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Effect of long-term use of fertilisers / nutrients on seed yield and quality in rice

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ABSTRACT

A study was undertaken to find out the response of long-term application of fertilisers / nutrients on seed yield and seed quality attributes in rice cv. Swarna. The treatments consisted of 50% NPK (T_1), 100% NPK (T_2), 150% NPK (T_3), 100% NPK + Zn (T_4), 100% NPK + FYM (T_5), 100% NPK + FYM + Lime (T_6), 100% NPK + B + Zn (T_7), 100% NPK + S + Zn (T_8), 100% N (T_9), 100% NP (T_{10}), 100% NPK + Lime (T_{11}) and Control (T_{12}). The per hectare dose of different nutrients were 80 kg N, 40 kg P_2O_5, and 60 kg K_2O, 5 tonnes FYM, one tonne lime, 30 kg gypsum, 12.5 kg $ZnSO_4$, and 0.25% borax as spray. While nitrogen was applied in three splits, potash and borax in two splits and all others were applied as basal. Observations were recorded on various seed yield and yield components and seed quality attributes. Application of RDF along with FYM, lime, borax, zinc and sulphur either alone or in combination resulted in significant yield enhancement. The highest seed yield (29.92 q/ha) was observed with application of recommended dose of NPK and FYM (T_5), followed by T_7 (28.17 q/ha). These treatments also resulted in improvement of various seed quality parameters, viz., percentage of seed germination, field emergence, seed vigour and storability. It may be concluded that integrated nutrients management through application of inorganic and organic nutrients is beneficial for quality seed production in rice.

Key words: *rice, integrated nutrients management, seed yield, seed quality*

Rice is one of the most important food crops grown across the world, particularly in Asia and Africa. On an average, 57 percent of Indian farmers grow rice and one-third of the total caloric need is met through rice. To meet the food demand of the increasing population, the production level of 106.65 million tonnes in 2013-14 needs to be increased to 130 million tonnes by 2025, which is to be achieved in the backdrop of declining and deteriorating resources such as land, water, labour and other inputs without adversely affecting the environment. Seed is the basic and crucial input in crop production. In the absence of quality seed, the investment made on other inputs such as fertilisers, pesticides, etc. both under rain fed and irrigated conditions will be ineffective in getting desired yield. The quality of seed is not only affected by genetic factors but also the environmental conditions in which the seed crop is grown. Among several ecological factors affecting seed quality, nutritional status of the soil greatly determines the yield and quality of the seed (Nema, 1989). On the other hand, long-term application of chemical fertilisers in the crop fields has adverse effects on the environment as well as the productivity of crops. The present study has been undertaken to study the effect of long-term use of fertilisers and other nutrients on seed yield and quality in rice.

MATERIALS AND METHODS

The present investigation was carried out at the Central Research Station and Department of Seed Science and Technology, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, to study the effect of long-term application of fertilisers / nutrients on seed yield and quality in rice cv. Swarna. The experiment was laid out in RBD with three replications and consisted of 12 treatments, *viz.*, 50% NPK (T_1), 100% NPK (T_2), 150% NPK (T_3), 100% NPK + Zn (T_4), 100% NPK + FYM (T_5), 100% NPK + FYM + Lime (T_6), 100% NPK + B + Zn (T_7), 100% NPK + S + Zn (T_8), 100% N (T_9), 100% NP (T_{10}), 100% NPK + Lime (T_{11}) and Control (T_{12}). The recommended per hectare dose of various fertilisers / nutrients were 80 : 40 : 60 kg N : P_2O_5 : K_2O, 5.0 tonnes FYM, 1.0 tonne lime, 30 kg gypsum (as source of S), 12.5 kg $ZnSO_4$, and 0.25% spray of borax (as source of B). Out of the above nutrients, nitrogen was applied in three splits, $ZnSO_4$ and borax in two splits and others were applied as basal. Recommended package of practices were followed in raising the seed crop. Observations were recorded on various yield attributes and per hectare seed yield and the seed quality was assessed in terms of germination (%), field emergence (%), seed vigour indices, following standards procedures (ISTA, 1985). The relative storability of seeds of different treatments was predicted on the basis of germinability of seeds subjected to accelerated ageing (AA) (Agrawal, 1993).

