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Review on Response of Rice to Nutrient Management Interventions

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A B S T R A C T

Rice (*Oryza sativa* L.) is the most important cereal crop in the world and is the staple food of over half the world's population. In intensive cropping systems, maintenance of soil fertility is the major criteria to sustain the crop yields for longer period of time. In these systems, they deplete substantial amount of nutrients from the soil throughout year. For maintaining fertility status of soil on a long run, we should dependent on the different nutrient sources rather than single source chemical fertilizers. Paddy respond well to the integration of different nutrient sources rather than single source. To achieve maximum yields without polluting the environment we should apply chemical fertilizers along with organic fertilizers.

Introduction

It is generally considered a semi-aquatic annual grass. About 20 species of the genus *Oryza* are recognized, but almost all cultivated rice belongs to *Oryza sativa* (L). Because of its long history of cultivation and selection under diverse environments, *Oryza sativa* has acquired a broad range of adaptability and tolerance so that it can be grown in a wide range of water/soil regimens from deeply flooded land to dry hilly slopes. In India, it is grown in an area of 43.9 m.ha with a production of 99.24 m t and productivity of 2494 kg ha^{-1}. In Andhra Pradesh, it is grown in an area of 2.152 m.ha with a production of 8.05 m.t and productivity of 3741 kg ha^{-1}. (Ministry of Agriculture, Govt of India, 2018-19).

The excessive reliance on chemical fertilizers and the negligence shown to the conservation and use of organic sources of nutrients have not only caused the exhaustion of soil nutrient reserves but also resulted in soil health problems which is not conducive to achieving consistent increase in agricultural production. Moreover, Indian soils are poor in organic matter and also in major plant nutrients. Soil organic matter is the key to soil fertility and productivity.

Organic fertilizers improve the soil physical, biological, and chemical properties. These increases the water holding capacity of soil, enabling the plant roots to have better access to available nutrients. Organic materials also increase the diversity microbial population. These are essential to transform fertilizer materials into available form for plant's use and to rejuvenate soil. In this context, we should focus on the integration of both organic and inorganic fertilizers to enhance the soil fertility and crop yields.

Response of rice to different nutrient management interventions in India and abroad

Growth parameters of rice as influenced by integrated nutrient management

The results of the experiments conducted in India and other parts of the world have indicated that plant height is significantly increased with combination of chemical fertilizers with organic manures.

Krishna *et al.,* (2007) reported that maximum plant height of rice (111) and No. of tillers m^{-2} (154.4) were recorded with 100% NPK (120:26:37 kg ha^{-1}) + FYM @15 t ha^{-1}. On silty clay loam soil the highest drymatter accumulation (8.0, 25.9, 66.8, 108.4, 151.6 & 153.9 q ha^{-1}) of rice at five different stages (20,40,60,80, 100 DAT and harvest) were recorded with N-120, P_2O_5- 60, K_2O-45 kg ha^{-1} + Poultry manure @ 20 t ha^{-1} (Altaf Hussain *et al.,* 2012). Fakhrul Islam *et. al* (2013) reported that the highest plant height of rice (84.72 cm) was recorded by the application of 50% RDCF + 4 ton poultry manure ha^{-1} on silt loam soil of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. The highest plant height (123 and 124 cm) and no. of tillers per hill (9.60 and 9.80) of hybrid rice were recorded with the application of 75%RDF + Greenmanure this was reported by Anil Kumar in 2013. The application of NPK @ 90-45-15 kg ha^{-1} (recommended dose) + farm yard manure 5 t ha^{-1} + lime top dressing 250 kg ha^{-1} + $MgSO_4$@ 20 kg ha^{-1} was recorded the maximum plant height (102.4 and 80.1 cm), drymatter production (17117 and 9827 kg ha^{-1}) and tillers m^{-2} (356 and 342) of rice in both *kharif* and *rabi* respectively this was noticed by Sheeja *et al.,* (2013). According to Paramesh *et al.,* (2014) the highest plant height (0.54 cm), No. of tillers per hill (30.04) and drymatter production per hill (84.78 g) of rice was recorded significantly highest with 50% RDN through chemical fertilizers + 50 % RDN through vermicompost on red sandy loam soil at Zonal Agricultural Research Station, Navile, Shimoga, Karnataka. In Maharashtra, application of 50% N through RDF+ 50% N through vermicompost significantly recorded higher plant height (42.2 & 118.1 cm) and No. of tillers per plant (8.7 & 12.1) of paddy variety G.R11 at 45 DAT and harvest stages (Dekhane *et al.,* 2014). Maximum drymatter production (1.33 kg m^{-2}) of rice was recorded with 25%N through green leaf manure + 75% N through fertilizer which was at par with the 25%N through FYM+75% N through fertilizer 1.30 kg m^{-2} by Sushil Kumar Yadav and Bholanath Saha in 2014. The higher number of tillers m^{-2} (451) and drymatter accumulation (11.6 t ha^{-1}) at maturity of rice was recorded with the *in situ* green manuring @ 10 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1} as soil application on sandy clay loam soils of Bapatla, Andhra Pradesh was reported by Prathibha Sree in 2014. Kandeshwari and Thavaprakash (2016) opined that the highest plant height at 50, 70, 100 and 135 DAS (70.7, 82.2, 123.3 and 129.4 cm, respectively) and drymatter production (3338, 5933, 10729 and 14454 kg ha^{-1}) of rice were recorded with 75% N +12.5% N through FYM + 12.5% N through well decomposed poultry manure in sandy clay loam soil of Tamil Nadu Agricultural University, Coimbatore. Pravin

