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Soil and Foliar Application of Zn and Fe Impact on Growth, Grain Yield and Seed Quality of Rice (*Oryza sativa L.*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted in *kharif* season of 2021-22 at Village Nuapur, Tal. Sadar, Dist.Balasore, (Odisha) through Department of Soil Science and Agricultural Chemistry College of Agriculture, Badnapur, VNMKV, Parbhani, with an objective to study the Soil and foliar application of zinc and iron impact on growth, grain yield and seed quality of rice (*Oryza sativa L.*).The treatment were tested in Randomized Block Design (RBD) with 4 replications i.e., T_1-RDF, T_2-RDF+Nano Zn(0.5% foliar spray at 30 DAS) , T_3-RDF+Nano Fe (0.5% foliar spray at 30 DAS) , T_4-RDF + Nano Fe+Nano Zn(0.5% foliar spray at 30 DAS) , T_5- RDF + $ZnSO_4$ (25 kg ha^{-1} soil application),T_6-RDF+$FeSO_4$(25 kg ha^{-1} soil application), T_7-RDF+$ZnSO_4$+$FeSO_4$(25 kg ha^{-1} soil application).The result emerged out clearly indicated the significantly higher plant height (128.2 cm) was noted at harvest stage with treatment T_7: RDF+$ZnSO_4$+$FeSO_4$ (25 kg ha^{-1} soil application)

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among all treatments. Significantly higher number of tillers plants^{-1} (16.5), effective tillers per square meter (337), panicle length (31.2cm) and number of grains per panicle (188) maximum grain and straw yield of rice (47.9 and 62.5 q ha^{-1}) at harvest stage were recorded in T_4 : RDF+ Nano Fe + Nano Zn (0.5%foliar spray at 30 DAS. In grain quality the maximum test weight (24.2g), highest starch content (86.4%) was obtained with treatment T_4: RDF + Nano Fe + Nano Zn(0.5%foliar spray at 30 DAS).

Keywords: Zinc; iron; rice; foliar application; 0.5 %; yield; quality.

1. INTRODUCTION

"Rice (*Oryza sativa, L.*) is one of the most important cereal crops of India, which is used as staple food by more than 70% of the population living in the Asian continent. It is extensively grown in tropical and subtropical regions of the world. The mineral elements most commonly lacking in human diets are iron (Fe) and zinc (Zn). In fact, rice is deficient of the above mineral elements. Since rice serves as staple food, even a minimum increase in nutritive value of rice can significantly impact human health" [1].

"Zn is one of the 17 essential micronutrients for optimum growth and development of the crop plants and is required to be fortified in the crop produce. Among eight micronutrients, which have key role in plants involved with enzymes and proteins in carbohydrate metabolism, protein synthesis, gene expression, auxin (growth regulator) metabolism, pollen formation, maintenance of biological membranes, protection against photooxidative damage, heat stress, and resistance to infection by certain pathogens. Zinc is a major component and activator of several enzymes involved in metabolic activities such as requirement for biosynthetic machinery of the respiratory system proteins cytochrome, structural proteins, and nucleotides, for proper gene expression, enzyme activation, chlorophyll production, maintenance of membrane activity and improved seed and stalk maturation In plant's biochemical and physiological processes, Zn plays multiple roles even slight deficiency of Zn may causes a decrease in growth, yield and Zn content of edible plant parts. Zn content in food is very important for human health as the artificial supplementation of food with essential minerals is often difficult to achieve, particularly in developing countries" (Katyal and Sharma, 1982) [2].

"Iron deficiency in rice mainly occurs under upland conditions; particularly in alkaline and calcareous soils. Sometimes severe chlorosis in rice due to Fe-deficiency has led to complete failure of rice crop" [2]. "In most of the studies, foliar application of Fe has an edge over soil. Iron is easily translocated acropetally and even retranslocated basipetally after foliar application as long as 2+ Fe does not get immobilized. But Fe salts rapidly oxidize upon exposure to ambient air under field conditions" [3].

"Nano fertilizers stand apart as one of the most helpful tool because of their high productivity, functionalities, advantageous and simple applications. Nano fertilizer improve growth parameters of plants such as height of plants, leaf area, number of leaves per plant,increase in dry matter and chlorophyll, photosynthesis rate which outcome more translocation of photosynthets and production to various parts of the plant contrast to chemical fertilizers. Nanotechnology based nutrients could be more dissolvable or more receptive than their mass counterparts. Zinc nano fertilizers was found to continuous increase in dry matter, total fresh and dry mass of root and shoot of rice crop. Highest rate being shown with increasing level of zinc nanofertilizers, which might be recognized to improved responses of antioxidant in rice crop treated with zinc nano fertilizers" [2].

