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Effect of integrated nutrient management on transplanted rice (*Oryza sativa*) and its residual effect on succeeding wheat (*Triticum aestivum*) crop in rainfed lowlands

G. SINGH, T. KUMAR, V. KUMAR, R.G. SINGH AND R.B. SHARMA[1]

Crop Research Station, Narendra Deva University of Agriculture and Technology, Ghaghraghat, Bahraich, Uttar Pradesh 271 901

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ABSTRACT

A field experiment was conducted during 1995–97 at Ghaghraghat, Uttar Pradesh, to study the effect of integrated nutrient management on rice (*Oryza sativa* L.) and residual effect on succeeding wheat (*Triticum aestivum* L. emend. Fiori & Paol.). Application of 50% of recommended dose of nitrogen (RDN) through inorganic fertilizer (IF) + *dhaincha* (*Sesbania aculeata* L.) @ 2.5 tonnes/ha to rice gave significantly higher mean grain yield of rice (31.8 q/ha) and wheat (28.4 q/ha) over rest of the treatments except 50% RDN-IF+PM @ 5 tonnes/ha in rice. The yield of succeeding wheat increased by 43.1 to 48.9% because of integrated use over the control. Rice fertilized with 75% RDN through inorganic fertilizer (IF) + blue green algae (BGA @ 16 kg/ha) resulted in significantly higher grain yield over 75% RDN-IF+BGA @12 kg/ha during both the years. Application of $ZnSO_4$ with full RDF resulted significantly higher yield of rice and succeeding wheat as compared to full RDF alone through inorganic fertilizers. There was a build-up of available N,P,K and organic carbon in soil in all integrated nutrient management practices except full RDF alone and RDF + $ZnSO_4$. The bulk density and pH reduced under in all nutrient management practices.

Key words : Integrated use, Inorganic fertilizer, Transplanted rice, Succeeding wheat, Rainfed lowland

The productivity of rice–wheat system is being declined day by day due to heavy and imbalance use of plant nutrients and it also causing degradation of soil. The integrated use of organic manures and chemical fertilizer well augment the efficiency of both substantially to maintain a high level of productivity and rice production (Lian, 1994; Prasad *et al.*,1995). Hence in order to bring the soil well supplied with all the essential plant nutrient and also to maintain it in good health, it is necessary to use

Present address : Agricultural Experiment Station, N.D.U.A.T., Kumarganj, Faizabad, Uttar Pradesh

manures like *Sesbaina aculeata*, pressmud, farmyard manures, blue green algae in conjunction with fertilizers.

An experiment was therefore conducted to study the effect of integrated nutrient management on transplanted rice and succeeding wheat.

MATERIALS AND METHODS

The field experiment was conducted at the Crop Research Station, Ghaghraghat (Bahraich), during 1995–96 and 1996–97, to study the effect of integrated nutrient management on wet season rice and its carry-over effect on succeeding whet crop. The soil was sandy loam, having pH 8.1, organic carbon 0.45%, available nitrogen 214, phosphorus 20.7 and potash 192 kg/ha and bulk density of 1.56 g/cm^3.

The experiment was laid out in randomized block design with 4 replications. Eight treatments, comprising T_1, no NPK; T_2, full recommended dose of fertilizer (RDF) (100 kg N + 50 kg P_2O_5 + 40 kg K_2O/ha) through inorganic fertilizers; T_3, T_4, T_5 (50% of recommended N by urea with each treatment + FYM @ 10 tonnes/ha, pressmud @ 5 tonnes/ha, and *dhaincha* @ 2.5 tonnes/ha in T_3, T_4, T_5, respectively; T_6 and T_7 (75% of recommended nitrogen by urea in both treatments + 16 and 12 kg/ha blue green algae (BGA) in T_6 and T_7, respectively; and T_8, full recommended dose of fertilizer + $ZnSO_4$ (25 kg/ha).

