***Original Research Article***

# "Influence of Nitrogen and Foliar Application of Nano Zinc on Growth and Yield of Wheat (*Triticum aestivum*)"

## ABSTRACT

The field experiment was conducted to find out the effect of Phosphorus and Iron on growth and yield of Wheat during *Rabi* 2023 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P). Totally there were ten treatments which were replicated thrice along with control plot. The experiment was laid out in Randomized Block Design. Results that observed that Significant and higher plant height (91.47 cm), number of tillers / hill (7.60), plant dry weight (25.31 g), number of effective tillers/hill (6.00), grains/spike (49.80), test weight (43.40g), grain yield (5.90 t/ha) and straw yield (7.02 t/ha) and also maximum Gross returns (1,15,460.00 INR/ha), Net returns (79,447.00 INR/ha) and Benefit cost ratio (2.21) was also recorded in treatment 6 (Nitrogen 125% + Nano zinc 4ml).

***Key words:*** *Nitrogen, Nano zinc, Growth, Yield, Economics*.

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## Introduction

Wheat (*Triticum aestivum* L.), which triggered green revolution in the Indian sub-continent, it is an important food grain providing nourishment nearly to 35 per cent people of the world. Wheat is the second most important crop in the family Phocaea next to rice and is called 'King of cereals' as it contributes to about 30-36 percent of food grain in national food production. It is basically a temperate region crop but can also be grown under different sub-tropical and tropical conditions successfully. It is an important winter cereal contributing about 38% of the total food grain production in India. Wheat straw is an important source of fodder for a large Indian animal population. The nutritive value of wheat is also an important component for nearly 35 percent of world population as it contains, 71.2 grams of carbohydrates, 11-12 grams of protein, 1.5 grams of fat, 306 milligrams of phosphorus and 41milligroms of calcium per 100 g of wheat grain and it is rich in carbohydrate, protein, fat and minerals like nano zinc, iron and also contains vitamins such as thiamine and vitamin-B.

On global scale, the crop is grown over an area of 215.48 m ha with annual production of 731.46 mt and productivity of 33.9 q/ha during 2019-20 worldwide **(USDA, 2021).** India is the second largest producer of wheat in the world next only to China and the crop has provided the fastest pace of growth to Indian agriculture. Among cereals, wheat is next to rice in area 24.23 million ha and production 75.6 million tonnes. In India, the major States where wheat is cultivated are Haryana, Punjab, Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh, Maharashtra, Karnataka and highest productivity of wheat is recorded in Punjab, nearly 29.14 mha area with annual production of 102.19 mt carrying average productivity of 3506.8 kg/ha in year 2018-19. Uttar Pradesh is the largest state of India with maximum contribution towards national production 35.03% from a large area 35.12%, but with productivity on a lower side of 2.7 tones/ha, the area is 9.2 m ha, with a production of 24.5 m t and productivity of 2.7 t/ha **(GOI, 2021)**.

Imbalance use of fertilizers has affected the soil health. The decline in growth rate of productivity of major crops as well as rate of response of crop to add fertilizers and intensive cropping system have possible resulted from deterioration in physical, chemical and biological properties of soil. In order to minimize these limitations, it is concerted efforts that a better nutrient management practices for efficient utilization of fertilizers should be adopted. Indian soils are generally deficient in nutrient particularly nitrogen, the reduction of nitrogen retarded growth and development of plants and also turns its foliage to pale green color and reduces the crop yield. It has been universally observed that nitrogen use efficiency by plants is about 30 to 37% while, the rest of nitrogen is lost through volatilization, denitrification and leaching **(Alam *et.al.* 2008).**

Nitrogen is found in plants as a part of protein. The most important nitrogen compounds in plants are chlorophyll a &b which carries out photosynthesis. Nitrogen is highly mobile and its deficiency symptoms first appear at lower leaves, which turns pale green. Nitrogen deficiency symptoms are quite obvious and the farmers are well familiar with it **(Prasad, 2014).** Availability of N has impacts throughout crop development, affecting seedling establishment, tillering, canopy development as well as grain filling. Although, nitrogen is the most important element which play the vital role in wheat nutrition as it is required throughout the growing period of the crop. So, appropriate dose of nitrogen should be applied in splits throughout the vegetative growth for higher use efficiency, which will avoid loss of nitrogen through gaseous form or leaching and it is reported by different scientists that N levels and its split application increased growth, yield attributes and yield of wheat **(Ram *et. al.* 2005).**