Nano-fertilizers are nutrient carriers that are being developed using substrates with nano dimensions of 1 – 100 nm. Nano particles have extensive surface area and capable of holding abundance of nutrients and release it slowly and steadily such that it facilitates uptake of nutrients matching the crop requirement without any associated ill effects of customized fertilizer inputs reported that nano-fertilizers and nano composites can be used to control the release of nutrients from the fertilizer granules so as to improve the nutrient use efficiency while preventing the nutrient ions from either getting fixed or lost to the environment.

2. MATERIALS AND METHODS

A field experiment was conducted in *kharif* season during 2021-22 on the field of Village

Nuapur, Tal. Sadar, Dist.Balasore, (Odisha). through Department of Soil Science and Agricultural Chemistry College of Agriculture, Badnapur, VNMKV, Parbhani, with an objective to study the **Soil and foliar application of zinc and iron impact on growth, grain yield and seed quality of rice (*Oryza sativa L.*).**After completion of preparatory tillage operations, the experimental units were laid out as per plan. The treatment were tested in randomized block design (RBD) with seven treatments. The layout consists of 28 experimental plots in four replications.The treatments comprises T_1-RDF, T_2-RDF+Nano Zinc (0.5% foliar spray at 30 DAS) ,T_3-RDF+Nano Fe (0.5% foliar spray at 30 DAS),T_4-RDF + Nano Fe+ Nano Zn (0.5% foliar spray at 30 DAS) ,T_5- RDF + $ZnSO_4$ (25 kg ha^{-1} soil application),T_6-RDF+$FeSO_4$ (25 kg ha^{-1} soil application), T_7-RDF+$ZnSO_4$+$FeSO_4$ (25 kg ha^{-1} soil application).

Rice seed variety 'Swarna' was obtained from local cultivar, which was prepared from previously grown crop, sown on 1st July, 2021. Firstly the seeds of paddy were sown in the nursery and in 15 days seedlings were ready for transplanting in the main field as per randomly replicated plot having size 4.5m x 5.0 m and 3.9m x 4.6 m in gross and net plot size, respectivelythe seedlings were transplanted bin the main field following the spacing 15cm×15 cm. All the plots were fertilized with recommended dose of the NPK as per the present recommendation of rice in coastal region of Odisha. The 100 (%) NPK dose in kg ha^{-1} worked out was 100:60:60 for rice crop. The sources used for applying N, P , K ,Zn and Fe were urea, single super phosphate , muriate of potash, ZnSO4, FeSO4,Nano Zn and Fe. The crop was raised with all the standard package of practices and protection measures also timely carried out as they required. The crop of net plot area was harvested at physiological maturity stage on 02 December 2021, with the help of sickle. The crop was harvested close to ground and plant were tied in bundles and kept for sun drying on threshing floor for few days. After sun drying of harvested plants of net plot area are threshed by threshing machine.

Five plants from each plot were randomly selected and used for recording biometric observations viz. Plant height (cm), number of tillers $plants^{-1}$, effective tillers per square meter, panicle length and number of grains per panicle, grain and straw yield of rice at harvest stage. Quality parameter like test weight value and starch content (%) were recorded. The data collected from the above observation were analysed statistically by the procedure prescribed by Panse and Sukhatme[4] The findings of the present study as well as relevant discussion have been presented under following heads.

3. RESULTS AND DISCUSSION

3.1 Effect on Growth Parameter

3.1.1 Plant height (cm) at harvest

The height of rice monitored at harvest stage of crop. The observations recorded under different treatments are presented in table 1. It was observed that there was continuous increase in plant height of crop due to each additional nutrient's application. Significant variation was observed on the plant height in rice at all the treatment. The plant height was significantly highest in treatment T_7: RDF+$ZnSO_4$+$FeSO_4$ (25 kg ha^{-1} soil application). Treatment (T_7) recorded significantly higher plant height (112.2 cm) and it was higher by 9% than (T_1) control (95.5 cm).All other treatments were at par with T_7 except T_3. The increase in plant height could be partly being attributed due to the beneficial soil application effect of Zinc and Iron. Improvement in growth parameters of rice crop is due to the application of different concentrations of zinc and iron over RDF is possibly due to the beneficial effects of Zn and Fe on cell elongation and cell division, increase in photosynthetic activity and better food accumulation and also stimulated the growth and expansion of cells through increasing the wall plasticity of the cells. The foliar application of Zn and Fe at 30 DAS might have reduced flower drop and also improved the reproductive development of rice crop and supported efficient translocation of photosynthates from source to sink .It was found that soil application of Zn and Fe was more effective than foliar application in case of plant height. The results were supported by the experiment conducted by Yadav and Yadav [5] as there was 8% increase in plant height due to application of nutrients through foliar spray.

