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Review on response to site specific nutrient management in rice-blackgram sequence

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Abstract
Rice (*Oryza sativa* L.) is the dominant cereal crop in many developing and Asian countries and is a staple food for more than half of the world population. Rice is a staple food crop not only in India but also for entire South Asia. Managing the location specific variability in nutrient supply is key strategy to overcome the current mismatch of fertilizer rates and crop nutrient demand in irrigated rice environments. Soil test based application of plant nutrient helps to realize higher response ratio and benefit- cost ratio as the nutrients are applied in proportion to the magnitude of the deficiency of a particular nutrient and the correction of the nutrients imbalance in soil helps to harness the synergetic effects of balanced fertilization. Location specific fertilizer recommendations are possible for soils of varying fertility, resource conditions of farmers and levels of targeted yield for similar soil classes and environment. Field specific balanced amounts of N, P, K could be prescribed based on crop estimates of the indigenous supply of N, P, K and by modelling the expected yield response as a function of nutrient management.

Keywords: Rice, STCR nutrient management, soil fertility, chemical 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).

Increase the productivity of crops using the combination of inorganic sources and organic sources. Thus, integrated approach of nutrient supply by chemical fertilizers along with organics is gaining importance as this system not only reduces the use of excessive use of inorganic fertilizers, but sustaining the crop productivity by improving soil health and is also an environment-friendly approach.

Rice – blackgram (cereal – legume) sequence is an age old and the best cropping sequence followed in the Krishna Agro-climatic Zone of Andhra Pradesh, India. The potential for increasing the productivity of both of these crops *i.e.*, rice and blackgram in sequence is tremendous with sustainable nutrient management practices. Farmers in this region grow blackgram crop only on residual soil fertility.

To get more and more yield, farmers inclined to the excess use of chemical fertilizer, but the decision on fertilizer use requires knowledge of the expected crop yield response to nutrient application, which is a function of crop nutrient needs, supply of nutrients from indigenous sources, and the short and long term fate of fertilizer applied. Application of fertilizers by the farmers in the fields without information on soil fertility status and nutrient requirement by the crop causes adverse effects in soil and crop regarding both nutrient toxicity and deficiency either by over use or inadequate use.

Response of rice to different organic and inorganic nutrient management in India and abroad

Plant height of rice as influenced by integrated organic and inorganic 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.

Begum *et al*. (2001) [2] reported that application of 120 kg N ha^{-1} has recorded the highest average plant height (80.06cm) of the grown during *rabi* season under silt loam soils at Bangladesh compared to plant height (75.15cm) obtained with application of 100 kg N ha^{-1}.

Mendhe *et al*. (2006) [13] conducted a field experiment in medium clay soil (pH 7.8) paddy var. PKV Makrand at College of Agriculture, Nagpur. They revealed that increase in plant height, number due to the application of UB-DAP (@ 56: 14 kg) at transplanting+25% N at panicle initiation, over the only organic manure FYM @ 5 t/ha at the time of transplanting (26.90 and 36.31 q/ha). Singh *et al*. (2006) [15] A pot experiment was carried out during wet seasons of 2000-2001 the response of semi tall rice *cv. Swarna* to varying levels of nitrogen in *alfisols* the application of 180 kg ha^{-1} N recorded significantly higher plant height (79.30cm) as compared to lower levels of nitrogen 60 kg ha^{-1} (72.90 cm). A study was conducted at Crop Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar on silty clay loam soil and the results revealed that the maximum rice plant height (111.0 cm) were recorded with the application of 100% NPK (120:26:37 kg ha^{-1}) +FYM @15 t ha^{-1} (Krishna *et al.,* 2007) [10]. Mollah *et al*. (2007) [12] reported that the maximum plant height (96.55 cm) of paddy were recorded with Integrated nutrient management for high yield goal (cow dung was used) at Joypurhat MLT Site, Bogra, Bangladesh. Umesh Kumar Patel *et al.* (2009) [21]. reported that application of 100% N-P-K + FYM 5 tones ha^{-1} (100-60-40) recorded significantly highest plant height (75.5 cm) than with application at 100% N-P-K (100-60-40 kg ha^{-1}) recorded lower plant height (74.5 cm). Hossaen *et al.* (2011) [9] conducted an experiment in silt loam soil at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh concluded that the maximum plant height (24.18, 31.34, 44.67, 67.05 and 89.00 cm) at 30,50,70,90 DAT and harvest of boro rice were recorded with the application of 70% NPKS + 2.4 t poultry manure ha^{-1} treatment which was statistically similar with 70% NPKS + 3 t cow dung ha^{-1} treatment.

