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Effect of integrated nutrient management on yield, nutrient availability and soil health of basmati/aromatic rice (*Oryza sativa* L.) in Inceptisol of eastern Uttar pradesh

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Abstract
Field experiment for quality rice production of scented rice variety Pusa Basmati & NDR- Lalmati was conducted on student's instructional farm, Narendra Deva university of Agriculture & Technology Narendra Nagar Faizabad in during *Kharif* season of 2013-14. The treatment were included inorganic and organic combinations. The treatments were replicated thrice in Factorial Randomized Block Design. The variety Pusa Basmati recorded higher grain and straw yield as compare to NDR-Lalmatiin both year of investigation. Maximum N P K uptake were recorded with the treatment T_2, followed by T_4 and T_1, which were statistically superior over T_3 and T_5. The minimum N P Kuptake were recorded in T_6 in both year of investigation. The application of FYM or GM might be have modified the physical condition of the soil and help in absorption and translocation of nutrients from soil. The application of fertilizer in combination with organic manure is known to improve various physico-chemical properties resulting in enhanced nutrient absorption and uptake and maximum grain (basmati-33.77 and NDR lalmati-30.09 qha^{-1}) and straw yield (basmati-49.69 and NDR lalmati-43.80 qha^{-1}) of aromatic rice was recorded under Integrated Nutrient Management of 100% NPK + 5 t FYM followed by treatment T_1 and T_4in both year of investigation.

Keywords: Grain, straw yield and nutrient uptake.

Introduction
Rice (*Oryza sativa* L.) is the most important staple food crop in the World. It is the rich source of energy and contains reasonable amount of protein (6-10%), carbohydrate (70-80%), mineral (1.2-2.0%) and vitamin (Riboflavin, Thiamine, Niacin and Vitamin E) (*Anonymous* 2014). The role of organic farming has been much emphasized in agriculture, but comprehensive evaluation of its efficiency and applicability in Asian countries, especially in India, is still required. Organic farming has emerged as an important priority area globally in view of the growing demand of safe and healthy food and long term sustainability; and concern on environmental pollution associated with indiscriminate use of agrochemicals. Though the use of chemical inputs in agriculture is inevitable to meet the growing demand for food in the world there are opportunities in the selected crops niche areas where organic production can be encouraged to tape the domestic export market (Singh and Singh, 1986). Application of Farm Yard Manure, Green manure are abundant in paddy fields and also referred as paddy organisms In addition, organic manuring of rice with farm yard manure (FYM) is practiced by Asian farmers and regarded as an important source of nutrient for rice (Singh, 1985; Watanabe, 1984). The FYM are generally low in nutrient content, so their high application rates are needed to meet crop nutrient requirement. Under these limitations, organic manures may be used in combination with other inputs for organic productions. India alone produces nearly one fourth (22%) of the total rice in the world. Globally, it rank 1st in respect of area (45.35 ha) and second (106.54 million tons) in production (Anonymous, 2014) [1]. The interaction of chemical fertilizers with the soil is considered less favorable to the soil environmental in comparison to organic sources of crop nutrient. Organic manures like farm yard manure (FYM) and green manure (GM) in association with chemical fertilizers would play an important role in quality production of scented rice and maintenance of soil fertility and health. The long grained local scented variety i.e. Narendra-Lalmati is also grown in Faizabad and nearly districts. The reason behind decreasing area and grain quality are lacking standard cultural practices, use of agrochemicals and inorganic fertilizer, lack of seed production system for local scented varieties. Crop Research Station Masodha has developed the improved aromatic rice variety, Narendra-Lalmati.

The information about integrated nutrient management practices for quality rice production for this variety is lacking. The area under its cultivation has remained at 0.5-0.6 million hectares and production has stagnated at 1.0 to 1.5 million tones. The scented rice variety Pusa Basmati can't be grown beyond stipulated tracts in Haryana, Punjab and Uttaranchal because the agro-climatic conditions of these areas are suitable for aroma and production of basmati rice and beyond this area it would lose aroma and essential traits. The reason is the extra importance given to basmati, which has overshadowed the existence of more than 300 non-basmati scented rice varieties in India.

