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Himanshu Sekhar Behera
Research Scholar, School of Agriculture, Lovely Professional University, Punjab, India

Dr. Bijoy Kumar Pany
Professor, HOD, Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Science, Siksha "o" Anusandhan University, Bhubaneswar, Odisha, India

Corresponding Author:
Himanshu Sekhar Behera
Research scholar, School of Agriculture, Lovely Professional University, Punjab, India

Impact of inorganic nitrogenous fertilizers and farmyard manure combination on grain, straw, biological yield and harvest index of rice (*Oryza sativa* L.)

Himanshu Sekhar Behera and Dr. Bijoy Kumar Pany

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Abstract
A pot culture experiment entitled *"Impact of inorganic nitrogenous fertilizers and farmyard manure combination on grain, straw, biological yield and harvest index of rice* (*Oryza sativa* L.). **"** was conducted during kharif 2018-2019.on sandy loam soil. 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 @ 5 t 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.

Keywords: inorganic nitrogen, FYM, plant growth and yield, yield attributing characters

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. As the global climate change continues, water shortage and drought have become an increasingly serious constraints limiting rice production worldwide (Guan *et al.*, 2010) [11]. 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. It covers 69% of the gross cultivated area and 63% of the total area under food grain in Odisha. A major portion of nitrogen in rice soils occur in organic pool, though this is usually very low. Conclusive evidences indicate that in production of irrigated rice, improvement in organic carbon content of soil and initial soil nitrogen content and efficiency of applied nutrient are more important. Rice is a heavy nitrogen feeder, however, fertilizer N efficiency in rice is very low under tropical conditions where it rarely exceeds 50 per cent and usually ranges between 15 to 35 per cent (De Dutta, 1984) [9].

2. Materials and Methods
The pot culture experiment was conducted at Research farm, Campus-4, Institute of Agricultural Science, Siksha '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. The composite surface (0-15 cm) soil samples were collected from the Campus-4 farm field for pot culture experiment. The soil type belongs to order *Alfisol*, with sandy loam texture. The soil samples thus collected were air dried, sieved through 2 mm sieve and stored in polythene bags for initial analysis of physico-chemical properties using standard analytical procedure, for the experimental set up, 10 kg of soil was filled in 12 kg capacity earthen pots with eight treatments and three replications. A thin film of water was maintained at the time of transplanting for better establishment of the seedlings. From the fourth day onwards 2 to 3 cm depth of water was maintained up to panicle initiation stage and frequently the water is drained out to create aeration and reflooded to maintain 3-4 cm depth of water up to physiological maturity. After dough stage, water was completely drained out to facilitate easy harvesting. Weeds were removed from the plots by manual labour three weeks after transplanting and the plots were kept weed free. The data of the results on soil analysis, plant analysis, yield, nutrient content and N,P, K content in rice were subjected to analysis of variance ANOVA and correlation statistics as suggested by Pense and Sukhatme (1985) [18]. For statistical analysis of data, Microsoft Excel (Microsoft Corporation, USA) and AGRES window version 7.0 software was used.

3. Results and Discussion

The results of the experiment were analyzed statistically and discussed with cause, effects and corroborative research findings of the scientists. Soil collected was acidic in reaction and pH was founded to be 5.65. Electrical conductivity of soil was non saline, sandy loam is texture. The Bulk density of soil was 1.58 g/cc and particle density of was 2.64 g/cc. The moisture content of soil was 26percent. The Cation Exchange Capacity of the soil was 5.8 mol (P+) kg^{-1} of soil. The soil was low in organic carbon, medium in available phosphorus and potassium.

4. Grain and Straw yield

4.1 Grain Yield

Grain yield of rice increased with different levels of inorganic fertilizer (50, 75, and 100% RFD levels) as well as their combination with FYM @ 5t ha^{-1} in each levels (Table.7). Grain yield of rice varied from 19 g per pot in control to 48.4 g per pot amongst different nutrient concentration alone and along with FYM. The maximum and significantly higher grain yield (48.4 g) per pot were obtained with 100% NPK (80: 40: 40) RDF + 5 t FYM (T_7) as compared to other treatments but was at par with T_8 (150% RDF). Treatment (T_5) receiving 75% RDF + 5 t FYM ha^{-1} gave significantly higher grain yield (42.8 g per pot) over 75% RDF (39.5 g per pot) and remained at par with 100% RDF (T_6) (44.9 g per pot). This may be due to the higher availability of nutrients and optimum soil properties in the pots receiving inorganic and organic fertilizers (FYM). The integrated effects of fertilizer and farm yard manure were noted to be more beneficial than the use of chemical fertilizer alone. Additional increase in grain yield was registered due to the integrated effect of FYM with inorganic fertilizer. The 50% doses of RDF combined with FYM alone resulted in significant increase in grain yield as compare to control and remained at par with 75% doses of RDF. Similar findings were reported by Ghosh and Singh (2003), Chaudary and Thakur (2007) and Urkurkar *et al.,* (2010) [10, 7, 31].