Nano zinc is an important micro nutrient required for plants. It plays a vital role in enzyme activation, synthesis of IAA and influence on stomatal opening and it also provides, resistance to virus and diseases in plants **(Prasad, 2014).** Nano zinc deficiency is a very important nutrient problem in the Indian soils. Soil pH, lime content, organic matter amount, clay type and the amount of applied phosphorus fertilizer affect the available Zn concentration in soil. Nano zinc deficiency is very common in cereal crops and it is a prevalent micronutrient deficiency in wheat, which causes severe reduction in wheat production and nutritional quality of grains. Wheat crop on nano zinc deficiency shows, dusty brown spots on upper leaves of stunted plants and also turn brown blotches and streaks which appear on the lower leaves.

The application of nano-technological formulation to agricultural crop inputs is one of the proposed tools for sustainable intensifications. Nano particles are expected to be ideal for use as a Zn fertilizer in wheat. Nano- fertilizer is required in less quantity, so it reduces the cost of fertilizers and also reduces the chemical load of fertilizers in the soil. Nano- fertilizers facilitates slow and steady release of nutrients, thus enhances nutrient use efficiency by reducing loss of nutrients. Among nano-particles, nano zinc oxide is the most widely used nano-particles and they have positive effect on the ecosystem **(Prajapati *et. al.* 2018).** Keeping these points in view, the present investigation entitled "Influence of nitrogen and foliar application of nano zinc on growth and yield of wheat (*Triticum aestivum*)".

**Materials and Methods**

The field experiment was conducted to find out the effect of Phosphorus and Iron on growth and yield of Wheat during *Rabi* 2023 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 8.0), low in organic carbon (0.62 %), available N (225 kg/ha), available P (38.2 kg/ha) and available K (240.7 kg/ha). There were 10 treatments, each being replicated thrice and laid out in Randomized Block Design. To study treatments consisting of three levels of Nitrogen (100%, 125% and 150%) with combination of Nano Zinc (2ml, 3ml and 4 ml/liter). The treatment combinations are T1:Nitrogen 100% + Nano zinc 2ml, T2:Nitrogen 100% + Nano zinc 3ml, T3:Nitrogen 100% + Nano zinc 4ml, T4:Nitrogen 120% + Nano zinc 2ml , T5:Nitrogen 120% + Nano zinc 3ml , T6:Nitrogen 120% + Nano zinc 4ml, T7:Nitrogen 150% + Nano zinc 2ml , T8:Nitrogen 150% + Nano zinc 3ml, T9:Nitrogen 150% + Nano zinc 4ml and T10:(Control). The data recorded on different aspects of crop such as, growth parameters, yield attributes and economics were subjected to statistical analysis by variance method **Gomez and Gomez (1976)**.

**RESULT AND DISCUSSION**

**Growth parameters**

**Plant height (cm)**

The data revealed that, significantly higher plant height (91.47cm) was recorded in treatment 6 (Nitrogen 125% + Nano zinc 4ml) as compared to rest of the treatments. However, the treatment 5 (Nitrogen 125% + Nano zinc 3ml) was found to be statistically at par with treatment 6 (Nitrogen 125% + Nano zinc 4ml) [Table 1]. Significant and higher plant height was with application of Nitrogen (125%) might be due to adequate availability of nitrogen at root zone leads to more nitrogen uptake by plants, which promotes protein synthesis, cell division and cell elongation, helps in better growth and development of plant. **Sanjeev *et. al.* (2021).** Further, significant and higher plant height was with application of nano zinc 4ml might be due to slow release of nano Zn fertilizers improves nutrient use efficiency and makes nutrients more available to nano scale plant pores during critical stages of crop growth, results in improved growth of plant. **Yuvaraj and Subramanian, (2014)**

**Number of tillers/hill**

The data revealed that, significantly maximum number of tillers/ hill (7.60) was recorded in treatment 6 (Nitrogen 125% + Nano zinc 4ml) as compared to rest of the treatments. However, the treatment 5 (Nitrogen 125% + Nano zinc 3ml) was found to be statistically at par with treatment 6 (Nitrogen 125% + Nano zinc 4ml) [Table 1]. Significant and maximum number of tillers/hill was with application of Nitrogen (125%) might be due favorable soil physical conditions and balanced proportion of plant nutrients supplied to the crop as per need during the growing period resulting in favorable environment for tiller growth. Similar result was also reported by in barley **Dundigala et. al.(2012)** Further, maximum number of tillers/hill was with application of nano zinc (4ml) could be due to application of nano zinc increase the vital activities, meristematic cell division, which gives better vegetative and root growth with great efficiency to absorb nutrients in soil and increases tillers per plant. **Mohammed and Alwan, (2021).**

