Indian Journal of Agronomy **46** (1) : 68–74 (March 2001)

Effect of rice (*Oryza sativa*) culture, nitrogen and weed control on nitrogen competition between scented rice and weeds

SUBHAS CHANDER AND JITENDRA PANDEY

Division of Agronomy, Indian Agricultural Research Institute, New Delhi 110 012

Received : December 1998

ABSTRACT

A field experiment having 2 nitrogen levels (60 and 120 kg/ha), 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) and 2 rice (*Oryza sativa* L.) cultures (direct seeded and transplanted) was conducted at New Delhi during the rainy season of 1993 and 1994. Intensity of competition for nitrogen increased with advance in age of crop and weeds. Weeds divested the crop of 43.0 kg N/ha in 1993 and 42.6 kg/ha in 1994 at maturity. At this stage weed control facilitated higher N uptake by the crop. Uptake of N in hand-weeding was 88.2 kg/ha in 1993 and 104.2 kg/ha in 1994, whereas it was only 57.6 kg/ha in 1993 and 54.1 kg/ha in 1994 in weedy check. Nitrogen uptake by crop at 120 kg N/ha was higher than at 60 kg N/ha in both the years. In transplanted rice culture, weed-control treatments were found approximately 4–18 times more efficient in arresting the N drain. In butachlor and anilofos, the N drain was relatively lower than chlorimuron ethyl. Hand-weeding was found more efficient in arresting N drain in both the cultures than herbicides.

Key words : Scented rice, Nitrogen, Herbicides, Rice cultures, Anilofos, Chlorimuron ethyl, Butachlor, Weed control

Scented rice varieties are poor competitor due to their initial slow growth. Severity of competition between scented rice varieties and weeds intensifies in light-textured soil due to recurrent weed germination owing to deep percolation of irrigation water. Cultivation of basmati rice is increasing every year owing to higher demand in international market and higher return. To regulate uniterrupted nitrogen supply and to realize higher yield potential, it is essential to ascertain how much nitrogen is depleted by weeds in different rice cultures under suboptimal and optimal nitrogen supply and impact of the weed management practices on nitrogen

Present address : [1]ARC, CSWRI, Bikaner, Rajasthan 334 006

availability to crop at different growth stages. Information on competition between scented basmati rice and weeds for nitrogen is scare in literature. The present experiment therefore was undertaken to study the effect of nitrogen and weed-management practices on nitrogen uptake by rice and N depletion by weeds at different growth stages under different rice cultures.

MATERIALS AND METHODS

A field experiment with scented rice cultivar 'Pusa Basmati 1' having 2 rice cultures (transplanting and direct seeding under puddled conditions) as main plot treatments, and 2 nitrogen levels (60 and 120 kg N/ha) and 5 weed-control treatments [weedy check (W_1), hand-weeding (W_2), butachlor @ 1.0 kg a.i./ha (W_3), anilofos @ 0.5 kg a.i./ha (W_4) and chlorimuron ethyl @ 0.012 kg a.i./ha (W_5)] as subplot treatments, was conducted in split-plot design with 3 replications at New Delhi, during rainy season of 1993 and 1994. The soil was sandy loam (Inceptisol) with pH 8.05–8.10 and organic carbon content 0.61–0.63%. The available N, P and K in 1993 were 160, 19.5 and 284 kg/ha, whereas in 1994 these were 175, 21.1 and 269 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 age, were transplanted at a spacing of 20 cm × 20 cm. Nitrogen was applied in 3 equal splits, at sowing or transplanting, at maximum tillering [45 days after sowing (DAS) and 20 days after transplanting (DAT)] and at 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) was applied at the time of sowing or transplanting. Herbicides were applied 5 DAS/DAT as pre-emergence to weed with the help of knapsack sprayer fitted with flat fan nozzle. The data on weed dry weight were subjected to square root transformation $\sqrt{X + 0.5}$ to normalize their distribution. Nitrogen content in weeds and crop plants was estimated by Kjeldahl's method. Nitrogen uptake was reckoned by multiplying dry weight of weeds and crop plants with corresponding values of N content and expressed in kg/ha.

RESULTS AND DISCUSSION

Effect on weeds

The predominant weed species in the field were *Echinochloa colonum* (L.) Link, *E. crus-galli* (L.) Beauv., *Leptochloa chinensis* (L.) Nees, *Eclipta alba* (L.) Hassk and *Commelina benghalensis* L. Dry-matter accumulation of weed increased as the growth stage of crop advanced. Weed dry weight was significantly lower in transplanted rice than in direct-seeded rice at tillering, flowering and maturity stages. Application of nitrogen @120 kg/ha significantly increased the dry-matter accumulation by weed over 60 kg N/ha. Hand-weeding was found to be the best in checking weed dry-matter accumulation and next best was anilofos @ 0.5 kg/ha (Table 1). Srinivasan *et al.* (1992) also found that higher nitrogen application increased the dry-matter accumulation of weeds.

