ABSTRACT
A field experiment was conducted in 2018 and 2019 seasons at the Teaching and Research Farm of the Federal University of Technology, Minna to determine the varietal response of maize to nitrogen and zinc fertilizer in Minna. The treatments included four levels of N: 0, 30, 60 and 90 kg ha\(^{-1}\), three levels of Zn: 0, 2.5 and 5 kg ha\(^{-1}\) and two varieties of maize (Oba Super 2 and Suwan-1-SR). The experimental design was a 4×3×2 factorial design fitted in a randomized complete block design with three replications. The data collected were, plant height, number of leaves, cob weight, cob length, stover yield, grain yield and 1000 grain weight. All data collected were subjected to analysis of variance and the means were separated using Duncan Multiple Range Test. Highest plant height (43.69 and 44.37 cm) were obtained in 60 and 90 kg N ha\(^{-1}\) treatment application respectively in year 2018 at 3 Week After Sowing (WAS), these heights were significantly different from that of control (0 kg N ha\(^{-1}\)). Zinc (Zn) fertilization has no significant effect on maize height at all growth stage of maize in year 2018. Application of Zn produced significantly taller plants than those without Zn application at 3 and 9 WAS in 2019. The treatment 60 kg N ha\(^{-1}\) had significantly higher yield (27873.7 kg ha\(^{-1}\)) than others but similar to 90 kg N ha\(^{-1}\) (2512.4 kg ha\(^{-1}\)). Application of 60 kg N ha\(^{-1}\) increased with 12 % than the 0 kg N ha\(^{-1}\) on maize yield in 2019. There was response to Zn fertilization on stover and grain yields. The interaction effects were significant on stover yield. The nitrogen rate of 60 kg N ha\(^{-1}\) and the zinc rate of 2.5 kg were optimum for maize grain yield in Minna, both Oba Super 2 and Suwan-1-SR performed better in the study.

Keywords: Varietal, zinc, nitrogen, response, Minna

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INTRODUCTION
Maize is one of the most important grains in Nigeria based on its economic value. It was introduced into Nigeria in the 10th century by the Portuguese (Oladejo and Adetunji, 2012). It is the third most important cereal crop worldwide after wheat and rice (Oladejo and Adetunji, 2012). It is referred to as the cereal of the future for its valuable nutritional facts in human diet (Enyisi et al., 2014).
Maize has been in the diet of Nigerians for centuries. Africans consume maize as a starchy-based food in a wide variety of porridges, pastes, grits, and beer (Eleweanya et al., 2005). Green maize (fresh on the cob) is eaten parched, baked, roasted or boiled; playing an important role in filling the hunger gap after the dry season (Olaniyi, 2015). Apart from food, maize is also useful as medicines and as raw materials for industries (Afzal et al., 2009). There is high demand of maize yield due to high market demand for poultry feed. Maize is recognized as highly sensitive to Zn deficiency (Hossain et al, 2011). Zinc deficiency is a problem in food crops, causing decreased crop yields and nutritional quality (Cakmak, 2008).

Nitrogen is a vital plant nutrient and a major yield-determining factor required for maize production (Subedi and Ma, 2005). It is also a characteristic constituent element of proteins and also an integral component of many other compounds essential for plant growth processes including chlorophyll and many enzymes. Nitrogen and phosphorus are very essential for good vegetative growth and grain development in maize production.

Zinc is most crucial amongst the micronutrients that take part in plant growth and development due to its catalytic action in metabolism of almost all crops (George and Schmitt, 2002). Deficiency of Zn in soil causes deficiency in crops and altogether this has become problem all over the world with acute zinc deficiency ranges in arid to semi-arid regions of the world (Rashid and Ryan, 2004). Zn plays a major role in chlorophyll development and function, of which most important are the Zn-dependent activity of spp peptidase and the repair process of photo system II by turning over photo damaged D1 protein. (Hansch and Mendel, 2009). Deficiency of Zn reduces growth, tolerance to stress and chlorophyll II synthesis (Kawachi, et al., 2009; Lee et al., 2010). The Zn that is available for plant uptake is in soil solution form, or is adsorbed in a labile form and thus, soil factors that affect its availability to plants are those which control the amount of Zn in soil solution and its sorption – desorption from / into the soil solution (Sharma et al., 2013). The objective of this study is to investigate the varietal response of maize to nitrogen and zinc fertilizer in Minna, Nigeria.

