Growth, grain yield and soil nutrient status of *kharif*rice (*Oryzasativa* l.) as influenced by integrated nutrient management in lower gangetic plains

ABSTARCT

A field experiment was conducted during *kharif* season, 2019 at Instructional Farm, BCKV, Jaguli, Nadia (West Bengal) to studyGrowth, yield and soil nutrient status of *kharif* rice (O*ryzasativa*L.) as influenced by integrated nutrient management in lower gangetic plains" in a Randomized Block Design (RBD) having three replications.Outcomes revealed that rice plot fertilized with 125% NPK of RDF + FYM at5 t/haalonewithVermicompost(2.0 t/ha)recorded the highest plant height, elongation rate,dry matter accumulation, crop growth rate, no. of tillers per hill. The maximum grain(5.25 t/ha) and straw yield(5.84 t/ha) as well as soil nutrient statusafter harvest of*kharif* rice was recorded with125% NPK of RDF + FYM5 t/ha+ Vermicompost2.0 t/hafollowed by NPK 80:40:40 kg/ha+ $ZnSO_4$@25 kg/ha which is 53.72% higher over control.

Keywords: *Kharif*rice, integrated nutrient management,soil nutrient status and yield

INTRODUCTION:

Integrated nutrient management (INM) is the judicious use of all possible nutrient sources to meet the plant nutrient requirement at an optimum level to sustain the desired crop productivity on long-term basis for increasing theavailableplant nutrients and improving the physico-chemical and biological properties of soil throughmaximizingnutrientuseefficiencyand boosting the soil health (Jana *et al*., 2020).Rice (*Oryza sativa* L.) is a leading food grain crop accounting half of the world's population and provides dietary energy and protein up to 2.5 billion people in the world predicted that around 50-60% improvement in rice production will be necessary to fulfill demand from population growth by 2025.India comes second to China in terms of area and production among the world's major rice producing nations. Out of 782 million tonnes of global rice production from 167.1 million hectares, India produced 116.42 m t in 44.5 m ha (rainy season: 102.13 m t from 39.27 m ha) (FAO, 2020; GOI2020). Rice production in Chhattisgarh, the total area of production was reported to about 3.87 million hectares with production accounting to be 11.63 million tonnes and a productivity of 3.0 t ha^{-1} (Anonymous, 2021). Nitrogen is one of the important elements in plant owing to its major part in chlorophyll production, which is essential for the photosynthesis processanda part of different enzymatic proteins that catalyze and regulate plant development processes(Sarkar*et al*, 2021).Phosphorus is an essential macronutrient stimulates root, nodule, fruit and grain development as well as aids in vital metabolic functions like photosynthesis, carbon partition, sugar transport, energy storage and transfer etc (Mitran*et al*., 2018).Potassium is important for the activation of several enzymes promoting sugar transport and regulating cell osmotic pressure involved in the stomatalregulationand maintaining the ion balance in the cytoplasm (Hu *et al*., 2016a). Zinc is closely related to the inhibition of RNA synthesis is directly or indirectly involved in activation of several enzymatic system closely involved in the nitrogen metabolism helps in cell wall development, respiration, photosynthesis, chlorophyll formation and enzyme activity (Mondal*et al*., 2020).Application of vermicompost and farm yard manureinfluences the physical, chemical and biological properties of soil helps in improving water holding capacity as well as efficiency the microbial growth and activity by providing vitamins and growth hormones supplies all major nutrients (N, P, K, Ca, Mg, S) necessary for plant growth as well as micronutrients (Fe, Mn, Cu and Zn)which have a direct role on plant growth leads to better agriculture production.Green leaf manuringcan be explained as the pruning and collecting of leaves and twigs from various trees, herbs and shrubs provides essential plant nutrients to the soil is capable of supplying the required plant nutrients with preserving very good soil health.Therefore, the present investigation was laid out to judge growth, yield attributes, grain yieldofRice cv. IET 25701(BidhanSuruchi)influenced by integrated nutrient managementunder lower Gangeticplains.

