***Original Research Article***

# Influence of nitrogen and zinc on yield attribute, yield and economics of wheat (*Triticum aestivum* L.)


## Abstract

The field experiment was conducted at crop research farm (CRF) during *Rabi* season 2021-22 Department of Agronomy, SHUATS, Prayagraj (UP). To study the "Influence of nitrogen and zinc on yield attributes, yield and economics of wheat". ~~The experiment consisting of 9 treatments viz., $T_1$ nitrogen at 80 kg/ha and zinc at 0.02 %, $T_2$ nitrogen at 80 kg/ha and zinc at 0.04 %, $T_3$ nitrogen at 80 kg/ha and zinc at 0.06 %, $T_4$ nitrogen at 100 kg/ha and zinc at 0.02 %, $T_5$ nitrogen at 100 kg/ha and zinc at 0.04 %, $T_6$ nitrogen at 100 kg/ha and zinc at 0.06 %, $T_7$ nitrogen at 120 kg/ha and zinc at 0.02 %, $T_8$ nitrogen at 120 kg/ha and zinc at 0.04 %, $T_9$ nitrogen at 120 kg/ha and zinc at 0.06 %~~ , where laid out in Randomized Block Design with 3 replications. The results showed that $T_9$ [nitrogen at (120kg/ha) + zinc at (0.06%)], found more productive as it attained the superior values of yield attributing trails i.e., spikes/m² (435.66), grains/spike (56.63), test weight (41.66 g), grain yield (4.82 t/ha), straw yield (11.66 t/ha) and proved significantly superior over other treatments of different levels of nitrogen and foliar application of zinc and that treatment also fetched the higher values of gross return (132110.00 INR/ha), net return (89650.70 INR/ha) and also found more remunerative due to highest benefit cost ratio (2.11).



**Key words:** Wheat, nitrogen, zinc, yield attributes, yield and economics


**Comment [A1]:** add a couple of lines of the problem studied

**Comment [A2]:** it is not necessary to mention all treatments

**Comment [A3]:** what would be the conclusions?

## INTRODUCTION

Wheat (*Triticum aestivum* L.) is a universal staple food for 40 % human population in the world and second most important cereal after rice. It is rich in carbohydrate, protein, fat and minerals (zinc, iron) and also contains good amount of vitamins such as thiamine and vitamin-B (Gupta *et al.*, 2019). Wheat is also a good source of essential dietary substances like carotenoids, flavonoids and phenolic compounds. The massive importance of ~~wheat can~~wheat can be understood with the figures of grown area of 215.48 m ha with annual production of 731.46 mt and productivity of 33.9 q/ha during 2018-19 worldwide (USDA 2020). ~~In India~~In India huge portion of ~~total cultivation~~total cultivation devoted under this crop, nearly 29.14 mha ?? area with annual production of 102.19 mt carrying average productivity of 3506.8 kg/ha in year 2018-19 (GOI). Uttar Pradesh is the largest wheat producing state in India, followed by Punjab, Haryana and Madhya Pradesh. More than 30 percent of area and production of wheat in India is by Uttar Pradesh state alone. Though Uttar Pradesh is leading in area and production of wheat, it's productivity is not the highest, and is less than the national average (Balaganesh *et al.*, 2019). Being the highest producer of wheat in the country, growth and stability of wheat production in Uttar Pradesh has higher significance. Also, since agriculture is the main source of livelihood to majority of population in Uttar Pradesh where wheat accounts for highest share in gross cropped area, understanding the growth and instability scenario of wheat and the driving forces behind it in the state is of utmost importance.

The yield potential for this crop is low with respect to area under cultivation and plagued with a number of diseases and pests. The production of cereal crop in our country including wheat is not enough to meet the domestic demand of the population. There is scope to enhance the productivity of wheat by proper agronomic practices and fertilizers. With the application of nutrient increasing and optimising genetic potential of the crop is considered as an efficient and economic method of supplementing the nutrient requirement. Application of nitrogen and zinc will enhance the nutrient availability and increases the productivity. Major nutrients like NPK and zinc was found to be advantageous and increases the productivity with its application.

Nitrogen plays a vital role in all living tissues of the plant. All vital processes in the plant are associated with protein, of which nitrogen is an essential constituent. Nitrogen is a constituent

**Formatted:** Font: Italic

**Comment [A4]:** this citation is not in the reference list, please add

**Formatted:** Highlight

**Formatted:** Highlight

of proteins, enzymes, coenzymes, nucleic acids, phytochromes and chlorophyll. It plays an important role in the biochemical processes of the plant. Therefore, it is one of the most required nutrients by wheat crops Kutman *et. al.,* (2011). ~~Consequently~~Consequently, to get more crop production, nitrogen application is essential in the form of chemical fertilizer Ali *et. al.,* (2000). Yield and yield components of high yielding varieties generally increase with increasing levels of nitrogen (~~Bahera~~ ~~*et. al.,*~~. Behera and Rautaray, 2010)

Formatted: Strikethrough, Highlight

Formatted: Strikethrough

Zinc is a requisite in normal growth and development of plants was convincingly established long years back carrying out the above function by being a cofactor of about 300 enzymes, by contributing in biosynthesis of growth hormones and maintaining in intra cellular homeostasis (Coleman 1998; Ranja and Das 2003). It participates in carbohydrate metabolism by getting involved in the most important process of photosynthesis as a co factor in enzymes such as ribulose 1,5-biphosphate carboxylase and carbonic anhydrase one catalysing the fixation of carbon dioxide in photosynthesis and other increasing its ab sorption (Brown et al. 1993).

