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Studies on Application of NPK Fertilizers on Yield and Protein Content of Different Varieties of Rice (*Oryza sativa* L.)

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ABSTRACT: The grains of different varieties of rice (*Oryza sativa* L.) namely Jogesh, Bandana, Parijat, MTU – 1001 and CR Dhan 201 were grown during the Kharif season of 2022 without any fertilizers and using NPK fertilizers @ 80 – 40 – 40 kgha^{-1} NPK and collected from the Regional Research and Technology Transfer Station (RRTTS), Odisha University of Agriculture and Technology (OUAT). The grain yield of the five rice varieties without any fertilizers varied between 9.7 qha^{-1} (CR Dhan 201) to 12.3 qha^{-1} (Bandana). But with fertilizers it varied between 10.4 qha^{-1} (CR Dhan 201) to 13.2 qha^{-1} (Bandana). Total N content of the rice varieties varied between 0.77% (CR Dhan 201) to 1.11% (Parijat) without fertilizers but resulted in an increase from 0.79% (CR Dhan 201) to 1.13% (Parijat) by the application of fertilizers. The crude protein (CP) content varied from 4.81% (CR Dhan 201) to 6.93% (Parijat) without fertilizers and from 4.93% (CR Dhan 201) to 7.06% (Parijat) with fertilizers. The non protein nitrogen (NPN) content without fertilizers showed a significant increase in Parijat and MTU – 1001 varieties as compared to CR Dhan 201 but recorded a significant change among the varieties with fertilizers. The true protein (TP) content varied significantly from 4.37% (CR Dhan 201) to 6.37% (Parijat) without fertilizers and between 4.43% (CR Dhan 201) to 6.43% (Parijat) with fertilizers. However the cv. MTU-1001 recorded a slight decrease by the application of fertilizers. It was observed that the application of NPK fertilizers has an overall beneficial impact on the grain yield and TP contents of those rice varieties and hence the amount of TP content per hectare can be increased.

Keywords: Grain yield, Total Nitrogen, Crude Protein, True protein.

INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food in our country (Sen *et al.,* 2020). Rice production relies heavily on chemical fertilizers to meet the food demands of the increasing population (Kaushik and Djiwanti 2017). Among various factors that are responsible for better yield and quality, the proper use of fertilizers is of prime importance (Sankaran *et al.,* 2005). Determination of optimum levels of NPK fertilizers is essential for obtaining maximum economic returns. The best rate of fertilizer application is that which gives maximum economic returns at least cost (Ananthi *et al.,* 2010). The grain yield increases with the application of NPK fertilizers when applied correctly. The optimal dose varies depending on soil type and rice variety (Akamine *et al.*, 2007; Chowdhury *et al.*, 2008; Hossain & Ishimine, 2005; Hossain *et al.,* 2011; Islam *et al.,* 2011; Oya, 1972; Oya *et al.,* 1977).

The chief livelihood of human beings abundantly depends on rice due to its sovereignty nutritive property and energy value (Burlando & Cornara 2014). A report from the Food and Agriculture Organization of the United Nations estimated the nutritional composition of rice and the protein content ranges from 5% to 9%. Three major components in endosperm, *i.e.* starch (70–80%), protein (7–10%), and lipids (~1%), predominantly determine the nutrition quality and cooking and eating quality (Martin and Fitzgerald 2002). Although it is not rich in protein it serves as a major source of the nutrients for the common people (Shih Frederick, 2004). It is important to improve its protein content, which has been observed to be varying with agronomical conditions and genotype (Acquaah, 2012). Therefore it is necessary to study the effects of a standard dose of the most commonly used NPK fertilizer on grain yields and TP contents of different rice genotypes.

MATERIALS AND METHODS

The rice cv. namely Jogesh, Bandana, Parijat, MTU 1001 and CR Dhan 201 were grown during the Kharif season of 2022 with NPK fertilizers @ 80 – 40 – 40 kgha^{-1} and without any fertilizers at the Regional Research and Technology Transfer Station (R.R.T.T.S), OUAT, Bhubaneswar. Bhubaneswar is the capital city of Odisha. The R.R.T.T.S. Bhubaneswar is located at the latitude of 20 15'N to 20 17'N and longitude 85 49'E to 85 52'E with 45 m above mean sea level. The average rainfall is about 1470 mm. The climate of Bhubaneswar is humid tropical with dry season from October to June and wet season from July to September. The duration of the varieties were between 90 to 100 days and were grown in 5m ×3m size plots in a random block design (RBD).

