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Influence of Levels of Phosphorus, FYM and Green Manure on Rice Yield and Economics in a Phosphorus Rich Vertisol

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ABSTRACT

A field experiment was conducted in paddy in a high soil available P Vertisol under K.C. Canal ayacut at Regional Agricultural Research Station, Nandyal to study the influence of levels of phosphorus either alone or in conjunction with FYM and green manure on rice yield and economics during *kharif* 2011. Application of 50% recommended dose of phosphorus (40 kg P_2O_5 ha^{-1}) in combination with green manure recorded the maximum grain and straw yield. The highest benefit cost ratio was obtained with green manure *in situ* followed by 50% recommended dose of phosphorus in combination with green manure and farmyard manure.

Key words : Paddy, Green manure, Farmyard manure, Vertisol, Yield and Economics.

Paddy is an important food crop in the world. It is the staple food in South-East Asia and at present more than half of the world population depends on this crop. It is also one of the most important cereals grown in India and occupies second position in area after wheat. In Andhra Pradesh, 10.51 million tonne of rice is being produced from an area of 3.44 million hectares with a productivity of 3056 kg ha^{-1} during the year 2009-2010.

Phosphorus is one of the major nutrients required for production of rice. The use efficiency of phosphorus is very low due to fixation in soil in addition to poor solubility of native soil phosphorus. Plants utilize fewer amounts of phosphatic fertilizers that are applied and the remaining portion is rapidly converted into insoluble complexes in the soil. In soil more than 80% of P becomes immobile and unavailable for plant uptake because of adsorption, precipitation, or conversion to organic form.

Paddy crop takes up phosphorus only at initial stages i.e. at root formation stage but farmers are applying phosphorus at different stages of the crop growth in the form of DAP, 28:28:0 etc., leading to its accumulation in the soil. It was found to occur mainly in places where intensive cultivation is being followed under irrigation commands with indiscriminate use of not only this nutrient but also fertilizers containing other nutrients. Also, the long term fertilizer experiments being conducted across the country revealed the accumulation of P in surface soils. Hence an attempt was made to study the P requirement of paddy in a Phosphorus rich Vertisols with green manure *in situ* and application of farmyard manure in combination with different doses of phosphorus.

MATERIAL AND METHODS

An experiment was carried out in *kharif* 2011 at Regional Agricultural Research Station, Nandyal, Kurnool district of Andhra Pradesh. The mean maximum and minimum temperatures during crop growth period ranged from 32.2°C and 19.8°C respectively. The soil of the experimental site was clay loam in texture with soil pH 8.12, EC 0.21 dS m^{-1}, low OC (0.43%), low in available N (227 kg ha^{-1}) but high in available P (153 kg ha^{-1}) and K (596 kg ha^{-1}). The experiment was comprised twelve treatment combinations laid out in a randomized block design and each treatment replicated thrice. Green manure (Dhaincha) was grown and ploughed *insitu* before transplanting. Rice variety BPT-5204 is taken as a test crop. The recommended dose of 200 kg/ha nitrogen through DAP and urea, P_2O_5 80 kg/ha in the form of DAP

and K_2O 80 kg/ha in the form of muriate of potash was applied as per treatments. The observations were recorded on yield and economics of rice. The treatments were T_1: Absolute control (no manure and fertilizers), T_2:Farm yard manure (FYM) @ 5 t ha^{-1} only, T_3: Green manure (GM) ploughed *insitu* only, T_4: 100% Recommended Dose of P (80 kg P_2O_5 ha^{-1}), T_5: 50% Recommended Dose of P (40 kg P_2O_5 ha^{-1}), T_6: 25% Recommended Dose of P (20 kg P_2O_5 ha^{-1}), T_7: Recommended Dose of N and K only (No P_2O_5), T_8: T_5 + FYM@5t/ha (T_2), T_9:T_5 + Green manure (T_3), T_{10}:T_6 + FYM@5t/ha (T_2), T_{11}: T_6 + Green manure (T_3), T_{12}: Soil test based fertilizer (STBF) application. Uniform recommended dose of N and K was applied for T_4 to T_{11} treatments.

RESULTS AND DISCUSSION

Yield

Grain and straw yields (Table 1) were significantly increased by different treatments. Combined application of 50% RDP with GM (T_9) recorded the highest grain yield (5167 kg ha^{-1}) and straw yield (9053 kg ha^{-1}), which was significantly highest among all other treatments. The highest grain yield was obtained with T_9 (50% P + GM), which was on par with T_3 (GM), T_4 (100% RDP), T_5 (50% RDP) and T_8 (50% P+FYM). With regards to manurial treatments alone, the treatment T_3 (green manure) recorded significantly higher yield than T_2 (FYM) and it might be due to the reason that green manure contains higher concentration of major nutrients. Among inorganic sources, the treatment T_5 (50% RDP) recorded the highest grain yield followed by T_4 (100% RDP) and T_6 (25% RDP). This clearly shows that, in soils with high soil available phosphorus's application of 50% of recommended P maintains a good buffer for higher available phosphorus in soil.

