EFFECT OF A SYNTHETIC FOLIAR FERTILIZER (SUPER GRO) ON GROWTH AND YIELD OF MAIZE (*Zea mays* L.) IN NORTHERN GUINEA SAVANNA OF NIGERIA

KOROMA, S.A.[1]* AND KAPSIYA, J.[2]

[1]Department of Agriculture and Natural Resources, Song Local Government Area, Adamawa, Nigeria

[2]Department of Horticultural Technology, Federal College of Horticulture Dadin-kowa, Gombe, Nigeria

ABSTRACT

Field experiments were conducted to study the effects of a synthetic foliar fertilizer (Super gro) and varieties on growth and yield of maize during 2013 cropping season. The experiments were carried out at Dumne in Song Local Government Area, and the Teaching and Research farm of the Department of Crop Production and Horticulture, Modibbo Adama University of Technology, Yola, Nigeria. The experimental design was a split-plot with the synthetic foliar fertilizer (Super gro) applied at 6 different rates (0, 100, 150, 200, 250, and 300 milliliters (mls) per hectare) in the main plot and three varieties of maize (Sammaiz 15, Sammaiz 17, and Sammaiz 26) planted in the sub-plots, replicated three times. Data were collected on physical and chemical properties of the soils of the experimental sites, rainfall conditions of the two areas, and the plant growth and yield parameters of the maize crop. Data collected were analyzed statistically using analysis of variance (ANOVA) and Duncan's Multiple Range Test was used to separate the means at 5% level of probability. The results showed that the textural class of the soils of the two sites were loamy sand at both depths at Dumne location and sand and sandy loam at the depths of 0-20 and 20-40cm respectively at Yola location. Similarly, the total amount of rainfall and the number of rain days at Dumne were higher compared to those of Yola area. The combined mean effects of the synthetic foliar fertilizer (Super gro) was not significant on growth and yield of maize. Also, the combined mean effects of variety on growth and yield parameters of maize did not significantly vary, but differed numerically with Sammaz 17 recording the highest grain yield of 3782.8 kg/ha It could be concluded that the synthetic foliar fertilizer (Super gro) had no influence on growth and yield of maize. Secondly, since variety differed numerically with Sammaz 17 producing the highest grain yield than the other two varieties, farmers may adopt the use of the variety as an alternative to the in availability of other high yielding varieties of maize. Thirdly, with the results of the physico-chemical properties of the soils of experimental sites and rainfall conditions of the two areas, it could be stated that Dumne location possessed a more suitable environmental conditions for maize production than Yola location.

Keywords: Fertilizer, Foliar, Maize, Super gro, Varieties
***Correspondence:** akeweta@gmail.com, 08085020704

INTRODUCTION

Maize (*Zea mays* L.) also known as corn is an important grain crop of the world, and it is considered by many authorities to have originated from Central America and Mexico (Onwueme *et al*. [1]. It further added that, in previous years, maize was ranked second to wheat in the world of cereal crop production but in recent years, it has taken the lead. Chidda *et al*. [2], also noted that maize is the leading crop cultivated over an area of 139 million hectares, with the total production of over 600 metric tons of grain. Food and Agriculture Organization [FAO] [3], confirmed that maize rank first in cereal crop production followed by wheat and rice. It further reported that in 2009, World maize, wheat and rice productions stood at 817 million tons, 682 million tons and 678 million tons respectively. In 2013/14, World Cereal Market stood at 2525.2 million metric tons, out of which 1315.1 metric tons is coarse grain that is made up of 70% maize. It is followed by wheat with 715.6 metric tons and rice, 494.5 metric tons [FAO] [4]. In 2012/13, United States of America rank first among world maize producers with a total maize production of 872,791,397 metric tons while Nigeria was the eleventh World and second African largest producer. Nigeria produced 9,410,000 metric tons while South Africa produced 11,890 metric tons of maize. [FAO] [5]. International Institute of Tropical Agriculture [IITA] [6] revealed that maize is grown widely throughout the world in range of agro-ecological environments. It also explained that more maize is produced annually than any other grain crop and the World leading producers includes USA, China, Brazil Mexico and India, with U.S.A producing 42%, and Africa 6.5% of which Nigeria is the second largest producer in Africa. Africa imports 28% of its maize requirements from Countries outside the Continent. Institute for Agricultural Research [IAR] [7], stated that Maize is grown in almost all parts of the country ranging from wet evergreen forest zone to the dry ecological zones of the Sudan

savanna of Nigeria. However, it noted that highest grain yield per unit area were recorded in the savanna zones.

Maize has numerous uses; where in industrialized countries, maize is used for livestock feeds and raw materials for industrial products. According to Erenstein [8] maize compared to wheat and rice, is a more versatile multi-purpose crop used in the developed economies primarily as a livestock feed crop with a varied role as an industrial and energy crop. In Africa, it accounts for 30 – 50% of low-income household expenditures Makurira [9] reported that in Nigeria, over 85% of maize is used for human food. It provides high quantities of carbohydrates, vitamins A, C and E. Maize grain contains about protein 10%, aluminizes 10.4%, carbohydrate 70%, 2.3% crude fiber, ash 1.4% and oil 4% Vinod et al. [10]. Several industries rely on maize for raw materials, such as flour mill, livestock feeds, fuel and corn meal, bioethanol, starch and cellulosic (Stover) material [11, 12]. Maize fodder is also used for feeding cattle [13].

