

Original Research Article

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Effect of Phosphorus, VAM and FYM on Soil Fertility Status under Rice Cultivation

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A B S T R A C T

A field experiment was conducted during Kharif season 2018-2019 on research plot of Udai Pratap Autonomous College, Varanasi (U.P.) adjoining the Department of Agricultural Chemistry and Soil Science. The experiment was conducted with seven treatments were control (T_1), 60kg P ha⁻¹ (T_2) 60kg P ha⁻¹+VAM (T_3), 30kg P ha⁻¹ (T_4), 30kg P ha⁻¹ + VAM (T_5), 30kg P ha⁻¹ + VAM + 10t ha⁻¹FYM (T_6), 80 kg P ha⁻¹ (T_7), the rice crop was laid out in randomized block design (RBD) with four replication. Soil pH and EC was significantly decreased with addition of phosphorus, VAM and FYM. Higher soil Organic carbon content was observed with the application of 30 kg P ha⁻¹ + VAM + FYM 10 ta /ha (T_6). The plots treated with 30 kg P ha⁻¹ + VAM + FYM @ 10ta ha⁻¹ (T_6) recorded significantly higher available nitrogen content as compared to other treatments. The effect of various treatment of phosphorus fertilizer, VAM and FYM on available phosphorus content of soil was recorded significantly higher in the treatment T_3 i.e. 60 kg P ha⁻¹ + VAM. Significantly higher soil available potassium content was observed in the treatment 30 kg P ha⁻¹ + VAM + FYM @ 10ta ha⁻¹ (T_6). Application 30 kg P ha⁻¹ + VAM + FYM 10 ta ha⁻¹i.e (T_6) were recorded significant higher dry matter, straw yield and grain yield of rice crop.

Keywords

VAM, FYM,
Rice, SSP and Soil

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Introduction

Rice (*Oryza sativa* L.) is the most common and important food crop of India in terms of both the area and production. It has the second highest wide production after maize. Rice production in India crossed the mark of 112 million tonnes achieved in 2017-18 accounting for 21.19% of global production in the year. The productivity of rice has 3742 kg per hectare in 2017-18. India has largest area

(43.20 million hectare) followed by China (30.35 m ha), Indonesia (12.16), Bangladesh (12.0 m ha) and Vietnam (7.66 m ha) (FAO STAT 2017). The major rice producing states in India falls in the regions of the middle and lower Ganga plains and the coastal lowlands of the peninsular India. Rice is grown in almost all the states of India but its cultivation is mainly concentrated in river valleys, deltas and low lying coastal areas in India. Andhra Pradesh (2.16 m ha), Bihar (3.21 m ha),

Madhya Pradesh (2.02 m ha), West Bengal (5.46 m ha) and Uttar Pradesh (5.87 m ha) lead in the area. West Bengal (15.75MT), Uttar Pradesh (12.51 MT) and Punjab (11.82 MT) have the highest share in rice production.

Phosphorus is an essential element classified as primary and also known as “Life of plant”. Plant required adequate P from the very early stages of growth for optimum crop production (Grant *et al.*, 2001). Phosphorus is one of the major nutrients generally added to soil in form of fertilizer. One of the main roll of the phosphorus is plant is in transfer of energy ATP and also involved in root development and in metabolic activities especially in synthesis of protein (D. Rodriguez, 2002). Phosphorus is major growth-limiting nutrient and unlike the case for nitrogen, there is no large atmospheric source that can be made biologically available (Laxminarayana 2005). The phosphorus concentration in soil usually ranges from 100 to 2000 mg P kg⁻¹ soil representing approximately 350 to 7000 mg P kg⁻¹ in the surface 25 cm of the soil, although only a small proton of this P is immediately available for crop uptake (Lanerd 2005). Phosphorus in soil solution is found lower range from 0.001 mg/L. In general plant root absorbs phosphorus in form of orthophosphate ions ($H_2PO_4^{-2}$ and HPO_4^{-2}) are primary forms of phosphorus taken up by plant. Phosphorus moves to the root surface through diffusion (Chaturvedi 2006). The phosphorus content of soil is quite variable ranging from less than 0.04% P_2O_5 in sandy soil to 0.3% in highly organic matter soil. Soil phosphorus levels are affected by erosion, crop removal and phosphorus fixation. The soil low in organic matter may contain only 3% of their total phosphorus in organic form, but highly organic matter may contain 50% or more of their total phosphorus in organic form (Bray and Kurtz 1945). The available phosphorus in Indian soil 52.5% of districts are in low phosphorus category 46% are

medium phosphorus category and only 1.6% is high phosphorus category. Plant required phosphorus for their energy transfer reaction, development of reproductive system, crop maturity, root growth and protein synthesis.