Nitrogen depletion by weeds was signif-

Table 1. Total dry-matter accumulation (g/m^2) by weeds at various growth stages as affected by different treatments

Treatment	35 DAS or DAT		70 DAS or DAT		100 DAS or DAT	
	1993	1994	1993	1994	1993	1994
Rice clture						
Transplanted	3.07(10.50)*	3.41 (12.83)	5.26 (30.07)	4.89 (27.47)	5.78 (30.80)	6.16 (42.47)
Direct seeded	6.04 (42.23)	6.69 (49.43)	12.51 (168.87)	14.26 (219.47)	15.56 (271.13)	15.37 (261.93)
CD (P = 0.05)	0.52	1.37	1.06	1.72	0.51	0.93
Nitrogen (kg N/ha)						
60	4.25 (22.90)	4.72 (26.80)	8.37 (89.27)	8.48 (98.40)	10.14 (137.20)	10.15 (134.53)
120	4.87 (29.83)	5.37 (35.47)	9.39 (109.67)	10.66 (148.53)	11.40 (173.73)	11.36 (169.87)
CD (P = 0.05)	0.40	0.44	0.45	0.59	0.69	0.67
Weed control						
W_1	7.77 (68.17)	7.92 (68.50)	12.64 (182.00)	14.09 (229.83)	17.00 (343.67)	16.61 (321.17)
W_2	2.54 (6.67)	2.94 (8.92)	4.92 (27.00)	6.07 (46.00)	6.03 (40.83)	5.75 (36.83)
W_3	4.11 (18.75)	4.66 (24.92)	8.98 (97.33)	9.18 (112.33)	10.14 (126.33)	10.34 (131.00)
W_4	3.91 (16.75)	4.35 (21.17)	8.24 (83.33)	8.55 (98.33)	9.32 (105.50)	9.95 (122.83)
W_5	4.46 (21.50)	5.37 (32.17)	9.62 (107.67)	9.96 (130.83)	11.34 (161.00)	11.31 (149.17)
CD (P = 0.05)	0.63	0.69	0.71	0.94	1.10	1.06

*Figures in parentheses indicate the original values; Details of treatments are given under Materials and Methods
DAS/DAT, Days after sowing/transplanting

icantly higher under direct-seeded puddled rice culture compared to transplanting rice culture at maturity. Nitrogen depletion increased with the age of crop and weeds thereby indicating that competition for nitrogen among weeds and crop increased with the age of crop and weeds, because both crop and weeds strive hard to take the nutrient present in limited amount. Nitrogen depletion by weeds was also significantly higher at 120 kg N/ha than at 60 kg N/ha at maturity stage (Table 2). Higher nitrogen depletion may be attributed to higher dry-matter production by weeds under these treatments. These findings confirm those of Moody and Mukopadhyay (1980) and Narsimha (1989).

Weeds divested the crop of 43.0 kg N/ha in 1993 and 42.6 kg N/ha in 1994 at maturity when they were allowed to grow unchecked in the weedy check treatment. Under hand-weeding treatment nitrogen depletion was significantly lower than the rest of weed-control treatments. Nitrogen depletion in herbicide-treated plots was identical but markedly lower thanweedy check. Chatterjee and Maiti (1981) observed herbicides less effective than hand-

Table 2. Nitrogen depletion by weeds and nitrogen uptake (kg/ha) by rice as affected by different treatments

Treatment	Nitrogen depletion by weeds		Nitrogen uptake uptake by crop		Total N removed by weeds and crop	
	1993	1994	1993	1994	1993	1994
Rice culture						
Transplanted	5.35	6.00	85.50	112.85	90.85	118.85
Direct seeded	34.47	35.73	35.14	35.80	69.61	71.53
CD (P=0.05)	3.53	4.03	15.27	16.56	18.80	20.59
Nitrogen (kg N/ha)						
60	16.97	16.64	53.08	66.73	70.05	83.37
120	22.85	25.10	67.47	81.91	90.32	107.01
CD (P=0.05)	4.13	4.13	3.72	3.52	7.85	7.11
Weed control						
W_1	42.96	42.61	42.18	54.14	85.04	96.75
W_2	5.69	5.03	88.22	104.18	93.91	109.21
W_3	15.74	17.75	55.09	68.89	70.83	86.64
W_4	15.38	16.96	61.27	72.09	74.65	89.05
W_5	21.87	22.00	54.60	72.31	76.47	94.31
CD (P=0.05)	6.53	5.68	5.88	5.58	12.41	11.26