Maize crop is an important annual plant that belongs to the family-graminae, with a remarkable adaptability to a wide range of environmental conditions and has a high demand for nutrients (especially nitrogen), which is often considered to be a factor which limits its production [14]. According to Pedro [15], over decades, small scale farmers have exhausted high quantities of nutrients from their soils without using sufficient quantities of manures or fertilizers to replenish the soil. This has resulted in a very high annual average depletion rate of 22 kg of Nitrogen, 25 kg of phosphorus and 15 kg of Potassium per hectare of cultivated land in 37 African Countries, over the last 30 years. He further explained that the traditional way to overcome nutrient depletion is the use of mineral fertilizers. But fertilizers in Africa cost two to six times as much as those in Europe, North America and Asia. Due to these difficulties, farmers tend to use any material that they feel it can improve their crop yields such as Super gro (a synthetic foliar fertilizer). However, the recommendation for use of this chemical does not state clearly its rate of application per unit area of land in terms of chemical concentration of the foliar fertilizer. The only instruction written on the label of the container by the manufacturer was for the farmer to add one milliliter of the liquid fertilizer in one liter of water and apply. This direction for use of the fertilizer does not take into consideration, the concentration of the active ingredients of the Super gro to be applied, the type of sprayer to be used, the speed of travel of the operator and the nozzle size etc., which could result to either higher or lower dose of the fertilizer.

The fast rate of nutrient depletion in tropical soils, unavailability and high cost of farm inputs (especially inorganic fertilizers), incapability of farmers to acquire these inputs, and above all ignorance and illiteracy of most farmers collectively brought about decrease in crop yield per unit area of land. Due to the high cost of soil applied fertilizers in the study area, most farmers were alternatively forced to use foliar fertilizers which relatively cost cheaper than conventional fertilizers. But the influence of the foliar fertilizers on the growth and yield of crops grown by the farmers is not known and hence the objectives of this study was to determine the effect of synthetic foliar fertilizer (Super gro) and variety on the growth and yield of maize.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at two locations – Dumne in Song Local Government Area (LGA) of Adamawa State and the Teaching and Research farm of the Department of Crop Production and Horticulture, Modibbo Adama University of Technology, Yola. The Experimental site at Dumne, Song (LGA) is located between latitude $09^0 46' 32''$ and $09^0 46' 33''$; and longitude $12^0 28' 43''$ and $12^0 28' 48''$ Anonymous [16]. The LGA lies in Sudan savannah ecological zone of Nigeria with short grasses intermingled with short trees. It has a mean annual temperature of between 21^0C and 34.5^0C and mean annual rainfall between 850 mm and 1400 mm. The hottest periods fall between March and April while the coldest periods are between November and February. The site of the experiment at the Research and Teaching farm of the Department of Crop Production and Horticulture, Modibbo Adama University of Technology (MAUTECH), Yola which lies between Latitude $12^0 30' 13.8''$and $12^0 30' 14.0''$ and longitude $09^0 21' 14.3''$ and $09^0 21' 16.3''$ and located at altitude 200 m above sea level within the Sudan savannah ecological zone. It has an annual mean rain fall of 900 mm to 1100 mm Adebayo and Tukur [17]

Sources of super gro

The Synthetic Foliar applied fertilizer (Super gro) used for the experiment was obtained from a known GNLD SUPER GRO registered dealer in Yola, Adamawa state for quality assurance.

Source of maize seeds

The three varieties of maize seeds (Sammaz 15, Sammaz 17 and Sammaz 26) were obtained from Adamawa Agricultural Development and Investment Limited (AADIL), Yola. All varieties are white in color, except that Sammaz 15 is medium maturity, good seed quality, high yielding and resistant to *Striga hermonthica*; The seeds of Sammaz 17 are large and the plants attain a height of 220 cm, tolerant to *Striga hermonthica* and a Quality Protein Maize (QPM) with a potential yield of 5.0 tons per hectare while Sammaz 26 is highly tolerant

to drought with resistance to streak and tolerance to low soil nitrogen.

Experimental treatments and design

The treatments consisted of six rates of the synthetic foliar fertilizer (Super gro) applied at 0, 100, 150, 200, 250 and 300 mls/ha and three maize varieties (Sammaz 15, 17 and 26). The treatments were laid out in a Split plot design with the synthetic fertilizer (the Super gro rates) allocated to the main plot whereas the variety was placed in the sub plots and replicated three times. The synthetic foliar fertilizer (Super gro) was applied three times at the designated rates, commencing from ten days after sowing (DAS) and repeated at intervals of ten days**.** The size of the experimental plots was 3 m x 5 m (15 m^2) laid at 1.0 m distance within plots and 2.0 m between replicated blocks, and its buffer was 2.0 m to separate the experimental site from other farms. The provision of such spaces in the design was to avoid fertilizer drifts within plots and blocks during spraying.

Agronomic practices

Land preparation

The land was cleared with axe, ploughed with a tractor and leveled with a hoe. This was done to provide a fine tilth for the experimental lay out.

Sowing

The sowing of the plots followed the pattern of the experimental design with varieties planted as soon as the rain was well established in June at the spacing of 25 cm x 75 cm of intra- and inter-row. Two seeds were sown at the depth of 3-5 cm per stand and was later thinned to one plant per stand at 2 weeks after crop emergence.

Weeding

Atrazine and paraquat were applied as pre-emergence immediately the seed was sown. The purpose was to control pre-emergence and existing weeds. Later at 6-7 weeks after sowing (WAS), supplementary weeding was done with a hoe to remove weeds that survived.