3.1.2 Number of tillers $plant^{-1}$

The number of tillers $plant^{-1}$ in rice was supervised at harvest stage of crop underseveral treatments and are presented in table 2. It was observed that there was continuous increase in number of tillers per plant of crop due to each additional nutrient's application. Significant difference was exhibited on the number of tillers in rice at all the treatments. The number of tillers was significantly highest in T_4: RDF+ Nano Fe+ Nano Zn (0.5%foliar spray at 30 DAS) (16.50) at harvest stage. Significantly lowest number of tillers per plant (10.83) was observed in (T_1). Treatments T_7: RDF+$ZnSO_4$+$FeSO_4$ (25 kg ha^{-1} soil application) (15.87) is at par with T_4. The availability of nutrient to the crops at various growth stages through agrochemical sources might have increased number of tillers. Zn and Fe might have accelerated photosynthetic rate, thereby increasing the supply of carbohydrates, resulted in increased cell division, multiplication and elongation leading to increased number of tillers per plant of field crop. Here foliar application was found to be more effective than soil application. The results were also confirmed with the findings of Maitra [6] which was 17% increase in number of tillers per plant through foliar application of nutrients.

3.1.3 Number of effective tillers square meter^{-1}

The number of effective tillers square^{-1} meter of rice was detected at harvesting stage of crop. Under different treatments appeared in Table 2. It was revealed that there was continuous rise in number of effective tillers per square meter of rice was significantly highest in treatment T_4: RDF+ Nano Fe+ Nano Zn (0.5 %foliar spray at 30 DAS) (336.6) at harvest stage over the treatment T_1 recommended dose of fertilizers (306.6). Treatment T_7: RDF+$ZnSO_4$+$FeSO_4$ (25 kg ha^{-1} soil application) (329.3) is at par with T_4. Significantly lowest number of effective tillers per square meter (306.6) was recorded in treatment T_1: Recommended dose of fertilizers. Foliar applications of nutrients were found to be more effective in increasing number of tillers per plant. The reason for improving the number of tillers per square meter might be due to availability of nutrients through foliar application to the rice crop Zn and Fe increase plants' tolerance to several abiotic stresses, reduce transpiration and increased nitrate reductase activity, flower longitivity and hence, increase in number of tillers. Similar findings were obtained by Yadav and Tiwari (2022).

Table 1. Effect of soil and foliar application of Zn and Feon plant height of rice

Treatments	Plant height (cm) at harvest
T_1: Recommended dose of fertilizer	95.5
T_2 :RDF+Nano Zn(0.5% foliar spray at 30 DAS)	104.2
T_3 :RDF+Nano Fe(0.5% foliar spray at 30 DAS)	102.1
T_4 :RDF+NanoFe+Nano Zn(0.5%foliar spray at 30 DAS)	110.4
T_5 : RDF+ZnSO4 (25 kg ha^{-1} soil application)	106.4
T_6 : RDF+FeSO4 (25 kg ha^{-1} soil application)	105.3
T_7 : RDF+ZnSO4+FeSO4 (25 kg ha^{-1} soil application)	112.2
SE(m)±	**2.95**
CD at 5%	**8.20**

Table 2. Effect of soil and foliar application of Zn and Fe on number of tillers plant-1 and number of effective tillers square-1 meter of rice

Treatments	Number of tillers plant^{-1}	Number of effective tillers square meter^{-1}
T_1: Recommended dose of fertilizer	10.83	306.6
T_2 :RDF+Nano Zn(0.5% foliar spray at 30 DAS)	14.67	322.3
T_3 :RDF+Nano Fe(0.5% foliar spray at 30 DAS)	12.30	314.6
T_4 :RDF+NanoFe+Nano Zn(0.5%foliar spray at 30 DAS)	16.50	336.6
T_5 : RDF+ZnSO4 (25 kg ha^{-1} soil application)	13.50	314.3
T_6 : RDF+FeSO4 (25 kg ha^{-1} soil application)	11.37	310.3
T_7 :RDF+ZnSO4+FeSO4(25 kg ha^{-1} soil application)	15.87	329.3
SE(m)±	**0.234**	**2.73**
CD at 5%	**0.722**	**8.52**

