RESPONSE OF MAIZE (ZEA MAYS L.) TO RATES OF NITROGEN AND ZINC APPLICATION IN MINNA, SOUTHERN GUINEA SAVANNA OF NIGERIA

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Abstract: A field experiment was conducted in 2014 and 2015 cropping seasons at the Teaching and Research Farm of the Federal University of Technology, Minna to evaluate the effects of different rates of nitrogen (N) and zinc (Zn) on the growth and yield of maize. The treatments included four levels of N: 0, 60, 90 and 120 kg ha\(^{-1}\) and three levels of Zn: 0, 2.5 and 5 kg ha\(^{-1}\). The experimental design was a \(4 \times 3\) factorial design fitted in a randomized complete block design with three replications. The soil was relatively low in initial N content and relatively high in soil extractable Zn of 2.30 mg kg\(^{-1}\). The main effect of N on the plant height of maize was significant (p<0.05) only at 8 weeks after sowing (WAS) in 2014 and 8 and 12 WAS in 2015. In 2014, the interaction effect of N and Zn on the plant height of maize was only significant (p<0.05) at 8 WAS in both seasons, and application of nitrogen rate of 90 kg N ha\(^{-1}\) with 5 kg Zn ha\(^{-1}\) produced the highest plant height at 8 WAS. The treatments without N produced the lowest grain and stover yields. There was a significant (p<0.05) response to N fertilization on grain yield in both seasons. The main effects of Zn on both stover and grain yields were only significant in 2015. The nitrogen rate of 60 kg N ha\(^{-1}\) with 2.5 kg Zn ha\(^{-1}\) was optimum for maize production in Minna, Nigeria.

Key words: zinc, nitrogen, fertilization, yield.

Introduction

Maize production in Nigeria and in sub-Saharan Africa has been found to have an increasing trend of between 2% and 3% annually (Boxall, 2000). It is one of the important staple and consumed food crops in sub-Saharan Africa (Chukwuaka et al., 2014). Maize also known as corn is a crop that is cultivated widely throughout the world in a range of agro-ecological environments (IITA, 2009). Nigeria is the largest producer of maize in Africa. The north central region is the main producing area in the country.
Maize is a heavy feeder, especially in terms of nitrogen. The crop cannot perform and grow optimally without the application of some inputs in form of inorganic or organic fertilizers. There is, therefore, need for use of organic or inorganic fertilizers to restore or sustain soil fertility under intensive cropping systems in the savanna (Sanginga et al., 2003). It has been observed that nitrogen is the most deficient nutrient in the soil and it most often limits maize yield (Casky and Iwuafor, 1995). The relatively high N requirement of maize and the inherently low plant-available N in the soils of the Guinea savanna of Nigeria make N be one of the major constraints to maize production. Hence, external input of N is inevitable for maize production.

Zinc is an essential human nutrient, a cofactor for over 300 enzymes, and is found in all tissues. Zinc fertilizers increase both the yield and quality of several crops, including wheat (Hu et al., 2003; Cakmak, 2008), and rice (Liu et al., 2003). Marschner (1993) reported that using micronutrients, especially zinc, can increase grain yield of maize. Generally judicious application of Zn fertilizer helps to not only increase crop production, but also helps to enrich Zn in plant organs including grains (Jiang et al., 2008). Soils of the savanna are the most likely to be deficient in Zn due to their low soil organic matter resulting from sparse vegetation cover and annual bush burning. Organic matter has been reported to be the main reservoir of available Zn in savanna soils of Nigeria (Kparmwang et al., 1998; Mustapha and Singh, 2003). The objective of this study is to determine the effect of rates of N and Zn application and the interaction on the growth and yield of maize (Zea mays L.) in Minna, Southern Guinea Savanna of Nigeria.

Materials and Methods

Study site

The study site was the Teaching and Research Farm, Federal University of Technology, Minna, located at Latitude 9° 30' 49.8'' N; Longitude 6° 26' 17.5'' E, 207.8 m above sea level in the Southern Guinea Savanna of Nigeria. The climate of Minna is sub-humid, and the rainfall pattern is monomodal with the rainy season starting in March and ending in October. The monthly rainfall during the period of the study is shown in Figure 1. The soil texture was sandy loam, and pH was slightly acidic in the area.

