Yield attributes and yield

Number of effective tillers/m^2, grains/panicle and grain yield were significantly higher under transplanted rice culture than direct-seeded, puddled rice (Table 1). Similar was the observation of Shah *et al.* (1990). Application of 120 kg N/ha resulted in significant increase in effective tillers/m^2, grains/panicle and grain yield compared with 60 kg N/ha in both the years (Table 1). Similar effect of nitrogen was reported by Chatterjee and Maiti (1981).

Effect of weed-control treatments was similar in both the years. Hand-weeding resulted in maximum increase in effective tillers/m^2 grains/panicle and grain yield and proved statistically superior to herbicidal treatments. The superiority of former was due to decrease in crop–weed competition owing to frequent removal of weeds and increased availability of nutrients. Application of anilofos, butachlor and chlorimuron ethyl significantly increased the yield attributes and grain yield over weedy check but they did not differ significantly among themselves, confirming the findings of Pandey *et al.* (1991). None of the herbicides applied under direct-seeded, puddled rice increased the grain yield to the level of significance in 1993 (Table 3), whereas under transplanted rice culture marked improvement was observed. Moist unflooded soil, high temperature and adequate light favour growth of grasses and sedges as well as stimulate rapid decomposition of herbicide compounds (Chatterjee and Maiti, 1981).

Grain-quality characters, viz. hulling, milling and head-rice recovery (%) grain length, grain breadth, length : breadth ratio before and after cooking remained unaffected due to variation in rice cultures, nitrogen levels and weed-control treatments as also observed by Rao *et al.* (1993a).

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