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Effects of Integrated Use of Organic Manure and Bio-fertilisers on Crop Productivity: A Case Study of Rice (*Oryza sativa* L.) Crop

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study conducted entitled, “Effect of Integrated use Organic manure and Bio-fertilizers on crop productivity under Rice (*Oryza sativa* L.) crop". Involved field trial conducted during Kharif season of year 2016-17 followed by laboratory analysis of the plant and soil samples in the Department of Soil science & Agriculture Chemistry, Udai Pratap Autonomous College, Varanasi (U. P). All grasses were removed from the experimental plots and soil samples have been taken from each replication plots at 30 DAT, 60 DAT and at harvesting. The experiment was conducted under randomized block design (RBD) with six treatment combinations. Treatments were replicated thrice making the total number of 18 plots. The effect of various treatments on dry matter production could be arranged in order of T6>T3>T5>T4>T2>T1 and the values were 70.25, 62.15, 59.45, 43.40, 41.25 and 35.59 gm-1 row length, respectively. Application of fertilizers alone or in combination with F.Y.M increased grain and straw yield of rice significantly over control. Further, the yield was significantly superior under the use of organic manure and bio-fertilizers over the sole use of chemical fertilizers. On the basis of data, the superiority of the treatments may be arranged as T6>T3>T5>T4>T2 and T1. Like dry matter yield, rice grain and straw yield was also highest in treatment where 50% NPK was substituted through FYM to rice crop. The integrated use of fertilizers with FYM and bio-fertilizers might have added huge quantity of organic matter in soil that increased grain and straw yield. In general, higher number of tillers (15.25 m-1 row length), plant height (92.50 cm), dry matter at 60 DAT (70.25 gm-1 row length), grain yield (46.25 Qha-1) and straw yield (91.25 Qha-1) obtained with T6 treatment followed by T3>T5>T4>T2>T1 (control).

Keywords: Integrated use; organic manure; Bio-fertilizers; rice (Oryza sativa L.); physico-chemical properties.

1. INTRODUCTION

“Rice (*Oryza sativa* L.) is the prime food crop for more than 65 percent of the people and provides livelihood security to 70 percent of Indian population” (Kulkarni et al. 2015). “India has largest farm area (43.9) million ha^{-1} followed by china (30.30 mha), Indonesia (13.80 mha), Bangladesh (11.30 mha) and Vietnam (7.86 mha) and production of rice 106.5 mtons and productivity of rice 3576 kg ha^{-1} in 2015-16” (Food and agricultural organization, STAT 2016)[1,2].

“Rice is grown in almost all state of India but its cultivation is mainly concentrated in river velleys, deltas and low-lying coastal areas in India. Andhra Pradesh, Bihar, Madhya Pradesh & Utter Pradesh lead in the area. West Bengal (15.10%), Utter Pradesh (11.99%) and Punjab (11.33%) have the highest share in rice production” (Directorate of economics and statistics DES)[3].

Rice is primarily a high energy food. it is good source of Carbohydrates (80g), sugar (0.12g), digestible fibre (1.3g), fat (o.66g), protein (7.12g) per 100g of grain (USDA Nutrient database, (2015). Rice bran is used as cattle and poultry feed. Rice is grown under many different conditions and production systems, but saturation in water is the most common method used worldwide.

“Rice is the only cereal crop that can grown for long periods of time in standing water, 57% of rice is grown in irrigated land, 25% on rainfed Introduction lowland, 10% on the upland, 6% in deep water, and 2% in tidal wetland. As the land area decrease with time, increasing land use intensity with inadequate and imbalanced use of chemical fertilizers with little or no use of organic manure caused severe fertility deterioration resulting in stagnating or even declining crop productivity” (Shormy et al. 2013)[4,5].

“Integrated use of inorganic fertilizers, bio-fertilizers and farmyard manure seems to be the practicable alternative to the present malady of unsustainable agriculture. Farmyard manure is an easily available, cheap, proven source of nourishing for agricultural crops and has been used by farmers traditionally. Blue-green algae have a vital role in soil fertility improvement and consequently increasing growth and yield as a natural fertilizer” (Song et al. 2005)[6].

“Phosphate solubilising bacteria (PSB) the capacity to solubilise and mineralize the residual or fixed phosphorous, gaining phosphorus availability in the soil. Integrated nutrient management (INM) aims for efficient and judicious use of all the major source of plant nutrients in an integrated manner” (Farouue and Takeya, 2007) [2,7].