3.1.4 Panicle length (cm)

Effect of soil and foliar application of Zn and Fe on panicle length of rice was calculated at harvest stage of crop. Calculated panicle length is presented in table 3.It was noted that panicle length was highest in treatment T_4: RDF+ Nano Fe+Nano Zn (0.5% at 30 DAS) (31.20 cm) over the treatment (T_1) (20.57 cm) RDF followed by (T_7) RDF+ZnSO^4+FeSO^4 (25 kg ha^{-1} soil application) (28.47 cm). Significantly lowest panicle length was recorded in treatment (T_1) (RDF). Treatment (T_4) recorded 33 per cent more rice panicle length than that of control plot.

The increase in panicle length might be attributed to the beneficial role of Zn and Fe in improving photosynthetic activity and plant nutrition. The reason for increasing the panicle length might be due to availability of nutrients through foliar application to rice which increased dry matter, plant assimilates, which directly reflect into number of tillers plant^{-1} and also higher panicle length. Foliar application of Zn and Fe was found to be more effective than soil application. Similarly results published by Tripathy and Sahoo [7] are in line.

3.1.5 Number of grains per panicle

The number of grains per panicle was calculated at harvest stage of crop. Observation under different treatments is presented in table 3. It was observed that there was continuous increase in number of grains per panicle of crop due to each additional nutrient's application. The number of grains per panicle was significantly highest in treatment (T_4) i.e., RDF+ NanoFe+ Nano Zn (0.5%foliar spray at 30 DAS) (188.4). Significantly lowest number of grains per panicle (144.2) was observed in treatment (T_1) (Recommended dose of fertilizer). Treatment (T_4) recorded 28 per cent more number of grains per panicle than that of control plot. T_7: RDF+ZnSO4+FeSO4 (25 kg ha^{-1} soil application) (178.8) is at par with T4. The number of grains per panicle increased due to greater diversion of assimilates towards reproductive organs.

For seed development, assimilate transfer to reproductive sinks is essential. The availability and use of assimilates may have an impact on seed set and filling [8]. The combination of traits that contribute to yield, improved photosynthetic efficiency, and improved reproductive sink ability to use incoming assimilates as a result of exogenous Zn and Fe application resulted in an increase in the number of grains per panicle. These results are in agreement with the work of Anshuman and Ankita Rao [9] They found that there was 15.66 % increase in number of grains per panicle by the application of nutrients through foliar application.

3.2. Effect on Yield Attributes

3.2.1. Grain yield (q ha-1)

The grain yield of rice was calculated at harvest stage of crop. Observation under different treatments is presented in table 4. It was observed that there was continuous increase in grain yield of crop due to each additional nutrient's application. The grain yield was highest in treatment T4: RDF+NanoFe+Nano Zn (0.5% foliar sprays at 30 DAS) (47.96 q ha^{-1}). Treatment T_7: RDF+$ZnSO_4$+$FeSO_4$ (25 kg ha^{-1} soil application) (47.14) was at par with T_4. Significantly lowest grain yield (40.55q ha$^-$1) was observed in treatment (T_1) (RDF). Treatment (T_4) recorded 18 % more rice grain yield than that of control plot. The grain yield of rice increased due to greater diversion of assimilates towards reproductive organs.

Assimilate translocation to reproductive sinks is vital for seed development. Seed set and filling can be limited by availability and utilization of assimilates (Asch et al. 2005) [8]. The grain yield of rice crop was increased due to cumulative effect of yield attributing characters, enhanced photosynthetic efficiency and improvement in the capacity of the reproductive sinks to utilize the incoming assimilates due to the exogenous application of Zn and Fe. Yield is the culmination of several comprehensive phases which starts at germination and end at harvest, encompassing through shoot growth, leaf development, photosynthesis, flowering, pollination and seed set. Higher vegetative growth of a crop is largely responsible for higher seed yield because number of photosynthesizing sites i.e., number of vegetative branches is influenced by initial growth stage, nutrition and mechanical/soil management. Here foliar application of Zn and Fe was found to be more effective than soil application. These results are in agreement with the work of Behera and Jena [10] found similar effect in grain yield that there was 53% increase in grain yield due to application of micronutrients.