Material and Methods

The field experiment was conducted on student's instructional farm, Narendra Deva university of Agriculture & Technology Narendra Nagar (kumarganj) Faizabad in during *Kharif* season of 2013-14. The treatment *viz*. T_1:RDF NPK (100:50:50) × V_1, T_2: RDF NPK + 5 tons FYM/ha × V_1, T_3: 75% RDF NPK+25%N with FYM × V_1, T_4: 75% RDF NPK+25%N with Green Manure × V_1, T_5 : 50% RDF +25%FYM- N+25% GM-N × V_1, T_6 : 20 tons FYM/ha × V_1, T_7 : RDF NPK (100:50:50) × V_2, T_8 : RDF NPK + 5 tons FYM/ha × V_2, T_9 : 75% RDF NPK+25%N with FYM × V_2, T_{10}: 75% RDF NPK+25%N with Green Manure × V_2, T_{11} : 50% RDF +25%FYM- N+25% GM-N × V_2, T_{12} : 20 t FYM/ha × V_2. Were comprised in factorial RBD. replicated as thrice. The soil of the experimental field was alluvial, partially reclaimed sodic soiltexture slit loam, sand 24.01, silt 56.71, clay 19.28% having pH (1:25) 8.12, EC 0.35dSm^{-1}, Organic Carbon 0.36%, CEC 14.96 (cmole (p+)/kg), Available Nitrogen 142.40, Phosphorus 16.86, Potassium 250.97 kg ha^{-1}, Zinc 0.62, Fe 0.65 ppm. There were six treatment combination replicated three times in factorial RBD. Scented rice Pusa basmati and NDR- Lalmati were grown as the test crop. The grains thus obtained were air-dried to maintain 12 per cent moisture and grain yield was recorded from each net plot. The grain and straw yield were recorded at maturity. The soil samples were collected as initial before and after harvest of the crop and analysed for chemical properties by following standard methods (Jackson, 1973) [2].

Result and discussion

Yield

Data on crop yield in the application of factorial RDF alone in combination of organic manure and inorganic are presented in table 1. The highest grain (36.96 qha^{-1}) and straw yield ((54.12q ha^{-1}) was recorded of rice were obtained with the application of T_2: RDF NPK + 5 tons FYM/ha × V_1 through inorganic fertilizer which was however, on followed by T_1: RDF NPK (100:50:50) × V_1. The variety Pusa basmati recorded higher grain and straw yield as compare to NDR-Lalmatiin both year of investigation. Treatment T_2maximum grain and straw yield, followed by T_1 and T_4. The minimum grain and straw yield were recorded in T_6 in both year of investigation. Interaction among varieties and different nutrient INM was found non- significant (Ghosh, A. 2007) [6]. The variety NDR-Lalmati recorded higher harvest index as compare to Pusa basmati in both year of investigation. Treatment T_6 maximum harvest index, followed by T_5 and T_2. The minimum harvest index was recorded in T_4 in both year of investigation. Interaction among varieties and different nutrient INM was found non- significant.

Soil Properties

The results revealed that improved soil physical conditions reflected soil reaction when applied chemical sources of nutrients continuously. Integration of organic sources with organic manure was found more effective as compared to single application in building up fertility and improving physical status of soil (Pandey *et al* 2008) [13]. The variety is recorded non-significant difference in pH has been observed in both year of investigation. The maximum pH in soil were recorded with the treatment T_1 followed by T_4 and T_2. The minimum pH in soil were recorded in T_5 in both year of investigation. The variety is recorded non-significant difference in EC has been observed in both year of investigation. The maximum O.C. in soil was recorded with the treatment T_6 Followed by T_5 and T_4. The minimum O.C. in soil were recorded in T_1 in both year of investigation. The maximum C.E.C. in soil were recorded with the treatment T_2 followed by $T_1$and T_3. The minimum C.E.C. in soil were recorded in T_6 in both year of investigation. The maximum available zinc in soil were recorded with the treatment T_2 followed by T_1 and T_3 (Mondal *et al* 2004) [11]. The minimum available zinc in soil were recorded in T_6 in both year of investigation. The maximum available iron in soil were recorded with the treatment T_2 followed by T_1 and T_4. The minimum available iron in soil were recorded in T_6 in both year of investigation. The maximum available N.P.K in soil were recorded with the treatment T_2 followed by T_1 and T_4. The minimum available nitrogen in soil were recorded in T_6 in both the year of investigation.