"On the other hand, continuous application of organic fertilizers such as FYM, PSB and BGA on rice fields outcome in low yield and low N and K content at the mid-tilling stage of rice plants" (Javier et al. 2004). "Combined use of organic manure and inorganic fertilizer help in maintaining yield stability through the correction of marginal deficiencies of secondary and micronutrients, enhancing the efficiency of applied nutrients and providing favourable soil physical condition" (Gill and Walia) [1,7,8].

2. MATERIALS AND METHODS

The present study entitled, **"**Effect of Integrated use Organic Manure and Bio-fertilizers on crop productivity under Rice (*Oryza sativa* L.) crop" involves field trial conducted during the Kharif season of the year 2016-2017–at the research plot of the Department of Agricultural, Chemistry and Soil Science, Udai Pratap (Autonomous) College, Varanasi. The soils of Varanasi formed by alluvial soil, deposited by Ganga river, dominance of illite, quartz and feldspar mineral. Illite minerals are partly inherited from micas which are predominant in the sand and silt fraction.

Varanasi is found under sub-tropical climate and situated in eastern U.P., India. The precipitation in this region is normally spread over a period of three and four months i.e. from the last week of June to the second week of October. The period from November to February is generally cool and dry. The summer season from the third week of March to June is hot and dry. The distribution of average annual rainfall is 96.65 mm of which 80% is from June to September, 5.7% from October to December, 3.3% from January to February and 3.0% from March to May. "The experiment was conducted under randomized block design (RBD) with six treatment combinations. Treatments were replicated thrice making a total number of 18 plots" [9].

There were six treatments which consisted of various levels of P and PSB. Details of treatments and their combinations are given below. T_1 = Control (no input), T_2 = 100% NPKS, T_3 = 100% NPKS+FYM (10 Ton ha^{-1}) +Bio-fertilizer (PSB+BGA), T_4 = 125% NPKS, T_5 = 150% NPKS, T_6 = 50% NPKS+FYM (10 Ton ha^{-1}) + Bio-fertilizer (PSB+BGA) *RDF = Recommended dose of fertilizer (120 kg N ha^{-1} , 60 kg P_2O_5 ha^{-1} and 60 kg K_2O ha^{-1}).

The field was prepared by ploughing, three cross harrowing followed by planking. Around each plot, bunds were made in the plots. Full care was taken during aligned the plots uniformly and grasses were removed from the plot.

Nitrogen, phosphorus, potash and sulphur were applied with synthetic fertilizers as per treatments. Half a dose of nitrogen (60 kg ha^{-1}) and a full dose of phosphorus and potassium were applied as basal application at the time of sowing. The resting half dose of nitrogen (60 kg ha^{-1}) was applied at flowering stage on standing crop. PSB and BGA are applied as per treatments at the time transplanting.

Healthy rice seedlings were transplanted in line with a spacing of 20 × 15 cm (row × plant). Irrigation was given whenever required to maintain an appropriate level of moisture in the field during the experimentation period.

Weeding and other intercultural operations were performed mechanically by hand and when required to maintain good cropping conditions. The heights of 4 marked plants in all the plots were recorded at different growth stages viz; 30, 60 and 90 days after transplanting (DAT) from the base of the plants to the tip of the uppermost, fully matured leaf. The average of all observations in each plot worked out and planned as mean plant height. The number of tillers per plot at different growth stages (30, 60 and 90 DAT) are recorded from the marked plants in each plot. The crop was harvested at maturity and allowed to dry in the sun. Separate bundles were made for each plot and weighed. After a week of harvesting bundles were weighed and threshed by hand. After threshing the bundles of each plot, grain and straw yield were recorded plot-wise. Straw and grain yield were presented in qha^{-1}.

All grasses have been removed from the experimental plots and soil samples taken from each replicated plot initial, 45 DAT and after harvesting. Khurpi and auger are used as sampling tools. The samples were collected in plastic bags. Soil samples were brought to the laboratory, air-dried, crushed and passed through 2 mm rounded sieves. The sieved samples were stored in labelled polythene bags plot-wise for conducting selected laboratory analysis.