Fertilization

All plots except the control plots, were treated with Super gro at the designated levels. The foliar fertilizer was applied three times at intervals of 10 days commencing from 10 days of seedling emergence. No other conventional fertilizer was used in the experiment.

Pests and diseases control

Pests and diseases control measures adopted to ensure crop health included seed treatment with Apron plus during seed packaging, prompt weeding and harvesting.

Harvesting

Harvesting was promptly carried out as soon as the moisture content of the grain has reached physiological stage. Maize plants within the net plot area were harvested to represent the plots in the experiment.

Soil analysis

Soil samples were collected at the depths of 0-20 and 20-40cm from the study sites and analyzed to determine the physicochemical properties of the soils at the Soil Science Laboratory of the Department of Soil Science, Modibbo Adama University of Technology, Yola

Crop establishment counts

Establishment count of maize was taken at 2 WAS to determine plant population.

Plant height per plant (cm)

Plant height was obtained by measuring 10 randomly sampled plants from each plot. The height was measured from the base of the plant to the base of the last well-developed leaf of the shoot at vegetative stage and from the base of the plant to the tip of the tassel at reproductive stage using graduated meter rule at intervals of three weeks and at 12 weeks after sowing (WAS). The average height for the 10 sampled plants in each plot was then calculated and recorded.

Number of leaves per plant

The total number of leaves per plant was obtained by counting the leaves of 10 randomly sampled plants and average number of leaves per plant determined and recorded. Number of leaves per plant for each plot was determined at 12WAS

Leaf area per plant (cm^2)

The length and width of the leaf of 10 randomly sampled plants were measured with a meter rule at 12WAS and the leaf area determined using the formula: - L x W x Q. Where L is the length of the leaf; W is the width of the leaf, and Q (0.75) is a constant. The mean leaf area for each plant was then calculated and recorded.

Cob weight per plot (g)

The cob weight of 10 randomly sampled cobs per plot was measured using a weighing scale (Model PN-999) and the average obtained and recorded.

Weight of 100 grains per cob (g)

One hundred (100) grains weight of the 10 randomly sampled cobs per plot were counted and weighed with a sensitive electrical digital weighing balance in the laboratory, and average obtained and recorded.

Grain yield per plot (g) and per hectare (kg)

The grain yield per plot was obtained from the interior net plot area measuring 2.5m by 3.5m. The output was then used to compute grain yield per plot and subsequently the yield per hectare.

Data analysis

All data collected were analyzed statistically using analysis of variance (ANOVA) for a split plot design. The difference between means was used to test the significant effects of all the treatments at 5% level of significance using Duncan Multiple Range Test at 5% level of probability [18].

RESULTS AND DICUSSION

Table 1 shows the chemical and physical properties of the soils of the experimental sites at Dumne and Yola locations at the depths of 0-20 and 20 40cm. Using the ratings and interpretation of soil test results by Pam and Brian[[19], the physical and chemical properties of the soil at Dumne location at the depth of 0-20cm were: Soil pH 6.10 (slightly acidic), cation exchange capacity (CEC) 0.15 Cmol/kg (very low), texture class - loamy sand, Organic carbon 1.59% (moderate M3), Total Nitrogen (N) 0.103% (very low), available Phosphorus (P) 8.13 Cmol/kg (low), exchange cations Cmol/kg were: Mg 0.19 (very low), Ca 4.23 (low), Na 0.57 (very low) and K 1.43 (high). The Base saturation was high (76.51). At the depth of 20-40cm, Soil pH was 6.13 (slightly acidic), CEC 0.14 (very low), texture class - loamy sand, Organic carbon 1.48 (moderate M3), Total Nitrogen 0.096% (low), available P 7.10 (low), the exchangeable cations were: Mg 0.19 (very low), Ca 5.20 (moderate), Na 0.56 (very low) and K 1.29 (high). The Base saturation was also high (75.90). On the other hand, the soil analysis results at Yola location at the depths of 0-20cm were: Soil pH was 5.70 (moderately acidic), cation exchange capacity (CEC) 0.13 Cmol/kg (very low), texture class - sand, Organic carbon 1.51% (moderate M3), Total Nitrogen 0.068% (low), available Phosphorus 7.45 Cmol/kg (low), exchange cations (Cmol/kg) were: Mg 0.64 (low), Ca 3.90 (low), Na 0.62 (very low) and K 1.21 (high). The Base saturation was high (74.87). At of 20-40cm depth, the physico-chemical properties were: Soil pH 5.83 (moderately acidic), CEC 0.15 (very low), texture class - loamy sand, Organic carbon 1.31 (moderate M3), Total Nitrogen 0.107% (low), available P 6.95 (low), and the exchangeable cations were: Mg 0.27 (very low), Ca 3.77 (low), Na 0.53 (very low) and K 1.24 (high). The Base saturation was also high (72.12).

Based on the results of the physico-chemical properties of the two experimental sites, it was observed that some properties such as the soil pH, texture, organic carbon and available K were suitable for maize production whereas properties including available Nitrogen and Phosphorus were low and therefore need to be amended. According to Onwueme and Sinha [1], maize can be grown on soils with wide reactions between soil pH of 5.5-8.0, but the optimum range is 5.5-7.0. and Manpreet *et al.* [20 [stated that maize can be cultivated successfully in loamy sand to heavy clay that is well drained, but highly sensitive to water stagnation especially during early period of growth. Toungos *et al.* [21] made it clear that maize is a heavy feeder crop due to its large nutrient requirement. In general, the fertility status of both the sites has been considered low. The soil fertility status of Dumne location was considered slightly higher compared to Yola location. Maize being a crop with high nutrient demand, there is a need to apply fertilizer to ensure good yield.