The organic manures were incorporated into soil, 20 days before transplanting of rice. Twentyfive days old seedlings of rice cv. 'Jalpriya' were transplanted at 20 cm × 15 cm spacing using 3 seedlings/hill on 15 July during both the years. The carry-over effect of wet-season treatment was studied during the winter (*rabi*) of 1995–96 and 1996-97 without change in layout. Wheat was fertilized @ 60 kg N + 25 kg P_2O_5 + 20 kg K_2O/ha. Wheat cv. 'HUW 234' was sown on 15 December, 20 cm apart, using 125 kg seed/ha during both the years. All the recommended package of practices were adopted for wheat. The soil and plant samples were analysed by adopting standard laboratory procedure as described by (Kanwar and Chopra, 1966), Olsen *et al.* (1954) for soil, and Jackson (1967) and Chapman and Pratt (1961) for plant. The total rainfall received during wet season was 995 mm and 978 mm and during dry season 34.2 mm and 30.1 mm in respective years. Data were analysed by using procedure as described by Gomez and Gomez (1983).

RESULTS AND DISCUSSION

The tallest plant of rice was recorded with full recommended dose of N (RDN) through chemical fertilizers, followed by 50% recommended dose (RD) through inorganic fertilizers + pressmud (5 tonnes/ha). Rice fertilizer with 50% recommended dose of nitrogen (RDN) through inorganic fertilizers + *dhaincha* (2.5 tonnes/ha) resulted the maximum values of leaf-area index (LAI), dry-matter yield, panicles/m^2, panicle weight and 1,000-grain weight (Table 1).

The significant improvement in growth and yield attributes of rice under above treatment was due to slow and prolonged availability of plant nutrients. Similar improvement in growth and yield attributes was noticed in succeeding wheat crop.

Table 1. Grain and straw yields of rice and succeeding wheat crop, and rice equivalent as influenced by various integrated nutrient management treatments in rainfed lowlands

Treatment	Grain yield (q/ha)						Straw yield (q/ha)						Rice equivalent (q/ha)
	Rice			Wheat			Rice			Wheat			
	1995	1996	Mean	1995–96	1996–97	Mean	1995	1996	Mean	1995–96	1996–97	Mean	
No N PK	16.3	16.6	16.5	14.7	14.3	14.5	20.3	20.7	20.5	21.2	21.9	21.6	42.88
Full RDF-IF	25.9	28.0	27.0	21.0	22.1	21.6	49.8	50.8	49.3	42.4	44.3	43.4	71.05
50% RDN-IF+FYM @ 10 tonnes/ha	28.8	30.8	29.8	24.7	26.2	25.5	52.4	54.6	53.5	44.7	46.8	45.8	80.09
50% RDN-IF+PM @ 5 tonnes/ha	30.0	32.7	31.6	26.0	27.2	26.6	56.3	59.4	57.9	47.6	49.5	48.6	84.50
50% RDN-IF+*dhaincha* @2.5 tonnes/ha	30.0	32.8	31.8	27.8	28.9	28.4	56.4	59.9	58.2	48.9	51.6	50.1	87.45
75% RDN-IF+BGA@16 kg/ha	28.3	30.8	29.6	22.8	23.7	23.3	51.8	54.0	52.9	44.7	46.8	45.8	76.88
75% RDN-IF+BGA@12 kg/ha	26.0	28.5	27.3	21.2	21.9	21.6	50.0	52.8	51.4	42.0	42.4	41.7	71.19
Full RDF-IF+$ZnSO_4$	28.2	29.9	29.1	23.0	24.4	23.7	51.2	53.5	52.4	43.1	5.9	44.5	76.59
CD (P=0.05)	1.1	2.1	1.98	1.6	1.5	1.6	4.3	5.1	4.7	3.3	3.0	3.2	3.15