This research was therefore conducted to determine how different dose of nitrogen and zinc effect on yield attributes, yield and economics of wheat crop. Similarly, suggestion be provided for better management practices to the farmers. Hence, keeping above facts in view, the present experiment "Influence of nitrogen and zinc on yield attributes, yield and economics of wheat (*Triticum aestivum* L.)" was planned.

Formatted: Font: Not Bold



## Material and method-

During *Rabi* season of 2021-22, a field experiment was conducted out a the Crop Research Farm of the Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (Allahabad) U.P. in alluvial soil, which is located at 25o 39' 42" N latitude, 81o 67' 56" E longitude and 98 m altitude above the mean sea level. Soil of experimental plot was sandy loam, having nearly neutral soil reaction (pH 6.9), electrical conductivity 0.29 ds/m, available nitrogen (278.93 kg/ha), available phosphorous (10.8 kg/ha) and available potassium (206.4 kg/ha). The experiment was laid out in Randomized Block Design (RBD) which consisted of 9 treatments and replicated thrice *viz*., $T_1$: Nitrogen at 80 kg/ha and Zinc at 0.02%, $T_2$: Nitrogen at 80kg/ha and Zinc at 0.04%, $T_3$: Nitrogen at 80 kg/ha and Zinc at 0.06%, $T_4$: Nitrogen at 100kg/ha and Zinc at 0.02%, $T_5$: Nitrogen at 100kg/ha and Zinc at 0.04%, $T_6$:

Nitrogen at 100kg/ha and Zinc at 0.06%, $T_7$: Nitrogen at 120kg/ha and Zinc at 0.02%, $T_8$: Nitrogen at 120kg/ha and Zinc at 0.04%, $T_9$: Nitrogen at 120kg/ha and Zinc at 0.06%. Nitrogen was applied in split dosage as half dose at the time of field preparation as basal dose and the remaining N was top dressed at CRI stage and jointing stages.

The whole dose of $P_2O_5$ and $K_2O$ was applied at the rate of 60 kg/ha at the time of field preparation. Though the source of $P_2O_5$ and $K_2O$ was single super phosphate (SSP) and muriate of potash (MOP), respectively. Zinc was used as a foliar application and was done twice viz., tillering and grain filling stages. The data collected were spikes/m², grains/spike, test weight (g), grain yield (t/ha), straw yield (t/ha) and harvest index. The yield attributes and yield were recorded at harvest. The economics of the treatments was computed based on cost of inputs applied in respective plots and value of produce obtained as per (grain and straw) prevailing price in the market. Statistical analysis was done and mean were compared at 5% probability level of significant results. (Kwanchai et al.Gomez & Gomez, 1976)

**Table 1. Effect of nitrogen and zinc on yield attributes and yield of wheat.**

| S. No. | Treatments | spikes/$m^2$ | grains/ spike | Test weight (g) | Grain yield (t/ha) | Straw yield (t/ha) | Harvest Index (%) |
|---|---|---|---|---|---|---|---|
| 1. | Nitrogen at 80 kg/ha + Zinc at 0.02% | 325.00 | 42.76 | 35.17 | 3.58 | 9.08 | 22.69 |
| 2. | Nitrogen at 80 kg/ha + Zinc at 0.04% | 328.00 | 44.10 | 35.64 | 3.78 | 9.14 | 22.71 |
| 3. | Nitrogen at 80 kg/ha + Zinc at 0.06% | 350.33 | 47.13 | 36.66 | 3.86 | 9.35 | 23.48 |
| 4. | Nitrogen at 100 kg/ha + Zinc at 0.02% | 363.66 | 50.07 | 37.22 | 4.07 | 10.22 | 23.49 |
| 5. | Nitrogen at 100 kg/ha + Zinc at 0.04% | 384.00 | 53.29 | 38.78 | 4.08 | 10.42 | 23.63 |
| 6. | Nitrogen at 100 kg/ha + Zinc at 0.06% | 420.33 | 55.46 | 39.66 | 4.51 | 10.66 | 23.76 |
| 7. | Nitrogen at 120 kg/ha + Zinc at 0.02% | 388.00 | 55.07 | 38.86 | 4.17 | 11.33 | 23.68 |
| 8. | Nitrogen at 120 kg/ha + Zinc at 0.04% | 425.00 | 55.54 | 40.66 | 4.54 | 11.43 | 24.32 |
| 9. | Nitrogen at 120 kg/ha + Zinc at 0.06% | 435.66 | 56.63 | 41.66 | 4.82 | 11.66 | 24.40 |
| | **F test** | S | S | S | S | S | NS |
| | **SEm±** | 17.21 | 1.47 | 0.72 | 0.23 | 0.27 | 1.31 |
| | **CD (P= 0.05)** | 51.59 | 4.42 | 2.17 | 0.69 | 0.83 | - |