**Plant dry weight (g)**

The data revealed that, significantly higher plant dry weight (25.31 g) was recorded in treatment 6 (Nitrogen 125% + Nano zinc 4ml) as compared to rest of the treatments. However, the treatment 5 (Nitrogen 125% + Nano zinc 3ml) was found to be statistically at par with treatment 6 (Nitrogen 125% + Nano zinc 4ml) [Table 1]. Significant and maximum plant dry weight was with application of Nitrogen (120%) might be due to adequate availability of nitrogen improves overall growth and development of plants, which enhance morphological and photosynthetic components, which leads to increase dry matter production at the successive growth stages. **Kaur *et al.* (2011).** Further, significantly maximum plant dry weight was with application of nano zinc (4ml) could be due to application of nano zinc accelerates the activity of enzymes and increases auxin synthesis in plants, which promotes better cell division, elongation and dry matter accumulation of plants. **Ponnmani *et. al.* (2019)** in rice.

**Crop growth rate (g/m$^2$/day)**

The data revealed that, significantly higher crop growth rate (20.15 g/m$^2$/day) was recorded in treatment 6 (Nitrogen 125% + Nano zinc 4ml) as compared to rest of the treatments. However, the treatment 5 (Nitrogen 125% + Nano zinc 3ml) was found to be statistically at par with treatment 6

(Nitrogen 125% + Nano zinc 4ml) [Table 1]. Significant and maximum crop growth rate was with application of Nitrogen (125%) might be due to adequate supply of nitrogen at initial stage results in rapid crop growth which was obtained by increased rate of light absorption and high photosynthetic activities. **Narayanan *et. al.* (2000)** in barley. Further, significant and maximum crop growth rate was with application of nano zinc 4ml might be due to slow release of Zn fertilization through plant pores enhance rapid cell division and internodal elongation in plants, which results to obtain better crop growth at initial stage. **Ponnmani *et. al.* (2019)** in rice.

**Relative growth rate (g/g/day)**

The data revealed that, highest relative growth rate (0.117 g/g/day) was recorded in treatment 10 (control) as compared to rest of the treatments and there was no significance difference between them [Table 1].

**Yield attributes**

**Number of effective tillers/hill**

The data revealed that, Treatment 6 (Nitrogen 125% + Nano zinc 4ml) was recorded significantly highest number of effective tillers/hill (6.00) as compared to rest of the treatments [Table 2]. Significant and maximum number of effective tillers was with Nitrogen (125%) could be due to split application of nitrogen reduces competition for nutrient requirement, which enhance better uptake of nitrogen from soil in all stages, results in development of effective tillers of crop. **Narayanan *et. al.* (2000)** in barley. Further, maximum number of tillers/$m^2$ was with application of nano zinc (4ml) could be due to, nano zinc enhances all vital activities, growth and division of meristematic cells in plants, which gives better vegetative and root development with great efficiency to absorb nutrients, which leads to formation of effective tiller of the crop. **Mohammed and Alwan, (2021).**

**Number of grains/spike**

The data revealed that, Treatment 6 (Nitrogen 125% + Nano zinc 4ml) was recorded significantly maximum number of grains/spike (49.80) as compared to rest of the treatments. However, the treatment 5 (Nitrogen 125% + Nano zinc 3ml) was found to be statistically at par with treatment 6 (Nitrogen 125% + Nano zinc 4ml) [Table 2]. Significant and maximum number of grains/spike was with application of nano zinc (4ml) could be due to favorable effect of nano zinc enhances pollen tube formation, pollen viability, starch utilization and chlorophyll biosynthesis, which results in better seed formation. **Arif *et. al.* (2005)** in barley.