Prakash and Gaurav Mahajan (2016) found that the highest plant height (65.20 cm), No. of tillers per hill (16.25) and drymatter production per hill (104.66 g) of rice was recorded with 50% of recommended fertilizers + 50% of N through FYM on sandy clay loam soil at Agricultural Research Farm, BHU, Varanasi. According to Abdur Rouf *et al.,* (2018) the maximum plant height (106.7 cm) of rice was recorded with the application of Shingair soil with $N_{60}P_{12.5}K_{30}S_{10}Zn_1$ + 5 ton cowdung ha^{-1} at Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh.

Yield attributing characters of rice as influenced by nutrient management interventions

Hossaen *et al.,* (2011) stated that the yield attributing characters *viz.*, No. of productive tillers (13.52), total No. of grains per plant (97.45), No. of filled grains per plant (91.63) and test weight (21.80 g/1000 grain) of boro rice were significantly highest in 70% NPKS + 2.4 t poultry manure ha^{-1} in silt loam soil at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. On silty clay loam soil, the maximum No. of productive tillers m^{-2}, (304.6), filled grains per panicle (115.1) and test weight (22.2 g/1000 grains) of rice was recorded with Recommended N-120, P_2O_5-60, K_2O-45 kg ha^{-1} + Poultry manure @ 20 t ha^{-1} treatment and it was on par with Poultry manure @ 20 t ha^{-1} + 75% recommended NPK (Altaf Hussain *et al.,* 2012). Krishna Murthy (2012) in Karnataka observed that highest No. of productive tillers (340.73), No. of grains per panicle (130.87) and test weight (24.88 g/1000 grains) of rice with RDF + Chromolaena compost @ 7.5 t ha^{-1}. Manoj Parihar (2015) carried out an experiment at crop research farm Nawabganj, C.S. Azad University of Agriculture and Technology, Kanpur and found that the maximum test weight (24.91 g/ 1000 grains) of rice was recorded with NPK (120-60-60 kg ha^{-1}) + S_{40}+Zn (5 kg ha^{-1}) + FYM @ 10 t ha^{-1}. Rizongba Kichu *et al.,* (2016) opened Nagaland and reported that the highest No. of productive tillers $plant^{-1}$ (5.10) was recorded with NPK (60-60-40 kg ha^{-1}) + FYM (10 t ha^{-1}) + Zn (10 kg ha^{-1}) application. The maximum No. of productive tillers $hill^{-1}$ (18.10) and test weight (25.48 g/1000 grains) of rice was recorded with FYM 5 t ha^{-1} + NPK @ 60-30-45 kg ha^{-1} + 50% N through vermicompost on sandy loam soil at Zonal Agricultural and Horticultural Research Station, Brahmavar, Udupi district, Karnataka Nagaraj *et al.,* (2018).