Conclusion

INM as well as organic manure applied treatment generally improved soil heath and availability of NPK after harvest. It could be concluded from the study that for maximum growth yield and quality scented rice production. Variety Pusa Basmati should be grown with application of 100% RDF-NPK + 5t FYM ha^{-1}.For sustainable production of good quality rice in Inceptisol of U.P. the variety Pusa Basmati should grown by giving 100:50:50 NPK supplemented with 5t FYM ha^{-1}. On the basis of present investigation, it can be concluded that the T_5 -75% RDF with inorganic fertilizer +5 tons FYM found most effective in increasing the growth, yield and quality of rice and also helped in maintaining soil health for sustainable rice production.

Table 1: Effect of integrated nutrient management on grain yield, straw yield, harvest index and nutrient availability in soil

Treatment	Grain Yield (q ha^{-1})	Straw Yield (q ha^{-1})	Harvest Index (%)	pH in Soil	E.C. (dSm^{-1})	O.C. (%)	CEC {c mol(p+) kg^{-1}}
	2014	2014	2014	2014	2014	2014	2014
Varieties							
Pusa Basmati	33.77	49.69	40.48	8.11	0.30	0.32	14.17
NDR-Lalmati	30.09	43.80	40.74	8.14	0.32	0.34	14.74
SEm±	0.62	0.92	0.75	0.07	0.003	0.003	0.12
C.D. at 5%	1.82	2.70	2.21	NS	NS	NS	NS

INM							
T1- RDF NPK (100:50:50)	34.10	50.55	40.29	8.27	0.33	0.31	14.81
T2- RDF NPK + 5 t FYM ha^{-1}	36.96	54.12	40.58	8.12	0.33	0.32	14.91
T3- 75% RDF NPK+25%N with FYM	32.96	48.23	40.58	8.02	0.32	0.33	14.31
T4- 75% RDF NPK+25%N with GM	33.48	49.06	40.58	8.21	0.29	0.33	14.30
T5- 50% RDF NPK+25% FYM-N+25% GM-N	29.08	42.52	40.64	8.00	0.31	0.34	14.21
T6- 20 t FYM ha^{-1}	25.00	36.00	40.99	8.11	0.29	0.37	14.19
SEm±	1.07	1.59	1.30	0.12	0.004	0.005	0.21
C.D. at 5%	3.15	4.68	3.82	NS	NS	0.013	NS

Table 2: Effect of integrated nutrient management on nutrient availability in soil

Treatment	**Available N in Soil (kg ha^{-1})**	**Available P in Soil (kg ha^{-1})**	**Available K in Soil (kg ha^{-1})**	**Zn (ppm)**	**Fe (ppm)**
	2014	2014	2014	2014	2014
Varieties					
Pusa Basmati	190.42	18.52	250.80	0.78	0.76
NDR-Lalmati	189.56	18.27	249.76	0.75	0.74
SEm±	1.56	0.15	2.01	0.006	0.006
C.D. at 5%	NS	NS	NS	NS	NS
INM					
T1- RDF NPK (100:50:50)	193.84	19.36	248.84	0.82	0.77
T2- RDF NPK + 5 t FYM ha^{-1}	194.72	20.50	264.41	0.92	0.80
T3- 75% RDF NPK+25%N with FYM	193.19	18.40	249.59	0.79	0.75
T4- 75% RDF NPK+25%N with GM	193.45	18.13	248.25	0.78	0.76
T5- 50% RDF NPK+25% FYM-N+25% GM-N	183.76	18.14	246.64	0.68	0.71
T6- 20 t FYM ha^{-1}	181.00	17.05	243.97	0.64	0.70
SEm±	2.70	0.26	3.48	0.01	0.01
C.D. at 5%	7.91	0.75	10.20	NS	NS

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