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Effect of organic manure and PGPR on quality, growth and yield under rice-wheat cropping sequence

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Abstract
A field experiment was conducted at Varanasi, Uttar Pradesh during the year 2008-09 in kharif and Rabi season to see the effect of PGPR and FYM on growth with different doses of organic fertilizers on growth and yield of rice-wheat, soil fertility status, soil health and microbial properties of rhizospheric soil. Significantly Effect the maximum and superior kharif rice grain yield (4.83t/ha), straw yield (5.6t/ha) and protein content (8.51%) on 36 t FYM ha^{1+} and PGPM (Azotobactor + *Azospirillum* + Aspergillus + Trico derma + PSB. and significantly effect on rabi wheat on treatment of 36 t /ha FYM with PGPR (*Azotobactor* + Trico derma) +PSB (*P. fluorescens* + P. *putida* + B. *megatera* + B. *polymyxa*) with yield of grain (3.42 t/ha) and straw (4.38 t/ha) and protein content (9.29%).

Keywords: FYM, PGPR, PGPM, Azotobactor, phosphate solubilizing bacteria, soil fertility, soil health

1. Introduction
The effects of rhizobacteria on an inoculated host may be natural, deleterious or beneficial. The beneficial rhizobacteria have been classified as plant growth promoting rhizobacteria (PGPR) by Kloepper and Schroth (1978) [1]. Several author have reported that inoculation with PGPR can result in increased germination, seedling emergence and modify growth and yield of various cereals and non-cereals crops chin *et al*. (1994) reported that PGPR used in a geographical area outside the isolated source of enrichment had variable effect for improving crop yields. Nowak (1998) found that inoculation benefits of certain stains varied with plant species, cultivar and growth conditions. Chanway *et al*. (1988) [2] further confirmed the specially of PGPR for certain soils and cultivars. Singh *et al*. (2009) [3] viewed that the effect of integrated nutrient management on the yield of rice and wheat, and nutrient uptake by rice-wheat cropping system the result showed that in rice and wheat, 25-50% NPK substituted by FYM, vermin compost. Katyal *et al*. (2001) [6] viewed that the effect of different management practices on soil organic carbon conservation for crop productivity and soil fertility in ricr-wheat cropping system. Sharma *et al*. found the effect of organics and fertilizers on scanted rice (*Oryza sativa* L.) in rice- wheat cropping sequence. Gangwar *et al*. (2008) [7] developed appropriate establishment technique of rice- wheat and to improve the growth, yield, profitability and soil fertility of rice based cropping system. Pirlax *et al*. (2007) suggested that the pseudomonas and bacillus alone or in combination have the potential to increase the yield, growth, and nutrition of apple trees.

2. Materials and Methods
Field experiments were carried out at Varanasi. The city Varanasi lies between 25º.18′ N latitude, 83º.03′ E longitude and 128.93 m above mean sea level. The experimental site lies approximately in the centre of North-Genetic alluvial plain, on the left bank of river Ganges. The soil of experimental field was sandy cly loam in texture having mechanical separates sand 48.86%, silt 30.68% and clay 20.46%, low soil organic carbon (0.34%), low available N (192.3 kg ha^{-1}), medium available P (19.9 kg ha^{-1}) and K (212.0 kg ha^{-1}), bulk density (1.41 Mg M^{-3}), particle density (2.62 Mg M^{-3}), water holding capacity (45.7%), cation exchange capacity (18.70 Cmol (P+) kg^{-1} soil) with neutral pH 7.3 (1:2.5 soil: water ratio). The experiment consisted of twenty four treatment combinations of four levels of FYM (control, 12, 24, 36 t /ha^{-1}), and four levels of FYM and biofertilizers (control + PGPR, 12 t ha^{-1} FYM,

24 t ha-[1] FYM + 36 t ha-[1] FYM) were replicated thrice in a randomized block design the levels of fertilizer and FYM were applied as per treatments. Appropriate management practices were adopted to raise the crop. Growth and yield attribute were recorded at different growth stages of the crop.

3. Procedure for seed inoculation and sowing

Seed inoculation was done just before sowing. Healthy, counted rice and wheat seed weighing for each particular size of plot were taken in to 250ml of different glass beakers. 5ml of sticker solution and 5 ml of desired broth of *rhizobium culture* ware added in to beaker with the help of different sterilized. Through shaking well was done for uniform distribution and good adherence of bacteria cell over the surface of each seed. After a little drying in shade, inoculated seed were sown in different plots at specific depth by hand at evening period. The uninoculated seed were sown first to avoid the risk of contamination followed by treatment wise inoculated seeds in each plots.