The soil of the experiment site was lateritic sandy loam having acidic pH, medium organic carbon (OC), available N, P and K were 370.0 kgha^{-1}, 19.6 kgha^{-1} and 166.8 kgha^{-1} respectively. After the harvest, the grain samples of the rice varieties were collected and dried to about 14% moisture content. The weight of grains from each plot were weighed and analysed for protein contents as per Juliano (1985).

The samples were powdered to pass through 100 mesh sieves and were stirred with petroleum ether (40-60 degree) for one hour. Then those were allowed to settle and the clear supernatant layer was decanted. This process was repeated three times. Finally, the samples were kept in petroleum ether overnight and the clear supernatant layer was decanted the next day. The defatted samples were air dried and stored. The samples were stored in poly-ethene bags inside a dessicator for physio-chemical analysis.

Percentage of nitrogen was determined by the microkjeldahl method and the percentage of CP was calculated using a conversion factor of 6.25 (Frederick, 1981). NPN was estimated according to the procedure given by Becker *et al.* (1940). In a 150 mL beaker, 0.5 gram of powdered grain sample was weighed and stirred with 20 mL. of 0.8*N* (13.6%) trichloro acetic acid for one hour on a magnetic stirrer. The suspension was centrifuged for 10 minutes at 2000 r.p.m. The clear supernatant liquid was taken for nitrogen determination. Percentage of TP was calculated by subtracting NPN from total nitrogen and multiplying the results with 6.25.

RESULTS AND DISCUSSION

The grain yield, percentage of total N, CP, NPN and TP with and without fertilizers among the varieties has been recorded in Table 1.

Table 1. Grain yield, Total N, CP, NPN and TP with and without NPK fertilizers.

Sr. No.	Variety	Grain Yield (qha^{-1})	Total Nitrogen (%)	Crude Protein (%)	NPN (%)	True Protein (%)	Grain Yield (qha^{-1})	Total Nitrogen (%)	Crude Protein (%)	NPN (%)	True Protein (%)
		Without fertilizers					With fertilizers				
1.	Jogesh	11.1	0.84	5.25	0.08	4.75	12.1	0.85	5.31	0.08	4.81
2.	Bandana	12.3	0.94	5.87	0.08	5.37	13.2	0.98	6.12	0.09	5.56
3.	Parijat	10.8	1.11	6.93	0.09	6.37	11.3	1.13	7.06	0.10	6.43
4.	MTU 1001	11.3	0.93	5.81	0.09	5.25	11.9	0.94	5.87	0.11	5.18
5.	CR Dhan 201	9.7	0.77	4.81	0.07	4.37	10.4	0.79	4.93	0.08	4.43
CD (0.05)		0.21	0.03	0.29	0.01	0.33	0.22	0.03	0.29	0.01	0.32

Grain yield of different rice varieties varied between 9.7 qha^{-1} to 12.3 qha^{-1} without the application of fertilizers whereas those varied between 10.4 qha^{-1} to 13.2 qha^{-1} by the application of fertilizers. In general, fertilizers containing N, phosphorus (P), and potassium (K), essential plant nutrients, are vital for productive crops (Stellacci *et al.*, 2013; Mantovani *et al*., 2017). The essential element for plant growth and protein synthesis is N as it encourages faster crop growth, improves grain yield and quality by increasing tillers (side shoots), leaf area development, grain formation, and grain filling (Kaya, 2014). P plays a vital role in energy storage and transfer, is a key component in nucleic acids, and is involved in cell division and root development. Adequate P ensures strong root systems, which are necessary for nutrient absorption and overall plant vigor. P also promotes early flowering and ripening (George *et al.*, 2016). K is involved in starch formation, activates enzymes, and helps in the translocation of carbohydrates from leaves to the grain. K also improves plant vigor, resistance to diseases, and helps prevent lodging (falling over) due

to its role in cell wall strength. N is one of the most required mineral elements for plant growth, and K plays a vital role in N metabolism. Hence application of NPK fertilizers has some synergic beneficial effect on the grain yield of rice. The grain yield with and without fertilizers has been shown graphically in Fig. 1. Total N without fertilizers varied between 0.77 % (CR Dhan 201) to 1.11% (Parijat) and between 0.79% (CR Dhan 201) to 1.13% (Parijat) with fertilizers and is shown in Fig. 2. There was significant increase of total N of all the varieties by the application of fertilizers. According to Dobermann and Fairhust (2000), the application of nitrogen fertilizer can increase the plant height, panicles number, spikelets number and number of filled spikelets which largely determine the yield capacity of rice. The application of organic manure together with fertilizers helps neutralize soil pH, and leads to higher levels of organic carbon and improved macro- and micronutrient availability, physical properties, and microbial activity (Liu *et al.*, 2009), thereby increasing crop yields (Dissanayake, 2000; Khan *et al.*, 2007; Kumar *et al*., 2014). It again proved that the use of NPK fertilizers increased the availability of N to the grains.