**Test weight (g)**

The data revealed that, Treatment 6 (Nitrogen 125% + Nano zinc 4ml) was recorded significantly higher test weight (43.40 g) as compared to rest of the treatments. However, the treatment 5 (Nitrogen 125% + Nano zinc 3ml) was found to be statistically at par with treatment 6 (Nitrogen 125% + Nano zinc 4ml) [Table 2]. Significantly higher test weight was with application of nitrogen (125%) might be due to split application of nitrogen during the growth stages of crop improved grain siz. significant and higher test weight was with application of nano zinc (4ml) might be due to zinc acts as an enzyme activator in plants **kumar *et. al.* (2021)**

**Seed yield (t/ha)**

The data revealed that, Treatment 6 (Nitrogen 125% + Nano zinc 4ml) was recorded significantly higher seed yield (5.90 t/ha) as compared to rest of the treatments. However, the treatment 5 (Nitrogen 125% + Nano zinc 3ml) was found to be statistically at par with treatment 6 (Nitrogen 125% + Nano zinc 4ml) [Table 2]. Significant higher grain yield was with application of Nitrogen (125%) might be due to higher dose nitrogen increases availability of nitrogen uptake by plants which improves protein synthesis, cell division and cell elongation results in increase in grain yield. **Dundigala *et. al.* (2012).** Further, significant higher grain yield was with application of nano zinc (4ml) might be due to quick translocation and assimilation of nano Zn fertilizers in plants leads to slow release of nutrients and makes availability of required nutrients in all growth stages of plant, this results in production of more grain yield of crop. **Poornima and Koti (2019).**

**Straw yield (t/ha)**

The data revealed that, Treatment 6 (Nitrogen 125% + Nano zinc 4ml) was recorded significantly higher straw yield (7.02 t/ha) as compared to rest of the treatments. However, the treatment 5 (Nitrogen 125% + Nano zinc 3ml) was found to be statistically at par with treatment 6 (Nitrogen 125% + Nano zinc 4ml) [Table 2]. Significant higher straw yield was with application of Nitrogen (120%) might be due to adequate supply of nitrogen helps in the increases green leaves production through meristematic activities in the cell, which helps in maximum utilization of sunlight and production of photosynthates and translocation from leaves to reproductive parts results in higher straw yield. **Jadon *et. al.* (2010).** Further, significant and higher straw yield was with application of nano zinc (4ml) might be due to increased growth of internodal portion with higher synthesis of auxins and IAA. **Kumar *et. al.* (2004).**

**Harvest index (%)**

The data revealed that, Treatment 10 (Control) was recorded highest harvest index (46.01 %) as compared to rest of the treatments and there was no significance difference between them [Table 2].

**Economics**

The results showed that, maximum Gross returns (1,15,460.00 INR/ha), Net returns (79,447.00 INR/ha) and Benefit cost ratio (2.21) was recorded in treatment 6 (Nitrogen 125% + Nano zinc 4ml). [Table 3].

**Table 1 Influence of Nitrogen and foliar application of Nano Zinc on growth attributes of Wheat**

| S.No. | Treatments combinations | Plant height(g) (100 DAS) | Number of tillers/hill (50 DAS) | Dry weight (g) (100 DAS) | CGR($g/m^2$/day) (25-50) DAS | RGR (g/g/day) (25-50) DAS |
|---|---|---|---|---|---|---|
| 1 | Nitrogen 100% + Nano zinc 2ml | 77.89 | 5.33 | 18.87 | 14.08 | 0.116 |
| 2 | Nitrogen 100% + Nano zinc 3ml | 80.33 | 5.60 | 19.82 | 14.79 | 0.110 |
| 3 | Nitrogen 100% + Nano zinc 4ml | 82.61 | 6.27 | 22.48 | 16.85 | 0.106 |
| 4 | Nitrogen 125% + Nano zinc 2ml | 80.98 | 6.07 | 21.94 | 16.40 | 0.108 |
| 5 | Nitrogen 125% + Nano zinc 3ml | 90.33 | 7.40 | 24.93 | 19.27 | 0.104 |
| 6 | Nitrogen 125% + Nano zinc 4ml | 91.47 | 7.60 | 25.31 | 20.15 | 0.103 |
| 7 | Nitrogen 150% + Nano zinc 2ml | 81.56 | 5.80 | 20.56 | 15.32 | 0.108 |
| 8 | Nitrogen 150% + Nano zinc 3ml | 84.46 | 6.47 | 23.51 | 17.75 | 0.105 |
| 9 | Nitrogen 150% + Nano zinc 4ml | 85.86 | 6.73 | 24.09 | 18.82 | 0.105 |
| 10 | Control (RDF -120:60:60) | 71.7 | 4.93 | 17.95 | 13.30 | 0.117 |
| | **F- test** | S | S | S | S | NS |
| | **S Em (±)** | 0.49 | 0.06 | 0.26 | 0.40 | 0.002 |
| | **CD (p =0.05)** | 1.47 | 0.19 | 0.80 | 1.18 | - |

