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Impact of inorganic nitrogenous fertilizers and FYM combinations on plant height at various phases of rice growth and combinations on number of tillers per hill at various stages of effective tillers per hill during rice harvest (*Oryza sativa* L.)

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Abstract
A pot culture experiment entitled **"**Impact of inorganic nitrogenous fertilizers and FYM combinations on plant height at various phases of rice growth and combinations on number of tillers per hill at various stages of effective tillers per hill during rice harvest (*Oryza sativa* L.)" was conducted at Institute of Agricultural Sciences farm, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar Odisha. on sandy loam soil during kharif 2018-2019.The experiment consisted of eight treatments viz. T_1-Control, T_2- 50% RDF, T_3-50% RDF + FYM @ 5 t ha^{-1}, T_4-75% RDF, T_5-75% RDF + FYM @ 5 t ha^{-1}, T_6- 100% RDF (NPK 80:40:40), T_7-100% RDF + FYM @ 5 t ha^{-1} and T_8-150% RDF. The experiment was laid out in a Randomized Block Design with three replications. The results revealed that highest and significant values were recorded with respect to growth parameters i.e., plant height, number of tillers per hill, effective tillers per hill and yield attributes i.e., number of panicles per hill, panicle length, number of filled grains 1000 seed weight (test weight) in the treatment that received 100% RDF + FYM @ 5t ha^{-1}. Combination of FYM (5 t ha^{-1}) with lower levels of RDF (50 and 75% RDF) also registered higher increase in the above parameters as compared to the application of inorganic fertilizers alone with the corresponding levels. Grain and straw yields followed the same trend as that of growth parameters and at higher levels of nitrogen in the inorganic form (150 % RDF) the values of the various parameters including grain and straw yield were significantly lower than the treatment where 100% RDF +FYM @ 5 t ha^{-1}was applied. More nutrient content (N, P, K) in grain and straw was observed with the application of 100% RDF + FYM @ 5t ha^{-1} as compared with 100 and 150% RDF. With the combined application of 100 percent RDF as an inorganic source and 5tha^{-1} FYM as an organic source, improvements in physico-chemical characteristics such as organic carbon, bulk density, porosity, and accessible macro nutrients (N,P,K) were found.

Keywords: Inorganic nitrogen, FYM, plant growth and yield, yield attributing characters, integrated nutrient management

1. Introduction
Rice (*Oryza sativa* L.) is one of the most important cereal crop in the world. It is staple food of more than 70% of world population. At global level, rice is grown on an area of about 155.62 million ha with production and productivity of 461 million tones and 4.09 tha^{-1}, respectively. In India it is the most important staple food, contributing 45% to the total food grain production. Its demand in India is bound to increase with growing population, which is projected to be 1.301 and 1.378 billion by 2020 and 2030 respectively.India ranks first in respect of area (44.50 million ha), second in production with 102.75 million tones, only after China, but the productivity of rice is very low with 2.20 tones ha^{-1}.The state of Orissa lies in the tropical belt in the eastern region of India 17°31' -22° 27' north latitude and 81° 27'-87°30' east longitude. Odisha cultivates rice in 4.18 million ha with an annual production of 7.58 million tones and average yield of 1815 kg ha^{-1}. The area of rice in Odisha contribute to 8.51% of gross rice cultivated area of the country. However its productivity is 33.55% less than the national productivity (GOI, 2014). The state economy is directly linked with improvements in production and productivity of rice in the state (Das, 2012) [2]. The best remedy for soil fertility management is, therefore, a combination of both inorganic and organic fertilizers,

Where the inorganic fertilizer provides nutrients and the organic fertilizer mainly increases soil organic matter and improves soil structure and buffering capacity of the soil (Jobe, 2003) [4]. The continued use of inorganic fertilizers over the years in paddy field without application of organic amendments resulted in the change of soil structure as well as decreasing the soil fertility (Sannathimmappa *et al*., 2015) [14]. Use of organic matter to meet the nutrient requirement of crops would be an inevitable practice in years to come, particularly for resource poor farmers. Furthermore, ecological and environment concerns over the increased and indiscriminate use of inorganic fertilizers have made research on use of organic materials as a source of nutrients very necessary.