Table 2 shows the rainfall data of Dumne and Yola experimental sites during 2013 cropping season. At Dumne location, the rainfall commenced in March and ended in December with the total annual rainfall of 1087.9 mm in 92 rainy days, with August having the highest total monthly rainfall of 317. 5 mm. It also recorded ten (10) dry spells (each dry spell consisting of five (5) consecutive days of rainfall break). Most dry spells (7) occurred between April and June. No dry spell was recorded in July and September, but one (1) and two (2) dry spells were experienced in August and October respectively. On the other hand, Yola location, the rainfall started in March and terminated in November with the total annual rainfall of 508.5 mm in 43 rainy days, with September having the highest total monthly rainfall of 114.4 mm. It also recorded twelve (12) dry spell days with 2 days each in June, July, August and November. The highest dry spell of 3 days was recorded in May and 2 days was recorded in November. The data revealed that Dumne location had received the highest total rainfall of 1087.9 mm compared to Yola location that got the lowest total rainfall of 508.5 mm. Based on the rainfall data collected and recommended annual precipitation required by maize for its good production, maize can be grown successfully in both locations. According to Kamara et al. [22] a minimal range of 480-880mm of well distributed rainfall is adequate for maize cultivation, depending on variety.

The synthetic foliar fertilizer (Super gro) rates did not have any significant effect on crop establishment count of maize possibly due to the available source of nourishment located in the cotyledon of the seed of the growing seedling (Table 3). Alison *et al.* [23] reported that a developing maize seedling relies on the kernel endosperm for nourishment until the nodal root system has fully developed, usually around 6-leaf stage. Thus mesocotyl acts as the pipeline for the translocation of nutrients from the kernel and seminal root seedling stalk and leaf tissues. On the other hand, the effect of variety on establishment of maize was highly significant at Dumne and Yola locations (Table 3). At both locations, Sammaiz 15 recorded the highest establishment percentage of 85.53% and 85.56%, Sammaiz 17 gave 73.39% and 85.06%, while Sammaiz 26 recorded the lowest establishment count of 71.61% and 82.22%, respectively. This shows that Sammaiz 15 has good germination and seedling establishment qualities compared to the two other varieties used. The differences in the establishment percentage could have occurred due to variation in the genetic composition and seed quality of the varieties. Maria *et al.* [24] observed that a successful emergence and establishment of crops is a combination of three key factors including environment (temperature, residue, compactness of the

soil and water), genetic (stress tolerance and vigor), and seed quality (harvest moisture, drying, conditioning and planting). Similarly, Orzolek [25] stated that crop stand establishment is controlled by biotic (pathogens that attack plants as parasites), abiotic (soil and planting requirements) and environmental factors (temperature, nutrients and water stress).

The non-significant effect of Super gro on plant height, number of leaves and leaf area of maize 12WAS in the two locations (Tables 4) was a clear revelation that Super gro had no influence on growth of maize. This result is similar to the findings of Asra *et al.* [26] who studied the effects of foliar application of Stimurel, Force 4-L and Dulzee on yield and yield components of sorghum and reported that foliar fertilization has no effect on height and thickness of plants. According to Carl *et al.* [27], there are many products in the market that can be used as foliar fertilizer but how beneficial are they to crops? This question is yet to be answered by researchers. On the contrary side, Drocelle *et al.* [28] studied the effect of foliar application of water-soluble fertilizers on growth and yield of maize and reported that foliar application of water-soluble fertilizers significantly increased plant height, number of green leaves, leaf area, leaf area index, chlorophyll content and dry matter production. According to them, significantly higher plant height of (231.80, 245.60 and 247.23 cm) was recorded in treatment of 100% RDF along with twice foliar spray at 6 leaf growth stage and tasseling stages at 60, 90 DAS and at harvest respectively as compared to soil application of RDF whereas the significantly lower plant height of (184.77, 199.70 and 210.20 cm) was noticed with soil application at 75% RDF along with one spray of WSF at 0.5% concentration at 6 leaf growth stage at the aforesaid stages.

The effect of variety was significant on mean plant height, highly significant on mean number of leaves and not significant on mean leaf area at 12WAS of maize. Here, Sammaiz 17 variety recorded the tallest plants and highest number of leaves while Sammaz 26 recorded the largest leaf area. This indicates that Sammaiz 17 had the highest ability to absorb and efficiently use nitrogen from the environment including soil and foliage fertilizer application. Plants that have the ability to absorb and utilize nitrogen more efficiently, grow faster and possess the potentials for better positioning of leaves to capture radiation. Anjorin [29] studied the comparative growth and yield response of five maize varieties to nitrogen fertilizer application and reported a positive and varied response of maize varieties to nitrogen fertilizer application due to variation in their genetic composition. Oikeh *et al.* [30] also reported that maize genotypes differ in the rate of nitrogen absorption and utilization.