MATERIALS AND METHOD:

An experiment was laid out during the kharif season of 2019 at Instructional Farm,Jaguli, Bidhan Chandra KrishiViswavidyalaya, Nadia, West Bengal to study crop growth and yield of rice (*Oryza sativa* L.) as influenced by integrated nutrient management in the lower gangetic plains. The farm is located at $22^o93^/$N latitude and $88^o53^/$E longitude with an altitude of 9.75 m above mean sea level with average precipitation during the experimental period is around 1450 mm. The soil of experimental site was neutral in reaction (pH 6.7) with soil organic carbon 0.52%, available N 202.45 kg ha^{-1}, P_2O_5 28.35 kg ha^{-1} and K_2O 196.50 kg ha^{-1} which managed in a Randomized Block Design (RBD) having three replications with 4.0mX3.0m plot size witheight different treatment combinations *i.e.*T_1-Control(Nofertilizer),T_2-NPK@80:40:40kg/ha(RDF),T_3-NPK@80:40:40kg/ha+leafmanure(subabul)2.5t/ha,T_4-

NPK@80:40:40kg/ha+Vermicompost 2 t/ha, T_5-NPK @ 80:40:40 kg /ha+ FYM 5 t/ha, T_6-NPK @ 80:40:40 kg /ha+$ZnSO_4$@25 kg /ha,T_7-NPK@125% of RDF, T_8-125% NPK (RDF)+FYM 5t/ha +Vermicompost 2 t/ha(BidhanSuruchi)is cultivated predominantly in West Bengal, Odisha, Uttar Pradesh and Assamgenerallyrecommended for both kharif and boro season with an average yield of 56 q/ha and 62.4 q/ha respectively of 110–114 daysmaturity which is moderately resistant to bacterial leaf blight, leaf blast, stem borer and brown plant hopper, non-lodging, non-shattering variety.Meteorological data pertaining to the cropping seasonsrevealed that maximum temperature ranged between23.35^oC to 33.92^oC and minimum temperature prevailedbetween 9.98^oC to 18.06^oC. The maximum andminimum relative humidity fluctuated between 94.08 to97.23% and 44.65 to 59.56%, respectively.Nitrogen, phosphorus and potassium at 80, 40 and 40 kg/haas urea, single super phosphate and muriate of potash respectively with green leaf manure, Farmyard manure, and vermicompost were given as per the schedule to control weeds one hand weeding was done before the first top dressing and another hand weeding was done before the next top dressing. The seedlings were transplanted in a row at 20cmX10cm spacing and 3seedlings/hillwithout damaging the seedlings.The depth of transplantingwas 2.5-3 cm.

Onedeep-ploughingwithtractorfollowedbytwoploughingswithpowertillerandsubsequent leveling with a ladder was done to make the soil in friable condition. Harvesting operation was done manually leaving the two borders rows on each side and the net plot was accounted for seed yield of the crop.Then,the harvested crop was left for two days in the field to make sun drying. The produce was then threshed and seeds were separately collected for each plot manually.After proper cleaning and drying, seeds and straw of each net plot were weighed andyieldwasrecorded. At different stages, the height was taken by measuring the distance by scale from the ground level to the top of the highest leaf by stretching the leaf of the plant.Ten samples of green leaf lamina from two hills of each plot were separated, a rectangular bit of 10 cm length and 1cm width were cut from the leaves. Leafareaindex(LAI)istheareaof leaf surface per unit area on the land surface,can be calculated for each treatment and plot at different growthstages.Observationswererecorded on growth parameters viz. plant height, elongation rate, drymatter accumulation, crop growth rate, tillers per hill and yield attributesviz. panicle length, panicle weight, filled grains, grain yield, straw yield as well as harvest index. All the data wereanalysedstatistically by OPSTAT(online statisticalanalysis tool).