**Table-2. Effect of biofertilizer and seaweed extract on economics of wheat**

| S. No. | Treatments | Cost of cultivation (INR/ha) | Gross returns (INR/ha) | Net returns (INR/ha) | B:C Ratio (B:C) |
|---|---|---|---|---|---|
| 1. | Nitrogen at 80 kg/ha + Zinc at 0.02% | 42154.30 | 99387.00 | 57232.70 | 1.36 |
| 2. | Nitrogen at 80 kg/ha + Zinc at 0.04% | 42165.30 | 103540.00 | 61374.53 | 1.46 |
| 3. | Nitrogen at 80 kg/ha + Zinc at 0.06% | 42176.30 | 105849.00 | 63672.70 | 1.51 |
| 4. | Nitrogen at 100 kg/ha + Zinc at 0.02% | 42198.30 | 112623.00 | 70425.03 | 1.67 |
| 5. | Nitrogen at 100 kg/ha + Zinc at 0.04% | 42209.30 | 113425.00 | 71215.53 | 1.69 |
| 6. | Nitrogen at 100 kg/ha + Zinc at 0.06% | 42220.30 | 116160.00 | 73939.53 | 1.75 |
| 7. | Nitrogen at 120 kg/ha + Zinc at 0.02% | 42440.30 | 125615.00 | 83175.03 | 1.96 |
| 8. | Nitrogen at 120 kg/ha + Zinc at 0.04% | 42451.30 | 125234.00 | 82782.37 | 1.95 |
| 9. | Nitrogen at 120 kg/ha + Zinc  at 0.06% | 42462.30 | 132110.00 | 89650.70 | 2.11 |

# Results and discussion

## Yield attributes

**Number of spikes/m²**

–Number of spikes/$m^2$ showed significant difference among all treatments. Whereas, maximum number of spikes/$m^2$ (435.66) was observed in treatment 9 [nitrogen at (120 kg/ha) and zinc at (0.06%)]. However, treatment 6 [nitrogen at (100 kg/ha) and zinc at (0.06%)], treatment 7 [nitrogen at (120 kg/ha) and zinc at (0.02%)] and treatment 8 [nitrogen at (120 kg/ha) and zinc at (0.04%)] were found statistically at par with treatment 9 [nitrogen at (120 kg/ha) and zinc at (0.06%)] [Table-1]. The amount of N significantly affected the total number of spikes/m². Data showed that the genotypes exhibited significant differences regarding the total number of spikes/m² when the N level was increased. Similar result was reported by Mansour *et. al., (2017).* The number of spikes/m² was affected by the application of Zn concentrations in leaves. Similarly, Seadh et al. (2009) showed that foliar Zn application provided 21% increase in the number of wheat spikes/m².

**Number of ~~grains/spike~~grains/spikes**

–Number of grains/spike (56.53) was recorded significantly maximum in treatment 9 [nitrogen at (120 kg/ha) and zinc at (0.06%)]. However, treatment 5 [nitrogen at (100 kg/ha) and zinc at (0.04%)], treatment 6 [nitrogen at (100 kg/ha) and zinc at (0.06%)], treatment 7 [nitrogen at (120 kg/ha) and zinc at (0.02%)] and treatment 8 [nitrogen at (120 kg/ha) and zinc at (0.04%)] were statistically at par with treatment 9 [nitrogen at (120 kg/ha) and zinc at (0.06%)] [Table-1]. Improvements in number of grains/spike are important aspects to achieve more grains/unit land area. It may be due to optimum amount of nitrogen and foliar application of zinc. These results are closely in conformity with findings of Firdous et al. (2018) and Mohd Arif et al. (2019).

**Test weight -** Significant & higher test weight (41.66 g) was recorded in treatment 9 [nitrogen at (120 kg/ha) and zinc at (0.06%)]. However, treatment 6 [nitrogen at (100 kg/ha) and zinc at (0.06%)], treatment 7 [nitrogen at (120 kg/ha) and zinc at (0.02%)] and treatment 8 [nitrogen at (120 kg/ha) and zinc at (0.04%)] were statistically at par with treatment 9 [nitrogen at (120 kg/ha) and zinc at (0.06%)] [Table-1]. This finding corroborates the finding of Firdous *et al*. (2018) and Mohd Arif *et al*. (2019).

## Yield (t/ha)

**Grain yield**

~~–~~Significantly higher grain yield (4.82 t/ha) of wheat was found in treatment 9 [nitrogen at (120 kg/ha) and zinc at (0.06%)]. However, treatment 6 [nitrogen at (100 kg/ha) and zinc at (0.06%)], treatment 7 [nitrogen at (120 kg/ha) and zinc at (0.02%)] and treatment 8 [nitrogen at (120 kg/ha) and zinc at (0.04%)] were statistically at par with treatment 9 [nitrogen at (120 kg/ha) and zinc at (0.06%)] [Table-1]. The increase in yield of the varieties with increasing N rates up to adequate level ~~might be~~might be ~~due to~~due to the role of N in increasing the leaf area and promote photosynthesis efficiency which promote dry matter production and increase yield (Belete *et. al.*, ~~(~~2018). In line with this, improvements in wheat yield and its components under the acceptable increasing N rates were reported by Sticksel *et al*. The increase in the grain yield is attributable to the improved physiology of plants with the added Zn consequently correcting the efficiency of different enzymes, chlorophyll content, IAA hormone and improvement in nitrate conversion to ammonia in plant leading to higher yield (Hacisalihoglu *et al.*, 2003; Abbas *et al.*, 2010).