The term Mycorrhiza used to describe the symbiotic association between a fungus and a root of higher plant (Frank, 1885). Both of the host plant and fungal member, benefited potentially form this association (Powel and Bagyarj, 1984). There are almost seven types of mycorrhizal (Reeves and Renente, 1991). Near about 80% of all terrestrial plant species form endomycorrhiza. ie vesicular arbuscular mycorrhizal (VAM). Arbuscular mycorrhizal fungi that specifically colonize roots of a plant species are therefore likely to be great relevance of function and their identification is important to understand the ecology of plant fungus interaction in natural ecosystem (Heganson *et al.*, 2002) vesicular arbuscular mycorrhizal fungi are ubiquitous in their distribution and occur abundantly. Majority of lower plants have the dynamic association of VAM fungi.

Materials and Methods

The present investigation entitled in the effect of phosphorus fertilization on its transformation under rice crop (*Oryza sativa L*”). The field experiment was conducted during Kharif season 2018-2019 on research plot of Udai Pratap Autonomous College, Varanasi (U.P.) adjoining the Department of Agricultural Chemistry and Soil Science. The initial physico-chemical properties of soil have been presented in table 1. Varanasi is found under sub-tropical climate and situated in eastern U.P. whereas the precipitation is normally spread over period of three and four months i.e. started from the last week of June to the second week of October in rainy season. The distribution of average annual rain fall is 96.65 cm.

The experiment was conducted with seven treatment were control (T_1), 60kg P ha^{-1} (T_2) 60kg P ha^{-1} + VAM (T_3), 30kg P ha^{-1} (T_4), 30kg P ha^{-1} + VAM (T_5), 30kg P ha^{-1} + VAM + 10t ha^{-1} FYM (T_6), 80 kg P ha^{-1} (T_7), the rice crop was laid out in randomized block design (RBD) with four replication.

All grass has been removed from the plot and plots and soil sample have been taken from each plot at 30 DAS and at harvesting. Khurpi and auger have been used as sampling tools. Sample was collected in plastic bag. Soil samples were brought to the laboratory, air dried soil samples were crushed and pass through 2 mm round here sieve. The sieved samples were stored in the labeled polythene bag plot wise for conducting selected laboratory analysis.

A soil water suspension was prepared in ratio of 1: 2.5 and pH was recorded with the help of glass electrode digital pH meter (Jackson 1967). Electrical conductivity of soil sample was measured in 1:2.5 soil and water suspension at 25°C temperature by EC Bridge (Bower and Wilcox, 1965). Organic carbon was determined by Walkley and Black's rapid titration method (Walkley and Black, 1934) as described by (Jackson 1967). The available nitrogen was determined by alkaline permanganate method (Subbiah and Asija, 1956). The available phosphorus in soil was determined by the Olsen's method (Olsen' *et al.*, 1954). The available potassium was determined by neutral normal ammonium acetate method (Honway and Heidel, 1952).

The data collected from field and laboratory was analyzed statically by using standard procedure of randomized block design (RBD), (Cochram and Cox, 1959). Critical difference (C.D.) and standard error of mean (S.E.M.) were calculated to determine the significance among all the treatment mean.

Results and Discussion

This experiment was conducted to investigate the different dose of phosphorus in combination with or without FYM and VAM on growth and yield and under rice. The result of experiment recorded during availability of nutrient this investigation are presented and critically discussed in this chapter under following heads.

Effect of phosphorus, FYM and VAM on soil fertility status

Soil Reaction (soil pH)

The results pertaining to the influence of phosphorus, VAM and FYM application on soil pH measured at 30 DAS and at harvesting stage under rice have been presented in figure -1. Form the data it is evident that, the pH of soil increased continuously with days after transplanting under all treatments. The effect of various treatment on soil pH could be arranged in the order $T_1 > T_7 > T_2 > T_4 > T_3 > T_5 > T_6$ and the values observed as 7.7, 7.6, 7.5, 7.43, 7.40, 7.35 to 7.7 at 30 DAT and 8.2, 8.0, 7.8, 7.68, 7.58, 7.52, 7.49 at harvesting under respective treatment. The significantly lower soil PH was recorded with addition of phosphorus, VAM and FYM. These result are corroborating with the findings of Sharma *et al.*, (2007) and Sharma *et al.*, (2013).