RESULTS AND DISCUSSION

The rice variety under investigation showed significant variation among the treatments in respect of all the yield parameters except number of seeds per panicle. Although application of all the nutrients had shown enhancing effects on all the traits as compared to the control, additional applications of FYM, lime, Zn, B, and S, either singly or in combinations along with the RDF (NPK) were found to have better effect (Tables 1 and 2). Among the treatments studied, application of RD of NPK + FYM (T_5) produced the highest enhancing effect on number of tillers per plant (3.5%), number of panicles per plant (22.6%), panicle length (7.5%), number of seeds per panicle (7.4%) and 1000-seed weight (4.0%) over the RD of NPK (T_2). The highest seed yield (29.92 q/ha) was obtained in this treatment showing 35.1% enhancement over T_2 (Table 1). Moderate enhancing effects in respect of these traits were observed in T_6, T_7, T_8 and T_{11} involving application of RD of NPK along with lime, B, Zn and S. Increase in plant growth characteristics, *viz.*, plant height, number of tillers and leaf area per plant by application of macro- and micronutrients might be due to their involvement in chlorophyll formation, cell division, cell expansion, formation of new cell wall and meristematic activity in apical tissue (Singh *et al.*, 1989). The increase in plant growth, yield attributes and seed yield in rice due to addition of various organic nutrients could be due to higher uptake and recovery of applied nutrients, which in turn must improved synthesis and translocation of metabolites to various reproductive structures of plants (Shekara *et al.*, 2010; Singh and Verma, 1999). Several workers have reported positive influence of INM in enhancing yield attributes in different crops (Sundara *et al.*, 2004; Singh, 2011; Raja *et al.*, 2011). The yield enhancement may be attributed to improved soil nutritional status by addition of various organic and inorganic fertilisers that encourage proliferation of root system and better absorption of nutrients to the growing points, thus resulting higher yield (Kabir *et al.*, 2013).

Knowledge on the relationship between nutrient status of soil and sowing quality of seed is of great importance for maintenance of better quality of seed. In the present study, the seed quality of different treatments was assessed in terms of germination and field emergence, seed vigour and relative storage potential based on accelerated ageing test. Like yield attributes, application of macro- and/or micronutrients had shown enhancing effects of all the five traits in comparison to the control (Table 2). However, additional application of FYM or other micronutrients along with the RD of NPK were found to have better effect on seed quality attributes. While the highest percentage of germination (94%), field emergence (89%) and seed vigour index-II (8.469) were observed in T_5, the highest seed vigour index-I (2701) and storability (64%) in T_6, both the treatments involving application of FYM along with the RD of NPK. Other treatments involving additional application of micronutrients have shown moderately enhancing effects. The enhancement of seed quality parameters might be due to participation of various macro- and micronutrients in catalytic activity, breakdown of complex macromolecules into simpler forms and their mobilisation into the developing seed. These, in turn, were reflected on enhanced germination, elongation of root and shoot of seedlings. These results are in agreement with the findings of several earlier workers in different crops (Vanangamudi and Karivaratharaju, 1986; Singh *et al.*, 2011; Pathak and Pandey, 2010; Singh, 2011).

In the present investigation, it was apparent that continuous long-term application of fertilisers/

Table 1. Effect of long-term application of fertilisers / nutrients on various yield and yield components in rice cv. Swarna