Table 3. Effect of soil and foliar application of Zn and Fe on Panicle length (cm) and number of grains panicle^{-1}of rice

Treatments	Panicle length (cm)	Number of grains panicle^{-1}
T_1: Recommended dose of fertilizer	20.57	144.2
T_2 :RDF+Nano Zn(0.5% foliar spray at 30 DAS)	27.30	166.3
T_3 :RDF+Nano Fe(0.5% foliar spray at 30 DAS)	26.40	155.5
T_4 :RDF+NanoFe+Nano Zn(0.5%foliar spray at 30 DAS)	31.20	188.4
T_5 : RDF+ZnSO4 (25 kg ha^{-1} soil application)	25.60	162.6
T_6 : RDF+FeSO4 (25 kg ha^{-1} soil application)	24.50	154.6
T_7 :RDF+ZnSO4+FeSO4(25 kg ha^{-1} soil application)	28.47	178.8
SE(m)±	**0.205**	**4.51**
CD at 5%	**0.633**	**11.84**

3.2.2. Straw yield (q ha^{-1})

Observations on straw yield of rice recorded at harvest stage under different treatments are presented in table no.4. The straw yield was significantly highest in treatment T_4: RDF+ Nano Fe+ Nano Zn (0.5%foliar spray at 30 DAS) (61.50 ha^{-1}) over the treatment T_1 : RDF (55.56 q ha^{-1}).T_7: RDF+$ZnSO_4$+$FeSO_4$ (25 kg ha^{-1} soil application) (60.67) was at par with T_4. It is clearly observed that increase in straw yield mainly due to more availability of micro nutrients with foliar application of nutrients. This might be due to application of nutrients like Zn and Fe through foliar application which enhances protoplasmic elements that assists in physiological functioning of plant such as chlorophyll and protein synthesis and thereby increasing straw yield. These results are in agreement with the work of Rath [11] that there was 4% increase in straw yield due to foliar application of Zn but insignificant difference between soil and foliar spray of micronutrients.

3.3. Effect on Quality Attributes

3.3.1. Test weight (gm)

Effect of soil and foliar application of Zn and Fe on the test weight of rice was calculated at harvest stage of crop. Calculated test weight is presented in table 5. The test weight was highest in treatment T_4: RDF+ Nano Fe+ Nano Zn (0.5% foliar spray at 30 DAS) (24.20g) over the treatment T_1: RDF (20.40).T_7: RDF +$ZnSO_4$ +$FeSO_4$ (25 kg ha^{-1} soil application) (23.83g) was at par with T_4. Lowest test weight (20.4gm) was recorded in treatment (T_1) (Recommended dose of fertilizers). Treatment (T_4) recorded 8 per cent more rice test weight than that of control plot. The increase in thousand grains weight might be attributed due to the beneficial role of Zn and Fe in improving photosynthetic activity and plant nutrition. The reason for increasing the test weight might be due to availability of nutrients through foliar application to rice which increased dry matter, plant assimilates which directly reflect into number of filled grains panicle^{-1} and also higher test weight. The results were supported by the experiment of Shankar and adhikary [12] that there was insignificant change in test weight due to application of nutrients through foliar spray.

3.3.2 Starch content (%)

Data on starch content (%) as influenced by different soil and foliar application of Zn and Fe are presented in table 5. Starch content was significantly influenced by different soil and foliar application of Zn and Fe. Starch content of rice showed significant variations with all the treatments. The starch content was significantly highest in T_4: RDF+ Nano Fe+ Nano Zn (0.5%foliar spray at 30 DAS) (86.40%). Among all the treatments T_7: RDF+$ZnSO_4$+$FeSO_4$ (25 kg ha^{-1} soil application) (85.45%) was at par with T_4. Significantly lowest starch content was obtained in T_1: Recommended dose of fertilizer (80.24%).

Stimulated growth by soil and foliar application of Zn and Fe enhanced absorption of carbon by plant and increased nitrogen concentration in plant which leads to the higher starch content in rice. Application of nutrients i.e., Zn and Fe enhances the plant growth, flower induction, nutrient uptake and photosynthesis and Zn and Fe leads to highest carbon concentrations in plant resulted in higher yield. Foliar application of Zn and Fe was found to be more effective in increasing starch content in grains. Similar result was reported by Sadasivam and Manikasm [13] reported that the seed starch content increased with carbon availability in rice.

