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

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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., T1-Control, T2 - 50% RDF, T3 - 50% RDF + FYM @ 5 t ha⁻¹, T4 - 75% RDF, T5 - 75% RDF + FYM @ 5 t ha⁻¹, T6 - 100% RDF (NPK 80:40:40), T7 - 100% RDF + FYM @ 5 t ha⁻¹ and T8 - 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 Sukhmatne (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% RDF 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 (T₁) as compared to other treatments but was at par with T₈ (75% RDF). Treatment (T₈) 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 (T₇) (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 T₁ (control). The treatment T₈ was found statistically at par with T₇ (100% RDF) and significantly higher than T₁ (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) [14, 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 T₈ (150% RDF) followed by T₇ (100% RDF + FYM 5 t ha⁻¹) and lowest with T₁ (control) treatment. 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 T₃ (50% RDF) followed by 42.25% in T₅ (100% RDF + FYM 5 t ha⁻¹) which remained at par with treatments T₃ (75% RDF+FYM 5 t ha⁻¹) and T₆ (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 (%) |
|--------------------|---------------------|---------------------|--------------------------|-------------------|
| T1 Control         | 19                  | 26.99               | 45.91                    | 41.37             |
| T2 - 50% RDF       | 34.2                | 43.18               | 77.38                    | 44.22             |
| T3 - 50% RDF + FYM @ 5t/ha | 36.9          | 50.87               | 87.77                    | 42.14             |
| T4 - 75% RDF       | 39.5                | 60.03               | 99.53                    | 39.78             |
| T5 - 75% RDF + FYM @ 5t/ha | 42.8          | 63.55               | 106.35                   | 40.28             |
| T6 - 100% RDF      | 44.9                | 73.77               | 118.77                   | 37.91             |
| T7 - 100% RDF + FYM @ 5t/ha | 48.4        | 66.20               | 114.6                    | 42.25             |
| T8 - 150% RDF      | 46.3                | 78.60               | 124.97                   | 37.12             |
| 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
1. AOAC. Association of Official Agricultural chemist, Methods of Analysis, 11\(^{th}\) ed. Washington, DC 1970, 18-19.
2. Acharya R, Dash AK, Senapati HK. Effect of integrated nutrient management on microbial-activity influencing grain yield under rice-rice cropping system in an acid soil. Asian Journal of Microbiology, Biotechnology & Environmental Sciences Paper 2012;14(3):365-368.
3. Aher SB, Lakaria BL, Kaleshananda S, Singh AB, Ramana S, Thakur JK et al. Soil microbial population and enzyme activities under organic, biodynamic and conventional agriculture in semi-arid tropical conditions of central India, Journal of Experimental Biology and Agricultural Sciences 2018;6(5):763-773.
4. Alim MA. Effect of Organic and inorganic sources and doses of nitrogen fertilizer on the yield of Boro Rice. J Environ. Sci. & Natural Resources 2012;5(1):273-282.
5. Babar S, Dongale JH. Effect of organic and inorganic fertilizers on soil fertility and crop productivity under mustard cowpea-rice cropping sequence on lateritic soil of Konkan. Journal of the Indian Society of Soil Science 2013;61(1):7-14.
6. Babhulkar PS, Wandile RM, Badole WP, Balpande SS. Residual effect of long term application of FYM and Fertilizers on soil properties (Vertisols) and Yield of Soyabean. Journal of the Indian Society of Soil Science 2000;48(1):89-92.
7. Chaudhary SK, Thakur RB. Efficient farm yard management for sustained productivity of rice (Oryza sativa)-wheat (Triticum aestivum) cropping system. Indian Journal of Agricultural Sciences 2007;77(7):443-444.
8. Dass A, Sudhishri S, Lenka NK. Integrated nutrient management for upland rice in Eastern Ghats of Orissa. Oryza 2009;46(3).
9. D. De Dutta SK. Availability and management of nitrogen in lowland rice in relation to soil characteristics. Workshop on ‘Characterization, classification and utilization of wetland soils. Manual IRRI, Manila, Philippines 1984.
10. Ghosh BN, Singh RD. Effect of conjoint use of farmyard manure and nitrogen on rice (Oryza sativa L.) - Wheat (Triticum aestivum) system in Uttarakhand mid-hill soils. Indian J Agril. Sci 2003;73(12):680-683.
11. Guan et al. Simultaneously improving yield under drought stress and non-stress conditions: a case study of rice (Oryza sativa L.) Journal of Experimental Botany 2010;61(15):4145-4156.
12. Islam MM, Anwar MP, Rahman MM, Islam AK, MM. Influence of mustard oil cake on the performance of fine rice cv. Chinigura. Intl. J Bio Res 2007a;3(6):50-54.