Electrical conductivity (EC)

The data related to the effect of phosphorus, VAM and FYM application on electrical conductivity of soil under rice, it showed they electrical conductivity increased continuously with advancement in crop growth stage under all treatments. The application of FYM with phosphorus + VAM recorder significantly lower electrical conductivity as compared to other treatments at all growth stages. The effect of different treatments on EC of soil

was found in the order $T_1 > T_7 > T_2 > T_4 > T_3 > T_5 > T_6$ and the values observed as 0.65, 0.6, 0.56, 0.53, 0.51, 0.49, 0.46 dS m⁻¹ at 30DAT and 0.73, 0.69, 0.64, 0.62, 0.58, 0.52dS m⁻¹ at harvesting. Further, the soil EC also decreased significantly with the application of FYM might be due to release of acids during decomposition of FYM which reduced the salt content responsible for exchange phenomenon.

Organic carbon

The result related to soil organic carbon content influence of phosphorus fertilization on its transformation under rice crop measured at 30 DAT and at harvesting stage have been presented in table-2. Data shows that organic carbon continuously decreased with advancement of crop age under all treatments. Significantly higher soil Organic

carbon content was observed with the application of 30 kg P ha⁻¹ + VAM + FYM 10 ta /ha (T_6) in comparison to other treatments. The effect of different treatment on organic carbon content of soil was found in order of $T_6 > T_3 > T_5 > T_7 > T_2 > T_4 > T_1$, and the values were 0.61, 0.57, 0.55, 0.54, 0.52, 0.49, 0.43% at 30DAT and 0.53, 0.49, 0.46, 0.45, 0.43, 0.40 and 0.35% at harvesting stage under respective treatments. Maximum soil organic carbon content in T_6 (30 kg P ha⁻¹ + VAM + FYM 10ta ha⁻¹) might be attributed to the direct incorporation of organic material through FYM and better root growth in influenced of VAM. The addition of FYM might have created environment conducive for formation of humic acid, which ultimately resulted in an increase in organic carbon content of soil (Bajpai *et al.*, 2006). The result is corroborated with the findings of Prakash *et al* (2002) and Dadhich *et al.*, (2011).

Table.1 Initial physio-chemical properties of experimental soil

SN	Parameters	Contents
1.	pH	7.71
2.	Electrical Conductivity(dSm ⁻¹)	0.61
3.	Bulk density (M gm ⁻¹)	1.35
4.	Organic carbon (%)	0.43
5.	Available nitrogen(kg ha ⁻¹)	210
6.	Available phosphorous (kg ha ⁻¹)	10.34
7.	Available potassium(kg ha ⁻¹)	220

Table.2 Effect of phosphorus, FYM and VAM on organic carbon under rice crop

Treatment	Days after transplanting (DAT)	
	30 DAT	At Harvesting
T_1	0.43	0.35
T_2	0.52	0.43
T_3	0.57	0.49
T_4	0.49	0.40
T_5	0.55	0.46
T_6	0.61	0.53
T_7	0.54	0.45
SEm±	0.0045	0.0055
CD (5%)	0.0135	0.0164

Table.3 Effect of phosphorus, FYM and VAM on available nitrogen under rice crop

Treatment	Days After Transplanting (DAT)		
	30 DAT	60 DAT	At Harvesting
T ₁	214	194	183
T ₂	246.35	223.35	110.35
T ₃	266.30	242.30	226.40
T ₄	228.00	206	191.60
T ₅	258.00	240.40	228.60
T ₆	280.40	262.50	248.46
T ₇	256.45	236.45	223.60
SEm±	0.5528	0.5118	0.6486
CD (5%)	1.6454	1.5205	1.9270

Table.4 Effect of phosphorus, FYM and VAM on available phosphorus under rice crop

Treatment	Days After Transplanting (DAT)		
	30 DAT	60 DAT	At Harvesting
T ₁	11.3	9.4	6.5
T ₂	19.4	17.8	16.4
T ₃	27.5	24.5	22
T ₄	15.8	13.2	11.8
T ₅	24.3	20.9	18.9
T ₆	16.4	14.8	12
T ₇	23.5	20	18.6
SEm±	0.8116	0.9759	0.3984
CD (5%)	2.4115	2.8995	1.1837

Table.5 Effect of phosphorus, FYM and VAM on available potassium under rice crop

Treatment	Days After Transplanting (DAT)		
	30 DAT	60 DAT	At Harvesting
T ₁	225	209	188
T ₂	239	223	200
T ₃	250	236	207
T ₄	235	221	199
T ₅	243	230	209
T ₆	255	242	220
T ₇	241	229	204
SEm±	2.2930	3.1497	3.2121
CD (5%)	6.8129	9.3583	9.5436