MATERIALS AND METHODS

Study Site

The study was conducted at the Teaching and Research Farm, Federal University of Technology Minna, located at latitude 9° 31’ 860’’ N; longitude 6° 27’ 244’’ E, its height is 207.8 m above sea level and is in the southern Guinea savanna of Nigeria. Climate of Minna is sub – humid, rainfall pattern is monomodal with the rainy season starting in April and ending in October. The physical features around Minna consist of gently undulating high plains developed on basement complex rocks made up of granites, migmatites, gneisses and schists. Inselbergs of Older Granites and low hills of schists rise conspicuously above the plains. Beneath the plains, bedrock is deeply weathered and constitutes the major soil parent material (saprolites) (Ojanuga 2006).

Field experiments

The experiments were conducted over two cropping seasons (2018 and 2019).
Treatments and experimental design

The experimental design was 4 x 3 x 2 factorial experiment fitted to a randomized complete block design (RCBD) and with three replications. Treatment comprises of four levels of N, 0, 30, 60, 90 kg N ha⁻¹ and three levels of Zn 0, 2.5, 5, kg ha⁻¹ with two maize varieties (Oba Super 2 and Suwan-1-SR) resulting in twenty-four treatment combination, each plot size was 4 m x 4 m, the net plot was 9 m².

Agronomic practices

The field was manually cleared and ridged at 75 cm apart. Maize variety, Oba super 2 was sowed (2 plants per stand) at 25 cm within the ridge, thinning was done to 1 plant per stand at 2 weeks after sowing (WAS). The N was supplied using NPK 15:15:15 fertilizer and urea and Zn was supplied using ZnSO₄ to the required plots. The N was applied in split dose, half at 2 WAS using NPK 15:15:15 while the remaining half was applied at 6 WAS using urea. The Zn was mixed thoroughly with NPK; Fertilizers were applied by side banding.

Soil sampling and analysis.

Surface soil (0–20 cm) samples were collected from eight points along four diagonal transects before the start of the experiment; they were bulked together to form a composite sample to characterize the field. Soil samples collected were air–dried, crushed and sieved with a sieve of 2 mm sieve. The samples were subjected to analysis using standard methods. Soil pH was determined in a 1: 2.5 (soil:water) ratio and 0.1 M CaCl₂ using a glass electrode pH meter. Particle size was determined by Bouyocous hydrometer method. Organic carbon was determined using Walkley-Black method (Nelson and Sommers, 1982). Determination of exchangeable bases was done by using ammonium acetate (NH₄OAc) displacement method. Na⁺ and K⁺ in the extract were determined by flame photometric method, while Ca²⁺ and Mg²⁺ by Na-EDTA titrimetric method. Exchangeable acidity (EA) was by KCl extraction method, the extract was determined by titrimetric method as described by Udoh et al., (2009). Available phosphorus extracted with the Bray P 1 method and P in extract determined using spectrophotometer. Total nitrogen was determined by micro-Kjeldhal method (Bremner, 1982). Zinc was extracted using the dilute HCl and Zn in solution was determined by atomic absorption spectrophotometer.

Growth and yield components analysis

Maize plant height: Plant heights were recorded at 3, 6, 9 and 12 WAS by measuring from the soil level of maize plants to the tips of the tallest leaf using meter rule.

Number of leaves: The numbers of leaves were recorded at 3, 6, 9 and 12 WAS by visual counting of the leaves.

Shoot biomass: The maize was cut above ground level in the net plot (9 m²) at physiological maturity, dried and weighed using weighing balance and the weight was recorded.

Cob length: The length of the harvested cobs was measured using meter rule.

Maize grain yield: Maize yield was carried out by harvesting maize ears in the net plot (8 m²). These were shelled, air-dried and weighed.
Statistical analysis: Analysis of variance (ANOVA) was used to evaluate the treatment effects on data collected. Means separation was carried out where significant differences were observed using Duncan Multiple Range Test (DMRT) at 5% level of probability using Statistical Analysis System (SAS).