Number of Tillers m^{-2} of rice as influenced by integrated organic and inorganic nutrient management

Hossaen *et al.* (2011) [9] conducted an experiment in silt loam soil at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh concluded that the maximum total No. of tillers per hill (5.43, 11.64, 21.01 and 17.90) at 30,50,70,90 DAT and harvest of boro rice were recorded with the application of 70% NPKS + 2.4 t poultry manure ha^{-1} treatment which was statistically similar with 70% NPKS + 3 t cow dung ha^{-1} treatment. Debi Prasad *et al*. (2011) reported that higher tillers m^{-1} under sandy clay loam at BHU, Varanasi during *kharif* season was recorded at RDF application of 209.8-130-100 Kg N, P_2O_5 and K_2O ha^{-1} (316.3) than at control (450.3).

Krishna Murthy (2012) [11] conducted an experiment at farmer's field at Aldur village, Chickmagalur taluk, Chickmagalore district, Karnataka. He found that highest no. of productive tillers (340.73), of rice was recorded with treatment RDF + Chromolaena compost @ 7.5 t ha^{-1}. Fakhrul Islam *et al* (2013) [7] opined that the highest effective tillers per hill (11.17), of rice was recorded with the application of 50% RDCF + 4t of poultry manure ha^{-1} on silt loam soil at Sher-e-Bangla Agricultural University, Dhaka, Bangladeah. Sheja K Raj *et al.* (2013) [16] conducted an experiment on silty clay soil at Rice Research Station, Moncompu, Kerala during *kharif* 2011 and *rabi* 2011-12. They concluded that the maximum no. of productive tillers m^{-2} (5.79 & 4.94 respectively) of rice were recorded with the application of NPK @ 90-45-15 kg ha^{-1} (recommended dose) + farm yard manure 5 t ha^{-1} According to Sangeetha *et al*. (2013) [17] Application of enriched poultry manure compost @ 3.30 t ha^{-1} recorded highest number of productive tillers m^{-2} (312 and 319) of rice in both the years of study at Tamil Nadu Agricultural University, Coimbatore on clay loam soil in 2007 and 2008. Anil Kumar Singh (2013) [1] reported that application of 100% RDF (150,60 and 60 kg N-P-K kg ha^{-1}) has recorded the highest average hybrid rice number of tillers per hill (9.60) of the grown during *kharif* season under alluvial calcareous soils at Uttar Pradesh to compared with application of 50 % RDF+GM (dhaincha) NPK kg ha^{-1} obtained number of tillers per hill of (7.60).

Dry matter production (kg ha^{-1}) of rice as influenced by integrated organic and inorganic nutrient management

Zayed *et al*. (2013) [22] conducted experiment under clay soil texture with extreme saline condition o rice variety Giza 178 from Egypt results showed that significant impact on highest dry matter content was observed (900 gm^{-2})with application of 7 tones of FYM + 110 kg N ha^{-1} followed by application nitrogen alone @110 kg ha^{-1} (700 gm^{-2}). Sheja K Raj *et al.* (2013) [16] conducted an experiment on silty clay soil at Rice Research Station, Moncompu, Kerala during *kharif* 2011 and *rabi* 2011-12. They concluded that the maximum drymatter production (17117 and 9827 kg ha^{-1} respectively), of rice were recorded with the application of NPK @ 90-45-15 kg ha^{-1} (recommended dose) + farm yard manure 5 t ha^{-1} According to Gautam Priyanka *et al*. (2013) [8] the drymatter accumulation at harvest of rice was highest with the application of FYM @ 20 t ha^{-1} and was followed by FYM @ 10 t ha^{-1} (1.109 and 0.937 kg m^{-2} respectively) and in chemical fertilizer treatments, 90-40-40 kg NPK ha^{-1} recorded highest drymatter accumulation (1.098 kg m^{-2}) followed by 45-20-20 kg NPK ha^{-1} (0.956 kg m^{-2}) at the Research Farm of CSK HPKV, Palampur, Himachal Pradesh. Paramesh *et al.* (2014) concluded that drymatter production per hill (84.78 g) of rice were recorded significantly highest with the treatment 50% RDN through chemical fertilizers + 50 % RDN through vermicompost on red sandy loam soil at Zonal Agricultural Research Station, Navile, Shimoga, Karnataka. Sushil Kumar Yadav and Bholanath Saha (2014) [18] field experiment was conducted at Banaras Hindu University, Agricultural Research Farm, Varanasi, Uttar Pradesh on sandy loam soil. The research findings revealed that the 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 treatment receiving 25%N through FYM+75% N through fertilizer (1.30 kg m^{-2})