**Straw yield**

~~–~~Significantly higher straw yield (11.66 t/ha) was recorded in treatment 9 [nitrogen at (120 kg/ha) and zinc at (0.06%)]. However treatment 6 [nitrogen at (100 kg/ha) and zinc at (0.06%)] and treatment 8 [nitrogen at (120 kg/ha) and zinc at (0.04%)] were found to be statistically at par with treatment 9 [nitrogen at (120 kg/ha) and zinc at (0.06%)] [Table-1]. Increase in straw yield of wheat with successive increase in N levels probably came through favourable influence of increasing N levels on growth parameters in terms of plant height, number of tillers, dry matter production (Patra and Ray 2018). Corroborative findings have been reported by (Behera~~Baheraa~~ and Rautaray 2010), Patel *et. al*., (2012). Straw yield of wheat, was significantly increased with the application of zinc. Similar results were reported by Keram *et. al.* 2013.

**Harvest index**

–Harvest index was found to be non-significant. However, highest harvest index (22.69 %) was recorded in treatment 9 [nitrogen at (120 kg/ha) and zinc at (0.06%)] as compared with other treatments [Table-1].

# Economics

It is noticeable from data given in table-2 that the gross monitory return, net monitory return and B:C ratio varied due to application of nitrogen and zinc at different levels. In wheat the values of these parameter where less in plots receiving lower quantity of nitrogen and zinc but these indices fetched maximum gross monitory return, net monitory return and benefit cost ratio in plots receiving treatment 9 with application nitrogen at 120 kg/ha and zinc at 0.06% due to higher grain and straw yields.

**The manuscript has a poor scientific quality related to the discussion of the results; therefore, I suggest that the authors increase the scientific quality by discussing the results with scientific research already published. I suggest adding a couple of paragraphs like this:**

Our results establish that plant nutrition, edaphic factors and environmental conditions such as temperature and rainfall are key in the development of this crop. Our results coincide with the study carried out by [521, 622, 723, 824, 925], who emphasize that Fertilizer application and soil quality are the factor that most influences both in terms of yield and certain management characteristics in tropical.

Likewise, the deficient soil moisture condition, in addition to causing delays in the growth of wheat and other winter cereals and even in tropical territories, delays sowing work, as pointed out by [1026, 1127, 1228]. Although the availability of water is an essential condition for seed germination, since it determines the imbibition and subsequent activation of metabolic processes, such as rehydration, repair mechanisms (membranes, proteins and DNA), cell elongation and appearance of the radicle, the quite negative water potentials that occur in soils in periods of drought prevent water absorption [1329,1430,1531,1632], affecting the sequence of events involved in the germination process of seeds and the growth of seedlings in cereals [1733,1834,1935,2036,2137].

It is also convenient to point out that although this study is oriented to the influence of nitrogen and zinc in wheat, the influence of water stress in the open field is still important and notorious, in terms of the amount of plant matter affected, the most important that this type of crop can suffer. In this sense, various authors [2238,2339,2440,2541,2642] have indicated that the stress caused by drought limits the productivity of these plants and that the intensity of their response depends on the severity and duration of the stress, and the state of development of the crop. That is why the search for sowing dates and varieties tolerant to drought stress constitutes one of the ways considered by researchers and producers for the exploitation of areas, where droughts are frequent or there is no water supply. necessary [2743]. Given the intense drought and the scarcity of water resources that have been occurring in the study site that have forced to limit the areas dedicated to cultivation, our study emphasized the need and relevance of studies on the effects of sowing date and variety of crops. wheat.



**Formatted:** Font: (Default) Times New Roman, 12 pt, Bold, Highlight

**Formatted:** Justified

**Formatted:** Font: (Default) Times New Roman, 12 pt, Bold

**Formatted:** Line spacing: 1.5 lines

**Formatted:** English (U.S.)

**Formatted:** English (U.S.)

**Formatted:** English (U.S.)

**Formatted:** English (U.S.)

**Formatted:** English (U.S.)

**Formatted:** English (U.S.)

**Formatted:** English (U.S.)

**Formatted:** Justified, Line spacing: 1.5 lines

**Formatted:** Font: Arial, 10 pt, English (U.S.)

**Formatted:** Font: Arial, 10 pt, English (U.S.)

**Formatted:** Font: Arial, 10 pt, English (U.S.)

Finally, the climatic risks and due to poor soil quality to wheat cultivation in our study area are expected to increase in the coming decades, particularly in low-income countries, where the adaptation capacity is weaker [2844], the Impacts on agriculture threaten food security [2945] and the fundamental role of agriculture in rural livelihoods and the development of sustainability [3046, 47, 48], which is why our study concludes that the treatment with [nitrogen at (120kg/ha) and zinc at (0.06%)], was more productive as it attained the superior values of yield attributing.