RESULTS AND DISCUSSION:

Crop growth characters:

The crop growth in terms of plant height of kharifrice cultivated with different nutrient managementpractices was found significant (Table 1). Amongdifferent nutrient management practices,125%NPK(RDF*i.e.*80:40:40kg/ha)+FYM @ 5t/ha+Vermicompost @ 2t/harecorded significantly higher plant height at 60 DAT (108.16 cm) over the other treatments which is statistically at par 125% NPK (RDF *i.e.* 80:40:40) obtaining value of 107.43 cm. The lowest plant height (82.93 cm) was obtained from control (No fertilizer). The increased plant height due to organic source of nutrients along with chemical applications, which might have boosted the metabolic and physiological activity of the plant assimilating more amounts of nutrients which ultimately increased the plant height (Nishi *et al.* 2019).Plantelongation rate (cm/day) of transplanted *Kharif*rice varied significantly with the variation of different nutrient managementpracticesinnewalluvialsoilsoflowerIndo-GangeticPlainsofWest Bengal.However, the elongation rate of plants with different treatments varied from 0.83 to 1.24cm/dayat 45-60 DAT.Amongdifferent treatments applied,NPK@80:40:40kg/ha+leafmanure@ 2.5t/haachievedthehighestelongation rate(1.24cm) which is followed by 125% NPK @ 80:40:40 kg/ha+FYM (5t/ha)+vermicompost@2 t/haobtaining value of 1.18 cm.Dry matter accumulation increased with increasingduration of crop (Table1).However,significantly highest dry matter accumulation(762.00g/m^2)observed at harvestwas recorded withapplication 125%NPK(RDF*i.e.*80:40:40kg/ha)+FYM @5t/ha+vermicompost@ 2t/ha. This value is followed by 125% NPK(RDF *i.e*.80:40:40 kg/ha) was recorded value of 745.70 g/m^2. The lowest value (386.33 g/m^2) of dry matter accumulation was recorded at control.Few studies have shown that, organic manures with associate adequate quantity of chemical N fertilizers may manufacture higher dry matter yield than those of conventional inorganic N fertilizers treatments (Singh *et al.*, 1994 and Chung *et al.*, 2000).The Crop growth rateofkharif rice was varied from 3.11 to 10.89 gm^{-2}day^{-1}with differentnutrientmanagementpractices from 60 DAT-harvest. The application of the dose of 125%NPK (@ 100:50:50 kg/ha)+FYM@5t/ha+Vermicompost @2.0t/harecorded the highest CGR depicting a value of (10.89g/m^2/day) , which is followed by NPK @ 125% of RDFobtaining value of 10.23 g/m^{2}daywhilethelowestCGRvaluewasfoundunderthetreatmentcontrolplot (3.11 g/m^2/day).Data pertaining to tiller numbers in kharifriceindicated that at 60 DAT the rice plantshowed significant variation in tiller number under different nutrient management practices. However application of 125%NPK(100:50:50)+ FYM 5t/ha +vermicompost 2t/harecorded significantly higher number of tillers per hill (12.06) over the others, whereas the lowest value(6.10)was obtained from control.Mirza*et al.* (2005) and they reported that productive tillers per hill were increased by the application of FYMalong with different macro and micro nutrients application.The root length of kharifrice at 60 DAT varied significantly with different nutrient management practices (Table 1). Significantly, highest root length at 60 DAT (28.2 cm) were found with 125% NPK (RDF) +FYM 5 t/ha+Vermicompost 2 t/haover the remaining treatments which was followed by NPK @ 80:40:40 kg/ha+Vermicompost 2 t/haand this value was statistically at par with other treatments. The lowest value (19.3) was obtained at control (No fertilizer).These findings are in close agreement with those of The increase in crop growth characters may be attributed to mineralization of FYM or through soubilization of nutrients from native source during the process of decomposition (Ghasal*et al.* 2015).