**Table 2 Influence of nitrogen and foliar application nano zinc on yield attributes of wheat.**

| S.No. | Treatments combinations | Number of effective tillers/hill | Number of grains /spike | Test weight (g) | Grain yield (t/ha) | Straw yield (t/ha) | Harvest index (%) |
|---|---|---|---|---|---|---|---|
| 1 | Nitrogen 100% + Nano zinc 2ml | 4.60 | 47.80 | 40.55 | 4.10 | 5.27 | 43.92 |
| 2 | Nitrogen 100% + Nano zinc 3ml | 4.80 | 48.07 | 41.67 | 4.45 | 5.85 | 43.17 |
| 3 | Nitrogen 100% + Nano zinc 4ml | 5.27 | 48.93 | 42.52 | 5.00 | 6.20 | 44.63 |
| 4 | Nitrogen 125% + Nano zinc 2ml | 5.13 | 48.80 | 42.40 | 4.85 | 6.00 | 44.70 |
| 5 | Nitrogen 125% + Nano zinc 3ml | 5.80 | 49.53 | 43.27 | 5.65 | 6.78 | 45.43 |
| 6 | Nitrogen 125% + Nano zinc 4ml | **6.00** | **49.80** | **43.40** | **5.90** | **7.02** | 45.67 |
| 7 | Nitrogen 150% + Nano zinc 2ml | 5.00 | 48.53 | 41.93 | 4.75 | 5.95 | 43.86 |
| 8 | Nitrogen 150% + Nano zinc 3ml | 5.40 | 49.13 | 42.73 | 5.20 | 6.33 | 45.10 |
| 9 | Nitrogen 150% + Nano zinc 4ml | 5.60 | 49.33 | 43.13 | 5.45 | 6.45 | 45.80 |
| 10 | Control (RDF-120:60:60) | 4.40 | 45.47 | 40.03 | 3.75 | 4.41 | 46.01 |
| | **F- test** | S | S | S | S | S | NS |
| | **S Em (±)** | 0.09 | 0.16 | 0.21 | 0.13 | 0.16 | 1.23 |
| | **CD (p =0.05)** | 0.28 | 0.49 | 0.64 | 0.39 | 0.48 | - |

**Table 3 Influence of nitrogen and foliar application of nano zinc on economics of wheat.**

| S.No. | Treatment combinations | Cost of Cultivation (INR/ha) | Gross returns (INR/ha) | Net Return (INR/ha) | B:C ratio |
|---|---|---|---|---|---|
| 1. | Nitrogen 100% + Nano zinc 2ml | 33,650.00 | 81,400.00 | 47,750.00 | 1.42 |
| 2. | Nitrogen 100% + Nano zinc 3ml | 35,150.00 | 88,760.00 | 53,610.00 | 1.53 |
| 3. | Nitrogen 100% + Nano zinc 4ml | 36,650.00 | 98,600.00 | 61,950.00 | 1.69 |
| 4. | Nitrogen 125% + Nano zinc 2ml | 34,013.00 | 95,590.00 | 61,577.00 | 1.81 |
| 5. | Nitrogen 125% + Nano zinc 3ml | 35,513.00 | 1,10,740.00 | 75,227.00 | 2.12 |
| 6. | Nitrogen 125% + Nano zinc 4ml | 36,013.00 | 1,15,460.00 | 79,447.00 | 2.21 |
| 7. | Nitrogen 150% + Nano zinc 2ml | 34,370.00 | 92,260.00 | 57,890.00 | 1.68 |
| 8. | Nitrogen 150% + Nano zinc 3ml | 35,870.00 | 1,02,180.00 | 66,310.00 | 1.85 |
| 9. | Nitrogen 150% + Nano zinc 4ml | 37,370.00 | 1,06,540.00 | 69,170.00 | 1.85 |
| 10. | Control (RDF-120:60:60) | 29,220.00 | 73,220.00 | 44,000.00 | 1.51 |

**CONCLUSION**

Based on the above findings it is concluded that application Nitrogen (125%) and Nano Zinc (4ml) in wheat was observed higher yield and benefit cost ratio.