## Conclusion

Based on the above findings it can be concluded that application of nitrogen and zinc performs positively and improves yield attributes, yield and economics of wheat. The application of nitrogen 120 kg/ha along with zinc 0.06% resulted in achieving maximum grain yield and straw yield. These findings are based on one season therefore, further trail may be required to confirm the findings.



### References

**The authors must carefully review the bibliographic references, adjust them to the standards of the journal, eliminate those that are not cited in the text and incorporate those that are missing in this list.**

**I suggest adding the following scientific publications that will improve the scientific quality of the manuscript.**


1. Halepyati, A.S. (2001). Influence of irrigation and nitrogen levels on growth and yieldn of wheat. *Karnataka. J. Agric.* Sci., **14**(2): 449-450. (CAB. Absts. 2002-2003).
2. Das, A., Sarkar, M. and Islam, N. (2019). Evaluation of different levels of nitrogen, zinc and their combined effect on yield and yield contributing traits of wheat. *Progressive Agriculture* **30**(3): 288-297.
3. Martin Ortiz, D., L.H. Ndez-Apaolaza and A. Ga-Rate, (2010). Wheat (Triticum aestivum L.) Response to a zinc fertilizer applied as zinc lignosulfonate adhered to a NPK fertilizer. *Journal of Agriculture and Food Chemistry*, **58**: 7886-7892.


**Formatted:** English (U.S.)
**Formatted:** English (U.S.)
**Formatted:** English (U.S.)
**Formatted:** English (U.S.)
**Formatted:** English (U.S.)
**Formatted:** English (U.S.)
**Formatted:** Highlight
**Formatted:** Font: (Default) Times New Roman, 12 pt, Bold
**Formatted:** Left, Indent: Left: 0", First line: 0", Line spacing: Multiple 1.15 li
**Formatted:** Font: Not Bold, Font color: Auto
**Formatted:** Strikethrough
**Formatted:** Strikethrough, Highlight
**Comment [A5]:** this reference is not cited in the text
**Formatted:** Strikethrough, Highlight
**Comment [A6]:** this reference is not cited in the text
**Formatted:** Strikethrough
**Formatted:** Strikethrough, Highlight
**Comment [A7]:** this reference is not cited in the text
**Formatted:** Strikethrough
**Formatted:** Strikethrough, Highlight
**Formatted:** Strikethrough
**Formatted:** Strikethrough, Highlight

4. Grant, C.A. and L.D. Bailey, (1989). Nitrogen, phosphorus and zinc management effects on grain yield and cadmium concentration in two cultivars of durum wheat. *Canadian Journal of Plant Science*, **1**: 63-70.

5. Zia, M.M. Sharif, A.M. Aslam, M.B. Baig and A. Ali, (2000). Fertility issues and fertilizer management in rice wheat system. *Quarterly Sciences and Veterinary*, **5**(4): 59-73.

6. Asif, M., Ali, A., Safdar, M. E., Maqsood, M., Hussain, S., & Arif, M. (2009). Growth and yield of wheat as influenced by different levels of irrigation and nitrogen. *International Journal of Agriculture and Applied Sciences*, **1**(1), 25-28.

7.1.Gupta, J. P., Kumar, R and Kumar, V. (2019). Effect of nitrogen management and plant growth regulators on yield and yield attributes of wheat (Triticum aestivam L.) 3rd National Conference On promoting & reinvigorating agri-horti, technological innovations [PRAGATI-2019]. *International Journal of Chemical Studies*. **6**: 272-274.

8.2. Kwanchai A. Gomez & Arturo A. Gomez. *Statistical Procedures for Agricultural Research*. *YEAR???*

9.3.Balaganesh, G., Makarabbi, G., and Sendhil, R. (2019). Tracking the performance of wheat production in Uttar Pradesh. *Indian Journal of Economics and Development*, **15**(2): 216-224. DOI:10.5958/2322-0430.2019.00026.X

10.4. U.B. Kutman, U.B., B. Yildiz, L. Cakmak, (2011). Effect of nitrogen on uptake, remobilization and partitioning of zinc and iron throughout the development of durum wheat. Plant and Soil. V. 342, n. 1-2, p. 149-164.

11.5. A. Ali, M.A. Choudhry, M.A. Malik, R. Ahmad and Saifullah ( 2000). Effect of various doses of nitrogen on the growth and yield of two wheat cultivar. *Pak. J. Biol. Sci.* **3**(6): 1004-1005

12.6. U.K. Behera, B.A. Chougule, R.S. Thakur, KN. Ruwali. R.C Bhawsar and H.N. Pandey (2000). Influence of planting dates and nitrogen levels on yield and quality of durum wheat (Triticum durum). *Indian J. Agric. Sci*.**70**: 434-6.

13.7. Coleman, J.E. (1998). Zinc enzymes. Current Opinion in Chemical Biology **2:**222–234.

14.8. Ranja, G., Das,P. (2003).Effect of metal toxicity on plant growth and metabolism: I. Zinc. Agronomy **23**:3–11.


Comment [A8]: this reference is not cited in the text

Formatted: Strikethrough, Highlight

Formatted: Strikethrough

Comment [A9]: this reference is not cited in the text

Formatted: Strikethrough

Formatted: Strikethrough

Comment [A10]: this reference is not cited in the text

Formatted: Strikethrough

Formatted: Strikethrough

Formatted: Numbered + Level: 1 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0.5" + Indent at: 0.75"

Formatted: Highlight

~~15.~~9. Brown, P.H., Cakmak, I., Zhang, Q. (1993). Form and function of zinc in plants. Chap. 7. In: Robson, A.D. (ed.), Zinc in Soils and Plants, Kluwer Academic Publishers, Dordrecht,The Netherlands, pp. **90**–106.