RESULTS AND DISCUSSION

Some Physical and Chemical Properties of the Soil Prior to Planting

The results of the physical and chemical properties of the soil prior to land preparation in 2018 are shown in Table 1. The soil texture was sandy loam, pH was slightly acidic in H₂O, low in organic carbon, available P, total N, and the extractable Zn (Esu, 1991). The pH was slightly acidic which was suitable for plant growth as most plant nutrients are available for plant uptake at pH 5.5-6.5 (Brady and Weil, 2002). The low organic carbon content of the soil might be partly attributed to the rapid organic matter mineralization. The extractable Zn was low (Esu, 1991) and below the critical range of 2.0 mg kg⁻¹ for extractable Zn established by Sims and Johnson (1991). And also, below the critical level of 2.20 mg kg⁻¹ established for some savanna soils by Yusuf et al. (2005).

Effect of Nitrogen, Zinc and Variety on the Growth of Maize in 2018 and 2019 Seasons

The main effect of N, Zn, and variety on the plant height of maize were significant in 2018 and 2019 seasons. At 3 WAS in 2018, 60 and 90 kg N ha⁻¹ produced the tallest plant 43.69 and 44.37 cm which was only significantly different from that of 0 kg N ha⁻¹. Application of N produced the taller plant at 6 WAS which was significantly different from others rates. The 30 and 60 kg N ha⁻¹ where statistically similar 153.93 cm and 158.29 cm but significantly different from the 0 kg N ha⁻¹ (126.49 cm) at 6WAS. The 60 (181.42 cm) and 90 (190.98 cm) kg N ha⁻¹ produced the taller plant which were significantly different from the 0 kg N ha⁻¹. Similar result was observed at 12 WAS (Table 2). Application of N produced taller plants at 3, 6, 9 and 12 WAS in 2019 which were significantly taller than plants without N fertilization (Table 2). The maize effect of Zn fertilization on the height of maize was not significant at all the growth stages of maize in 2018. Application of Zn produced significantly taller plants than those without Zn application at 3 and 9 WAS in 2019, but at 6 WAS, plants with 5 kg Zn ha⁻¹ produced the tallest plant with a height of 119.22 cm which was only significantly from the treatment with 0 kg Zn ha⁻¹. There was significantly different from the variety. The Suwan-1-SR produced tallest plant which was significantly different from Oba Super 2 at all stages of the growth of plant in both 2018 and 2019 except at 12 WAS in 2018 which was significantly similar to each other.

The interaction effect of N and Zn on growth of maize plant was only significant at 9 WAS in 2018 season. The application of Zn at 5 kg Zn ha⁻¹and 60 and 90 kg N ha⁻¹ fertilization produced the tallest maize plants (Table 3). Plants with the shortest height of 144.85 cm was obtained with application of 0 kg Zn ha⁻¹ and 0 kg N ha⁻¹ which was not significantly different from those of 2.5 and 5kg Zn ha⁻¹ + 0 kg N ha⁻¹ and 30 kg N ha⁻¹ + 5kg Zn ha⁻¹ in 2018. There was interaction effect between the N and variety at 3 and 6 WAS in 2018 (Table 4). At 3 WAS application of 30 kg N ha⁻¹ with Suwan-1-SR produced the taller plant which was significantly different from other combinations except the 90 kg N ha⁻¹ with Oba Super 2.
and 60 kg N ha\(^{-1}\) with Suwan-1-SR. At 6 WAS Application of N irrespective of seasons, the rate and variety were significant taller than 0 kg N ha\(^{-1}\) with either of the variety except the 90 kg N ha\(^{-1}\) with Oba Super 2 with 148.59 cm.

The main effect of N, Zn and variety on the number of maize leaves in 2018 and 2019 seasons was shown in Table 5. The 30 kg N ha\(^{-1}\) produced the highest number of leaves which was significantly different from others at 6 WAS in 2018, similar results was observed at 9 WAS but it is similar to application of 60 kg N ha\(^{-1}\). There were no significantly different at 3 and 9 WAS in 2018. The N produced the highest leaves at 3, 6 and 12 WAS which were significantly different from the 0 kg N ha\(^{-1}\) in 2019 (Table 5). The maize effect of Zn fertilization on the number of maize leaves was not significant at all the growth stage of maize in both 2018 and 2019 seasons. The Suwan-1-SR was significantly different from Oba Super 2 at 3 WAS in 2018 and 3, 6 WAS in 2019. There were no significantly different on number of leaves at 6, 9 and 12 in 2018 and 9 and 12 WAS in 2019.