Treatments and experimental design

The application rate included three levels of Zn 0, 2.5, 5 kg ha⁻¹ and four levels of N, 0, 60, 90, 120 kg N ha⁻¹. The experimental design was a 3 × 4 factorial design fitted to a randomized complete block design with three replications. Each plot size was 6 m × 4 m. The net plot was 12 m².
Agronomic practices

The field was manually cleared and ridged at 75 cm apart. The maize variety, Oba super 2 (quality protein maize), was sown (2 plants per stand) at 25 cm within the ridge. Thinning was done to one plant per stand at 2 weeks after sowing (WAS). All the plots received basal fertilizer application of 30 kg P ha⁻¹ as single superphosphate, 30 kg K ha⁻¹ as muriate of potash at 2 WAS. The N was applied in split application, one-third at 2 WAS while the remaining two-thirds were applied at 5 WAS. The Zn was mixed thoroughly with fertilizers. The N fertilizer was applied as urea and Zn as ZnSO₄ and were applied to required plots. Fertilizers were applied by side banding at about 5 cm away from the seedlings and at about 5 cm deep along the ridge. All the plots were hoe-weeded at 2 and 5 WAS and remoulding was done in place of the last weeding at 8 WAS.

Soil sampling and analysis

Surface soil (0–15 cm) samples were collected from ten points along four diagonal transects. The samples were bulked together to form a composite sample which was used to characterize the field before land preparation. The soil samples collected were air-dried, crushed gently and passed through 2-mm sieve and taken to the laboratory for physical and chemical analyses using the method described by Agbenin (1995).
Particle size distribution was determined by the Bouyoucos hydrometer method (Anderson and Ingram, 1993). Soil reaction was determined potentiometrically in 1:2.5 soil to water suspension with the glass electrode pH meter (Thomas, 1982). Organic carbon was determined by the Walkley and Black wet oxidation method (Nelson and Sommers, 1982). Exchangeable bases were determined by extraction with 1 N NH₄OAC. Potassium in the extract was determined with a flame photometer, while calcium and magnesium were determined using an atomic absorption spectrophotometer as described by Udol et al. (2009). Available phosphorus was extracted by the Bray P1 method and the P concentration in the extract was determined colorimetrically using spectrophotometer (Murphy and Riley, 1962). Total N was determined by the Kjeldahl digestion method (Bremner, 1982). Zinc was extracted using the diethylenetriamine penta-acetic acid (DTPA) extractant and Zn in solution was determined by an atomic absorption spectrophotometer.

Plant height and yield components

Plant height was observed at 4, 8 and 12 WAS by measuring from the soil level of maize plants to the tips of the tallest leaf using a meter rule. Twenty maize stands from the middle row in each of the plots were selected and the mean determined. The maize in the net plot was cut above ground level at physiological maturity, dried and weighed using a weighing balance to determine the stover yield. Maize grain yield was measured by harvesting maize ears in the net plot. The ears were air-dried, shelled and weighed.

Statistical analysis

Analysis of variance (ANOVA) was used to evaluate the treatment effects on data collected. Means separation was carried out on means of a significant difference using Duncan’s multiple range test (DMRT) at the 5% level of probability. All computation was carried out by the General Linear Model (GLM) procedure of SAS (SAS, 2002).

Results and Discussion

The results of the physical and chemical properties of the soil prior to land preparation in 2014 are shown in Table 1. The soil texture was sandy loam, pH was slightly acidic, low in organic carbon, available P, total N and the extractable Zn was relatively high (Esu, 1991) and above the critical range of 0.2 to 2.0 mg kg⁻¹ for DTPA extractable Zn established by Sims and Johnson (1991). The value of Zn obtained (2.30 mg kg⁻¹) was similar to the critical level of 2.20 mg kg⁻¹ established for some savanna soils in the pot experiment by Yusuf et al. (2005).
Table 1. Some physical and chemical properties of the soil prior to planting.