~~16.~~10. E. Mansour, A. M. A. Merward, M. A. T.Yasin, M. I. E. Abdul- Hamid, E.E.A. EL- Sobky and H.F. Oraby (2017), *The Journal Of Agriculture Science* 155, 1407-1423

~~17.~~11. Seadh, S.E. et al. Influence of micronutrients foliar application and nitrogen fertilization on wheat yield and quality of grain seed. *Journal of Biological Sciences*, v.9, n.8, p.851-858, (2009).

~~18.~~*12.* ~~S~~ Firdous, S BK Agarwal and V Chhabra (2018), *Journal of Pharmacognosy and Phytochemistry*

~~19.~~13. Mohd Arif, L N Dashora, J Choudhary, S.S. Kadam, and Mohammed Mohsin (2019). *Indian Journal Of Agricultural Science* **89**(10): 1664-8

~~20.~~14. Fresew Belete, Nigussie Dechassa, Adamu Molla and Tamado Tana (2019). Agriculture and Food Security.

~~21.~~15. Sticksel E, Maid! F-X, Retzer F, Dennert J, Fischbeck G. Efficiency of grain Production of winter wheat as affected by N fertilisation under particular consideration of single culm sink size. Eur J Agron. (2000); **13**:287-94. 26.

~~22.~~16. Hacisalihoglu G, Hart JJ, Wang YH, Cakmak I, Kochian. LV. Zinc efficiency is correlated with enhanced expression and activity of zinc-requiring enzymes in wheat. Plant Physiology. (2003); **131**:595-602.

~~23.~~17. Abbas G, Hassan G, Ali MUA, Aslam M, Abbas Z. Response of wheat to different doses of ZnSO4 under Thal desert environment. Pak. J Bot. (2010); **42**(6):4079.

~~24.~~18. ~~Bishnupriya~~ Patra, B. and ~~Pratik Kumar~~ Ray, P. K. (2018). *Journal of Experimental Agriculture International* **21**(1): 1-5

~~25.~~19. Behera~~a~~ UK, Rautaray SK. Effect of biofertilizers and chemical fertilizers on productivity and quality parameters of durum wheat (Triticum turgidum) on a Vertisol of Central India. Arch. Agron, Soil Sci. (2010). **5**6(1):65-72.

~~26.~~20. Patel CB, Singh RS. Yadav MK, Singh SK, Singh MK, Singh KK, Mall RK. Response of different wheat (Triticum aestivum L. Emend Fiori & Paol.) genotypes to various nitrogen levels under late sown conditions of Eastern Uttar Pradesh. Env. & Ecology. (2012). **30**(3C):1 1192-1196.

27. Keram KS, Sharma BL, Sharma GD, Thakur RKD. Impact of zinc application on its translocation into various plant parts of wheat and its effect on chemical composition and quality of grain. Scientific Research and Essays. (2013). **8**(45):2218-2226.

21. ZAFAR, K., IMTIAZ H., BADRUDDIN, K. AND MUHAMMAD S., 2010. Effect of planting date on yield of wheat genotypes. *In Sindh. J. Agric. Res.*, 23(3-4):103-107

Olivares B, Hernández R. Application of multivariate techniques in the agricultural land's aptitude in Carabobo, Venezuela. Tropical and Subtropical Agroecosystems. 2020; 23(2):1-12. Doi: https://n9.cl/zeedh

22. Olivares B, Hernandez R, Arias A, Molina JC, Pereira Y. Eco-territorial adaptability of tomato crops for sustainable agricultural production in Carabobo, Venezuela. Idesia. 2020; 38(2):95-102. Doi: http://dx.doi.org/10.4067/S0718-34292020000200095

23. Olivares, B, Hernández R. Ecoterritorial sectorization for the sustainable agricultural production of potato (*Solanum tuberosum* L.) in Carabobo, Venezuela. Agricultural Science and Technology. 2019; 20(2): 339-354. Doi: https://doi.org/10.21930/rcta.vol20num2art:1462

24. Olivares B, Hernández R. Análisis regional de zonas homogéneas de precipitación en Carabobo, Venezuela. Revista Lasallista de Investigación. 2019; 16(2):90-105. Doi: 10.22507/rli.v16n2a9

**25.** Casana S, Olivares B. Evolution and trend of surface temperature and windspeed (1994 - 2014) at the Parque Nacional Doñana, Spain. Rev. Fac. Agron. (LUZ). 2020; 37(1):1-25. Doi: https://n9.cl/xkfb

26. Bertorelli M, Olivares BO. Population fluctuation of *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) in sorghum cultivation in Southern Anzoategui, Venezuela. Journal of Agriculture University of Puerto Rico. 2020; 104(1):1-16. Doi: https://doi.org/10.46429/jaupr.v104i1.18283