The interaction effects of both N, Zn and variety on number of leaves was not significant in both years. Zinc has lesser role in the vegetative growth of plant while its requirement is more during reproductive phase in comparison to vegetative growth stage (Dileep, 2013). The same was observed during this experiment. Zinc application improves the growth because zinc is involved directly and indirectly as co-enzyme in photosynthetic process which provide substrate for growth and development (Vallee and Falchuk, 1998). It produced more tillers in similar crop like rice (Moussavi-Nik et al., 1997).

### Effect of Nitrogen, Zinc and Variety on the Yield of Maize in 2018 and 2019 Seasons

The main effects of N, Zn and variety on the yields of maize in 2018 and 2019 seasons are shown in Table 6. The main effects of N and Zn on grain yield and stover yield of maize were significant in both seasons while cob weight was significant only in 2019 season. The treatment 60 kg N ha\(^{-1}\) had significantly higher yield (27873.7 kg ha\(^{-1}\)) than others but similar to 90 kg N ha\(^{-1}\) (2512.4 kg ha\(^{-1}\)). The 90 kg N ha\(^{-1}\) was statistically similar to 30 kg N ha\(^{-1}\) (2308.4 kg ha\(^{-1}\)) Application of 60 kg N ha\(^{-1}\) increased with 12 % than the 0 kg N ha\(^{-1}\) on maize yield in 2019. There was similarity between the 30 kg N ha\(^{-1}\) and 90 kg N ha\(^{-1}\) on grain yield of maize. There was significantly different on the stover yield of maize. The highest rate of application produced significantly higher stover than others both season but similar to that of 60 kg N ha\(^{-1}\). In 2019 maize cobs weight was significantly higher with the 90 kg N ha\(^{-1}\) than the 30 kg N ha\(^{-1}\) and 0 kg N ha\(^{-1}\). There were no significant differences on cob length and 1000 grain weight in respect to N in both seasons.

Main effects of Zn on both stover and grain yields were only significant in both seasons while the cob weight was significant in 2019. There was response to Zn fertilization by both yields with the 0 kg Zn ha\(^{-1}\) treatment providing stover and yields of 2518.8 and 2007.5 kg ha\(^{-1}\) respectively in 2018 and 2477.71 and 1402.5 kg ha\(^{-1}\) in 2019 which were significantly different from that of those with Zn fertilization. The 5 kg Zn ha\(^{-1}\) produced higher cob weight than others in 2019. There was no significant difference on the variety used except in 2019 where the cob weight produced the heaviest weight with application of 5 kg Zn ha\(^{-1}\).
There were interaction effects between the N and Zn, N and V, N, Zn and V on stover yield of maize in 2019.

The interaction effects of nitrogen and zinc on stover yield in 2019 season in Minna was shown in Table 7. Application of 90 kg N ha\(^{-1}\) and 5 kg Zn ha\(^{-1}\) produced the heaviest weight (4083.3 kg ha\(^{-1}\)) which was significantly different from other treatment combinations. The treatment combination of 90 kg N ha\(^{-1}\) + 2.5 kg Zn ha\(^{-1}\) were similar to 60 kg N ha\(^{-1}\) + 5 kg Zn ha\(^{-1}\) and 30 kg N ha\(^{-1}\) + 2.5 kg Zn ha\(^{-1}\). The interaction effects of nitrogen and variety in 2019 was shown in Table 8. Application of 90 kg N ha\(^{-1}\) with Suwan-1-SR produced the stover yield of 3455.80 kg ha\(^{-1}\) which was significantly higher than 0 kg N ha\(^{-1}\) with either Oba Super 2 or Suwan-1-SR. The interaction effects of nitrogen, zinc and variety on stover yield in 2019 in Minna. The 90 kg N ha\(^{-1}\)+ 5 kg Zn ha\(^{-1}\) with Suwan-1-SR produced significantly higher stover yield than other treatment combinations but similar to the 30 kg N ha\(^{-1}\)+ 2.5 kg Zn ha\(^{-1}\) with Suwan-1-SR (Table 9). Grain yield increased with the application of Zn as reported by Morshedi and Farahbakhsh (2010) and Bashir et al., (2012). They also attributed the superior yield attributes with the application of ZnSO\(_4\) ha\(^{-1}\) and more translocation of photosynthate towards sink. The increase in these parameters might be due to involvement of zinc in various enzymatic processes which helps in catalyzing reaction for growth finally leading to development of more yield attributing character.