Yield attributes and grain yield

Panicle length of rice varied from 20.26 to 23.48 cm with a variation of 17.04% over control. The maximum panicle length (23.48cm) was achieved with the combined application 125%NPK(100:50:50)+FYM @ 5t/ha+Vermicompost @ 2t/hawhich was statistically at par with NPK@125% RDF. The lowest value in panicle length (20.26 cm) was observed by the control treatment.Effectivetillers/m^2(326)wasfoundsignificantobtainingbest result 125%NPK(100:50:50)+FYM @ 5t/ha+Vermicompost @ 2t/ha^{-1} which was followed by NPK @ 80:40:40 kg/ ha+ $ZnSO_4$ @ 25 kg/ ha. The lowest value of effective tillers/m (191) was obtained from control.Filled grain/panicleof transplanted Kharif rice was significantly influenced by integrated nutrientmanagementpractices(Table 2). However, the number of filled grainspanicle^{-1}recording best value in 125% RDF+FYM @ 5t/ha +Vermicompost@2t/hawas significantly superior (123.33).The lowest number of filled grain/panicle was recorded in the control plot (83.66). Similar kind of association was revealed by Patel *et al*. (2014) and Rao*et al*. (2014) for number of filled grains per panicle.The same trend was followed in terms of grain ,straw yield as well as 1000-seed weight obtaining best value of 5.25 kg/ha, 5.84 kg/ha and 20.17 gm at 125%RDF+ FYM@5t/ha+vermicompost@ 2t/ha. This values are statistically at par with NPK @ 80:40:40 kg ha^{-1}+ $ZnSO_4$@ 25 kg/ha. Acharya*et al.* (1998) pointed out that the application of N, P, and K fertilizer along with FYM increased the growth attributes, yield components and grain yield of rice compared with that of N, P and K through fertilizer alone.Balasubramanian and Wahab (2012) observed that straw yields were favorably influenced by combined application of inorganic fertilizers and organic manures. Organic nutrients like Farmyard manure andvermicompostmight have supplied the essential minerals and worked as catalyst for efficient use of applied nutrients for increasing the yield attributes Ramkrishna*et al.*, 2007 and Sowmya*et al*., 2011.

Soil nutrient status after harvest

After the harvest of Kharif rice, available soil nitrogen, phosphorus, and potassium varied significantly with different nutrient management practices (Table 3). The available nitrogen was more (279.30 kg/ha) in the plot fertilized with higher dose of 125%RDF+ FYM @ 5t/haalong with vermicompost@ 2t/ha. The lowest available nitrogen (161.30 kg/ha) was recorded in the control plot because the plant utilized the native soil nutrient. The highest available phosphorus (42.63 kg/ha) recorded in the application of a higher dose of nutrient *i.e.*125%RDF+FYM (5t/ ha)+Vermicompost(2.0t/ha)followed by the NPK @125%RDF and lowest available phosphorus recorded in the control plot.The highest available potassium was obtained from the higher dose of125%RDF+FYM(5t/ha)along withVermicompost(2.0t/ha)fertilizedplot(235.03kg/ha)thelowestdata was obtained in control plot where no fertilizer wasapplied.

Conclusion

Conclusively, integrated nutrient management wasfound to be superior for enhancing growth and yield ofricecv.IET-25701(BidhanSuruchi). Among the different combination given,application of 125% NPK (80:40:40 kg/ha) + FYM @ 5t/ha along withVermicompost@ 2.0 t/harecorded the highest grain yield (5.25t/ha) was found more beneficial in terms of growth parameters and yield attributes of rice along with available nutrient status after harvest in lower Gangeticalluvialsoil of West Bengal.