4. Results and Discussion

The results obtained from the present investigation are summarized below in the following sub heads:

4.1 Effect of PGPR and FYM on growth, yield and quality of rice in rice- wheat cropping sequence

4.1.1 Effect PGPR and FYM on growth and yield attributes

In rice the number of tillers/m^2 varies from 241 to 288 according to treatment and there was significant difference in organic and PGPR application in subsequent treatment (Table 1) the test weight varies from 22 to 23 gm, the lowest value were recorded under control and the highest value under 36t /ha FYM and PGPM (Azotobactor + *Azospirillum* + *Aspergillus* + *Trico derma* + *PSB*) application in rice which was significantly superior to organic fertilization. Panicale length was at par under organic and organic with PGPM application but grains /panicle were higher in 36 t/ha FYM with PGPM 121 grains per panicle. Under only FYM without PGPM application was (105-113). there was significant difference in the panicle length, grain/panicle, and tillers/m^2, test weight with each successive dose of FYM and FYM with PGPM application of 36 t/ha FYM with PGPM gives better response to growth and yield as compare to another dose.

4.1.2 Effect of PGPR and FYM on Grain and straw yield

Rice yield increased during the successive dose of FYM application but the margin was more with the application of FYM+PGPM as compared to only FYM. It increased under graded doses of FYM application (3.86 to 5.0 t/ha), the highest under 36 t/ha FYM with PGPM 5.46 t/ha in rice (Table 1). Similar trend was observed in the yield of rice straw which was 5.1 to 6.5 t/ha and 5.6 to 6.9 t /ha under FYM and FYM+PGPM respectively. Application of only PGPM gives 4.06 t/ha without applying FYM. Singh *et al*. (2009) [3] viewed that the effect of integrated nutrient management on yield on rice and wheat, and nutrient uptake by rice-wheat cropping system the result showed that in rice and wheat, 25-50% NPK could be substituted by FYM.

4.1.3 Effect of PGPR and FYM on grain quality

In rce, grain protein content was significant difference with different doses of FYM with PGPM (Table 1). Protein content in rice grain was significantly higher under dose of FYM with PGPM was applied compared with zero fertilizer application (table-1) i.e. (8.11 to 8.51%) the highest protein content recorded under the treatment of 36 t FYN with PGPM but difference between highest doze of FYM and FYM with PGPM is 0.40%. Guruswamy and Amutha *et al*. 2009 studied for co-aggregation with other plant growth promoting rhizobacteria, such as Azotobactor chroococcum, *Azorhizobium caulinodans*, and Bacillus magisterium. The co-aggregation efficiency was found to be enhanced by addingcertaincautionions,suchascalcium chloride, aluminium sulphate, magnesium sulphate, ferric chloride and sodium sulphate. combination of *Azospirillum brasilense with Azotobactor chroococcum* using calcium chloride as a concentration of 1.6Mm augmented the highest co-aggregation percentage and floe yield.

4.2 Effect of PGPR and FYM on growth, yield and quality of wheat in rice- wheat cropping sequence

4.2.1 Effect of PGPR and FYM on growth, yield attributes

The plant height of wheat increased significantly with the application of successive doses of FYM and different PGPR and the highest was (89 cm) under FYM treatment as compared with 36 t /ha FYM with PGPR (Azotobactor +PSB + Trico derma) that less. Highest plant height was 90 cm in that treatment. Tiller/m2 were 143 under zero fertilizer application wich increased to 238, at the highest FYM with PGPR (*Azotobactor* + PSB + *Trico derma*) application (table-2). 238 recorded under only PGPR. The test weight (41.53 to 44.06g) of wheat remained affected by FYM and FYM with PGPR, similarly the highest grain /ear 40 were recorded with 36 t /ha FYM with PGPR, that are varies from (27 to 40), under zero fertilization there was recorded as the 22.

4.2.2 Effect of PGPR and FYM on grain and straw yield

Grain and straw yield of wheat increased with successive doses of FYM and PGPR (Azotobactor + PSB + Tricoderma) application, but there was highest yields were obtained under 36 t /ha FYM with PGPR (Table 2), the wheat straw yield ranged from 1.45 to 3.42 t/ha. The highest yield recorded under 36t /ha FYM with PGPR was 3.42 t/ha wich was significantly superior to all the treatment combination. the grain yield range from 1.93 t/ha under zero fertilization of FYM to 4.83 under 35 t /ha FYM with PGPR application, it recorded up to 4.59 t/ha under high dose of FYM without PGPR application as well as 2.79 t/ha was recorded under application of only PGPR without FYM. Aftab Afzal and Ashgari bano (2008) reported that Rhizobioum and phosphorus (P) solubilizing bacteria are important to plant nutrition, the effects of a Rhizobial strain (Thai 8) and a P solubilizer strain in single and dual combination with and without P_2O_5 on wheat in a P deficient natural non – sterilized sandy loam soil. The result of this pot experiment revealed that single and dual inoculation with fertilizer (P_2O_5) significantly increased root and shoot weight, plant height, spike length, grain yield, leaf protein content of the test.