Sharma et al., (1992) reported that the seed yield of maize increased by 11.4% up to Zn levels from 0 to 9 kg Zn/ha. Similar result was also reported by Cakmak et al. (1997) with other crops like rye, triticale, bread and durum wheats increase due to application of Zn.

There was clear evidence that N nutrition was a major constraint to maize production (Yusuf et al., 2009). Lawal et al., (2013) reported that application of N fertilizer increased maize yield in the Guinea savanna. Adeboye et al., (2009) also reported that 90 kg N ha\(^{-1}\) to be optimum for maize in the area. In the West African savannas, 60 to 120 kg N ha\(^{-1}\) had been recommended by Carsky and Iwuafor (1999). Onasanya et al., (2009) attributed an increase in the growth of the maize plant to N fertilizer application.

CONCLUSION

The result of this study established the response of maize to inorganic nitrogen and zinc fertilizer application. Nitrogen and zinc application to maize is therefore required for optimum yield. 90 kg N ha\(^{-1}\) improved the growth in both 2018 and 2019 seasons. Suwan-1-SR performed better in term of growth and 5 kg Zn ha\(^{-1}\) also increased the plant height in 2019. In addition, the nitrogen rate of 60 kg N ha\(^{-1}\) and the zinc rate of 2.5 kg were optimum for maize grain yield in Minna. Both Oba Super 2 and Suwan-1-SR performed better in the study.
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APPENDIX

Table 1: Some soil physical and chemical properties before sowing

| Parameters                        | Values |
|-----------------------------------|--------|
| Sand                             | 768    |
| Silt (g kg\(^{-1}\))              | 79     |
| Clay (g kg\(^{-1}\))              | 153    |
| Textural class                    | Sandy loam |
| Soil pH (H\(_2\)O)                | 5.22   |
| Soil pH (CaCl\(_2\))              | 4.27   |
| Total nitrogen (g kg\(^{-1}\))    | 0.10   |
| Organic carbon (g kg\(^{-1}\))    | 3.56   |
| Available phosphorous (mg kg\(^{-1}\)) | 6     |
| Exchangeable bases (cmol kg\(^{-1}\)) |        |
| Ca                                | 1.68   |
| Mg                                | 0.03   |
| K                                 | 0.31   |
| Na                                | 0.08   |
| Exchangeable acidity (cmol kg\(^{-1}\)) | 0.12  |
| ECEC                              | 2.22   |
| Zinc (mg kg\(^{-1}\))             | 1.34   |

Means for same column and factor followed by the same letter are not significantly different at 5 % level of probability.

Table 2: Effects of nitrogen zinc and variety on plant height of maize in 2018 and 2019

|            | 2018         |            | 2019         |            |
|------------|--------------|------------|--------------|------------|
|            | 3WAS | 6 WAS | 9 WAS | 12 WAS | 3WAS | 6 WAS | 9 WAS | 12 WAS |
| Nitrogen (N) |      |        |        |        |      |        |        |        |
| 0          | 40.14b | 126.49c | 148.49c | 164.77b | 38.37b | 81.45b | 181.94b | 209.49b |
| 30         | 44.37a | 153.93b | 172.64b | 200.82a | 99.33a | 123.67a | 202.73a | 226.04ab |
| 60         | 41.14ab | 158.29b | 181.42ab | 194.27a | 103.51a | 124.99a | 209.84a | 230.43a |
| 90         | 44.37a | 177.70a | 190.98a | 172.57b | 104.92a | 122.21a | 214.17a | 242.79a |
| SE±        | 1.25   | 6.19   | 4.85   | 6.00   | 4.36   | 5.45   | 6.89   | 6.65   |
| Zinc (Z)   |        |        |        |        |        |        |        |        |