"A soil-water suspension was prepared in the ratio of 1:2.5 (10 g soil and 25 ml of distilled water) and pH was recorded with the help of a glass electrode digital pH meter" (Jackson, 1967). "The electrical conductivity of the soil samples was measured in 1:2.5 soil and water suspension at 25^0C temperature by TDS meter" **(**Bower and Wilcox, 1965). "Organic carbon was determined by the modified Walkley and Black's rapid titration method" (Walkley and Black's, 1934). "The available soil nitrogen was determined by the alkaline permanganate method" (Subbiah and Asija, 1956). "The available phosphorus in soil was determined by Olsen's method" (Olsen's et al., 1954). "The available potassium was determined by ammonium acetate method" (Honway and Heidel)[3].

"Plant samples were drawn 45 days after transplanting, and output crops were dried in shade and cut into pieces and then kept in an oven at 700C for 12 hours to make them free from moisture. Oven-dried plant samples were ground in a grinder. After mixing well, the ground samples were kept in labelled sample bags for analysis. Primarily 0.5-gram ground plant sample was digested in sulphuric acid and perchloric acid with a ratio of 9:1, and digested samples were used to determine the nitrogen, phosphorus, potassium and nickel content in the plant. Nitrogen in the plant samples was determined by micro Kjeldahl's method" (Jackson, 1973). "Phosphorus was determined calorimetrically" as described by Jackson (1973). "Potassium in the plant samples was determined by flame photometer procedure" (Jackson, 1973). "The data collected from field and laboratory studies were analyzed statistically using the standard procedure of randomized block design (RBD)", (Cochran and Cox, 1959). Critical difference (C.D.) and standard error of mean were calculated to determine the significance among treatment mean.

3. RESULTS AND DISCUSSION

Table 1 revealed that effects of the Integrated use of organic manure and bio-fertilizers on crop productivity under rice (*Oryza sativa* L.). The results obtained in respect of the effect of the various treatments of organic manure and bio-fertilizers on dry matter, straw and grain yields of rice has been presented in the table. Application of fertilizers alone or in combination with FYM increased the dry matter, grain yield and straw yield significantly over the control. Dry matter yield of rice revealed that different treatments significantly increased the dry matter yield of wheat over control. The dry matter production was significantly higher in treatment where 50% NPK might be applied with FYM as compare to chemical fertilizers alone attributed to higher number of tillers and plant height under integrated application of chemical fertilizers, organic manure and bio-fertilizers applied plot. Similar results were observed by kumar et al. (2012). The effect of various treatments on dry matter production could be arranged in order of T6>T3>T5>T4>T2>T1 and the value were 70.25, 62.15, 59.45, 43.40, 41.25 and 35.59 gm^{-1} row length, respectively. Application of fertilizers alone or in combination with FYM increased grain and straw yield of rice significantly over control (table). Further, the yield was significantly superior under the conjoint use of chemical fertilizers, organic manure and bio-fertilizers over the sole use of chemical fertilizers. On the basis of the evidence collected, the superiority of the treatments may be arranged as T6>T3>T5>T4>T2 and T1. "The integrated use of fertilizers with FYM and bio-fertilizers might have added huge quantity of organic matter in soil that increased grain and straw yield. This might be due to the improvement in physico-chemical properties of soil that resulted in increased productivity by increasing the availability of nutrients**".** Chaudhary and Thakur (2007), Ghose et al. (2003), Singh et al.(2014) and Chesti et al. (2015) also observed the significant effect of chemical fertilizers, organic manure and bio-fertilizers on rice crop. grain yield, straw yield was also recorded significantly higher in T6 (50% NPKS +FYM (10 ton ha-1) + bio-fertilizers (PSB+BGA) as compared to other treatments. The effect of various treatments on straw yield could be arranged in order of T6>T3>T5>T4>T2>T1 and values were 91.75, 86.25, 79.25, 75.75, 70.75 and 62.00 q ha-1 respectively. "The beneficial effect of organic manure (FYM) on yield might be due to an additional supply of plant nutrients as well as an improvement in the physical and chemical properties of soil" Satish et al. and Satyanarayana et al. [4,6].