Yield of rice as influenced by nutriment management interventions

According to Morteza Siavoshi and Shankar (2013), highest grain yield (4776 kg ha^{-1}) of rice was recorded in Cow manure + poultry manure+ rice straw and husk @ 2 t ha^{-1} + NPK @ 50-25-25 kg ha^{-1} at Baykola Research Center, Neka, Mazandaran, Iran. The highest rice grain yield (3000 kg ha^{-1}) was obtained with the application of N-P-K @ 80-50-50 kg ha^{-1} + farm yard manure @ 5 t ha^{-1} along with soil application of $FeSO_4$ and $ZnSO_4$ @ 10 kg ha^{-1} each Jadhav *et al.,* (2014). On the other hand, Vinod Kumar *et al.,* (2014) stated that the maximum grain and straw yield (69.16 and 83.12 q ha^{-1}) of paddy was recorded with the treatment, that received 75% RDF + 25% FYM-N (22.5 t ha^{-1}). In Maharashtra the application of 50% N through RDF + 50% N through vermicompost significantly recorded higher grain (4.97 t ha^{-1}) and straw yield (5.77 t ha^{-1}) of paddy, variety G.R 11 (Dekhane *et al.,* 2014). Manoj Parihar (2015) found that the highest rice grain (60.32 q ha^{-1}), straw yield (73.69 q ha^{-1}) and harvest index (45.01%) was recorded with NPK (120-60-60 kg ha^{-1}) + S_{40}+Zn (5 kg ha^{-1}) + FYM @ 10 t ha^{-1}. The highest grain (36.21 and 36.96 q ha^{-1} during 2013-2014

years of study) and straw yield (52.92 and 54.12 q ha^{-1} during 2013-2014) of paddy was recorded with N_{100} P_{50} K_{50} +FYM @ 5 t ha^{-1} (Rajesh Kumar *et al.,* 2016). Rizongba Kichu *et al.,* (2016) reported that the maximum rice grain yield (37.70 q ha^{-1}) was recorded with NPK (60-60-40 kg ha^{-1})+ FYM (10 t ha^{-1}) + Zn (10 kg ha^{-1}) application. Application of 75% N +12.5% N through FYM + 12.5% N through well decomposed poultry manure recorded highest grain (5802 kg ha^{-1}) and straw yield (8409 kg ha^{-1}) of rice on sandy clay loam soil at Tami Nadu Agricultural University, Coimbatore Kandeshwari, and Thavaprakaash (2016). The highest grain and straw yields (6662 and 8890 kg ha^{-1}) of paddy was recorded with the application of 75% RD of NPK (90-45-45 kg ha^{-1}) + 25% N through green leaf manure on sandy clay loam soil at College farm, College of Agriculture, Rajendranagar, Hyderabad (Geetha Sireesha, 2017). Nagaraj *et al.,* (2018) concluded that the maximum grain (5159 kg ha^{-1}), straw yield (6679 kg ha^{-1}) and harvest index (43.6%) of rice was recorded with FYM 5 t ha^{-1} + NPK @ 60-30-45 kg ha^{-1} + 50% N through vermicompost on sandy loam soil at Zonal Agricultural and Horticultural Research Station, Brahmavar, Udupi district, Karnataka.

Economics of rice as influenced by nutrient management interventions

The highest B:C ratio (3.1) of paddy was recorded with Recommended practice (80-40-30 kg NPK+ 5kg Zn +5t FYM+12 kg BGA+3kg PSB ha^{-1}) over the farmers practice (2.5) *viz.,*1.5 bags of each DAP and Urea (Dwivedi *et al.,*2012). According to Sheeja *et al.,* (2013), highest gross returns (₹ 105980 & ₹ 58245 respectively), net returns (₹68433 & ₹20698) and B:C ratio (2.82 & 1.55) of rice was recorded with NPK @ 90-45-15 kg ha^{-1} (recommended dose) + farm yard manure 5 t ha^{-1} + lime top dressing 250 kg ha^{-1} + $MgSO_4$@ 20 kg ha^{-1} (T_1) on silty clay soil at Rice Research Station, Moncompu, Kerala in both *kharif* and *rabi*. The highest gross returns (77505.00 Rs ha^{-1}), net returns (52157.28 Rs ha^{-1}) and B:C ratio (2.06) of paddy was recorded with application of Pelleted FYM 2.5t + 80:50:30 kg N: P_2O_5:K_2O ha^{-1} followed by pelleted 100:60:40 kg N:P_2O5:K_2O ha^{-1} (Manish Kumar Sharma *et al.,* 2015). According to Senthil Kumar (2015), highest gross (₹52560 & ₹53225), net returns (₹19710 & ₹ 21917) and B:C ratio (1.60 & 1.70) of rice in both *kharif* and *rabi* seasons were recorded with the application of *Sesbania aculeata* @ 6.25 t ha^{-1} as greenmanure+ NPK @ 120:48:48 kg ha^{-1} for short duration rice in *kharif* + *Sesbania aculeata* @ 6.25 t ha^{-1} + NPK @ 150:50:50 kg ha^{-1} for medium duration rice in *rabi* at Agricultural Research Station, Thirupathisaram in Kanyakumari.

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