| Parameters                  | Values |
|-----------------------------|--------|
| Sand (g kg\(^{-1}\))        | 881    |
| Silt (g kg\(^{-1}\))        | 36     |
| Clay (g kg\(^{-1}\))        | 83     |
| Textural class              | Sandy loam |
| pH in H\(_2\)O (1:2.5)       | 6.6    |
| pH in CaCl\(_2\) (1:2.5)     | 5.5    |
| Organic carbon (g kg\(^{-1}\)) | 5.08  |
| Total nitrogen (g kg\(^{-1}\)) | 0.06  |
| Available P (mg kg\(^{-1}\)) | 9      |
| Exchangeable bases (cmol kg\(^{-1}\)) |
| Ca\(^{2+}\)                 | 2.80   |
| Mg\(^{2+}\)                 | 0.66   |
| K\(^+\)                     | 0.18   |
| DTPA extractable Zn (mg kg\(^{-1}\)) | 2.30  |

The main effect of N on the growth of maize was significant only at 8 WAS in 2014 and at 8 and 12 WAS in 2015. At 8 WAS in 2014, 90 kg N ha\(^{-1}\) produced the tallest plant (181.43 cm), which was only significantly different from that of 0 kg N ha\(^{-1}\). The application of N produced taller plants at 8 and 12 WAS in 2015 which were significantly taller than plants without N fertilization (Table 2).

Table 2. Effects of application rates of nitrogen and zinc on the plant height of maize in the 2014 and 2015 seasons.

| Plant height (cm) | Year | Treatment | 2014 | 2015 |
|-------------------|------|-----------|------|------|
|                   |      | 4WAS      | 8WAS | 12WAS | 4WAS | 8WAS | 12WAS |
| Nitrogen (N) (kg N ha\(^{-1}\)) |      |           |      |      |
| 0                 |      | 42.91a    | 167.08b | 206.31a | 57.10a | 141.56b | 184.00b |
| 60                |      | 47.80a    | 177.59a | 217.96a | 59.23a | 178.97a | 216.22a |
| 90                |      | 43.00a    | 181.43a | 190.31a | 57.16a | 198.69a | 223.68a |
| 120               |      | 44.56a    | 174.44ab | 212.13a | 60.34a | 188.01a | 225.28a |
| SE ±              |      | 3.13      | 3.55   | 10.55 | 1.99 | 4.85 | 3.92 |
| Zinc (Z) (kg Z ha\(^{-1}\)) |      |           |      |      |
| 0                 |      | 44.75a    | 173.63a | 193.09a | 53.39b | 182.96a | 214.13a |
| 2.5               |      | 45.58a    | 177.38a | 212.05a | 62.58a | 162.95b | 208.26a |
| 5                 |      | 46.08a    | 174.40a | 214.89a | 62.84a | 171.76ab | 214.50a |
| SE ±              |      | 2.71      | 3.07   | 9.14 | 1.72 | 4.20 | 3.40 |
| Interaction       |      | N*Z       | NS    | *    | NS | NS | NS |

Means for the same column and factor followed by the same letter are not significantly different at the 5% level of probability. * Significant at the 5% level of probability. NS – Not significant.
The main effect of Zn fertilization on the height of maize was only significant at the early growth stage of maize in 2015. The application of Zn produced significantly taller plants than those without Zn application at 4 WAS in 2015, but at 8 WAS, plants without Zn produced the tallest plant with a height of 182.96 cm, which differed significantly only from the treatment with 2.5 kg Zn ha⁻¹.

The interaction effect of N and Zn on the growth of maize plants was only significant at 8 WAS in both seasons. The application of the 5 kg Zn ha⁻¹ and 90 kg N ha⁻¹ fertilization produced the tallest maize plants at 8 WAS in 2014 (Table 3). Plants with the shortest height of 159.3 cm were obtained with the application of 5 kg Zn ha⁻¹ and 120 kg N ha⁻¹ which was not significantly different from those of 0 kg Zn ha⁻¹ at 0 kg N ha⁻¹ and 60 kg N ha⁻¹. In 2015, the application of N produced tall maize plants and Zn fertilization produced the shortest plant with a height of 128.67 cm at 8 WAS in 2015 (Table 4).