Fig.1 Effect of integrated use of phosphorus, FYM and VAM on pH under rice crop

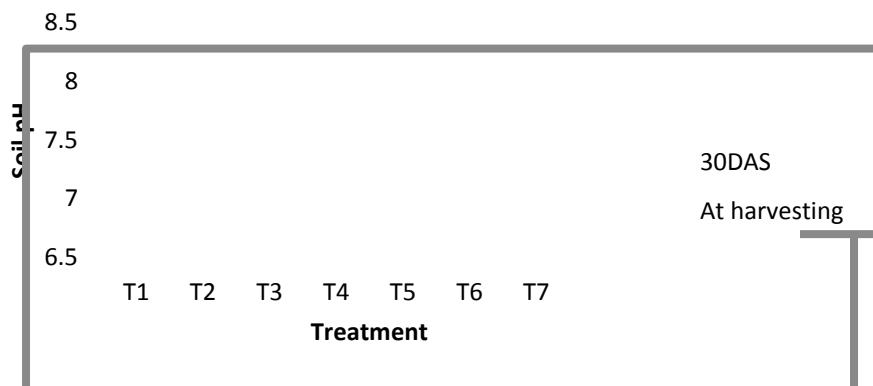


Fig.2 Effect of integrated use of phosphorus, FYM and VAM on Electrical conductivity under rice crop

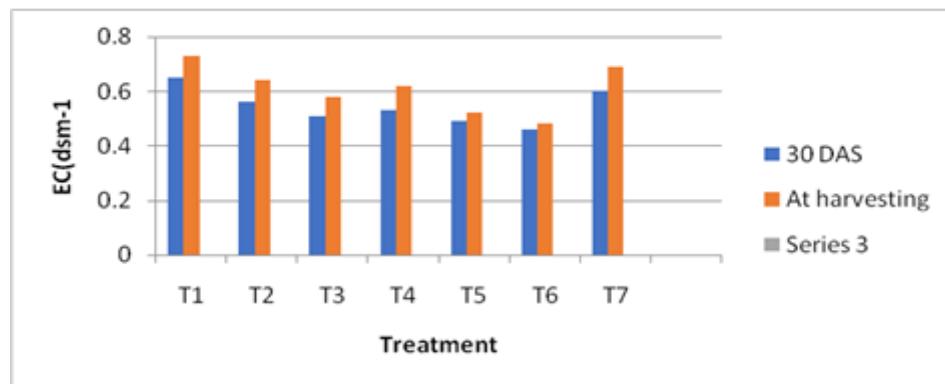
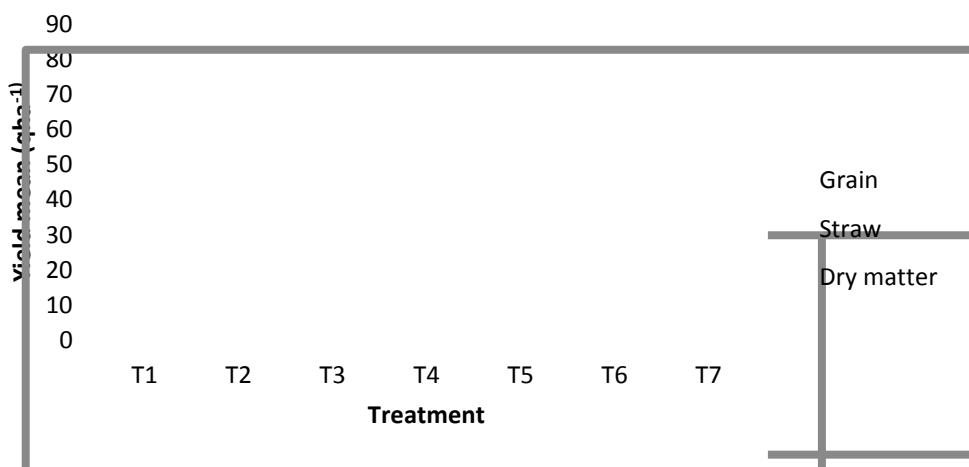


Fig.3 Effect of integrated use of phosphorus, FYM and VAM on dry matter (g m^{-1} row length), grain and straw yield (q ha^{-1}) of rice crop



Available nitrogen

Available nitrogen content of soil under rice have presented in table-3. The data revealed that available nitrogen content of soil decreased continuously with advancement in crop growth stage under all treatments. Statistically was significant difference was observed among between T₇ and T₅ at 30 DAT. The plots treated with 30 kg P ha⁻¹+VAM + FYM @ 10ta ha⁻¹ (T₆) recorded significantly higher available nitrogen content as compared to other treatments. Decline in nitrogen content with increase in age of crop can be attributed to N requirement for the crop with age. The favourable soil conditions under organic manure application might have facilitated the mineralization of soil N leading to build up of higher available nitrogen (Vipin Kumar and Singh 2010).