Generally, variations in growth parameters (plant height, number of leaves, and leaf area) were observed in the three varieties of maize due to differences in the heritable traits in them. The findings showed that Sammaiz 17 has highest growth ability followed by Sammaiz 15 and the lowest was recorded by Sammaiz 26. Research conducted by various Scholars showed that lots of variability exists among maize genotypes for different traits. Ihsan *et al.* [31] reported significant genetic differences for morphological parameters for maize genotypes and Abayi *et al.* [32] observed significant variation in growth traits, especially earliness, to sufficiently justify for the initiation of selection program.

The yield components of maize considered in this research include cob weight, 100 grains weight and grain yield per hectare. The synthetic foliar fertilizer (Super gro) has not affected any of the three yield parameters of maize This could be attributed to the poor performance of super grow on the maize crop. According to Weinbaum [33], factors that determine the performance of foliar fertilization are complex and encompass aspects of physics, chemistry, environment and economics as well as intangibles such as risk aversion and ease of management. The result in this study is similar to that obtained by George [34] who studied corn yield as affected by foliar fertilization of N, P_2O_5, K_2O and S, and concluded that foliar fertilizer had no effect on corn yield. In IOWA, John Sawyer [35] reported that he has not seen recent university trials of foliar fertilization that has indicated positive response.

Concerning the effect of varieties on yield parameters of maize; although there was variation among varieties on growth traits, the result shows that the maize varieties produced statistically similar yields. This is an indication that the three varieties possess similar growth traits and have no much differences among them to cause significant variation in terms of the yield. Possible reasons that could be attributed to the phenomenon was the low soil fertility status of the experimental sites and the non-influential effects of the foliar fertilizer (Super gro) recorded on the growth parameters. According to Pioneer [36], maize plants produce high dry matter yield and therefore have high requirement for nutrients, especially Nitrogen (N), Phosphorus (P), and Potassium (K). Ross *et al.* [37] studied modern corn hybrids' nutrient uptake patterns and reported that the maximum rate of nutrients uptake coincided with the greatest period of dry matter accumulation during vegetative growth for all observed nutrients. During V10-V14 growth stages, corn required the availability of 7.8 lb N/day, 2.1 lb P_2O_5/day, 5.4 lb K_2O/day, 0.56 lb S/day, 0.21 oz Zn/day, and 0.05 oz B/day. They further explained that effectively minimizing nutrient stress requires matching nutrient supply with the time the plant needs it. For example,

Nitrogen uptake follows a sigmoid (S- shaped) pattern with two-third of the total plant uptake acquired by VT/RI while S accumulation was greater during grain filling.

Critically viewing the low soil fertility status of the experimental sites, the non-influential effect of super gro on growth and yield parameters and the large quantity of nutrients that maize requires for its maximum yield, it could be concluded that maize varieties failed to show significant differences due to insufficient nutrient supply.

CONCLUSION

Based on the findings, it can be concluded that the synthetic foliar fertilizer (Super gro) had no significant influence on growth and yield of maize. There was also no significant difference among the three varieties of maize, but Sammaz 17 produced numerically, the highest mean grain yield/ha than the other two varieties of maize. As per the fertility status and rainfall conditions of the study areas, Dumne location could be considered to possess a more suitable environmental conditions for maize cultivation than Yola location.

RECOMMENDATIONS

Based on the findings from this study, the following recommendations could be made: -

i. Since the synthetic foliar fertilizer (Super gro) had no influence on growth and yield parameters of maize, farmers do not need to use it in maize production in the area of study
ii. farmers may use Sammaz 17 variety in the absence of any other high yielding variety of maize in the study area.
iii. further investigation is required on effect of the synthetic foliar fertilizer (Super gro) on growth and yield of other crops such as legumes and vegetables.

ACKNOWLEDGEMENT

I wish to acknowledge late Professor A. A. Sajo and Prof. B.B. Jakusko of The Department of Crop Production and Horticulture, Modibbo Adama University of Technology, Yola, for their immense contributions towards the success of this project work.

Table 1: Physical and chemical properties of the soil of the experimental sites at Dumne and Yola locations in 2013

Parameter	Dumne location Soil depth		Yola location Soil depths	
	0-20cm	20-40cm	0-20cm	20-40cm
Soil Ph	6.10	6.13	5.70	5.83
Cation exchange capacity	0.15	0.14	0.13s	0.15
Sand (%)	85.58	86.0	90.0	86.67
Silt (%)	6.13	7.93	5.13	5.60
Clay (%)	8.01	6.07	4.73	7.73
Texture class	Loamy sand	Loamy sand	Sand	Loamy sand
Organic Carbon (%)	1.59	1.48	1.51	1.31
Total N (%)	0.103	00.96	0.068	0.107
Mg (Cmol/kg))	0.19	0.41	0.64	0.27
Ca (Cmol/kg)	4.23	5.20	3.90	3.77
Na (Cmol/kg)	0.57	0.56	0.62	0.53
K (Cmol/kg)	1.43	1.29	1.21	1.24
H (Cmol/kg)	6.42	7.46	5.94	5.67
Al (Cmol/kg)	6.42	7.46	5.94	5.67
Total exchangeable acids	1.95	2.27	1.93	2.10
ECEC (%)	8.37	9.72	7.87	7.77
Base Saturation (%)	76.51	75.90	74.87	72.12