Table 3. The interaction effect of nitrogen and zinc on plant height at 8 weeks after sowing in 2014.

| Treatment | Zinc (kg Zn ha⁻¹) |
|-----------|------------------|
|           | 0                | 2.5         | 5            |
| Nitrogen (kg N ha⁻¹) |
| 0         | 159.5e           | 171.3d      | 180.6bcd     |
| 60        | 169.5de          | 185.5abc    | 171.0d       |
| 90        | 172.4d           | 188.1ab     | 193.1a       |
| 120       | 176.0cd          | 175.6cd     | 159.3e       |
| SE ±      | 3.07             |             |              |

Means in the column or row followed by the same letters are not significantly different at the 5% level of probability.

Table 4. The interaction effect of nitrogen and zinc on plant height at 8 weeks after sowing in 2015.

| Treatment | Zinc (kg Zn ha⁻¹) |
|-----------|------------------|
|           | 0                | 2.5         | 5            |
| Nitrogen (kg N ha⁻¹) |
| 0         | 154.67cd         | 128.67e     | 141.33de     |
| 60        | 195.00ab         | 149.33de    | 192.57ab     |
| 90        | 194.77ab         | 17450ab     | 175.80abc    |
| 120       | 187.40ab         | 199.30a     | 177.33abc    |
| SE ±      | 8.40             |             |              |

Means in the column or row followed by the same letters are not significantly different at the 5% level of probability.

Nitrogen application increased the growth of maize plants. This increase might be due to the positive effect of N on plant growth (Hani et al., 2006). Several reports had earlier attributed a significant increase in the development of vegetative
plant parts and dry matter accumulation to N fertilizer application as N is an important constituent of chlorophyll, amino acid and nucleic acid (Anjorin, 2013). The improvement in plant growth also corroborated the findings of Cox et al. (1993) and Sumi and Ketayama (2000), who have reported that N promotes higher leaf area development and reduced rate of senescence. Similarly, Onasanya et al. (2009) attributed an increase in the growth of the maize plant to N fertilizer application.

The main effects of N and Zn on the yields of maize in 2014 and 2015 seasons are shown in Table 5. The main effects of N and Zn on the stover yield of maize were significant in both seasons. The treatment without N produced the lowest yield which was significantly different from that of treatments with only 60 kg N ha\(^{-1}\) in 2014 and from those with N in 2015. There was a response to N with 0 kg N ha\(^{-1}\) recording significantly lower yield compared to others in both years.

The main effects of Zn on both stover and grain yields were only significant in the 2015 season. There was a response to Zn fertilization by the grain and stover yields with the 0 kg Zn ha\(^{-1}\) treatment providing the least stover and grain yields of 4778 and 3479 kg ha\(^{-1}\) respectively which were significantly different from 2.5 and 5kg Zn ha\(^{-1}\). The interaction effects of both N and Zn on stover and grain yields were not significant in both years.

Table 5. The effects of nitrogen and zinc on the yields of maize in the 2014 and 2015 seasons.

| Treatment | Year | 2014 | 2015 |
|-----------|------|------|------|
|           |      | Stover yield (kg ha\(^{-1}\)) | Grain yield (kg ha\(^{-1}\)) | Stover yield (kg ha\(^{-1}\)) | Grain yield (kg ha\(^{-1}\)) |
| Nitrogen (N) (kg N ha\(^{-1}\)) | | | | | |
| 0 | | 5274b | 3052b | 4256b | 3089b |
| 60 | | 5919a | 4366a | 6317a | 5644a |
| 90 | | 5800ab | 4447a | 6178a | 5480a |
| 120 | | 5712ab | 4587a | 6372a | 5945a |
| SE ± | | 185 | 188 | 198 | 445 |
| Zinc (Z) (kg Z ha\(^{-1}\)) | | | | | |
| 0 | | 5602a | 3937a | 4778b | 3479b |
| 2.5 | | 5738a | 4292a | 5965a | 5275a |
| 5 | | 5690a | 4110a | 6349a | 6115a |
| SE ± | | 160 | 163 | 190 | 386 |
| Interaction | N*Z | NS | NS | NS | NS |

Means for the same column and factor followed by the same letter are not significantly different at the 5% level of probability. NS – Not significant.
There was clear evidence that N nutrition was a major constraint to maize production. Application of N fertilization produced the highest yield irrespective of the rate. A similar response to inorganic N fertilizer had been reported in the same area by Adeboye et al. (2009) who reported 90 kg N ha\(^{-1}\) to be optimum for maize in Minna. Lawal et al. (2015) reported an increased grain yield of maize with nitrogen application. Sajedi et al. (2009) reported that N has been found as a key input for achieving the highest yield of maize in the savanna agroecological zones. There was no response to Zn by yields of maize in 2014. This might be a result of relatively high extractable Zn in the soil.