2. Materials and Methods

A pot culture experiment was conducted to study the "Impact of inorganic nitrogenous fertilizers and FYM combinations on plant height (cm) at various phases of rice growth and combinations on number of tillers per hill at various stages of effective tillers per hill during rice harvest (*Oryza sativa* L.)" during kharif 2018-2019 at Institute of Agricultural Sciences farm, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar Odisha. The material used and techniques adopted in conducting the experiments for collection of soil and plant samples, analytical methodologies followed and statistical methods adopted are presented in this article.

The pot culture experiment was conducted at Research farm, Campus-4, Institute of Agricultural Science, Sikhsha 'O' Anusandhan, Bhubaneswar, Odisha during 2018-2019. The experimental site lies at 85.7920°E longitude and 20.2588 °N latitude with an elevation of 50.6 meter above mean sea level. The experimental location experiences tropical climate with a maximum temperature ranged from 31.5 to 28.5 ˚C and a minimum temperature ranged from 18.7 to 13.0 ˚C. Besides, the experimental site received an average rainfall of 3.7 mm. The relative humidity varied from 48 to 38 percent. For the pot culture experiment, composite surface (0-15 cm) soil samples were obtained from the Campus-4 farm field. The soil belongs to the Alfisol category and has a sandy loam texture. For the experimental set up, 10 kg of soil was poured in 12 kg capacity clay pots with eight treatments and three replications, then air dried, sieved through a 2 mm sieve, and kept in polythene bags for initial investigation of physico-chemical characteristics using standard analytical technique.

3. Results and Discussion

The department of soil science, Institute Of Agricultural Sciences, Siksha 'O' Anushandhan University, Bhubaneswar, undertook a pot culture experiment. The soil sampled had an acidic response, with a pH of 5.65. The soil's electrical conductivity was non-saline, and the texture was sandy loam. Soil had a bulk density of 1.58 g/cc and a particle density of 2.64 g/cc. The soil had a moisture content of 26%. The soil has a Cation Exchange Capacity of 5.8 mol (P+) kg-1. The soil had a low organic carbon content and a medium phosphorus and potassium content.

3.1. Plant height

Application of inorganic nitrogenous fertilizers alone and in combination with farmyard manure (FYM) increased plant height up to 90 days after transplanting (DAT) and subsequently it slowed down between 90 DAT and at harvest mainly due to demand of photosynthetic activity to meet the reproductive requirement after reduction division stage (Table.1). In the present study the height of plants increased with increasing fertility level from T_1 (Control) to T_8 (150% RDF) and also indicated that there was significant effect of different treatments on height of rice crop. Highest plant height (101.19 cm) (Table -1) was recorded with treatmentT_7 (100% NPK (80: 40: 40 kg ha^{-1} as RDF + FYM @ 5t/ha) which was at par with application of 150% RDF (T_8). The treatment (T_7) recorded taller plant heights significantly superior over control/ under fertilized pots (T_1 to T_6) at all the growth stages and at harvest stage. The 50% and 75% of RDF combined with FYM 5t ha^{-1} resulted in significant increase in plant height as compare to control (62.79 cm) but insignificant to full 100% and 150% RDF and 100% RDF in combination with FYM (5t ha^{-1}). This observation may be due to higher availability of nutrients in the soil for plant food at higher nutrient doses as well as slow and continuous release of nutrients from FYM, which enhanced cell division, elongation as well as various metabolic processes which ultimately increased the plant height. The results have got close conformity with the findings of Singh *et al*., (2018) [15], Murthy (2002), Kumari *et al.* (2010) [7] Krishna *et al.*, (2008) [5], Dutt and Chauhan (2010) [5], Murthy (2012) [8] and Pan *et al*., 2009 [10].