Table 1. Effect of integrated use of organic manure and bio-fertilizers on dry matter (g m^{-1} row length), grain and straw yield (Q ha^{-1}) of rice crop

Treatment	Dry matter at 60 (DAT) (g m^{-1} row)	Grain yield(Q ha^{-1})	Straw yield(Q $ha^{-1)}$
T_1	35.59	26.25	62.00
T_2	41.25	31.00	70.75
T_3	62.15	43.25	86.25
T_4	43.40	34.25	75.75
T_5	59.45	37.00	79.25
T_6	70.25	46.25	91.75
SEm±	**0.065**	**0.114**	**0.135**
CD (P=0.05)	**0.205**	**0.306**	**0.426**

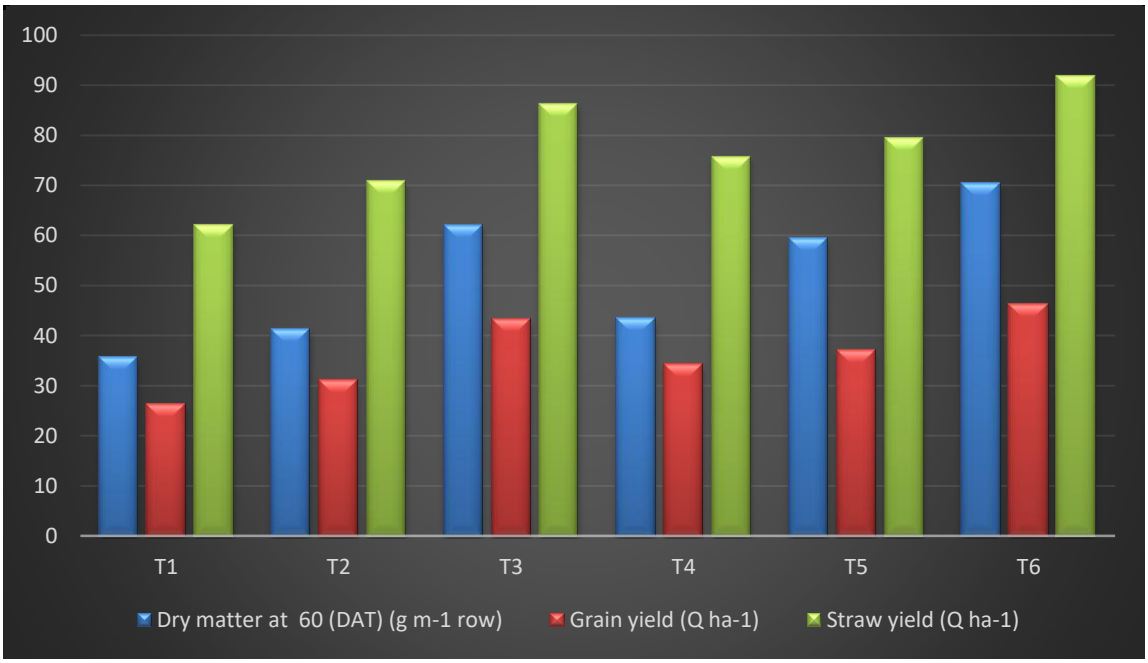

Fig. 1. Effect of integrated use of chemical fertilizers, organic manure, and bio-fertilizers on dry matter (g m^{-1} rowlength), grain and straw yield (Q ha^{-1}) of rice crop

4. SUMMARY AND CONCLUSIONS

An experiment was undertaken with rice crop on sandy loam soil during kharif season (2016) to investigate the effect of integrated use of chemical fertilizers, organic manure and bio-fertilizers on soil properties, growth, yield and nutrient uptake by rice crop. The analysis were T1 (control), T2 (100% NPKS), T3 [100% NPKS + 10 ton ha-1 FYM + Bio-fertilizers (PSB+BGA)], T4 (125% NPKS), T5 (150% NPKS) and T6 [50% NPKS + 10 ton ha-1 FYM + Bio-fertilizers (PSB +BGA)]. The rice experiment was laid out in a randomized block design (RBD) with three replications.

In general, higher number of tillers (15.25 m-1 row length), plant height (92.50 cm), dry matter at 60 DAT (70.25 gm-1 row length), grain yield (46.25 Qha-1) and straw yield (91.25 Qha-1) were obtained with T6 treatment followed by T3>T5>T4>T2>T1 (control).

It is concluded that the application of 50% NPKS + 10 ton FYM ha-1 + Bio-fertilizers PSB + BGA not only produced a higher yield of rice but also enhanced soil fertility as compared to inorganic fertilizers alone. Higher nutrient availability was also recorded in inorganic fertilizers, organic manure and bio-fertilizers treated plots.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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