Price : Grain [Rice Rs 450/q, wheat (Rs 600/q)], Straw [rice Rs 60/q, wheat Rs 90/q]; RDN, recommended dose of nitrogen; RDF, recommended dose of fertilizer, IF, inorganic fertilizers; PM, pressmud; BGA, blue green algae

Application of 50% of RDN (50 kg N/ha) by inorganic fertilizers + *dhaincha* (2.5 tonnes/ha) (T_5) resulted in significantly higher grain yield in 1995–96 and 1996–97, respectively, compared to rest of the treatments except 50% of RDN – inorganic fertilizer + pressmud (5 tonnes/ha) (T_4). This improvement in yield could be attributed to higher uptake of nutrients (Table 3) by rice in *Sesbania*-treated plot, because it contain narrow (C : N ratio) coupled with succulent nature undergone rapid decomposition and released nutrients which exerted favourable effect on rice growth and yield attributes, and finally the yields (Tables 1, 2). Similar findings were also reported by Ram and Shah (1999). Other organic manures like the pressmud and farmyard manure could also be considered as alternative source for providing nutrients to step-up yield of rice (Table 1). The lower yield with full RDF treatment may be due to rapid mineralization, resulting in higher losses of nutrients by way of leaching, denitrification and ammonia volatilization.

The treatment receiving full RDF along with $ZnSO_4$ (T_8) increased the rice grain yield by 7.8% over full RDF alone (T_2). The synergistic effect of zinc with other nutrients resulted improvement in the availability of nutrient to the rice plant. Similar synergism of zinc application with inorganic fertilizers in rice yield was reported by Vyas *et al.* (1990).

Application of 75% RDN (75 kg N/ha) through inorganic fertilizers + blue green algae (16 kg/ha) (T_6) gave significantly higher grain yield of 28.3 and 30.8 q/ha during 1995–96 and 1996–97, respectively, as compared to 75% RDF (75 kg N/ha) + 12 kg/ha BGA (T_7) and RDF alone (T_2). Singh (1981) also reported increase in rice yield with innoculation of BGA in combination with inorganic fertilizers. Similar trend was observed for straw yield.

Residual effect on wheat

The higher mean grain yield of wheat and rice equivalent was recorded with the 50% RDN-IF+*dhaincha* @ 2.5 tonnes/ha which was significantly superior to all other treatments. However, application of 50% RDF-IF+PM @ 5 tonnes/ha to rice was found to be the next best treatment with grain yield of wheat and rice equivalent.

Application of blue green algae with inorganic fertilizers (T_6 and T_8) to rice increased the grain yield of succeeding wheat by 33.7% over the control. This could be attributed to significant improvement in growth and yield attributes of wheat and physico-chemical properties of soil.

Nutrient uptake

The maximum uptake of nutrients by rice was recorded under treatment of 50% recommended dose of N through inorganic fertilizers + *Sesbania aculeata* (2.5 tonnes/ha), however the lowest value of nutrients uptake was recorded in unfertilized plot. Higher uptake of nutrient with above treatment was attributed to higher biomass (grain + straw) yield due to slow and prolonged availability of nutrient to crop. Poor availability and higher loss of nutrient under full recommended dose of fertilizer alone resulted lower uptake. The succeeding wheat crop also showed similar trend.

Table 2. Yield attributes of rice and succeeding wheat as influenced by various integrated nutrient-management practice in rainfed lowland (average data of 2 years)