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Table 3: Interaction effects of nitrogen and zinc on plant height in 2018 at 9 weeks after sowing season in Minna

| Zinc | Plant height (cm) |
|------|------------------|
| 0    | 144.85e          |
| 0    | 154.30cde        |
| 0    | 146.33de         |
| 30   | 175.82abc        |
| 30   | 191.17ab         |
| 30   | 169.51bcde       |
| 60   | 170.62abcde      |
| 60   | 198.48a          |
| 60   | 193.77ab         |
| 90   | 183.30ab         |
| 90   | 193.77ab         |
| 90   | 179.87abc        |

Means in a column followed by the same letters are not significantly different at 5% level of probability.
Table 4: Interaction effects of nitrogen and variety on plant height at 3 and 6 weeks after sowing in Minna 2018

| Nitrogen | Oba super 2 | Suwan-1-SR | Oba super 2 | Suwan-1-SR |
|----------|-------------|------------|-------------|------------|
| 0        | 37.20d      | 38.62cd    | 122.31d     | 130.66dc   |
| 30       | 40.12cd     | 45.79ab    | 168.45ab    | 186.96a    |
| 60       | 40.10cd     | 48.64a     | 158.25abc   | 158.32abc  |
| 90       | 45.07ab     | 42.44bc    | 148.59bcd   | 160.62ab   |

WAS- weeks after sowing

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

Table 5: Effects of nitrogen zinc and variety on number of leaves of maize in 2018 and 2019

| Nitrogen | 2018 | 2019 |
|----------|------|------|
|          | 3    | 6    | 9    | 12   | 3    | 6    | 9    | 12   |
| 0        | 6.67a| 10.21c| 11.09c| 11.86a| 6.71b| 8.61b| 12.13a| 12.82b|
| 30       | 6.81a| 12.16a| 12.25a| 12.67a| 8.93a| 10.50a| 12.91a| 13.23ab|
| 60       | 6.76a| 11.18b| 11.84ab| 12.25a| 9.32a| 10.86a| 12.34a| 14.22a|
| 90       | 6.65a| 10.60bc| 11.33bc| 11.86a| 8.93a| 10.91a| 12.13a| 14.25a|
| SE±      | 0.22 | 0.29  | 0.22  | 0.25  | 0.30 | 0.33 | 0.27  | 0.31  |
| Zinc (Z) |      |       |       |       |      |      |       |       |
| 0        | 6.78a| 11.00a| 11.64a| 12.28a| 8.22a| 10.31a| 12.34a| 13.54a|
| 2.5      | 6.63a| 11.37a| 11.81a| 12.32a| 8.43a| 10.32a| 12.34a| 13.81a|
| 5        | 6.74a| 10.75a| 11.42a| 11.98a| 8.71a| 10.52a| 12.64a| 14.00a|
| SE±      | 0.14 | 0.29  | 0.20  | 0.15  | 0.33 | 0.34 | 0.24  | 0.35  |
| Variety(V) |      |       |       |       |      |      |       |       |
| Oba Super 2 | 6.41b| 11.26a| 11.72a| 12.31a| 7.86b| 9.39b| 12.33a| 13.62a|
| Suwan-1-SR| 7.03a| 10.81a| 11.52a| 12.07a| 9.04a| 10.96a| 12.52a| 14.00a|
| SE±      | 0.10 | 0.23  | 0.17  | 0.18  | 0.25 | 0.26 | 0.27  | 0.20  |

Means for same column and factor followed by the same letter are not significantly different at 5 % level of probability.

NS- Not Significant
Table 6: Effects of nitrogen zinc and variety on yield of maize in Minna in 2018 and 2019 seasons