4.2.3 Effect of PGPR and FYM on grain quality

The protein content in wheat increased with increase in the doze of FYM as well as FYM with PGPR, and highest (9.23%) under 36t/ha with PGPR (Azotobacter +PSB + Trichoderma) (Table 2). The protein content on zero fertilizer application, there was 9.01% and the difference befference between the zero fertilizer and higher dose of FYM with PGPR (*Azotobacter* +PSB + *Trichoderma*) recorded as 0.22% so there was significant differene between each successive doze of only FYM and FYM with PGPR. Akhtar *et al*., (2009)

studied integrated use of seed inoculation with growth promoting rhizobacteria (PGPR), compost and mineral fertilizer for improving growth and yield of wheat sown at different plant spacing.

Table 1: Effect of PGPR and organic manure on plant growth, yield attributes and quality of ricin rice – wheat cropping sequence under nascent organic farming system

Treatments	Plant height (cm)	Tillers/m^2	Grains/ears	1000-grains Wt.(g)	Protein content (%)	Grain yield (t/ha)	Strain yield (t/ha)
T_1= Control	27	241	105	22.23	8.11	2.83	3.83
T_2= 12 t FYM ha -^{1}	28	258	108	22.33	8.13	3.86	5.1
T_3=24 t FYM ha -^{1}	28	263	112	22.4	8.17	4.36	5.76
T_4=36 t FYM ha -^{1}	28	267	113	22.56	8.29	5.0	6.5
T_5= T_1+PGPR	27	246	109	22.33	8.12	3.26	4.06
T_6= T_2 + PGPR	29	274	116	22.5	8.26	4.43	5.60
T_7= T_3 + PGOR	30	282	119	22.56	8.30	4.96	6.46
T_8= T_4 + PGPR	30	288	121	22.7	8.51	5.46	6.90
SEM +	0.74004	4.7713	4.223	0.2242	0.0337	0.309	1.187
CD (P=0.05%0	1.58739	10.2346	9.0592	0.4809	0.0724	0.663	0.402

PGPR = *Azotobacter* + *Trichoderma* + PSB (P. *fluroscence* + P. *futida* + B. *megatera* + B *polymyxa*)

Table 2: Effect of PGPR and organic manure on plant growth, yield attributes and quality of wheat in Rice- wheat cropping sequence under nascent organic farming system

Treatments	Plant height (cm)	Tillers/m^2	Grains/ears	1000-grains Wt.(g)	Protein content (%)	Grain yield (t/ha)	Strain yield (t/ha)
T_1= Control	76	143	22	41.53	9.01	1.93	1.45
T_2= 12 t FYM ha -^{1}	87	172	27	42.86	9.08	3.15	2.07
T_3=24 t FYM ha -^{1}	88	181	31	43.36	9.11	4.27	2.56
T_4=36 t FYM ha -^{1}	89	188	37	43.36	9.13	4.59	3.04
T_5= T_1+PGPR	86	171	26	41.90	9.05	2.79	1.96
T_6= T_2 + PGPR	87	192	35	43.43	9.15	3.88	2.67
T_7= T_3 + PGOR	89	234	39	43.63	9.18	4.58	3.05
T_8= T_4 + PGPR	90	238	40	44.06	9.23	4.83	3.42
SEM +	1.00156	3.729	1.3987	0.427	0.0256	0.115	0.141
CD (P=0.05%)	2.14836	7.999	3.0002	0.916	0.0549	0.248	0.302

PGPR= *Azotobactor* + Tricoderma +PSB (*P. fluorescens* + P. *putida* + B. *megatera* + B. *polymyxa*)

5. Conclusion

The effect of FYM and PGPM were T_8 was more effective with maximum and significantly superior on grain yield (4.83t/ha) straw yield (5.6 t/ha), similarly, the same treatment given significantly superior values of yield attributes, T_7 was at par to T_8, as well as highest protein content in T_8 (8.51%).

In second experiment of wheat crop, the treatment of t8 was more effective with highest protein content in grain (9.29%), higher attributes. the same PGPR combination also proved its validity of effectiveness with highest and significant yield of grain (3.42 t ha^{-1}) and straw (4.38t ha^{-1}). the treatment T_7 was next to T8 with at par values.

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