Table1:Growth characters of *kharif* rice as influenced by different nutrient management practices

Treatment	Plant height(cm) at 60 DAT	Elongation rate(cm/day) at45-60 DAT	Drymatter accumulation (g/m^2) at harvest	Crop growth rate (g/m^2/day) at60-Harvest	Tillers/hill at 60 DAT	Root length (cm) 60 DAT
T_1	82.93	0.83	386.33	3.11	6.10	19.3
T_2	95.46	0.92	699.10	8.48	9.19	23.6
T_3	103.10	1.24	712.43	9.45	9.30	25.4
T_4	102.83	1.01	722.90	9.29	9.56	25.6
T_5	102.76	1.11	725.06	10.11	9.43	25.3
T_6	104.80	1.03	734.80	9.32	11.53	22.5
T_7	107.43	0.94	745.70	10.23	11.18	23.2
T_8	108.16	1.18	762.00	10.89	12.06	28.2
SEm (±)	0.67	0.04	4.93	1.25	0.12	0.92
CD at 5%	2.06	0.13	15.10	3.82	0.38	2.87

[T_1-Control(Nofertilizer),T_2-NPK@80:40:40kg/ha(RDF),T_3-NPK@80:40:40kg/ha+leafmanure(subabul)2.5t/ha,T_4-NPK@80:40:40 kg/ha+Vermicompost 2 t/ha, T_5-NPK @ 80:40:40 kg /ha+ FYM 5 t/ha, T_6-NPK @ 80:40:40 kg /ha+$ZnSO_4$@25 kg /ha,T_7-NPK@125% of RDF, T_8-125% NPK (RDF) +FYM 5 t/ha +Vermicompost 2 t/ha]

Table 2: Yield attributes and grain yield of *kharif* rice as influenced by different nutrient management practices

Treatment	Panicle length (cm)	Effective tiller m^{-2}	Filled grains $Panicle^{-1}$	1000-seed weight(g)	Grain yield (t/ha)	Straw yield (t/ha)
T_1	20.26	191	83.66	18.42	2.43	4.45
T_2	22.24	306	112.20	18.54	4.06	5.23
T_3	22.37	310	114.66	18.73	4.32	5.33
T_4	21.97	316	119.00	18.82	4.40	5.58
T_5	22.07	311	116.00	18.65	4.22	5.47
T_6	23.24	321	120.66	19.99	4.89	5.80
T_7	22.62	314	115.33	19.32	4.30	5.29
T_8	23.48	326	123.33	20.17	5.25	5.84
SEm (±)	0.33	2.88	4.58	0.02	0.27	0.16
CD at 5%	1.02	8.82	14.04	0.09	0.38	0.5

[T_1-Control(Nofertilizer),T_2-NPK@80:40:40kg/ha(RDF), T_3-NPK@80:40:40kg/ha+leaf manure(subabul) 2.5 t /ha ,T_4-NPK @ 80:40:40 kg/ha+Vermicompost 2 t/ha, T_5-NPK @ 80:40:40 kg /ha+ FYM 5 t/ ha, T_6-NPK @ 80:40:40 kg /ha+$ZnSO_4$@25 kg /ha,T_7-NPK@125% of RDF, T_8-125% NPK (RDF) +FYM 5 t/ha +Vermicompost 2 t/ha]

Table 3: Soil nutrient status as influenced byintegrated nutrient management practices of rice during *kharif* season

Treatment	Available N (kg/ha)	AvailableP_2O_5 (kg/ha)	Available soilK_2O (kg/ha)
T_1	161.30	23.23	155.50
T_2	251.33	34.16	215.33
T_3	255.46	35.20	221.26
T_4	262.26	37.40	224.26
T_5	260.33	38.43	223.30
T_6	263.96	35.43	218.20
T_7	269.16	39.53	229.30
T_8	279.30	42.63	235.03
SEm (±)	2.38	0.65	0.81
CD at 5%	7.31	2.01	2.49
Initial	**202.45**	**28.35**	**196.50**