27. Olivares B, Torrealba J, Caraballo L. Variability of the precipitation regime in the period 1990-2009 in the location of El Tigre, Anzoátegui state, Venezuela. Rev. Fac. Agron. (LUZ). 2013; 30 (1): 19-32. Doi: https://n9.cl/mic0l

28. Olivares B, Zingaretti ML. Application of multivariate methods for the characterization of meteorological drought periods in Venezuela. Revista Luna Azul. 2019; 48, 172:192. Doi: 10.17151/luaz.2019.48.10

29. Olivares B, Zingaretti ML. Análisis de la sequía meteorológica en cuatro localidades agrícolas de Venezuela mediante la combinación de métodos multivariados. UNED

Formatted: Font: (Default) Times New Roman, 12 pt
Formatted: Normal, Indent: Left: 0.5", No bullets or numbering
Formatted: Normal, Indent: Left: 0.5", Line spacing: single, No bullets or numbering
Formatted: No bullets or numbering
Formatted: Font: (Default) Times New Roman, 12 pt, Highlight
Comment [A11]: this reference is not cited in the text
Formatted: Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt, Highlight
Formatted: Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto
Formatted: Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto
Formatted: Indent: Left: 0"
Formatted: Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto
Formatted: Numbered + Level: 1 + Numbering Style: 1, 2, 3, … + Start at: 23 + Alignment: Left + Aligned at: 0.25" + Indent at: 0.5"
Formatted: Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold, No underline, Font color: Auto, Spanish (International Sort)
Formatted: Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto, English (U.S.)
Formatted: Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto, English (U.S.)
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted

Research Journal. 2018; 10 (1):181-192. Doi: http://dx.doi.org/10.22458/urj.v10i1.2026

30. Olivares B, Cortez A, Parra R, Lobo D, Rodríguez MF, Rey JC. Evaluation of agricultural vulnerability to drought weather in different locations of Venezuela. Rev. Fac. Agron. (LUZ). 2017; 34 (1): 103-129. Doi: https://n9.cl/hc5xs

31. Cortez A, Olivares B, Parra M, Lobo D, Rey JC, Rodriguez MF. Systematization of the calculation of the Standardized Precipitation Index as a methodology to generate meteorological drought information. Rev. Fac. Agron. (LUZ). 2019; 36(2):209-223. Doi: https://n9.cl/z9k1b

32. Olivares B. Descripción del manejo de suelos en sistemas de producción agrícola del sector Hamaca de Anzoátegui, Venezuela. La Granja: Revista de Ciencias de la Vida. 2016. 23(1): 14–24. Doi: https://doi.org/10.17163/lgr.n23.2016.02

33. Olivares B, Hernández R, Coelho R, Molina JC, Pereira Y. Analysis of climate types: Main strategies for sustainable decisions in agricultural areas of Carabobo, Venezuela. Scientia Agropecuaria. 2018; 9(3): 359 – 369. Doi: 10.17268/sci.agropecu.2018.03.07

34. Olivares B, Hernández R, Arias A, Molina JC, Pereira Y. Zonificación agroclimática del cultivo de maíz para la sostenibilidad de la producción agrícola en Carabobo, Venezuela. Revista Universitaria de Geografía. 2018; 27 (2): 139-159. Doi: https://n9.cl/ah6c

35. Olivares B. Tropical conditions of seasonal rain in the dry-land agriculture of Carabobo, Venezuela. La Granja: Journal of Life Sciences. 2018; 27(1):86-102. http://doi.org/10.17163/lgr.n27.2018.07

36. Cortez A, Olivares B, Parra R, Lobo D, Rodríguez MF, Rey JC. Descripción de los eventos de sequía meteorológica en localidades de la cordillera central, Venezuela. Ciencia, Ingenierías y Aplicaciones. 2018; I (1):22-44. Doi: http://dx.doi.org/10.22206/cyap.2018.vlil.pp23-45

37. Cortez A, Rodríguez MF, Rey JC, Ovalles F, González W, Parra R, Olivares B, Marquina J. Variabilidad espacio temporal de la precipitación en el estado Guárico, Venezuela. Rev. Fac. Agron. (LUZ). 2016; 33 (3): 292-310. Doi: https://n9.cl/pmdck

38. Paredes-Trejo F, Olivares B. El desafío de la sequía en Venezuela. En: Núñez Cobo, J. y Verbist, K. (Eds.). Atlas de Sequía de América Latina y el Caribe. 2018; (pp.127-136). Francia: UNESCO.

39. Olivares B, Parra R, Cortez A. Characterization of precipitation patterns in Anzoátegui state, Venezuela. Ería. 2017; 3 (3): 353-365. Doi: https://n9.cl/llwyx