Available phosphorus

Data showed that available phosphorus content of rice plots decreased continuously with age of crop under all treatments (table - 4). The effect of various treatment of phosphorus fertilizer, VAM and FYM on available phosphorus content of soil was recorded significantly. Higher in the treatment T₃ ie 60 kg P ha⁻¹ + VAM. In case of available phosphorus statistically significance difference was observed among the treatments except between T₇, T₅ and T₆, T₄ which was remained at par 30 DAT and at harvesting. Increase in available phosphorus content of soil due to increasing level of phosphorus might be attributed to direct addition of phosphorus to solution pool of phosphorus in soil. The increase in available phosphorus content of soil due to the incorporation FYM and VAM might be attributed solubilisation of native phosphorus through release of various organic acids during the decomposition of FYM. The increase in available P content of soil due to the incorporation of FYM may be attributed to

the direct addition of P as well as solubilisation of native P through release of various organic acids during decomposition. A part of that VAM helped to enhance the mobility of P. Similar result was observed by Sharma *et al.*, (2005) and Shinde and Bangar, 2003).

Available potassium

Available potassium content of soil decreased continuously with advancement in crop growth stage under all treatments. Significantly higher soil available potassium content was observed in the treatment T₆ 30 kg P ha⁻¹ + VAM + FYM @ 10ta ha⁻¹. In case of available potassium statistically significance difference was observed among the treatments except between T₇ and T₅ which was remained at par 30 DAT and at harvesting. Increase in available K due to phosphorus, VAM and FYM application might be attributed to the addition of potassium from decomposition of FYM to the available pool of soil. A part of that the beneficial effect of FYM on available K might be attributed to the reduction in fixation and release of K due to interaction of FYM with clay. Similar reports were also observed by Laxminarayana (2005). These observation by Abraham Lal (2004) and Thakur *et al* (2011).

Effect of phosphorus, FYM and VAM on dry matter, straw and grain yield of rice

Dry matter

The data revealed that the dry matter yield of rice was found in the order T₆> T₃> T₅> T₇> T₂> T₄>T₁ and the values of grain yield were 82.24, 75.24, 64, 62, 57.24, 55.72, 42.42 gm/m under respective treatments. In case of dry matter yield statistically significance difference was observed among the treatment except between T₇ T₅ which was remained at

par at harvesting. Application 30 kg P ha⁻¹ + VAM + FYM 10 ta ha⁻¹i.e (T₆) recorded significant higher yield in comparison to other treatments. It might be due to more availability of nutrients under P+ VAM + FYM application led by the vegetative growth of crop.

Grain yield

The effect of integrated use of phosphorus, VAM and FYM on grain (q ha⁻¹) yield of rice have presented in figure – 2 The data revealed that the grain yield of rice was found in the order T₆> T₃> T₅> T₇> T₂> T₄> T₁ and the values of grain yield were 48, 45.44, 43.42, 42, 38.25, 34.46 and 30.42q ha⁻¹ under respective treatments. In case of grain yield statistically significance difference was observed among the treatment except between T₇ and T₅ which was remained at par at harvesting. Application 30 kg P ha⁻¹ + VAM + FYM 10 ta ha⁻¹i.e (T₆) recorded significant higher yield in comparison to other treatments. It might be due to more availability of nutrients under P+ VAM + FYM application led by the vegetative growth of crop.

Straw yield

The data revealed that the straw yield of rice was found in the order T₆> T₃> T₅> T₇> T₂> T₄>T₁ and the values of straw yield were 68.54, 60.42, 55.64, 54, 47.45, 44.46, 40.42 q ha⁻¹ under respective treatments. In case of straw yield statistically significance difference was observed among the treatment except between T₇ T₅ which was remained at par at harvesting. Application 30 kg P ha⁻¹ + VAM + FYM 10 ta ha⁻¹i.e (T₆) recorded significant higher yield in comparison to other treatments. It might be due to more availability of nutrients under P + VAM + FYM application led by the vegetative growth of crop.

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