[T_1-Control(Nofertilizer),T_2-NPK@80:40:40kg/ha(RDF),T_3-NPK@80:40:40kg/ha+leaf manure(subabul) 2.5 t /ha ,T_4-NPK @ 80:40:40 kg/ha+Vermicompost 2 t/ha, T_5-NPK @ 80:40:40 kg /ha+ FYM 5 t/ ha, T_6-NPK @ 80:40:40 kg /ha+$ZnSO_4$@25 kg /ha,T_7-NPK@125% of RDF, T_8-125% NPK (RDF) +FYM 5 t/ha +Vermicompost 2 t/ha]

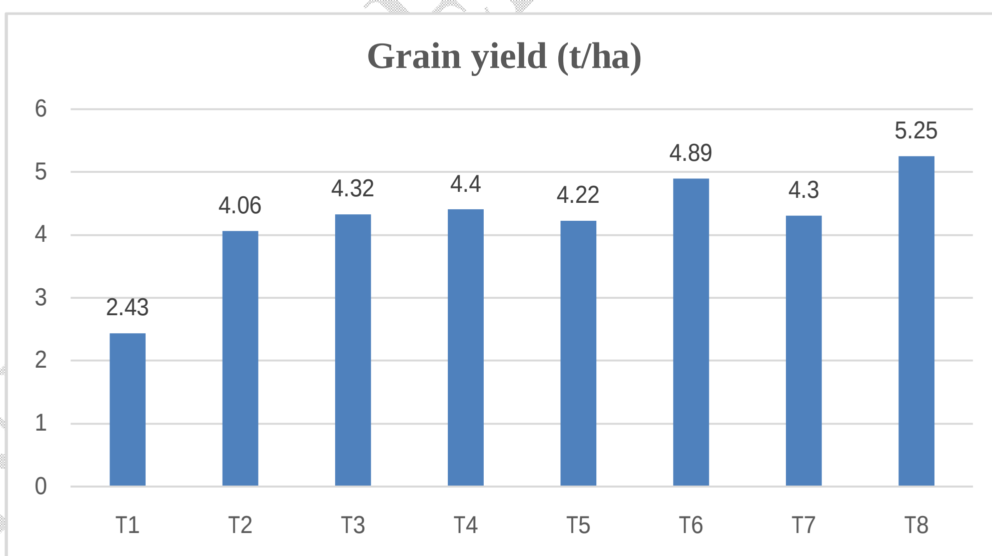

Fig 1: Grain yield (t/ha) of rice grown with integrated nutrient management

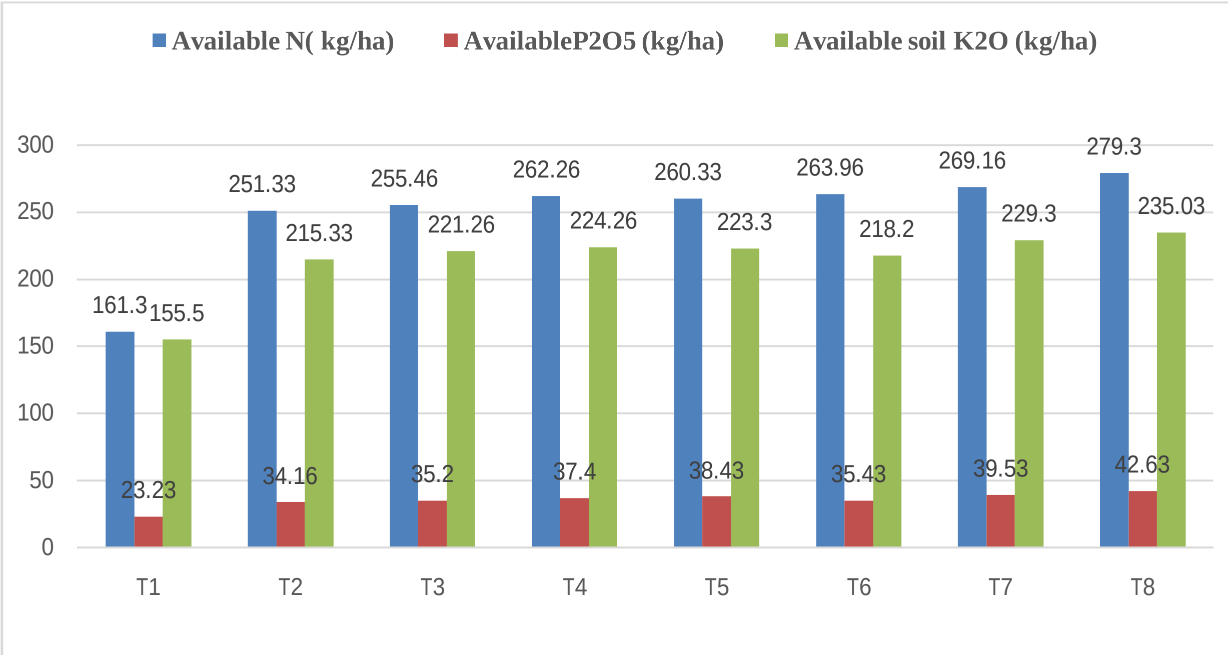

Fig 2: Soil nutrient status (kg/ha) of rice grown with integrated nutrient management

REFERENCES

1. Acharya CL, Bisnoi SK and Yaduvanshi H S.1998. Effect of long term application of fertilizer and amendment under continuous cropping and soil physical properties in Alfisols. Indian Journal of Agricultural Science, 58: 509- 516.

2. Anonymous. KrishiDarshika, Annual publication of Directorate of Extension Services, IGKV, Raipur (C.G.), 2021

3. Balasubramanian, A. and Wahab, K. 2012. Integrated nutrient management in rice for Cauvery Deltaic zone of Tamil nadu, India. Plant Archives, 12(1): 95-97.

4. Basavaraja, T., Gang prasad, S., Dhusyantha Kumar, B. M and ShilajaHittlamani. 2011. Correlation and path analysis of yield and yield attributes in local rice cultivars (Oryza sativa L.). Electronic J. Pl. Breed.,2(4): 523-26

5. Bhagat, G.J., Kamdi, S.R., Neharkar, P.S., Ghate, S.R. and Kadu, P.R. (2015). Influence of integrated nutrient management on paddylathyrus cropping system in eastern Vidarbha region. International Journal of Tropical Agriculture. 4(2): 16-20