*Figures in parentheses indicate the original values
DAS/DAT, Days after sowing/transplanting

weeding. Interaction effect between rice cultures and weed-control treatments was also found significant (Table 3). In transplanted rice cultures, weed-control treatments were found approximately 4–18 times more efficient in arresting the N drain, because transplanting provides better conditions for herbicides to check germination of emerging weeds. In butachlor- and anilofos-treated plots, N drain was relatively lower than chlorimuron ethyl. This may be due to the fact that chlorimuron ethyl is more effective against broad-leaved weeds. Hand-weeding was found more efficient in arresting N drain in both the cultures than herbicides because hand-weeding effectively checked all the weeds time to time.

Effect on rice

The dry-matter production at harvest was significantly higher under transplanted rice culture than under direct-seeded rice culture. Increase in dry-matter production might have occurred due to favourable effect of puddling which decreases weed competition and increases nutrient availability, viz. P and Fe, conserves N, facilitates seedlings establishment and increases water-retention capacity of soil (Chatterjee and Maiti, 1981). Nitrogen at 120 kg/ha markedly increased the grain as well as straw yields compared with to 60 kg/ha application. This can be ascribed to improvement in plant growth, tillers/m^2 and grains/panicle owing to higher nitrogen supply and its uptake. Hand-weeding significantly increased grain as well as straw yields compared with herbicides and weedy check. Superiority of hand-weeding could be ascribed to absence of competition by weeds due to frequent elimination of weeds from field and hence better crop growth. Herbicides caused identical increase but statistically higher than weedy check (Table 4). Nitrogen uptake by rice was significantly higher in transplanted rice culture at maturity as compared to direct-seeded rice culture. This was obvious because dry-matter production as well as N content in grain and

Table 3. Nitrogen depletion (kg/ha) by weeds as affected by interaction between rice cultures and weed-control treatments

Rice	Weed-control treatment					
	WC	HW	Buta	Anil	Chlor.	CD (P=0.05)
1993						
TP	12.62	2.22	3.91	3.52	4.44	9.23
DS	73.09	9.17	27.50	23.24	39.31	
1994						
TP	14.56	2.36	4.27	3.47	5.36	8.03
DS	70.64	7.69	31.22	30.45	38.65	

TP, Transplanted; directed seeded

WC, Weedy check; HW, hand-weeding; Buta, butachlor; Anil, anilophos, Chlor, chloimuron ethyl

Table 4. Dry-matter production of rice at maturity as affected by different treatments

Treatment	Grain yield (q/ha)		Straw yield (q/ha)	
	1993	1994	1993	1994
Rice clture				
Transplanted	31.57	43.62	84.76	97.70
Direct seeded	13.04	13.88	35.41	35.51
CD (P = 0.05)	3.92	4.08	6.60	
Nitrogen (kg N/ha)				
60	19.93	26.62	55.75	61.53
120	24.68	30.89	64.41	71.68
CD (P = 0.05)	1.55	1.43	3.94	1.71
Weed control				
W_1	15.48	21.07	45.47	49.87
W_2	33.31	38.63	86.11	97.81
W_3	20.14	26.61	53.00	59.25
W_4	22.11	28.86	63.21	60.83
W_5	20.49	28.60	52.64	65.31
CD (P = 0.05)	2.46	2.26	6.22	2.71

*Figures in parentheses indicate the original values
DAS/DAT, Days after sowing/transplanting

straw were higher in transplanted rice culture. Nitrogen uptake in transplanted rice was 85.5 and 112.9 kg/ha in 1993 and 1994 respectively at harvest (Table 2). At 120 kg N/ha, N uptake by rice was higher than 60 kg N/ha. This could be ascribed to better crop growth at all the stages owing to higher nitrogen content in rice plant. These findings are in close agreement with those of Rajkhowa and Baroova (1991).

Among the weed-control treatments, hand-weeding resulted in the maximum nitrogen uptake (Table 2). Nitrogen uptake in butachlor, anilofos and chlorimuron ethyl treatments was identical but significantly higher than weedy check. This might be due to reduced competition and higher content in crop plants. The results confirm the findings of Ramamoorthy (1991).

In transplanted rice, total nitrogen removal by crop and weeds together was significantly higher than under direct-seeded rice culture. Higher nitrogen application (120 kg/ha) resulted in significantly higher nitrogen removal as compared to lower level (60 kg/ha) in both the years. Among weed-control treatments, in hand-weeding total nitrogen removal both by crop was significantly higher than weedy check at flowering and maturity (Table 2).

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