13. Islam MM, Anwar MP, Rahman MM, Islam AK, MM. Influence of mustard oil cake on the performance of fine rice cv. Chinigura. Intl. J Bio Res 2007b;3(6):50-54.
14. Karmakar B, Ali BA. Effect of mustard oil cake and other organic fertilizers on the performance of boro rice. Annual Internal Review, Bangladesh Rice Res. Inst, Joydebpur, Gazipur 2006, 26-28.
15. Kattyal JC, Rao NH, Reddy MN. Critical aspects of organic matter management in the tropics: the example of India. Nutr. Cycling Agroecosyst 2001:61:77-88.
16. Majumdar B, Venkateshi MS, Saha R. Effect of nitrogen FYM and non-symbiotic nitrogen-fixing bacteria on yield, nutrient uptake and soil fertility in upland rice (Oryza sativa L.). Indian J Agri. Sci 2007;77(6):335-339.
17. Naing A, Banterng P, Polthanee A, Trelo-Ges V. The effect of different fertilizers management strategies on growth and yield of upland black glutinous rice and soil property. Asian Journal of Plants Science 2010;9(7):414-422.
18. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. 4\(^{th}\) ed. ICAR, New Delhi 1985, 347.
19. Singh RN, Singh S, Prasad SS, Singh VK, Kumar P. Effect of integrated nitrogen management on soil fertility nutrient uptake and yield of rice Leo cropping system on soil of Jhark and JISS 2011;59(2):158-163.
20. Singh SK, Verma SC, Singh RP. Integrated nutrient management in rice and its residual effect on lentil. Indian Journal of Agricultural Research 2002;39(4):286-289.
21. Singh V, Dubey YP. Impact of organic and inorganic sources of nutrients on chemical properties of soil, yield attributes and yield in Sesamum-pea cropping sequence, Journal of Pharmacognosy and Phytochemistry 2018;7(6):1925-1931.
22. Singh SK, Verma SC, Singh RP. Integrated nutrient management in rice and its residual effect on lentil. Indian Journal of Agricultural Research 2002;39(4):286-289.
23. Sowmya C, Ramana MV, Kumar M. Effect of systems of rice cultivation and nutrient management options on yield, nutrient uptake and economics of rice. Crop Research (Hisar) 2011;42(5):369.
24. Singh RN, Singh S, Prasad SS, Singh VK, Kumar P. Effect of integrated nitrogen management on soil fertility nutrient uptake and yield of rice Leo cropping system on soil of Jharkhand. JISS 2011;59(2):158-163.
25. Satyanarayana V, Prasad PV, Murthy VRK, Boote KJ. Influence of integrated use of farmyard manure and inorganic fertilizers on yield and yield components of irrigated lowland rice. Journal of Plant Nutrition 2002;25(10):2081-2090.
26. Sudha B, Chandini S. Vermicompost: A potential organic manure for rice. Intensive Agric 2003.
27. Senthilvelu M, Padian BJ, Surya Prabha ACS. Dry matter production and nutrient removal in wet seeded rice-cotton cropping sequence under integrated nutrient management practices. Oryza 2009;46(4):279-289.
28. Singh M, Singh VP, Sammi Reddy K. Effect of integrated use of fertilizer nitrogen and farmyard manure or green manure on transformation of NKS and productivity of rice-wheat system on a Vertisols. Journal of Indian Society of Soil Science 2001;49(3):430-435.
29. Tandon HLS. Phosphorus research and agricultural production in India, Fertilizer Development and Consultation Organization (FDCO), New Delhi 1987.
30. Tejada M, Gonzalez JL. Application of two vermicomposts on rice crop: effects on soil biological properties and rice quality and yield. Agronomy 2009.
31. Virdia HM, Mehta HD, Parmar VN, Bafna AM, Patel ZN, Gami RC. Integrated nutrient management in transplanted rice (Oryza sativa L.). Green Farming 2010;1(3):249-252.
32. Urkurkar JS, Tiwari A, Chitale S, Baintai RK. Influence of long-term use of inorganic and organic manures on soil fertility and sustainable productivity of rice (Oryza sativa L.) and wheat 2010.
33. Virdia HM, Mehta HD. Integrated nutrient management in transplanted rice. Journal of rice research 2008;2(2):99-104.
34. Walia MK. Long term effect of integrated nutrient management on rice (Oryza sativa L.) productivity and soil health in rice-wheat system. M.Sc. Thesis, Punjab Agri-cultural University, Ludhiana 2007.
35. Walkley A, Black CA. An examination of wet acid method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Science 1934, 38.
36. Wang Y, Zhang H. Physicochemical Properties of a Red Soil Affected by the Long-term Application of Organic and Inorganic Fertilizers, (Triticum aestivum) in Inceptisols. Indian Journal of Agricultural Sciences 80(3):208-212 Journal 2016;101:336-344.