Table 4. Effect of soil and foliar application of Zn and Fe on grain yield (q ha^{-1}) and straw yield (q ha^{-1}) of rice

Treatments	Grain yield (q ha^{-1})	Straw yield(q ha^{-1})
T_1: Recommended dose of fertilizer	40.55	55.56
T_2 :RDF+Nano Zn(0.5% foliar spray at 30 DAS)	44.42	58.43
T_3 :RDF+Nano Fe(0.5% foliar spray at 30 DAS)	43.66	57.67
T_4 :RDF+NanoFe+Nano Zn(0.5%foliar spray at 30 DAS)	47.96	61.50
T_5 : RDF+ZnSO4 (25 kg ha^{-1} soil application)	42.65	54.80
T_6 : RDF+FeSO4 (25 kg ha^{-1} soil application)	42.33	55.60
T_7 :RDF+ZnSO4+FeSO4(25 kg ha^{-1} soil application)	47.14	60.67
SE(m)±	**0.340**	**0.336**
CD at 5%	**0.939**	**0.920**

Table 5. Effect of soil and foliar application of Zn and Fe on Test weight (gm) and starch content (%) of rice

Treatments	Test weight (gm)	Starch content (%)
T_1: Recommended dose of fertilizer	20.40	80.84
T_2 :RDF+Nano Zn(0.5% foliar spray at 30 DAS)	23.20	84.97
T_3 :RDF+Nano Fe(0.5% foliar spray at 30 DAS)	21.63	83.50
T_4 :RDF+NanoFe+Nano Zn(0.5%foliar spray at 30 DAS)	24.20	86.40
T_5 : RDF+ZnSO4 (25 kg ha^{-1} soil application)	22.70	82.94
T_6 : RDF+FeSO4 (25 kg ha^{-1} soil application)	21.30	91.30
T_7 :RDF+ZnSO4+FeSO4(25 kg ha^{-1} soil application)	23.83	84.45
SE(m)±	0.219	**0.314**
CD at 5%	0.565	**0.964**

4. CONCLUSION

It can be concluded that the rice performed the best with the application of Nano Zn and Fe through foliar mode alongwith recommended dose of NPK (100:60:60 kg ha-1) (T_4) and found effective to its advantageous effect on improved growth attributes, grain yield attributes and seed quality of rice.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Chandel S. Comparative antioxidant property of leaves and fruits plant. International Journal of Pharma Science. 2010;38(1):216-222.
2. Katyal, Sharma. A new technique of plant analysis iron chlorosis. Plant and Soil, 1982;55:105–119.
3. Fernandez V, Ebert G. Foliar iron fertilization: A critical review. J. Plant Nutr., 2005;28:2113-2124
4. Panse VG, Sukhatme PK. Statistical methods for agriculture workers, (IV Edn.)ICAR, New Delhi. 1985;145-156.
5. Yadav D, Yadav S. Studies on the effect of integrated nutrient management Practices on yield and economics of aromatic rise. The Pharma Journal. 2021;10(4): 600603.
6. Maitra S. Productivity, nutrient uptake and nutrient use efficiency of summer rice as influenced by integrated nutrient management practices. Department of agronomy,CUTM . 2020;65-72.
7. Tripathy SK, Sahoo B. Phenotypic and association analysis of Zinc biofortified rice varieties for grain yield.International Journal of Plant and Environment. 2021;7(3) 1117-2454.
8. Asch F. Effect of field Pea bio culture cover crops on tunnel vegetable production system. Organic Agriculture. 2005;12(3): 1-12
9. Anshuman K, Rao A. Studies on the effect of integrated nutrient management Practices on yield and economics of aromatic rise. The Pharma Journal. 2021; 10(4):600-603.

10. Behera BC, Jena S. Effect of INM on growth and yield of rice in south and eastern coastal plain of Odisha.(2021).The Pharma Journal. 2021;11(4):2287-2890.
11. Rath B. Effect of INM on growth and yield of rice in south and coastal plain of Odisha. The Pharma Journal. 2021;2287-2890.
12. Shankar T, Adhikary R. Productivity, nutrient uptake and nutrient use efficiency of summer rice as influenced by INM practices.Crop Res. 2020;55(3&4): 65-72.
13. Sadasivam S, Manickam A. Biochemical determination. Age Determination; 1992.

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