Treatment code	Treatment details	No. of tillers plant^{-1}	No. of panicles plant^{-1}	Panicle length (cm)	No. of seeds panicle^{-1}	1000-seed weight (g)	Seed yield (q/ha)
T_1	50% NPK	7.83 (-18.1)	5.33 (-1.8)	20.71 (-1.9)	128.71 (-5.6)	19.19 (-1.1)	20.65 (-6.7)
T_2	100% NPK (RD)	9.56	5.43	21.11	136.41	19.40	22.14
T_3	150% NPK	8.33 (-12.8)	5.46 (0.5)	20.86 (-1.2)	135.60 (-0.6)	19.30 (-0.5)	25.30 (14.3)
T_4	100% NPK + Zn	9.40 (-1.6)	6.26 (15.3)	21.11 (0.0)	138.36 (1.4)	19.40 (0.0)	24.87 (12.3)
T_5	100% NPK + FYM	9.90 (3.5)	6.66 (22.6)	22.69 (7.5)	146.56 (7.4)	20.18 (4.0)	29.92 (35.1)
T_6	100% NPK + Lime + FYM	7.66 (-19.8) (27.2)	6.13 (12.9)	21.76 (3.1)	138.46 (1.5)	19.41 (0.1)	28.17
T_7	100% NPK + B + Zn	7.86 (-17.8)	6.33 (16.5)	21.71 (2.8)	141.66 (3.8)	19.43 (0.2)	23.58 (6.5)
T_8	100% NPK + S + Zn	7.76 (-18.8)	6.36 (17.1)	21.86 (3.5)	142.96 (4.8)	19.72 (1.6)	24.00 (8.4)
T_9	100% N	8.66 (-9.4)	5.26 (-3.1)	20.53 (-2.7)	141.76 (3.9)	19.66 (1.3)	18.39 (-16.9)
T_{10}	100% NP	8.33 (-12.8)	5.30 (-2.4)	20.09 (-4.8)	135.75 (-0.5)	19.15 (-1.3)	21.73 (-1.8)
T_{11}	100% NPK + Lime	7.66 (-19.8)	5.96 (9.7)	22.01 (4.2)	127.11 (-6.8)	18.99 (-2.1)	23.67 (6.9)
T_{12}	Control	5.00 (-47.7)	5.86 (7.9)	18.96 (-10.2)	117.56 (-13.8)	18.79 (-3.1)	10.76 (-51.4)
	CD (P<0.05)	1.042	1.047	3.365	NS	0.951	3.258

Figures in the parentheses are percentage change over RD of NPK (T_2)

Table 2. Effect of long-term application of fertilisers / nutrients on various seed quality attributes in rice cv. Swarna

Treatment code	Treatment details	Germination (%)	Field emergence (%)	SVI-I	SVI-II	Germination (%) of seeds after AA
T_1	50% NPK	73 (-17.9)	68 (-21.8)	1917 (-20.5)	5.914 (-21.6)	42 (-12.5)
T_2	100% NPK (RD)	89	87	2411	7.549	48
T_3	150% NPK	83 (-6.7)	80 (-8.0)	2630 (8.3)	7.585 (0.5)	46 (-4.1)
T_4	100% NPK + Zn	87 (-2.2)	83 (-4.6)	2406 (-0.2)	7.212 (-4.4)	57 (18.7)
T_5	100% NPK + FYM	94 (5.6)	89 (2.3)	2502 (3.8)	8.469 (12.2)	62 (29.1)
T_6	100% NPK + Lime + FYM	89 (0.0)	82 (-5.7)	2536 (5.2)	7.981 (5.7)	64 (33.3)
T_7	100% NPK + B + Zn	93 (4.5)	88 (1.1)	2701 (12.0)	7.491 (-0.7)	54 (12.5)
T_8	100% NPK + S + Zn	91 (2.2)	87 (0.0)	2593 (7.5)	7.497 (-0.6)	51 (6.2)
T_9	100% N	79 (-11.2)	74 (-14.9)	2269 (-5.8)	6.006 (-20.4)	22 (-54.1)
T_{10}	100% NP	83 (-6.7)	78 (-10.3)	2321 (-3.7)	6.853 (-9.2)	25 (-47.9)
T_{11}	100% NPK + Lime	91 (2.2)	88 (1.1)	2717 (12.7)	7.096 (-6.0)	57 (18.7)
T_{12}	Control	54 (-39.3)	50 (-42.5)	1451 (-39.8)	4.040 (-46.5)	32 (-33.3)
	CD (P<0.05)	5.1	4.7	167.8	1.1603	4.5

Figures in the parentheses are percentage change over RD of NPK (T_2)

nutrients in the field does not have any adverse effect on crop production. Combined application of plant nutrients in both inorganic and organic forms had not only enhanced crop growth but also increased seed yield and sowing quality.

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