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Interaction effect of organic nutrient management and different aromatic rice varieties on soil properties and available nitrogen, phosphorus and potash in soil

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Abstract
A field experiment was carried out at Research cum Instructional Farm, IGKV, Raipur, during kharif season of 2011. The soil of experiment field was 'Vertisols'. The soil was neutral (pH 7.12) in reaction and medium in fertility having 0.52% organic carbon, low N (205.5 kg ha-1), medium P (17.0 kg ha-1) and high K (345 kg ha-1). The treatments consisted of four aromatic rice varieties as main plot *viz.* Jeeraphool, Kasturi Badshah Bhog and Sugandhamati with six organic nutrient management treatments as sub plot *viz.* T1 (CDM + CCR + Vermicompost), T2 (T1 + BGA + PSB + Azospirillum), T3 (T1 + Rock Phosphate), T4 (T1 + Panchgavya), T5 (T2 + Rock Phosphate + Panchgavya) and T6 (T1 + Neemastra).The results revealed that pH, electrical conductivity and organic carbon (OC) were found to be not affected due to varieties as well as organic nutrient management options. Further, as the OC in soil takes a long time to change hence even different organic nutrient management options had no effect on the OC of the soil. And available N, P and K status of soil due to both varieties and organic nutrient management were not affected due to the different aromatic rice varieties. T_1+ BGA+ PSP + *Azospirillum* + rock phosphate + panchagavya (T_5) helped to store the significantly higher N (261 kg ha^{-1}) and P (21.92 kg ha^{-1}) in soil over the application of CDM + CCR + VC (T_1). T_2 (T_1+ BGA+ PSP + *Azospirillum*) and T_3 (T_1 + rock phosphate) also improved comprehensively the N and P status in soil respectively. Interaction between varieties and organic nutrient management was found to be significant and the highest amount of nitrogen (269 kg ha^{-1}) in soil was obtained in plots of Badshah Bhog (T_4) variety with T_5 (T_2 + RP+ panchagavya).

Keywords: Interaction, organic, nutrient, management, phosphorus

Introduction
The slogan 'Rice is life' is most appropriate for India as this crop plays a vital role in our national food security and is a means of livelihood for millions of rural households. More than 90% of world's rice is grown and consumed in Asia, where 60% of the earth's people live. Rice accounts for 35 to 75 perscent of the calories consumed by more than 3 billion Asians (Kumar *et al.*, 2006) [3] and is planted to about 154 m ha annually or on about 11 perscent of the total world's cultivated land. India is the second largest producer after China and has an area of over 43.77 m ha under rice and produced 89.05mt during 2010 (Anonymous, 2011a) [1]. In India, Chhattisgarh state is considered as one of the centre of origin and evolution of rice and is blessed with resources of rice variability. Being endowed with the most favorable climate, the Chhattisgarh state has an excellent geographical centre of diversity particularly rice including aromatic cultivars. In Chhattisgarh, rice occupies an area around 3.61 m ha with the production of 5.22mt and productivity of 1619 kg ha^{-1} (Anonymous, 2011b) [2].

Rice quality is considered from the viewpoint of milling quality, grain size, shape, appearance and cooking characteristics. Consumer judges the quality of rice mostly on its appearance, particularly the colour, size and shape and on its elongation during cooking. While, maintaining its quality too. This objective cannot be achieved by chemical nutrients source only. Because it is considered that, the quality characteristics of aromatic rice are improved through organic sources of nutrient on sustainable yield basis. Farmers of the state have been practicing *in situ* green manuring and using organic manures for years and sustained variety aroma and special taste. FYM is very common source of nutrients to the farmers of Chhattisgarh, which is prepared easily and contains substantial amount of plant nutrients. However, unfortunately during last 40-50 years, these local varieties have lost their specific scent and taste due to one or another reason.

This might be due to use of chemical fertilizers or by increasing use of pesticides or due to pollution.

Sustainable agricultural productivity and improvement in soil health and soil physical properties can be achieved by the use of organic manures and biofertilizer etc. Using organic resources like, cow dung manure, compost crop residue, vermicompost, blue green algae, phosphorus solubilizing bacteria, rock phosphate and *Azospirillum* etc. deserves priority for sustained production and better resource utilization in organic nutrient management.

The role of plant nutrient would be extremely important from sustainability point of view. Nitrogen is the key nutrient element limiting the yield of rice. Fertilizer N use efficiency varies from 18 to 40 perscent in different rice soils, because applied inorganic N is rapidly lost from the soil by ammonia volatilization and denitrification. Organic materials minimize N loss and increase N use efficiency. With the increasing trend in price of fertilizers and the reduction in the use of chemical fertilizers it has become necessary to judiciously manage the inflow of organic sources of nutrients. Therefore, information needs to be generated with respect to suitable combination of different organic sources and inclusion of biofertilizers and organic preparations to develop the suitable nutrient management practices for better quality and high productive fine and fine scented rice varieties by organic sources of nutrients to increase the nutrient use efficiency as well as sustainability. Improvement in inherent nutrient supplying capacity of the soil and improved physical properties due to application of different organic nutrient sources has been well documented (Hati *et al.*, 2006) [4], and might have promoted better rooting, higher water and nutrient uptake by rice (Zhang *et al.*, 1998) [5].