6. Chung, R.S.; Wang, C.H.; Wang, C.W.; Wang, Y.P. 2000. Influence of Organic Matter and Inorganic Fertilizer onthe Growth and Nitrogen Accumulation of Corn Plants. Journal of Plant Nutrition, 23 (3): 297–311.

7. FAO. Food and agriculture data. FAOSTAT, food and agriculture organization of the United Nations, 2020. Available at:www.fao.org/faostat/en/#data/QC

8. Ghasal, P. C., Shivay, Y. S. and Pooniya, V. 2015. Response of basmati rice (Oryza sativa) varietiesto zinc fertilization. Indian J. Agron., 60(3), 403- 09.

9. GOI (Government of India). First advanced estimates of production of food grains. Directorate of economics and statistics. Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi, 2020.

10. Hu, W., Jiang, N., Yang, J., Meng, Y., Wang, Y., Chen, B., et al. (2016a). Potassium (K) supply affects K accumulation and photosynthetic physiology in two cotton (Gossypiumhirsutum L.) cultivars with different K sensitivities. Field Crop. Res. 196, 51–63. doi: 10.1016/j.fcr.2016.06.00

11. Jana K, Mondal R and Mallick GK (2020). Growth,productivity and nutrient uptake of aerobic rice(Oryza sativa L.) as influenced by different nutrientmanagement practices. Oryza 57(1): 49-56

12. Kalam, M. A., Hossain, M. B., Sarmin, T., Moslehuddin, A. Z. M., & Khan, M. M. K. (2011). Different levels of nitrogen and phosphorus with or absence of VAM fungal inoculum on rice (Oryza sativa L.). Journal of Agroforestry and Environment, 5(2), 7-10.