Source: Field survey 2013

Table 2: Rainfall record of Dumne and Yola locations in 2013

Month	Dumne Total rainfall (mm)	Number of rain days	Number of dry days	Number of dry spell	Yola Total rainfall (mm)	Number of rain days	Number of dry days	Number of dry spell
January	0.0	0.0	31	-	0.0	0.0	31	-
February	0.0	0.0	28	-	0.0	0.0	28	-
March	2.3	1.0	30	-	1.8	1.0	30	-
April	15.2	25.0	5	3	2.7	1.0	29	-
May	989.9	10.0	21	1	67.9	6.0	25	3
June	133.6	7.0	23	3	96.4	6.0	24	2
July	213.2	14.0	17	0	85.3	8.0	23	2
August	317.5	13.0	18	1	74.8	7.0	24	2
September	271.6	12.0	18	0	114.4	9.0	21	-
October	89.0	9.0	22	2	55.2	5.0	26	1
November	0.0	0.0	30	-	0.0	0.0	30	-
December	0.0	1.0	30	-	0.0	0.0	31	2
TOTALS	1087.9	92.0	273	10	508.5	43.0	322	12

Source: Ministry of Agriculture, Meteorological Station, Song 2013
Geography and Surveying Department, Modibbo Adama University of Technology, Yola, Nigeria, 2013

Table 3: Effect of a foliar fertilizer (super gro) and variety on establishment counts (%) at 2WAS of maize at Dumne and Yola locations in in 2013

	Establishment counts (%)	
Treatment	**Dumne location**	**Yola location**
FFS levels		
0	83.13 [a]	87.89 [a]
100	80.46 [a]	85.11 [ab]
150	79.58 [a]	83.44 [ab]
200	79.05 [a]	83.78 [ab]
250	77.55 [a]	86.33 [a]
300	79.51 [a]	79.11 [b]
P < F	0.4347	0.0794
SE (±)	3.948	1.337
Variety (V)		
Sammaz 15	85.53 [a]	85.56 [a]
Sammaz 17	79.61[b]	85.06 [a]
Sammaz 26	73.39 [c]	82.22 [a]
P < F	0.0001	84.28
SE (±)	2.515	3.001
FFS x V	NS	**

Means followed by same letter (s) within treatment group are statistically similar at $P \leq 0.05$
WAS = Weeks After Sowing
FFS = Foliar Fertilizer (Super-gro)
NS = Not Significant

Table 4: Effect of a foliar fertilizer (super gro) and variety on plant height, number of leaves and leaf of maize at 12WAS of maize at Dumne and Yola locations in 2013

Treatment	Plant height at 12WAS			Number of leaves at 12WAS			Leaf area at 12WAS		
	Dumne	**Yola**	**Mean**	**Dumne**	**Yola**	**Mean**	**Dumne**	**Yola**	**Mean**
FFS levels									
0	174.3[a]	140.98[a]	157.64[a]	12.55[a]	11.44[a]	12.00[a]	4.67[a]	3.00[a]	3.88[a]
100	171.8[a]	132.56[a]	152.19[a]	12.42[a]	11.2[a]	11.81[a]	4.65[a]	2.55[b]	3.66[a]
150	180.5[a]	134.28[a]	157.41[a]	12.72[a]	11.14[a]	11.93[a]	4.92[a]	2.85[ab]	3.88[a]
200	177.5[a]	135.62[a]	156.55[a]	12.39[a]	11.32[a]	11.86[a]	4.55[a]	3.12[ab]	3.83[a]

250	172.1[a]	149.98[a]	161.04[a]	12.18[a]	11.72[a]	11.95[a]	4.53[a]	3.28[a]	3.90[a]
300	173.6[a]	136.10[a]	154.86[a]	12.47[a]	11.63[a]	12.05[a]	4.32[a]	3.07[a b]	3.70[a]
P < F	0.9046	0.4065	0.8805	0.6507	0.5922	0.9760	0.7354	0.2503	0.8253
SE (±)	5.71	6.45	12.34	0.2543	0.273	0.5225	25.7	17.69	35.17
Variety (V)									
Sammaz 15	175.8[b]	139.12[a]	157.44[a]	12.06[b]	11.01[b]	11.54[b]	4.61[a]	2.92[b]	3.77[a]
Sammaz 17	189.0[a]	135.63[a]	162.32[a]	13.43[b]	11.51[a]	12.47[a]	4.72[a]	2.69[c]	3.71[a]
Sammaz 26	160.1[c]	140.01[a]	150.08[b]	11.86[c]	11.72[a]	11.47[a]	4.49[a]	3.38[a]	3.97[a]
P < F	0.0002	0.7623	0.0549	0.0001	0.035	0.0002	0.6790	0.0120	0.5791
SE (±)	8.72	8.81	4.31	0.3018	0.376	0.6566	37.5	28.24	15.60
FFS x V	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by same letter (s) within treatment group are statistically similar at $P \leq 0.05$
WAS = Weeks After Sowing
FFS = Foliar Fertilizer (Super gro)
NS = Not Significant

Table 5: Effect of a foliar fertilizer (super gro) and variety cob weight (g), 100 seed weight (g) and grain yield (kg/ha) on of maize at Dumne and Yola locations in 2013