## References


1. Alam, Amjed, Ali., Ahmad, A., Syed, W.H., Khaliq, T., Asif, M., Aziz, M., Mubeen, M. 2008. Effects of Nitrogen on Growth and Yield Components of Wheat, *Sci.Int*., **23**(4),331-332.
2. Arif., L, N., Dashora., Choudhary, J., S. S., Kadam and Mohammed, Mohsin., (2005). Effect of nitrogen and zinc management on growth, yield and economics of bread wheat (*Triticum aestivum*) varieties. *Indian Journal of Agricultural Sciences* **89** (10): 1664–1668.
3. Dundigala,Ravali., Abul, Azad, K., and Sahadeva, Singh., Ibrahim, Kaleel., (2021). Growth and yield response of Barley (*Hordeum vulgare* L.) on various Nitrogen Level. *International Journal of Scientific Engineering and Applied Science* **7**, Issue-7: 2395-3470.
4. GOI (2021). Agricultural Statistics at a Glance, Agricultural Statistics Division, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi.
5. Gomez, K.A and Gomez, A.A., (1976). Three more factor experiment in: Statistical procedure for agricultural Research 2nd edition :139-141.
6. Jadon, K.P. S, Dindayal, Gupta, Singh, S.B., Lakhpat, Singh and Pratap, Singh., (2010). Effect of Nitrogen on Growth, Yield and Nutrient Uptake by Malt Barley Genotypes. *Annals of Plant And Soil Research* **17**(4): 377-380.
7. Kaur, Kirandeep and Singh, Harmeet. (2011). Effect of levels and time of nitrogen application on grain and malt quality characteristics of barley varieties. *Environment and Ecology* **29**(2):542-545.
8. Kumar, V. and Ahlawat, I.P.S., (2004). Carry-over effect of biofertilizers and nitrogen applied to wheat (*Triticum aestivum)* and direct applied N in maize (*Zea mays*) in wheat maize cropping systems. *Indian Journal of Agronomy* **49** (4): 233-236.

9. Kumar. Sanjeev., Shilpa, Kaushal., Abhishek, Abhishek, Singh., Kritika. 2021. Influence of different sources of nitrogen and time of application on growth and yield of wheat (Triticum aestivum). International Journal of Botany Studies, **6**, Issue 5, 148-150.

Mohammed and Alwan, Asif. (2021).Influence of Organic and Inorganic Nitrogen on the Growth and Yield of Wheat. *Asian Journal of Research in Crop Science,***7**(4): 103-114.

10. Narayanan, A., Poonguzhalan, R., Mohan, R., Moha, J.R., Suburayalu, E. and Hanifa, A.M., (2000). Chemical weed management in transplanted rice in Karaikal region of Pondicherry Union Territory. *Madras Agriculture Journal Publ.,* **87**(10):691-692.
11. Ponnmani, P., Muthukumararaja, T. and Sriramachandrasekharan, M.V. 2019. Influence of Bio and Nano Zinc Fertilization on Growth and Yield of Rice. *IJSRR*, **8**(2), 4088-4095.
12. Poornima, B. and Koti, S. 2003. Response of timely sown wheat in levels and time of nitrogen application. Journal of Research RAU, **15** (1): 35-38
13. Prasad., 2014. Principles and Practice of Crop Nutrition. Pp: 27-53.
14. Ram, K. V., Gopal, G. V., and Naik, Shiva. 2005. Improving nitrogen use efficiency for cereal production. Agronomy journal, **91**(3), 357-363.
15. Sriman, Narayan, Dubey., Ankit, Tiwari., Vinay, Kumar, Pandey., Vivek, Singh and Ghanshyam, Singh., (2018). Effect of nitrogen levels and its time of application on growth parameters of barley (*Hordeum vulgare* L.). *Journal of Pharmacognosy and Phytochemistry* **7**(1): 333-338.
16. United States Department of Agriculture (USDA), website: https//quickstasts.nass.usda.gov.in.
17. Yuvaraj, M. and Subramanian, K.S. 2014. Fabrication of Zinc Nano Fertilizer on Growth Parameter of Rice. *Trends in Biosciences* **7**(17): 2564-2565.