| Nitrogen (N) | 2018 |  | 2019 |  |  |
|--------------|------|---|------|---|---|
| Cob Length (cm) | 1000 grain weight (g) | Grain yield (kg/ha) | Cob weight (kg/ha) | Stover yield (kg/ha) | Cob Length (cm) | 1000 grain weight (g) | Grain yield (kg/ha) | Cob weight (kg/ha) | Stover yield (kg/ha) |
| 0 | 12.94a | 417.84a | 1895.8c | 379a | 2302.1c | 11.26a | 397.15b | 1747.20c | 379a | 2302.1c | 11.26a | 397.15b | 1747.20c | 379a | 2302.1c | 11.26a | 397.15b | 1747.20c | 379a | 2302.1c | 11.26a | 397.15b | 1747.20c |
| 30 | 12.57a | 429.20a | 2308.4b | 383a | 2654.2bc | 13.39a | 434.77a | 2375.71b | 391b | 2737.31b | 14.65a | 443.80a | 2867.11a | 463ab | 2904.12ab | 15.29a | 454.15a | 2965.51ab | 470ab | 3028.92ab | 15.84a | 463.80a | 3087.31ab |
| 60 | 13.29a | 436.18a | 2783.7a | 450a | 2839.7ab | 14.65a | 443.80a | 2867.11a | 463ab | 2904.12ab | 15.29a | 454.15a | 2965.51ab | 470ab | 3028.92ab | 15.84a | 463.80a | 3087.31ab | 470ab | 3028.92ab | 15.84a | 463.80a | 3087.31ab |
| 90 | 24.15a | 430.81a | 2512.4ab | 2933a | 3145.8a | 25.38a | 438.46a | 2593.2ab | 1938.12a | 2978.52a | 26.18a | 443.80a | 2660.13a | 470ab | 2904.12ab | 15.84a | 463.80a | 3087.31ab | 470ab | 3028.92ab | 15.84a | 463.80a | 3087.31ab |
| SE± | 3.10 | 12.63 | 144.39 | 652.62 | 170.71 | 3.08 | 12.61 | 144.60 | 25.76 | 170.82 | 3.10 | 12.63 | 144.39 | 652.62 | 170.71 | 3.08 | 12.61 | 144.60 | 25.76 | 170.82 | 3.10 | 12.63 | 144.39 | 652.62 | 170.71 |

| Zinc (Z) | 2018 |  | 2019 |  |  |
|----------|------|---|------|---|---|
| Cob Length (cm) | 1000 grain weight (g) | Grain yield (kg/ha) | Cob weight (kg/ha) | Stover yield (kg/ha) | Cob Length (cm) | 1000 grain weight (g) | Grain yield (kg/ha) | Cob weight (kg/ha) | Stover yield (kg/ha) |
| 0 | 13.22a | 446.83a | 2007.5b | 2312a | 2518.8b | 13.48a | 418.07a | 1402.51b | 399c | 2477.71b | 13.48a | 418.07a | 1402.51b | 399c | 2477.71b | 13.48a | 418.07a | 1402.51b | 399c | 2477.71b |
| 2.5 | 12.70a | 417.60a | 2426.6a | 396a | 2685.9b | 13.23a | 445.89a | 2430.72a | 406b | 2660.13a | 13.23a | 445.89a | 2430.72a | 406b | 2660.13a | 13.23a | 445.89a | 2430.72a | 406b | 2660.13a |
| 5 | 21.29a | 421.09a | 2441.2a | 400a | 3001.6a | 21.82a | 421.67a | 2484.11a | 1291.11a | 2978.52a | 21.82a | 421.67a | 2484.11a | 1291.11a | 2978.52a | 21.82a | 421.67a | 2484.11a | 1291.11a | 2978.52a |
| SE± | 3.00 | 10.65 | 135.79 | 647.03 | 155.03 | 3.07 | 11.22 | 152.04 | 21.27 | 171.58 | 3.00 | 10.65 | 135.79 | 647.03 | 155.03 | 3.07 | 11.22 | 152.04 | 21.27 | 171.58 |

| Variety (V) | 2018 |  | 2019 |  |  |
|-------------|------|---|------|---|---|
| Cob Length (cm) | 1000 grain weight (g) | Grain yield (kg/ha) | Cob weight (kg/ha) | Stover yield (kg/ha) | Cob Length (cm) | 1000 grain weight (g) | Grain yield (kg/ha) | Cob weight (kg/ha) | Stover yield (kg/ha) |
| Oba Super 2 | 18.62a | 422.34a | 2374.5a | 400a | 2616.7a | 19.06a | 422.38a | 2345.21a | 401.21b | 2586.00a | 19.06a | 422.38a | 2345.21a | 401.21b | 2586.00a | 19.06a | 422.38a | 2345.21a | 401.21b | 2586.00a |
| Suwan-1 SR | 12.85a | 434.67a | 2475.7a | 1672a | 2854.2a | 13.28a | 434.71a | 2446.31a | 1062.42a | 2824.80a | 13.28a | 434.71a | 2446.31a | 1062.42a | 2824.80a | 13.28a | 434.71a | 2446.31a | 1062.42a | 2824.80a |
| SE± | 2.90 | 8.85 | 109.95 | 643.26 | 129.00 | 2.96 | 9.24 | 122.73 | 19.18 | 142.38 | 2.90 | 8.85 | 109.95 | 643.26 | 129.00 | 2.96 | 9.24 | 122.73 | 19.18 | 142.38 |