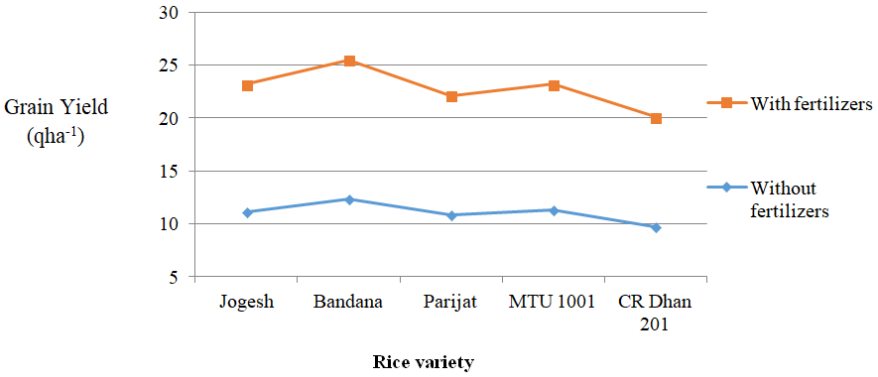

Fig. 1. Grain yield with and without fertilizers.

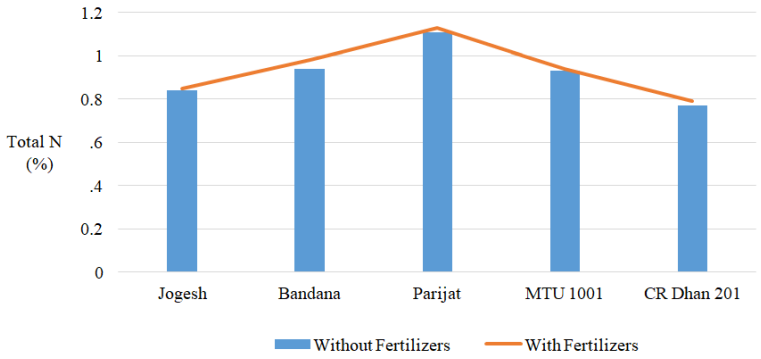

Fig. 2. Total Nitrogen with and without fertilizers.

CP content varied significantly between the varieties from 4.81% (CR Dhan 201) to 6.93% (Parijat) without any fertilizer. Same variation was observed with fertilizers from 4.93% (CR Dhan 201) to 7.06% (Parijat). It might be due to the different genetic predispositions that influence their ability to take up, utilize and store nutrients from the soil effectively. Mae (1997) reported that the mineral uptake and translocation are related to the genetic makeup of crop plants, therefore, different genotypes show differential behavior to similar fertilizers. The variation of CP contents with and without fertilizers have been shown in Fig. 3.

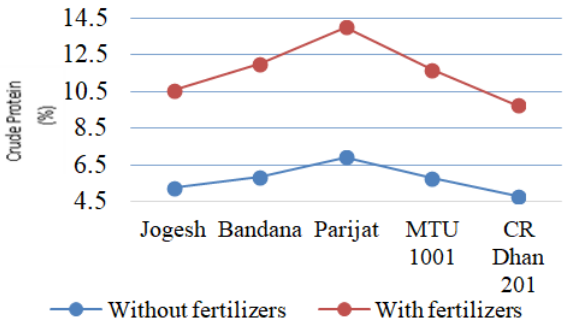

Fig. 3. Crude protein with and without fertilizers.

NPN varied significantly between 0.07% (CR Dhan 201) to 0.09% (Parijat and MTU-1001) in the rice varieties grown without fertilizers and between 0.08% (CR Dhan 201) to 0.11% (MTU-1001) with fertilizers. Except the cv. Jogesh in which NPN remained constant, all other varieties recorded an increase by the use of NPK fertilizers.