Materials and Methods

The field experiment was conducted during *Kharif* season of 2011 at the Research cum Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). Raipur is situated in mid – eastern part of Chhattisgarh state and lies at 21^0 16’ North Latitude and 81^0 36' East Longitude with an altitude of 314.15 m above the mean sea level. Raipur comes under the Chhattisgarh plains agro climatic sub zone and having dry moist to sub humid climatic condition. The region receives an average of 1200-1400 mm annual rainfall, out of which about 87 percent received during the rainy season (June to September) and the rest 13 percent during the winter season (October to February). January is the coolest and May is the hottest month. The maximum temperature ranges from 26.7 ^{0}C and 42.5 ^{0}C. Atmospheric humidity varies between 70 to 90 per cent from mid June to March and wind velocity is high from May to August with its peak in June to July months. Soil surface temperature of this region crosses 60 ^{0}C, air temperature to 48 ^{0}C and humidity drops down to 3 to 4 per cent during summer season.

The experiment was laid out in split plot design with 3 replication. The main plot consisting of four aromatic rice varieties *viz.* Jeeraphool, Kasturi Badshah Bhog and Sugandhamati with six organic nutrient management treatments as sub plot *viz.* T_1 (cowdung manure + composted crop residue + Vermicompost), T_2 (T_1 + BGA + PSB + *Azospirillum*), T_3 (T_1 + Rock Phosphate), T_4 (T_1 + Panchagavya), T_5 (T_2 + Rock Phosphate + Panchagavya) and T_6 (T_1 + Neemastra). Rice varieties were transplanted in rows with planting geometry of 20 X 10 cm on July 20, 2011 and harvested on November 05, 2011 and November 16, 2011 due to different duration of varieties. The crop received 1193.7 mm rainfall during the study period.

All the organic sources of nutrients and rock phosphate were applied as per the treatments in respective plots to fulfill the nutrient requirement of 50:50:30 kg N: P_2O_5: K_2O ha^{-1}. Entire quantity of all sources was applied 4 days before the transplanting. Blue green algae were applied 10 days after transplanting as top dressing. 3-5 cm water level was maintained to up 25-30 days for better growth of Blue green algae. All the three main sources- i.e. cow dung manure, compost crop residue, and vermicompost were applied on N basis (1/3 of each) 4 days before the transplanting. Accordingly, 2563 kg ha^{-1} cow dung manure, 3332 kg ha^{-1} compost crop residue, and 1041 kg ha^{-1} of vermicompost were required to fulfill the required N to the crop in each and every treatment. These quantities of all three nutrient sources supplied 21.53 kg ha^{-1} (6.92+7.33+7.28 respectively) of P and 37.71 kg ha^{-1} (12.30+15.00+10.41 respectively) of K. Chemical analysis of Cow dung manure (CDM), Compost crop residue (CCR), and vermicompost (VC) were done before basal application. In order to evaluate the nutrient status of soil, 15 randomly selected samples from 20 cm depth of the experimental field reduced to a composite sample for mechanical and chemical analysis. Soil samples for various soil physico-chemical properties i.e. pH, electrical conductivity, organic carbon, available nitrogen, available phosphorous and available potassium were analyzed after harvest of crop.

Results and Discussion

PH of soil

The pH of soil ranged from 7.04 to 7.19 among different varieties and from 7.05 to 7.16 among organic nutrient management treatments but did not differed significantly (Table 1); however higher pH value was recorded with variety Sugandhmati planted plots and lowest under Kasturi. Whereas, in different organic nutrient supply, highest pH was recorded with T_6 (T_1 + Neemastra). Slight decrease in pH was recorded in T_3 (7.07) and T_5 (7.05) due to the application of phosphorus in form of rock phosphate.

Table 1: Effect of organic nutrient management and different aromatic rice varieties on pH, EC and organic carbon in soil

Treatment	pH	EC (dsm^{-1})	OC (%)
Aromatic rice varieties			
V_1=Jeeraphool	7.09	0.34	0.531
V_2=Kasturi	7.05	0.34	0.532
V_3=Badshahbhog	7.04	0.35	0.528
V_4=Sugandhmati	7.19	0.36	0.527
S.Em+	0.18	0.04	0.020
CD (P = 0.05)	NS	NS	NS
Organic nutrient management			
T_1= CDM+CCR+VC	7.11	0.33	0.527
T_2=T1+BGA+PSB+Azo	7.07	0.33	0.527
T_3=T1+RP	7.07	0.37	0.529
T_4=T1+ Panchagavya	7.08	0.36	0.528
T_5=T2+RP+ Panchagavya	7.05	0.35	0.534
T_6=T1+Neemastra	7.16	0.35	0.531
S.Em+	0.30	0.05	0.023
CD (P = 0.05)	NS	NS	NS

EC of Soil

The data on EC are presented in Table 1. The reading of electrical conductivity ranged from 0.33 to 3.37 and found to be not significantly affected due to varieties as well as organic nutrient supply. Among varieties highest reading of EC of soil was recorded under variety Sugandhamati that was at par with all other varieties. The lowest reading was recorded under Jeeraphool and Kasturi.