Yield of rice as influenced by integrated organic and inorganic nutrient management

Subbaiah *et al*. (2000) [20] at Tamil Nadu in clay loam soils variety ADT-38 the well NPK fertilizer ratio of 4:2:1 (240-120-60 kg ha^{-1}) in conjunction with 10 t ha^{-1} FYM and foliar spray of DAP2%+ KCL 1% at booting and panicle initiation stages with an spacing of 20X10 cm recorded maximum grain yield (6.92 t ha^{-1}) over the 2.5:1:1 ratio (6.78 t ha^{-1}). Begum *et al*. (2001) [2] reported that application of 120 kg N ha^{-1} has recorded the highest average grain yield (4.80 t ha^{-1}) of the grown during *rabi* season under silt loam soils at Bangladesh compared to lowest grain yield (4.37 t ha^{-1}) obtained with application of 100 kg N ha^{-1}. Bera *et al.* (2006) [3] reported that STCR fertilizer use for 8 tons ha^{-1} targeted yield is an

approach to use fertilizer according to needs of crop application of 126-73-84 kg ha^{-1} to hybrid rice at West Bengal recorded improved grain yield (7.2 t ha^{-1}) over the farmers practice with the application of 100-80-40 N-P-K kg ha^{-1} (6.0 t ha^{-1}). Mendhe *et al*. (2006) [13] conducted a field experiment in medium clay soil (pH 7.8) paddy var. PKV Makrand at College of Agriculture, Nagpur. They revealed that increase in grain yield (34.02 q/ha) and straw yield (45.90 q/ha) due to the application of UB-DAP (@ 56: 14kg) at transplanting + 25% N at panicle initiation, over the only organic manure FYM @ 5 t/ha at the time of transplanting (26.90 and 36.31 q/ha). Singh *et al*. (2006) [15] A pot experiment was carried out during wet seasons of 2000-2001 the response of semi tall rice *cv. Swarna* to varying levels of nitrogen in *alfisols* the application of 180 kg ha^{-1} N recorded significantly higher grain yield (g $hill^{-1}$ 20.6) as compared to lower levels of nitrogen 60 kg ha^{-1} (15.4). Sanyali *et al*. (2007) [19] reported that from G.B Pant Nagar University, Uttarakhand was reported highest rice grain yield (39.86 q ha^{-1}) at 100% RDF *i.e* application of 120-60-40 N-P-K than that of control (16.50 q ha^{-1}).

Economics of rice as influenced by integrated organic and inorganic nutrient management

A field experiment was conducted in *kharif* at Raipur the results revealed that 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 the treatment Pelleted 2.5 t FYM + 80:50:30 kg N: P_2O_5:K_2O ha^{-1} followed by followed by pelleted 100:60:40 kg N:P_2O5:K_2O ha^{-1} (Manish Kumar Sharma *et al.,* 2015) [14]. Also similar result in Dakshina Murthy *et al*. (2015) [6] evaluted that the highest gross (Rs. 58339), net returns (Rs. 30398) and rupee per invested (1.09) were recorded in paddy with application of various rates of N-P-K @ 210-60-40 kg ha^{-1} but which was on par with 180-60-40 kg NPK ha^{-1} 56821, 29224 and 1.06 respectively on clay loam soil at Maruteru. Chaubey *et al.* (2015) [4] reported that STCR fertilizer use for targeted yield is an approach to use fertilizer according to needs of crop application of 150-80-80 kg ha^{-1} to hybrid rice at Raipur recorded increase gross returns, net returns and B:C ratio (66780-48080 and 3.68 Rs ha^{-1}) over the farmers practice (59760-42080 and 3.38 Rs ha^{-1}) with the application of 100-60-60 N-P-K kg ha^{-1}.

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