13. Kumar, V., Tripathi, H. C. and Mishra, S. K. (2012). Impact of integrated nutrient management on yield, economics and soil fertility in hybrid rice (Oryza sativa) - mustard (Brassica juncea) cropping system. New Agriculturist 23(1):21-26.

14. Mirza, B.B., Zia, M.S., Szombathova, N. and Zaujec, A. 2005. Rehabilitation of Soils throughEnvironmentalFriendlyTechonologies: Role of Sesbania and Farm Yard Manure. Agric. TropicaEtSubtropica., 38(1): 11-17.

15. Mitran T, Mani PK (2018) Effect of organic amendments on rice yield trend, phosphorus use efficiencyuptake, and apparent balance in soil under long-term rice-wheat rotation. J Plant Nutr40(9):1312–1322

16. Mohaddesi, A., Abbasian, A., Bakhshipour, S. and Aminpanah, H. 2011. Effect of different levels of nitrogen and plant spacing on yield, yield components and physiological indices in high-yield rice (number 843). American-Eurasian J. Agric. Env. Sci., 10(5), 893-900.

17. Mondal R, Goswami S, Goswami SB and Jana K (2020). Effectof different nutrient management practices ongrowth, grain yield, production economics, soilnutrient availability of transplanted kharif rice (Oryzasativa L.) and correlation studies. Journal of Cropand Weed 16(1): 172-179

18. Nishi, K. N., S. Rahman, K. Nakamura & M. K. Rahman. (2019). Influence of vermicompost and NPK on the growth and protein content of boro rice (Oryza sativa L.).

Journal of Biodiversity Conservation and Bio resource Management, 5(2), 69-74. https://doi.org/10.3329/jbcbm. v5i2.44916.

19. Patel, J.R., Saiyad, M.R., Prajapati, K.N., Patel, R.A and Bhavani R.T. 2014. Genetic variability and character association studies in rainfed upland rice (Oryza sativa L.) Electronic J. Pl. Breed., 5(3): 531- 37.
20. Prakash, H.C., Sunitha, B.P. and Gurumurthy, K.(2010). Effect of INM approach on productivity and economics of rice cultivation (Oryza sativa L.) in Bhadra Command, Karnataka, in relation to soil properties. Mysore Journal of Agricultural Sciences 44(4):786-792

21. Ramakrishna, Y., Subedar, Singh and Parihar, S. S. (2007). Influence of irrigation regime and nitrogen management on productivity, nitrogen uptake and water use by rice (Oryza sativa). Indian Journal of Agronomy52(3): 102-106.

22. Rao, V.T., Mohan, Y.C., Bhadru, D., Bharathi, D and Venkanna, V. 2014. Genetic variability and association analysis in rice. Int. J. Appl. Biol. Pharma. Technol., Vol.5, Issue 2

23. Sarkar A, Jana K, Mondal R. Growth and yield of hybrid mustard (Brassica juncea L.) as influenced by foliar nutrition in Gangetic plains of West Bengal. Journal of Crop and Weed. 2021;17(3):35-40.

24. Satish Chandra, B., Dayakar Reddy, T., Ansari, N.A. and Sudheer Kumar, S. 2009. Correlation and path analysis for yield and yield components in rice (Oryza sativa L.) Agri. Sci. Digest, 29(1): 45-47

25. Singh, Y.; Singh, B.; Khera, T.S. Meelu, O.P. 1994. Integrated Management of Green Manure, Farmyard Manureand Nitrogen Fertilizer in a Rice-Wheat Rotation in Northeastern India. Arid Soil Research and Rehabilitation, 8(2): 199–205.

26. Sowmya, C., Ramana, M.V. and Kumar, M. (2011).Effect of systems of rice cultivation and nutrient management options on yield, nutrient uptake and economics of rice.Crop Research (Hisar)42 (½): 3,69.