Treatment	Rice						Wheat					
	Plant height (cm)	LAI at 90 DAT	Dry matter (q/ha) 90 DAT	Panicles/ m^2	Panicle weight (g)	1,000-grain weight (cm)	Plant height (cm)	LAI at 90 DAT	Dry matter (q/ha) at 90 DAS	Tillers/ m^2 at harvest	Grains/ ear	1,000-grain weight (g)
Control	99	1.89	13.1	103	1.81	21.2	89	1.92	15.56	119	20	35.4
Full RDF-IF	122	2.32	16.07	225	2.25	25.0	113	2.40	18.15	212	24	40.3
50% RDN-IF+FYM @ 10 tonnes/ha	120	2.47	17.41	240	2.31	25.7	111	2.55	19.62	230	29	42.3
50% RDN-IF+PM @ 5 tonnes/ha	121	2.51	18.04	255	2.37	26.4	112	2.60	20.41	238	31	43.4
50% RDN-IF + *dhaincha* @ 2.5 tonnes/ha	120	2.58	18.17	261	2.38	26.9	111	2.65	20.83	240	33	43.8
75% RDF-IF+BGA @ 16 kg/ha	115	2.42	17.23	243	2.27	25.3	105	2.51	19.29	220	26	41.9
75% RDN-IF+BGA @ 12 kg/ha	114	2.38	16.79	240	2.25	15.1	104	2.44	18.84	220	23	41.1
Full RDF-IF + $ZnSO_4$	121	2.35	17.55	252	2.36	25.5	111	2.41	20.63	215	27	42.7
CD (P=0.05)	07	0.12	1.02	09	0.08	0.9	06	0.11	1.01	011	NS	0.8

DAT, Days after transplanting; DAS, days after sowing; LAI, leaf-area index

Table 3. Nutrient uptake (kg/ha) by rice and wheat, and residual soil fertility status as influenced by various integrated nutrient-management practices in rainfed lowland

Treatment	Nutrient uptake (kg/ha)						Residual soil fertility					Bulk density (g/cm^3)
	Rice			Wheat			Available nutrient (kg/ha)			Organic carbon (%)	pH	
	N	P	K	N	P	K	N	P_2O_5	K_2O			
Control	29.01	6.25	30.20	35.52	3.57	29.69	208	20.0	175	0.44	8.1	1.56
Full RDF-IF	61.93	12.48	75.85	65.64	6.66	62.47	209	21.0	185	0.44	7.9	1.54
50 % RDN-IF+FYM @10 tonnes/ha	70.42	14.60	84.85	76.24	8.23	69.23	224	23.1	193	0.50	8.0	1.50
50% RDN-IF+PM @ 5 tonnes/ha	78.72	15.90	94.22	80.72	9.25	75.80	229	23.9	198	0.54	7.6	1.48
50% RDN-IF+ *Dhaincha* @ 2.5 tonnes/ha	82.77	61.81	97.11	86.00	10.08	80.01	234	24.8	199	0.56	7.7	1.46
75% RDN-IF+BGA @ 16 kg/ha	70.26	14.02	82.03	71.10	7.00	66.98	220	22.9	192	0.49	7.8	1.52
75% RDN-IF+BGA @ 12 kg/ha	64.28	12.13	79.18	65.08	5.49	59.30	218	21.8	190	0.47	7.8	1.53
Full RDF-IF+$ZnSO_4$	69.27	13.62	81.30	80.64	6.98	66.06	212	21.4	186	0.44	7.9	1.53
CD (P=0.05)	3.26	2.07	8.74	4.55	1.77	3.84						
Initial soil value							214	20.7	192	0.45	8.1	1.56

Residual fertility

Available N, P and organic carbon content was improved under integrated nutrient management practices (T_3 to T_7) compared to its initial soil fertility (Table 3). This improvement could be attributed to addition of root biomass of rice and succeeding wheat, and organic matter through *dhaincha*, FYM, pressmud and blue green algae. These results are in close conformity with the findings of Bhardwaj and Omanwar (1994). The values of bulk density and pH were reduced in all fertilizer treatments (T_2 to T_8), however the lowest was with 50% of recommended dose of nitrogen (RDN) through inorganic fertilizer + *Sesbania aculeata* (@ 2.5 tonnes/ha) (T_5), followed by 50% of RDN through inorganic fertilizer + pressmud (5 tonnes/ha) (T_4). This may be ascribed to addition of higher organic matter, better soil aggregation and higher macro-pore space. Similar finding was reported by Bellakki and Badanaur (1994).

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