The application of Zn fertilizer judiciously has been reported to increase crop production as well as enrich the Zn content in plant organs including grains (Sudhalakshini et al., 2007). Hossain et al. (2008) and Afolabi et al. (2016) observed that the soil application of Zn resulted in an increase in the grain yields of maize. Esmaeili et al. (2016) attributed the increased maize yield to the foliar application of Zn. Abunyewa and Mercer-Quarshie (2004) also observed an increase in the maize grain yield due to the application of 5 kg Zn ha\(^{-1}\) to the soil.

Conclusion

The results of this study show that adequate N fertilization enhanced the growth and yield of maize plants in both seasons. In addition, the nitrogen rate of 60 kg ha\(^{-1}\) and the zinc rate of 2.5 kg ha\(^{-1}\) were optimum for maize grain yield in Minna, southern Guinea savanna of Nigeria.

References

Abunyewa, A.A., & Mercer-Quarshie, H. (2004). Response of maize to magnesium and zinc application in the semi arid zone of West Africa. Asian Journal of Plant Science, 3, 1-5.
Anderson, J.M., & Ingram, J.S. (1993). Tropical soil biology and fertility. A handbook of methods. Information press Eynsham.
Adeboye, M.K.A., Osunde, A.O., Tsado, P.A., Odofin, J.A., Bala, A., & Adeyemi, R.A. (2009). Response of maize grain yields to rates and split application of nitrogen and NPK combinations in the southern Guinea savanna of Nigeria. Journal of Agriculture and Agricultural Technology, 2 (1), 108-118.
Afolabi, S.G., Adeboye, M.K.A., Lawal, B.A., Daniya, E., & Chinma, C.E. (2016). Effects of Methods and Time of Application of Zinc on Maize (Zea mays L.) Productivity in the Southern Guinea Savanna of Nigeria. Nigerian Journal of Soil and Environmental Research, 14, 92-99.
Agbenin, J.O. (1995). Laboratory Manual for Soil and Plant Analysis. (Selected Methods and Data Analysis). Published by the author. 140pp.
Anjorin, F.B. (2013). Comparative growth and grain yield response of five maize varieties to nitrogen fertilizer application. Greener Journal of Agricultural Sciences, 3 (12), 801-808.
Boxall, R.A. (2000). Post-harvest technology of quality protein maize: storage and processing, choosing the right technology, fruit report. Chatham U.K. NRI.
Bremner, J.M. (1982). Inorganic nitrogen. In page A. L, Miller, R. H and Keeney, D. R. (eds). Methods of soil analysis. Part II 2nd edition. America Society of Agronomy. Madison Wisconsin.
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Cakmak, I. (2008). Enrichment of cereal grains with zinc: Agronomic or genetic biofortification? *Plant and Soil*, 302, 1-17.

Carsky, R.J., & Iwuafor, E.N.O. (1995). Contribution of soil fertility research and maintenance to improved maize and productivity in sub-Saharan Africa. In: Drechsel, P., Olaleye, A., Adeoti, A., Thiombiano, L., Barry, B. and Vohland, K. Adoption driver and constraints of resource conservation technologies in sub-Saharan Africa. proceedings of Regional Maize workshop, held on 29 may-2June 1995 at IITA Cotonou, Benin Republic.

Chukwuka, K.S., Ogunsumi, I.A., Obiakara, M.C., Ojo, O.M., & Uka, U.N. (2014). Effects of decaying leaf litter and inorganic fertilizer on growth and development of maize (Zea mays L.). *Journal of Agricultural Sciences*, 59 (2), 117-127.