**Formatted:** Font: (Default) Times New Roman, 12 pt

**Formatted:** Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto

**Formatted:** Font: (Default) Times New Roman, 12 pt

**Formatted:** Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto, English (U.S.)

**Formatted:** Font: (Default) Times New Roman, 12 pt

**Formatted:** Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto

**Formatted:** Font: (Default) Times New Roman, 12 pt, Spanish (International Sort)

**Formatted:** Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto, Spanish (International Sort)

**Formatted:** Font: (Default) Times New Roman, 12 pt

**Formatted:** Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto

**Formatted:** Font: (Default) Times New Roman, 12 pt, Spanish (International Sort)

**Formatted:** Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto

**Formatted:** Font: (Default) Times New Roman, 12 pt

**Formatted:** Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto

**Formatted:** Font: (Default) Times New Roman, 12 pt

**Formatted:** Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto

**Formatted:** Font: (Default) Times New Roman, 12 pt

**Formatted:** Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto

**Formatted:** Font: (Default) Times New Roman, 12 pt

**Formatted:** Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto

**Formatted:** Font: (Default) Times New Roman, 12 pt

40. Olivares B, Cortez A, Rodríguez M, Parra R, Lobo D, Rey JC. Análisis temporal de la sequía meteorológica en localidades semiáridas de Venezuela. UGCiencia. 2016; 22 (1):11-24. Doi: https://doi.org/10.18634/ugcj.22v.1i.481

41. Olivares B, Cortez A, Rodríguez MF, Rey JC, Lobo D. Information system development of an alternative raingauge network in rural areas. Case state Anzoategui, Venezuela. Acta Universitaria. 2016; 26 (4):65-76. Doi: 10.15174/au.2016.961

42. Parra R, Olivares B, Cortez A, Lobo D, Rodríguez MF, Rey JC. Características de la sequía meteorológica (1980-2014) en dos localidades agrícolas de los andes venezolanos Revista de Investigación. 2018; 42(95):38-55.

43. Olivares B, Pitti J, Montenegro E. Socioeconomic characterization of Bocas del Toro in Panama: an application of multivariate techniques. Revista Brasileira de Gestao e Desenvolvimento Regional, 2020; 16(3):59-71. Doi: https://n9.cl/1dj6

44. Olivares B, Lobo D, Cortez A, Rodríguez MF, Rey JC. Socio-economic characteristics and methods of agricultural production of indigenous community Kashaama, Anzoategui, Venezuela. Rev. Fac. Agron. (LUZ). 2017; 34 (2): 187-215. Doi: https://n9.cl/clm17

45. Olivares B, Franco E. Agrosocial diagnostic of the indigenous community of Kashaama: An empirical study in the state of Anzoategui, Venezuela. Revista Científica Guillermo de Ockham. 2015; 13 (1): 87-95. Doi: https://n9.cl/mizb

~~23.~~ Olivares B, Hernández R, Coelho R, Molina JC, Pereira Y. Análisis espacial del índice hídrico: un avance en la adopción de decisiones sostenibles en los territorios agrícolas de Carabobo, Venezuela. Revista Geográfica de América Central. 2018; 60 (1): 277-299. Doi: https://doi.org/10.15359/rgac.60-1.10

46.

~~24.~~ Olivares, B.O., Calero, J., Rey, J.C., Lobo, D., Landa, B.B., Gómez, J. A. (2022). Correlation of banana productivity levels and soil morphological properties using regularized optimal scaling regression. Catena, 208: 105718. https://doi.org/10.1016/j.catena.2021.105718

47.

48. Olivares, B., Araya-Alman, M., Acevedo-Opazo, C. et al. 2020. Relationship Between Soil Properties and Banana Productivity in the Two Main Cultivation Areas in Venezuela. J Soil Sci Plant Nutr. 20 (3): 2512-2524. https://doi.org/10.1007/s42729-020-00317-8

**Formatted:** Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto
**Formatted:** Font: (Default) Times New Roman, 12 pt
**Formatted:** Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto
**Formatted:** Font: (Default) Times New Roman, 12 pt, English (U.S.)
**Formatted:** Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto
**Formatted:** Font: (Default) Times New Roman, 12 pt
**Formatted:** Font: (Default) Times New Roman, 12 pt, No underline, Font color: Auto
**Formatted:** Font: (Default) Times New Roman, 12 pt
**Formatted:** Font: Times New Roman, 12 pt, Not Bold, No underline, Font color: Auto
**Formatted:** Font: Times New Roman, 12 pt
**Formatted:** Font: Times New Roman, 12 pt, Not Bold, No underline, Font color: Auto
**Formatted:** Line spacing: single, Numbered + Level: 1 + Numbering Style: 1, 2, 3, … + Start at: 23 + Alignment: Left + Aligned at: 0.25" + Indent at: 0.5"
**Formatted:** Font: (Default) Times New Roman, 12 pt
**Formatted:** Font: (Default) Times New Roman, 12 pt, Not Bold, Spanish (International Sort)
**Formatted:** Font: (Default) Times New Roman, 12 pt, Spanish (International Sort)
**Formatted:** Font: (Default) Times New Roman, 12 pt
**Formatted:** Font: Times New Roman, 12 pt, Spanish (International Sort)
**Formatted:** Font: Times New Roman, 12 pt
**Formatted:** Font: Times New Roman, 12 pt, Not Bold, Spanish (International Sort)
**Formatted** ...
**Formatted** ...
**Formatted** ...
**Formatted** ...
**Formatted** ...
**Formatted** ...
**Formatted:** Font: Times New Roman, 12 pt
**Formatted** ...
**Formatted:** Font: Times New Roman, 12 pt
**Formatted** ...
**Formatted:** Spanish (International Sort)
**Formatted** ...
**Formatted** ...
**Formatted:** Spanish (International Sort)