Table 1: Impact of inorganic nitrogenous fertilizers and farmyard manure combination on plant height (cm) at different growth stages of rice

Treatment	Days after transplanting(DAT)			
	30 DAT	60 DAT	90 DAT	At Harvest
T_1 - Control	51.55	53.26	63.01	62.79
T_2 - 50% RDF	51.93	67.55	80.72	81.16
T_3 - 50% RDF + FYM @5t/ha	54.57	71.50	90.31	90.73
T_4 - 75% RDF	57.25	72.54	91.36	92.16
T_5 - 75% RDF + FYM @ 5t/ha	60.62	82.05	92.73	93.58
T_6 - 100% RDF	62.70	75.39	95.49	96.31
T_7 - 100% RDF + FYM @ 5t/ha	63.70	81.69	99.56	100.19
T_8 - 150% RDF	62.96	79.84	98.45	99.35
S.Em±	4.17	0.83	0.66	0.74
CD (P=0.05)	NS	2.52	2.01	2.25

3.2. Number of tillers per hill

The data revealed that number of tillers per hill at 30 and 90 DAT and effective tillers per hill at harvest (Table 2) indicated increase up to the stage of 90 DAT, thereafter. Declined with the advancement in age. The reduction in the number of tillers at harvest resulted due to the ageing and senescence which was responsible for dying of the secondary and tertiary tillers. Among the different treatments, 100%

NPK + FYM 5 t ha^{-1} (T_7) significantly enhanced the number of tillers (19) at 90 DAT and effective tillers per hill (18.33) over control (7.33 and 6.33) which was at par with100% and 150% NPK. Tillering is the product of the expansion of auxiliary buds which is closely associated with the nutritional conditions of the Culm because a tiller receives carbohydrate and nutrient from the Culm during its early growth period which improved by the application of nitrogen (Tisdale and Nelson, 1985). Similarly, Bellakki *et al.,* (1998) [18, 1] reported the superior performance of organic N as FYM /GM might be owing to reduced loss of N by fixation of NH_4^+ ion with humus present in FYM and increased availability of N to crop which ultimately increased the tillers. Nayak *et al.,* (2007) [9] reported a significant increase in number of effective tillers per hill due to application of chemical fertilizer with organic manure. Similar results were also reported by several other scientists (Sahu *et al*., 2018 [11], of Singh *et al*., (2018) [15].

Table 2: Impact of inorganic nitrogenous fertilizers and farmyard manure combinations on number of tillers per hill at different growth stages and effective tillers per hill at harvest of rice

Treatment	Days after transplanting(DAT)		
	30 DAT	90 DAT	At Harvest
T_1 - Control	6.00	7.33	6.33
T_2 - 50% RDF	7.33	8.33	7.33
T_3 - 50% RDF + FYM @5t/ha	9.00	9.00	8.00
T_4 - 75% RDF	10.00	12.00	11.33
T_5 - 75% RDF + FYM @ 5t/ha	12.00	14.00	13.33
T_6 - 100% RDF	12.67	16.00	15.33
T_7 - 100% RDF + FYM @ 5t/ha	14.00	19.00	18.33
T_8 - 150% RDF	13.33	18.00	15.67
S.Em±	0.62	0.42	0.79
CD (P=0.05)	1.87	1.26	2.39

4. Conclusion

Due to enhanced nutrient availability, the use of 5t FYM ha^{-1} in conjunction with 100 percent RDF boosted grain production and yield attributing features of rice, as well as improved soil physical, chemical, and biological qualities. As a result, using FYM 5t ha-1 with 100 percent (80:40:40NPK) RDF was found to be more effective than using 100 percent RDF alone in improving rice production and soil physiochemical characteristics. As a result, mineral fertilizer should be used in conjunction with farm yard manure in order to achieve sustainable agriculture. When FYM 5tha^{-1} was sprayed in conjunction with inorganic 100 percent RDF after rice harvest, soil BD, porosity, OC, available N, available P, available K, and grain and straw yield of rice increased much more than when 100 percent RDF was used alone. The combined application of 5t ha^{-1} FYM with 75 percent RDF inorganic fertilizer outperformed 50 percent RDF + FYM 5t ha^{-1} but was considerably inferior to 100 percent RDF + FYM 5t ha^{-1} among the treatments. As a result, FYM and inorganic fertilizers should be used in integrated crop management for long-term sustainability.

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