Cox, W.J., Kalonoge, S., Cherney. D.J.R., & Raid, W.S. (1993). Growth yield and quality of forage maize under different nitrogen management practices. *Agronomy Journal*, 85, 341-347.

Esmaeili, M., Ayoub, H. & Gholipour, M. (2016). Response of maize to foliar application of zinc and azotobacter inoculation under different levels of urea fertilizer. *Journal of Agricultural Sciences*, 61 (2), 151-162.

Esu, I.E. (1991). Detailed soil survey of NIHORT Farm at Bunkure, Kano State, Nigeria. Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria.

Hani, A.E., Muna, A.H., & Eltom, E.A. (2006). The Effect of Nitrogen and Phosphorus Fertilization on Growth, Yield and Quality of Forage Maize (Zea mays L.). *Journal of Agronomy*, 5, 515-518.

Hossain, M.A., Jahiruddin, M., Islam, M.R., & Mian, M.H. (2008). The requirement of zinc for improvement of crop yield and mineral nutrition in the maize-mungbean-rice system. *Plant and Soil*, 306, 13-22.

Hu, Y.X., Qu, C.G., & Yu, J.N. (2003). Zinc and iron fertilizers effects on wheat output. *Chinese germplasm*, 2, 25-28.

IITA, (2009). *Maize crop production*. Manual series. International institute for Tropical Agricultural, Ibadan, Nigeria.

Jiang, W., Struik, P.C., Kevlin, H.V. Zhao, M., Jin, L.N., & Stomph, T.J. (2008). Does increased zinc uptake enhance grain zinc mass concentration in rice? *Annals of applied biology*, 153, 135-147.

Kparmwang, T., Esu, I.E., & Chude, V.O. (1998). Available and total forms of copper and zinc in basaltic soils of the Nigerian savanna. *Communication in soil and plant Analysis*, 29, (15/16), 2215-2216.

Lawal, B.A, Adeboye, M.K.A., Usman, A., Afolabi, S.G., & Adekanmbi, A.A. (2015). Rotation effect of Aeschynomene histrix on soil carbon and nitrogen and maize grain yield at Minna in the southern Guinea savanna of Nigeria. *Journal of Agriculture and Agricultural Technology*, 6 (1), 1-9.

Liu, J., Li, K., Xu, J., Liang, J., Lu, X., Yang, J., & Zhu, Q. (2003). Interaction of cadmium and five mineral nutrients for uptake and accumulation in different rice cultivars and genotypes. *Field Crops Resources*, 83 (3), 271-281.

Marschner, H. (1993). Zinc in soils and plants, Robson A.D. (ed). Kluwer Academic Publishers, Drodrecht, The Netherlands, pp 59-78.

Murphy, J., & Riley, J.P. (1962). A modified single solution method for the determination of phosphorous in natural water. *Analytical Chimica ACTA*, 27, 31-36.

Mustapha, S., & Singh, B.R. (2003). Available zinc, copper, iron and manganese status of the basement complex rock derived Ultisols in Bauchi State, Nigeria: A case study. *Nigerian Journal of Soil Research*, 4, 35-40.

Nelson, D.W., & Sommers, L.S. (1982). Total carbon, organic carbon and organic matter. In Page, A.L. et al., *Agronomy Monogram 9 (2nd edition)*. P. 403-430. ASA and SSSA. Madison, Wisconsin.

Ojanuga, A.G. (2006). *Agroecological Zones of Nigeria Manual*. FAO/NSPFS, Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria.
Onasanya, R.O., Aiyelari, O.P., Onasanya, A., Oikeh, S., Nwilene, F.E., & Oyelakin, O.O. (2009). Growth and Yield Response of Maize (Zea mays L.) to Different Rates of Nitrogen and Phosphorus Fertilizers in Southern Nigeria. *World Journal of Agricultural Science*, 5(4), 400-407.

Sajedi, N.A., Ardakani, M.R., Naderi, A., Madani, H., Mashhadi, A., & Boojar, M. (2009). Response of maize to nutrients foliar application under water deficit stress condition. *American Journal of Agriculture and Biological Science*, 4(3), 242-248.