The endosperm, the specialized tissue within seeds provides nutrients to the developing embryo. It has three major components namely starch (70-80%), protein (7-10%) and lipids (~1%) which predominantly determines the quality of rice (Yang *et al.*, 2019). The TP content without fertilizers varied significantly from 4.37% (CR Dhan 201) to 6.37% (Parijat). The application of fertilizers registered a significant variation from 4.43% (CR Dhan 201) to 6.43% (Parijat). This proves that among the five varieties analyzed, CR Dhan 201 recorded lowest with and without fertilizers and the cv. Parijat recorded highest values. This suggests that the cv. CR Dhan 201 could not absorb the available N but the cv. Parijat could. It might be due to the varietal genetic differences in the rice varieties themselves, which influence how they utilize nutrients and accumulate protein. The cv. MTU-1001 recorded a decrease in the TP content by the application of the fertilizers. These have been shown in Fig. 4.

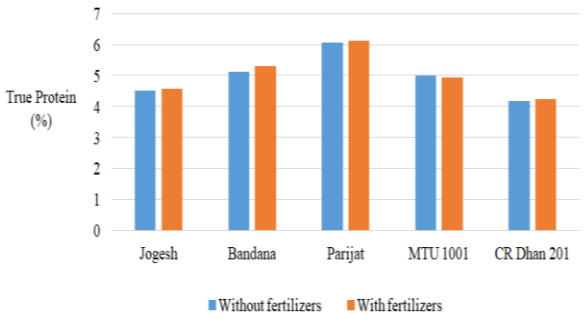

Fig. 4. True protein content with and without fertilizers.

CONCLUSIONS

It was observed from the study that by the application of NPK fertilizers there is an overall increase in grain yield and total N content of all the varieties. Also the CP values registered an increase with the fertilizers. Besides an overall increase of TP contents were observed in all the varieties except the cv. MTU 1001, in which it registered a marginal decrease. Hence it can be concluded that the application of NPK fertilizers in the prescribed dose results in an overall increase of yield as well as protein contents in different varieties of rice.

FUTURE SCOPE

The study can be extended to other rice varieties and also in various combinations of organic and inorganic fertilizers.

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Conflict of Interest. None.

REFERENCES

Ananthi, T., Amanullah, M. M. & Subramanian, K. S. (2010). Influence of mycorrhizal and synthetic fertilizers on soil nutrient status and uptake in hybrid maize. *Madras Agricultural Journal, 97*(10/12), 374-378.

Akamine, H., Hossain, M. A., Ishimine, Y., Yogi, K., Hokama, K., Iraha, Y. & Aniya, Y. (2007). Effects of application of N, P and K alone or in combination on growth, yield and curcumin content of turmeric (*Curcuma longa* L.). *Plant Production Science*, *10*, 151–154.

Acquaah, G. (2012). Principles of Plant Genetics and Breeding (second ed.), Wiley Blackwell.

Burlando, B. & Cornara, L. (2014). Therapeutic properties of rice constituents and derivatives (*Oryza sativa* L.): A review update. *Trends in Food Science & Technology*, *40*(1), 82-98.

Becker, H. C., Milner, R. T. and Nagel, R. H. (1940). A method for the determination of non-protein nitrogen in soybean meal. *Cereal Chem*., *17***,** 447.

Chowdhury, A. H. M. R. H., Rahman, G. M. M., Saha, B. K. & Chowdhury, M. A. H. (2008). Addition of some tree leaf litters in forest soil and their effect on the growth, yield and nutrient uptake by red amaranth. *Journal of Agroforestry and Environment*, *2*, 1–6.

Dissanayake, S. T. (2000). Increasing rice yields through integrated plant nutrition systems to face the new millennium. In Proceedings of the International Conference on Paddy Soil Fertility, Manila, Philippines, pp 24–27.

Dobermann, A. and Fairhurst, T. (2000). Rice: Nutrient Disorders and Nutrient Management. Handbook series. Potash & Phosphate Institute (PPI), Potash & Phosphate Institute of Canada (PPIC) and International Rice Research Institute. 191

Frederick, K. (1981). Official methods of analysis of the AOAC, 13th ed. Edited by WILLIAM HORWITZ. The Association of Official Analytical Chemists.

George, T. S., Hinsinger, P. & Turner, B. L. (2016). Phosphorus in soils and plants–facing phosphorus scarcity. *Plant and Soil*, *401*, 1-6.

Hossain, M. A. & Ishimine, Y. (2005). Growth, yield and quality of turmeric (*Curcuma longa* L.) cultivated on dark-red soil, gray soil and red soil in Okinawa, Japan. *Plant Production Science*, *8*, 482–486.