Means for same column and factor followed by the same subscript letters are not significantly different at 5 % level of probability. NS- Not Significant
### Table 7: Interaction effects of nitrogen and zinc on stover yield in 2019 season in Minna

| Nitrogen | Zinc | Stover yield (kg/ha) |
|----------|------|----------------------|
| 0        | 0    | 1812.50d             |
| 0        | 2.5  | 1850.0d              |
| 0        | 5    | 2197.9cd             |
| 30       | 0    | 2701.5bcd            |
| 30       | 2.5  | 3248.4b              |
| 30       | 5    | 2762.1bcd            |
| 60       | 0    | 2695.8bcd            |
| 60       | 2.5  | 2645.80bcd           |
| 60       | 5    | 2870.8bc             |
| 90       | 0    | 2700.8bcd            |
| 90       | 2.5  | 2895.8bc             |
| 90       | 5    | 4083.3a              |
| SE±      |      | 265.36               |

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

### Table 8: Interaction effects of nitrogen and variety on stover yield in 2019 season in Minna

| Nitrogen | Variety    | Stover yield (kg/ha) |
|----------|------------|----------------------|
| 0        | Oba Super 2| 1630.50c             |
| 0        | Suwan-1-SR| 2276.40bc            |
| 30       | Oba Super 2| 2803.50ab            |
| 30       | Suwan-1-SR| 3004.60ab            |
| 60       | Oba Super 2| 2912.50ab            |
| 60       | Suwan-1-SR| 2562.50b             |
| 90       | Oba Super 2| 2997.50ab            |
| 90       | Suwan-1-SR| 3455.80a             |
| SE±      |            | 225.47               |

Means in a column followed by the same letters are not significantly different at 5% level of probability.
Table 9: Interaction effects of nitrogen zinc and variety on stover yield in 2019 season in Minna

| Nitrogen | Zinc | Variety   | Stover yield (kg/ha) |
|----------|------|-----------|----------------------|
| 0        | 0    | Oba Super 2 | 1000.0h              |
| 0        | 2.5  | Oba Super 2 | 1412.5gh             |
| 0        | 5    | Oba Super 2 | 2479.1def            |
| 0        | 0    | Suwan-1-SR  | 2625.0cdef           |
| 0        | 2.5  | Suwan-1-SR  | 2287.5defg           |
| 0        | 5    | Suwan-1-SR  | 1916.6fg             |
| 30       | 0    | Oba Super 2 | 2773.0cdef           |
| 30       | 2.5  | Oba Super 2 | 2562.5cdef           |
| 30       | 5    | Oba Super 2 | 3075.0bcde           |
| 30       | 0    | Suwan-1-SR  | 2630.0cdef           |
| 30       | 2.5  | Suwan-1-SR  | 3934.7ab             |
| 30       | 5    | Suwan-1-SR  | 2449.1def            |
| 60       | 0    | Oba Super 2 | 3183.3bcd            |
| 60       | 2.5  | Oba Super 2 | 2270.8defg           |
| 60       | 5    | Oba Super 2 | 3283.3bcd            |
| 60       | 0    | Suwan-1-SR  | 2208.3efg            |
| 60       | 2.5  | Suwan-1-SR  | 3020.8bcde           |
| 60       | 5    | Suwan-1-SR  | 2458.3def            |
| 90       | 0    | Oba Super 2 | 2825.8cdef           |
| 90       | 2.5  | Oba Super 2 | 2583.3cdef           |
| 90       | 5    | Oba Super 2 | 3583.3bc             |
| 90       | 0    | Suwan-1-SR  | 2575.8cdef           |
| 90       | 2.5  | Suwan-1-SR  | 3208.3bcde           |
| 90       | 5    | Suwan-1-SR  | 4583.3a              |
| SE±      |      |            | 237.34               |

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