Sanginga, N., Dashiell, K., Diels, J., Valauwe, B., Lyasse, O., Carsky, R.J., & Ortiz, R. (2003). Sustainable resource management coupled with resilient germplasm to provide new intensive cereal-grain legume-livestock systems in the dry savanna. *Agriculture Ecosystems and Environment*, 100, 305-314.

SAS (2002). SAS user’s guide; statistical Cary N.C. Statistical Analysis System Institute Inc.

Sims, J.T., & Johnson, G.V. (1991). Micronutrients Soil Tests. Second Edition. In Mortvedt, J.J., Cox, F.R., Shirman, L.M., Welch, R.M. (Eds). Micronutrients in Agriculture. Soil Science Society of America Inc., Madison, Wisconsin, USA.

Sudhalakshini, C., Krishnasamy, R., & Rajarajan, R. (2007). Influence of zinc deficiency in shoot / root dry weight ratio of rice genotypes. *Research Journal of Agriculture and Biological Sciences*, 3, 295-298.

Sumi, A., & Ketayama, T.C. (2000). Effect of nitrogen fertilizer application and solar on the growth response of sorghum seedling to soil moisture. *Crop Science*, 69, 513-519.

Thomas, G.W. (1982). Exchangeable cations method of soil analysis. Part II *Agronomy Monograph* 9. 3rd edition of ASA and SSSA, Madison Wisconsin.

Udo, E.J., Ibia, T.O., Ogunwale, J.A., Ano, A.O., & Esu, I.E. (2009). *Manual of soil, plant and water analysis*, Sibon books LTD, flat 15, blk. 6, fourth avenue Festac, Lagos.

Yusuf, A.A., Abdu, N., Chude, V.O., Yusuf, H.A., & Pam, S.G. (2005). Response of maize (Zea mays L.) to zinc fertilization in relation to mehlich extractable zinc in northern Nigeria. *Nigerian Journal of Soil Research*, 6, 32-41.

Received: November 20, 2017
Accepted: April 16, 2019
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ODGOVOR KUKURUZA (*ZEA MAYS* L.) NA DOZE PRIMENE AZOTA I CINKA U MINI, JUŽNOGVINEJSKA SAVANA U NIGERIJI

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**R e z i m e**

Poljski ogled sproveden je tokom 2014. i 2015. godine na nastavno-istraživačkem gazdinstvu Federalnog tehnološkog univerziteta u Mini kako bi se procenili uticaji različitih doza azota (N) i cinka (Zn) na rast i prinos kukuruza. Tretmani su obuhvatili četiri doze azota: 0, 60, 90 i 120 kg ha⁻¹ i tri doze cinka: 0, 2,5 i 5 kg ha⁻¹. Ogled je postavljen kao 4 × 3 faktorijski dizajn po slučajnom potpunom blok dizajnu u tri ponavljanja. Početni sadržaj azota u zemljištu bio je relativno nizak, dok je priistupačni cink od 2,30 mg kg⁻¹ u zemljištu bio relativno visok. Glavni uticaj azota na visinu biljke kukuruza bio je značajan (*p*<0,05) samo 8 nedelja posle setve (engl. *WAS* – *weeks after sowing*) u 2014. i 8 i 12 nedelja posle setve u 2015. godini. Uticaj interakcije azota i cinka na visinu biljke kukuruza bio je samo značajan (*p*<0,05) tokom 2014. godine 8 nedelja posle setve tokom obe godine, a primena doze azota od 90 kg N ha⁻¹ sa 5 kg Zn ha⁻¹ proizvela je najveću visinu biljke. Tretmani bez korišćenja azota proizveli su najniži prinos zrna i kukuruzovine. Značajan (*p*<0,05) odgovor na đubrenje azotom zabeležen je kod prinosa zrna u obe godine. Glavni uticaji cinka, kako na prinos kukuruzovine tako i na prinos zrna, bili su samo značajni u 2015. godini. Doza azota od 60 kg N ha⁻¹ sa 2,5 kg Zn ha⁻¹ optimalna je za proizvodnju kukuruza u Mini u Nigeriji.

**Ključne reči:** cink, azot, đubrenje, prinos.

Primljeno: 20. novembra 2017.
Odobreno: 16. aprila 2019.

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