Highest straw yield (9053 kg ha^{-1}) was obtained with T_9 (50% P + GM), which was on par with T_8 (50% RDP +FYM), T_5 (50% RDP), T_{12} (STBF), T_4 (100% RDP), T_{11} (25% RDP +GM) and T_{10} (25% RDP + FYM) and all the seven treatments were significantly superior to rest of the treatments. Lowest grain yield (3967 kg ha^{-1}) straw yield (6190 kg ha^{-1}) were recorded with T_1 (absolute control). Among inorganic sources of phosphorus, application of 50% RDP recorded the highest straw yield followed by 100% RDP and 25% RDP. Compared to organic and inorganic sources alone, their combinations recorded higher values of grain and straw yields. This might be due to the immediate release of nutrients through inorganic sources and later by the mineralization of nutrients through FYM and green manure in steady supply of nutrients.

The straw yield of rice was maximum with the application of FYM than GM, which was not significantly superior to that obtained with green manure incorporation. Significantly lower straw yield was associated with the absence of organics. Increased plant height, more light interception and enhanced dry matter production noticed with FYM incorporation might have resulted in significant increase in straw yield. These results confirm the findings of Singh *et al*. (2001), Mankotia and Shekhar (2007) and Shekara *et al*. (2010).

Economics

The results revealed that highest B:C ratio was observed with T_3 (green manure) treatment (Table 2) than all other treatments, but highest gross and net returns were observed with T_9 (50% RDP + GM). Among organic sources alone the highest gross and net returns as well as benefit-cost ratio (2.07) were realized with T_3 (GM). Among inorganic sources alone highest gross returns, net returns and benefit-cost ratio was observed with T_5 (50% RDP) which might be due to the higher grain and straw yield and half the amount of phosphorus applied when compared with 100% RDP. The higher net returns might be due to higher yield and lesser additional treatment cost as compared to others. Similar results were reported by Lathika Mandal, *et al*. (2009).

In case of organic and inorganic combination treatments, highest gross returns, net returns and benefit-cost ratio (1.94) were observed with T_9 (50% RDP + GM) followed by T_{11} (25% RDP + GM) while the lowest gross returns were observed with absolute control (T_1). The lowest net returns and B:C ratio were observed with T_2 (FYM) than the treatment T_1 (absolute control) which might be due to high cost of FYM and lower yield. The higher gross returns might be due to higher grain and straw yields. Similar findings were observed by Mehla and Panwar (2000).

Table 1. Influence of different treatments on grain and straw yield (Kg ha^{-1}) of rice.

Treatment	Grain yield	Straw yield
T_1-Absolute control	3967	6190
T_2-FYM@5t ha^{-1}	4200	6903
T_3-Green manure	4700	6867
T_4-100% RDP	4700	8453
T_5-50% RDP	5100	8640
T_6- 25% RDP	4400	7497
T_7-No P	4167	7940
T_8-50% RDP+FYM	4900	8903
T_9-50% RDP+GM	5167	9053
T_{10}-25% RDP+FYM	4500	8163
T_{11}- 25% RDP+GM	4533	8200
T_{12}-STBF	4633	8607
SEm±	163	342
CD (P=0.05)	471	1003

Table 2. Influence of different treatments on Gross returns, Net returns and B:C ratio of rice.

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:Cratio
T_1-Absolute control	3967	6190	28250	52242	23992	1.85
T_2-FYM@ 5t ha^{-1}	4200	6903	32750	55578	22828	1.70
T_3-Green manure	4700	6867	29700	61550	31850	2.07
T_4-100% RDP	4700	8453	36268	62740	26472	1.73
T_5-50% RDP	5100	8607	34993	67655	32662	1.93
T_6- 25% RDP	4400	7497	34355	58423	24068	1.70
T_7-No P	4167	7940	33718	55955	22237	1.66
T_8-50% RDP+FYM	4900	8903	38493	65478	26985	1.70
T_9-50% RDP+GM	5167	9053	35443	68790	33347	1.94
T_{10}-25% RDP+FYM	4500	8163	37855	60122	22267	1.59
T_{11}- 25% RDP+GM	4533	8200	34805	60550	25745	1.74
T_{12}-STBF	4633	8640	35884	62080	26196	1.73

Conclusion

Application of 50% RDP with GM resulted in significantly higher grain yield of paddy in high soil available P Vertisols under K.C. Canal ayacut followed by application of 50% RDP only or in combination with FYM @ 5 t ha^{-1}. This shows that even in high soil available P Vertisol application of 50% RDP is required to realize higher grain yield of paddy. In high soil available P Vertisols, adopting green manure (Dhaincha) *in situ* only (2.07) followed by application of 50% RDP + GM (1.94) or 50% RDP alone (1.93) resulted in highest B:C ratio.

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