Among organic nutrient supply, the highest reading of EC was obtained with T_3 (T_1 + Rock phosphate) and lowest with T_2 (T_1 + BGA + PSB + *Azospirillum*) and T_1 (CDM + CCR + Vermicompost).

Organic Carbon

The data on organic carbon (OC) are presented in Table 1. It is obvious that as OC is a soil property, it was not influenced by the different rice varieties. Since the organic carbon in soil takes a long time to improve over initial hence even different organic nutrient management options had no effect on the OC of the soil Treatment T_5 (T_2 + RP+ Panchagavya) recorded higher percent of organic carbon (0.534) but found no significantly superiors with any of other treatment as well as variety.

Available N

Available Nitrogen status of soil after harvesting of rice are shown in Table 2. The data on available N status in soil clearly shows that it was not significantly affected due to different rice varieties at harvest. However, Application of BGA+ PSB + *Azospirillum*, (T_2), and BGA+ PSP + *Azospirillum* + rock phosphate + Panchagavya (T_5) helped to accumulated the significantly higher N in soil over the application of cow dung manure, composted crop residue and vermicompost (T_1). T_5 (T_2 + rock phosphate + panchagavya) stored highest N (261 kg ha^{-1}) in soil.

Interaction between varieties and organic nutrient management was found to be significant and the highest amount of nitrogen (269 kg ha^{-1}) in soil was obtained in plots of Badshah Bhog (T_4) variety with T_5 (T_2 + RP+ panchagavya). However, all other varieties with same application of organic nutrients as in T_5 was found to be similar and recorded at par value. Similarly, T_2 (T_1 + BGA+ PSB + *Azospirillum*) with variety Sugandhamati, Badshah Bhog and Kasturi varieties was also significantly superior over Jeeraphool and found at par among each other (Table 3).

Available P

The data on available P status in soil are presented in Table 2, which clearly shows that different rice varieties have no significant effect in terms of P status of soil after harvest of crop. As far as organic nutrient management factor is concerned, application of CDM+CCR+VC alongwith BGA+ PSB+ *Azospirillum* + rock phosphate and panchagavya (T_5) significantly recorded higher amount of P in soil over rest of the treatment. However this treatment was at par with T_3 and T_2. The lowest amount of P in soil was obtained with plot of treatment T_1. In different treatments available P ranged from 17.58-21.92 kg ha^{-1}. Application of rock phosphate in T_3 and T_5 and use of PSB increased the available P in soil as compared to T_1, T_4, and T_6. Use of PSB solubilized the native as well as applied phosphorus in the form rock phosphate reduced the P fixation.

Table 2: Effect of organic nutrient management and different aromatic rice varieties on available nitrogen, phosphorus and potash in soil

Treatment	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
Aromatic rice varieties			
V_1=Jeeraphool	237	18.68	347
V_2=Kasturi	244	19.16	346
V_3=Badshahbhog	241	18.71	344
V_4=Sugandhmati	248	18.76	344
S.Em+	14	1.27	30
CD (P = 0.05)	NS	NS	NS
Organic nutrient management			
T_1= CDM+CCR+VC	225	16.58	346
T_2=T1+BGA+PSB+Azo	257	18.86	341
T_3=T1+RP	237	21.87	345
T_4=T1+ Panchagavya	240	17.10	347
T_5=T2+RP+ Panchagavya	261	21.92	353
T_6=T1+Neemastra	234	16.64	340
S.Em±	11	1.34	31
CD (P = 0.05)	30	3.82	NS

Table 3: Interaction between organic nutrient management and aromatic rice varieties on available nitrogen (kg ha^{-1}) in soil

Varieties Organic nutrient management	Jeera phool (V_1)	Kasturi (V_2)	Badshah bhog (V_3)	Sugandh mati (V_4)	Mean
T_1= CDM+CCR+VC	202	235	220	242	225
T_2=T1+BGA+PSB+Azo	236	254	262	268	255
T_3=T1+RP	236	247	223	242	237
T_4=T1+ Panchagavya	244	234	243	238	240
T_5=T2+RP+ Panchagavya	261	253	269	262	261
T_6=T1+Neemastra	234	238	239	236	234
Mean	202	235	220	242	225
	S.Em+	CD (P=0.05)			
Interaction	5	15			

Available K

Data presented in Table 2 reveal that all varieties as well as organic nutrient management was found to be non significant. However, application of T_2 + RP + panchagavya in T_5 recorded higher potash in soils while the lowest was obtained with combination of T_1 and Neemastra. The value of available K in soil ranges from 341-353 kg ha^{-1}.

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