Hossain, M. A., Yamanishi, M., Yara, T., Chibana, S., Akamine, H. & Tamaki, M. (2011). Growth characteristics, yield and mineral content of redflower ragleaf (*Crassocephalum crepidioides* (Benth.) S. Moore) at different growth stages, and in dark-red soil, red soil and gray soil in Okinawa. *Science Bulletin of the Faculty of Agriculture, University of the Ryukyus*, *58*, 1–11.

Islam, M. M., Karim, A. J. M. S., Jahiruddin, M., Majid, N. M., Miah, M. G., Ahmed, M. M. & Hakim, M. A. (2011). Effects of organic manure and chemical fertilizers on crops in the radish-stem amaranth-indian

spinach cropping pattern in homestead area. *Australian Journal of Crop Science*, *5*, 1370–1378.

Juliano, B. O. (1985). Polysaccharides, proteins and lipids. In: *Rice: chemistry and technology*. (Ed): B.O. Juliano. AACC, St. Paul, pp. 59-174.

Kaushik, S. & Djiwanti, S. R. (2017). Genetic improvements of traits for enhancing NPK acquisition and utilization efficiency in plants. In *Plant Macronutrient Use Efficiency* (pp. 267-283). Academic Press.

Kaya, E. (2014). Pengaruh pupuk organik dan pupuk NPK terhadap pH dan Ktersedia tanah serta serapan-K, pertumbuhan dan hasil padi sawah (*Oriza sativa* L.). *Buana Sains.*, *14*(2), 113-122.

Khan, M. U., Qasim, M. & Khan, I. U. (2007). Effect of integrated nutrient management on crop yields in rice-wheat cropping system. *Sarhad. J. Agric.*, *23*, 1019–1026.

Kumar, P., Singh, F., & Singh, A. P. S. M. (2014). Integrated Nutrient Management in Rice–Pea Cropping System For Sustainable Productivity. *International Journal of Engineering Research*, *3*(4), 1093–1095.

Liu, M., Hu, F., Chen, X., Huang, Q., Jiao, J., Zhang, B. & Li, H. (2009). Organic amendments with reduced chemical fertilizer promote soil microbial development and nutrient availability in a subtropical paddy field: The influence of quantity, type and application time of organic amendments. *Applied Soil Ecology*, *42*(2), 166-175.

Mae, T. (1997). Physiological nitrogen efficiency in rice: Nitrogen utilization, photosynthesis and yield potential. *Plant Soil*, *196*, 201-210.

Martin, M. & Fitzgerald, M. A. (2002). Proteins in rice grains influence cooking properties. *Journal of Cereal Science*, *36*(3), 285-294.

Mantovani, J. R., Silveira, L. G. D., Landgraf, P. R. C., Santos, A. R. D. & Costa, B. D. S. (2017). Phosphorus rates and use of cattle manure in potted gerbera cultivation. *Ornam. Hortic.*, *23*, 412–418.

Oya, K. (1972). Evaluation of potassium availability of four Michigan soils. *Science Bulletin of Agriculture, University of the Ryukyus*, *19*, 123–257.

Oya, K., Tokashiki, Y. & Ishimine, Y. (1977). Effects of potassium fertilization on the yields of sweet potato autumn crop grown on a calcareous soil of Okinawa. *Science Bulletin of the Collage of Agriculture, University of the Ryukyus*, *24*, 191–197.

Sen, S., Chakraborty, R. & Kalita, P. (2020). Rice-not just a staple food: A comprehensive review on its phytochemicals and therapeutic potential. *Trends in Food Science & Technology*, *97*, 265-285.

Shih, Frederick (2004). Rice proteins. Rice Chemistry and Technology, 143-162.

Sankaran, N., Meena, S. & Sakthivel, N. (2005). Input management in maize. *Madras Agricultural Journal*, *92*, 464-468.

Stellacci, A. M., Cristiano, G., Rubino, P., Lucia, B. D. & Cazzato, E. (2013). Nitrogen uptake, nitrogen partitioning and N-use efficiency of container- Grown Holmoak (*Quercus ilex* L.) under different nitrogen levels and fertilizer sources. *J. Food Agric. Environ.*, *11*, 132–137.

Yang, Y., Guo, M., Sun, S., Zou, Y., Yin, S., Liu, Y. & Yan, C. (2019). Natural variation of *OsGluA2* is involved in grain protein content regulation in rice. *Nature Communications*, *10*(1), 1949.

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