Treatment	**Cob weight (g)/cob**			**100 seed weight (g)**			**Grain yield (kg/ha)**		
	Dumne	**Yola**	**Mean**	**Dumne**	**Yola**	**Mean**	**Dumne**	**Yola**	**Mean**
FFS levels									
0	108.64[a]	55.54[a]	82.09[a]	22.07[a]	19.59[a]	20.83[a]	4168.9[a]	2359.9[a]	3264.4[a]
100	124.41[a]	47.87[b]	86.14[a]	23.43[a]	18.14[a]	20.79[a]	4644.2[a]	2300.1[a]	3496.3[a]
150	129.42[a]	52.58[a]	91.00[a]	26.51[a]	17.60[a]	22.06[a]	5000.9[a]	2348.3[a]	3654.8[a]
200	131.40[a]	55.75[a]	93.58[a]	68.91[a]	19.63[a]	22.30[a]	4701.3[a]	2446.9[a]	3574.1[a]
250	128.23[a]	63.39[a]	95.81[a]	25.69[a]	18.58[a]	22.14[a]	4621.1[a]	2674.9[a]	3648.0[a]
300	123.97[a]	48.33[b]	86.15[a]	23.33[a]	19.53[a]	20.89[a]	4767.3[a]	2044.6[a]	3406.0[a]
P < F	0.4096	0.1672	0.6306	0.1568	0.8123	0.6680	0.5942	0.8154	0.9614
SE (±)	12.61	6.22	20.79	1.562	2,075	1.411	493.0	525.5	1260.7
Variety (V)									
Sammaz 15	128.74[a]	62.79[a]	95.77[a]	24.43[a]	18.22[a]	21.70[a]	4804.3[a]	2238.6[a]	3521.4[a]
Sammaz 17	129.45[a]	45.55[b]	85.50[a]	25.07[a]	18.75[a]	21.91[a]	4881.7[a]	2683.8[a]	3782.8[a]
Sammaz 26	114.84[a]	53.38[b]	84.11[a]	23.51[a]	18.28[a]	20.89[a]	4270.2[a]	2164.9[a]	3217.5[a]
P < F	0.1389	0.0019	0.1664	0.4762	0.8422	0.5030	0.1273	0.2047	0.2550
SE (±)	10.22	5.87	7.03	1.378	1.465	1.299	421.9	375.9	342.4
FFS x V	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by same letter (s) within treatment group are statistically similar at $P \leq 0.05$
WAS = Weeks After Sowing; FFS = Foliar Fertilizer (Super gro); NS = Not Significant

REFERENCES

1. ONWUEME, I.C. & SINHA, D.T. (1991). *Field Crop Production in Tropical Africa*. The Technical Centre for Agricultural and Rural Co-operation (CTA), Ede. The Netherlands. ISBN No.92 9081 086. 157-175pp.
2. CHIDDA, S., PREM, S. & RAJBIR, S. (2003). *Modern Techniques for Raising Field Crops*. Second edition. ISBN- 81-204 – 1599-X.
3. F.A.O. (2009). *Maize, Rice and Wheat: Area Harvested Production Quantity and Yield*. http://Faostat. Fao. Org/site/567 Desktop. Default.aspx page I. D=567.
4. F.A.O. (2014). Top Production-World Cereal Demand and Supply *Brief* http//faostat.3.fao.org.
5. F.A.O. (2013). *Final 2012 Data and Preliminary 2013 Data for 5 Major Commodities Aggregates*. http//Faostat.3.fao.org.
6. INSTITUTE OF TROPICAL AGRICULTURE [IITA] (2013). *Maize News and Events*, 6/8/2013 3:23 pp.
7. I.A.R. 2010. Maize production in Nigeria *Manual series*, 08 Vol.1 and 2.
8. ERENSTEIN, O. (2010). The evolving maize sector in Asia: Challenges and opportunities. *Journal*