4.2 Straw Yield

Data presented on Table 7 indicated that there was significant effect of different treatments on straw yield of rice crop. It ranges from 26.99 g per pot to 78.6 g per pot. The higher straw yield (78.6 g per pot) was recorded in T8 (150% RDF) while the minimum straw yield (26.99 g per pot) was recorded in T_1 (control). The treatment T_8 was found statistically at par with T_6 (100% RDF) and significantly higher thanT_7 (100% RDF + 5 t FYM) and to rest of the treatments. Application of RDF with FYM, improved straw yields which might be due to favorable soil condition. Alim (2012) and Urkurkar *et al.,* (2010) [4, 31] reported similar findings. Straw yield increased with the increase of N levels. Similar results were found by Karmakar and Ali (2006) [14] and Islam *et al.* (2007a and b) [12, 13].

4.3 Biological Yield

Highest biological yield (124.97 g per pot) was obtained with T_8 (150% RDF) followed by T_7 (100% RDF + FYM 5 t ha^{-1}) and lowest with T_1 (control)

All the grain and straw yield were higher at all three levels (50, 75, 100% RDF) inorganic fertilizers alone and their combination with FYM @ 5 t ha^{-1} due to slow release and continuous supply of nutrients in balance quantity throughout the various growth stages enables the rice plants to assimilate sufficient photosynthetic products and thus, increased the dry matter and source capacity resulted in increased of yield attributes and finally yield of grain and straw. FYM being store-house of both macro and micro nutrients which might have enhanced the metabolic process vis-à-vis enlarged source and sink capacity, which ultimately enhanced the grain and straw yields. The results are in agreement with finding of Sowmya *et al.,* (2011) [23], Singh *et al.,* (2011) [24], Majumdar *et al.,* (2007) [16].

In this study the increased grain and straw yields can also be ascribed to the effect of adequate availability of NPK in soil solution, may cause increase in root growth, thereby increasing uptake of nutrients. Higher yield due to combined application of inorganic fertilizers and organic manures might have attributed to sustained nutrient supply and also as a result of better utilization of applied nutrients through improved micro-environmental conditions, especially the activities of soil micro-organisms involved in nutrient transformation and fixation. Similar results were opined by Satyanarayana *et al.*, 2002 [25], Sudha and Chandini, 2003 [26], Virdia and Mehta, 2008 [33], Senthivelu *et al.*, 2009 [27] as well as Naing *et al.*, 2010 [17].

4.4 Harvest Index (HI)

Harvest index (HI) is the ratio of seed yield to total above ground plant yield. It shows that there were significant differences among different treatments (Table 7). Harvest index (44.22%) was obtained with T_2 (50% RDF) followed by 42.25% in T_7 (100% RDF + FYM 5 t ha^{-1}) which remained at par with treatments T_5 (75%RDF+FYM 5 t ha^{-1}) and T_3 (50%RDF+FYM 5 t ha^{-1}. Higher harvest index of 50% of RDF indicates better partitioning of photosynthetic substance to economic yield. Appreciably high harvest index shows the efficiency of converting biological yield into economic yield. The effect of integration of inorganics and organics on harvest index was non-significant indicating proportionate partitioning with increasing and decreasing supply of nitrogen (Singh, 2001 and Singh *et al.*, 2002) [28, 22].

Table 1: Inorganic nitrogenous fertilizers and farmyard manure combination on grain, straw, biological yield and harvest index of rice

Treatment	Grain yield (g/pot)	Straw yield (g/pot)	Biological yield (g/pot)	Harvest Index (%)
T_1 Control	19	26.99	45.91	41.37
T_2 - 50% RDF	34.2	43.18	77.38	44.22
T_3 -50% RDF+ FYM @5t/ha	36.9	50.87	87.77	42.14
T_4 -75% RDF	39.5	60.03	99.53	39.78
T_5 -75% RDF + FYM @ 5t/ha	42.8	63.55	106.35	40.28
T_6 -100% RDF	44.9	73.77	118.77	37.91
T_7-100% RDF+ FYM @ 5t/ha	48.4	66.20	114.6	42.25
T_8 -150% RDF	46.3	78.60	124.97	37.12
SEm±	1.01	3.34	3.48	1.44
CD (P=0.05)	3.07	10.13	10.57	4.53

5. Conclusion

From results of the study it is concluded that combined application of organic manures (FYM) and inorganic fertilizers improve the growth and yield of rice. Application of FYM @ 5 t ha^{-1} in combination with 100% of RDF increased grain yield of rice. The higher yield obtained with integrated use of FYM and inorganic fertilizers was attributed to increased nutrient availability and nutrient content resulting in greater number of fertile tillers, number of grains per panicle, number of panicles per hill, filled grains per panicle, 1000 grain weight, biological yield, grain yield and harvest index. The soil test results after rice harvest revealed significant increase in soil BD, porosity, OC, available N, available P, available K and grain and straw yield of rice when FYM 5 t ha^{-1} was applied in combination with inorganic 100% RDF than the use of 100% RDF alone. Among the treatments, combined application of 5 t ha-1 FYM with 75% RDF inorganic fertilizer was superior to 50% RDF + FYM 5 t ha-1 but significantly inferior to 100% RDF + FYM 5 t ha-1. Thus use of FYM and inorganic fertilizers should be included in integrated crop management for sustainable agriculture.

6. References

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