of New Seeds, **11,** 1–15. https://doi. org/10.1080/15228860903517770.
9. MAKURIRA, H. (2010), Rainfed agriculture in sub-saharan africa. *water product. Rain fed Agriculyure*; **181:9**–21. doi: 10.1201/b10823-[CrossRef] [Google Scholar] [Ref list] .
10. VINOD, K.P., NARENDRA, S., ASHISH, M. & REENA, L. (2018). Effect of different dose of NPK and vermicompost on growth and yield attributes of maize (*Zea mays* L.). Cv.MM2255. *Journal of Pharmaconosy and Phytochemistry*, 2018; **7**(1): 2830-2832.
11. JEFFREY, A., GWIRTZ, 1. & MARIA, N.G. (2013). *Annals of the New.York Academy Sciences*. **1312**(2014) 66–75.
12. DRINIĆ, M. S., SEMEČENKO, V., RADOSAVLJEVIĆ, M., TERZIĆ, 1. D., SIMIĆ, 1. M., STEVANOVIĆ, 1. M. and STIPEŠEVIĆ, B. (2011). *Maize as raw material for bioethanol production*. https://www.researchgate.net/publication/266839985.
13. CHAUDHARY, D.P., ASHWANI, K., SAPNA S. M., SRIVASTAVA, P. & KUMAR, R. S. (2011). *Maize as fodder? an alternative approach*. 32pp www.maizeindia.org; 25842372; Fax: 011-25848195.
14. KINDIE, T. & TOLESSA, D. (2015). Effects of nitrogen and phosphorus fertilizers on the yield of maize (Zea mays L.) at Nedjo, West Wollega, Ethiopia. *Journal of Natural Sciences Research*. Volume **5** (13):197-202. ISSN 2224-3186. http://www.iiste.org.
15. PEDRO, A., (2002). Soil Fertility and Hunger in Africa. *Science's Compass,* **295:** 15
16. ANONYMOUS (2013). *Etrex GPS Observation* Ministry of Land and Survey, Yola Nigeria 1p.
17. ADEBAYO, A. A. AND TUKUR, A. L. (1999). *Mean Annual Rainfall of Adamawa State in Maps*. First Edition. Paraclete Publishers Yola, Nigeria. 22-26pp.
18. STATISTICAL ANALYSIS SYSTEM [SAS] (1999). *SAS/Stat Users Guide, Version 8*, SAS Institute Inc., Cary NC USA.pp378.
19. PAM, H. & BRIAN, M. (2007). *Interpreting soil test results: What do all the numbers mean?* CSIRO Publishing 150 Oxford Street (PO Box 1139) Collingwood VIC 3066 Australia 169pp.
20. MANPREET, J., SHIKHA, B. & RAMANJIT, K. (2019). *Improved technologies for higher Maize production*. Open access peer Reviewed Chapter. DOI: 10.5772/intechopen.88997 21pp.
21. TOUNGOS, M.D., BAMAI, N. & YAMMA, K.M. (2016). Effects of Combined Application of NPK and Foliar Fertilizer (Boost-Extra) On Yield and Yield Components of Maize (*Zea mays L.*) In Mubi, Northern Guinea Savannah Zone of Nigeria. *International Journal of Innovative Agriculture & Biology Research* **4**(3): 17-25.
22. KAMARA, A.Y., KAMAI, N., OMOIGUI, L.O., TOGOLA, A., ELEKEME, F. & ONYIBE, J.E. (2020). Guide to maize production in Nigeria. Feed the future Nigeria integrated agriculture activity.19pp Published by Institute of Tropical Agriculture (IITA) Ibadan, Nigeria. www.iita.org.
23. ALISON, R. (2006). Corn Seedling Health and Stand Establishment. Dept. of Plant Pathology. *Integrated Crop Management News,* IOWA State University. University Extension. 2006;496(12).
24. MARIA, S. & IMAD, S. (2014). Crop Insight: Soil, Temperature and Corn Emergence. *Du Pont Pioneer Agronomy Sciences Research update*, The Depont Oval Logo, U.S.A. **4**: (10) 8-11.
25. ORZOLEK, M.D. (1991). Establishment of Vegetables in the Field. *American Journal for Horticultural Science*, Hort. Technology Department, Dept of Horticulture. The Pennsylvania State University Park, P.A 1680 **2**: (10)78-81.
26. ASRA, S. & MEDHI, T. (2013). Effects of Foliar application of Stimurel, Force-4 L and Dulzee on Yield and Yield Components of Sorghum Speed Seed. *International Research Journal of Biotechnology*, **3**(1): 018-021.
27. CARL, R. & BERMAN, P. (2011). *Foliar Fertilization- PRO's and CON's* Dept. of Soil, Water and Climate. University of Minnesota. Walter Reeves /The Simple Gardner. INC.
28. DROCELLE, N., KALYNA, M., LALITHA, K. N., MURUKANNAPPA, B.S., & FRANCOISE, M. (2019). Effect of Foliar Application of Water-Soluble Fertilizers on Growth and Yield of Maize. Rwanda *Journal of Agricultural Sciences*, **1**(1): 44-51.
29. ANJORIN, F.B. (2012). Comparative Growth and Grain Yield Response of Five Maize Varieties to Nitrogen Fertilizer Application. *Greener Journal of Agricultural Sciences.* **3**(12): 801-808.
30. OIKEH, S.O., KLING, J.G., CHUDE, V.O. & HORST, W.J. (1997). Yield and N- Use efficiency of Five Tropical Maize Genotypes under N levels in the moist Savanna of Nigeria. In: Ransom KJ, Palmer AFE, Zambeji BT, Mduruma ZO, Waddington SR, Pixley KV, Jewell DC (eds.) Maize Productivity Gains through Research and Technology

Dissemination. *Proceedings 5th Eastern and Southern Africa Maize Conference*. Arusha, Tanzania, 3-7 June 1996. CIMMYT, Addis Ababa, Ethiopia, 163-167.

31. IHSAN, H.I., KHALIL, H.R. & M. IQBAL. (2005). Genotypic Variability for Morphological Traits among Exotic Maize Hybrids. *Sarhad Journal of Agriculture,* **21**(4): 599-602.
32. ABAYI, I.K., OJO, A.A., KALU, B.A. & ADEYEMO, M.O. (2004). Genetic Variability, Inheritability and Genetic Variance in SI Progenies of Extra Early and Early Maize (*Zea mays* L.) Population. *Journal of Sustainable Agriculture and Environment*; **6**: 179-184.
33. WEINBAUM, S. (1988). *Foliar Nutrition in fruit trees. Plant growth and leaf Applied Chemicals*. P.M. Neumann, editor. CRC Press, Boca Raton. 81- 100.
34. GEORGE, R. (2003). Foliar Fertilization of corn and soybeans. Department of Soil, Water and Climate, University of Minnesota. *Crop News 2001 – 2008 Archives.*
35. JOHN, S. (2009). Foliar Fertilization of Corn and Soybean. Department of Agronomy, *Integrated Crop Management News.* IOWA State University, University Extension. http/www.iastate.edu/store/ListCategories.asp x? TopicID=2: **1**(7)1-3
36. PIONEER (2014). *Fertilizer Application for Maize Crops Maize for Silage,* Technical insights 332.
37. ROSS, R.B., JASON, W.H., MARTIAS, L.R. &FRED, E.B. (2013) ILLINOIS Modern Corn Hybrids' Nutrient Uptake Patterns. *Better Crops,* Volume **97**(2013No.1).