Evaluation of Different Maize Varieties (*zea mays L.*) for Drought Tolerance in Relation to Root and yield Parameters in Gaya LGA Sudan Savannah

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Abstract**—**The research was conducted at University Research Farm Gaya, during 2012/2013to assess ten (10) varieties of maize (Zea mays L.) for drought tolerance. All varieties were laid down in a randomized complete block design (RCBD) and replicated three (3) times. Varieties KAIKAI, EEYH-16, EEYH-15, SDM-1, TZEE-129, EEYH-3, EEYH-17, SYN-EE-Q, 30G-19 were studied under irrigation condition and their response to water stress conditions was revealed based on grain yield and root parameters. The result showed that yield obtained from all the varieties grown under water stress conditions was significantly different as compared with control with outstanding performance recorded in favour of TZEE-129 and SDM-I in terms of grain yield, this indicated that the letter can be recommended as the most suitable varieties for growing in drought prone area of Sudan Savannah.

Keywords**—**Varieties, drought tolerance, yield and root parameters.

I. Introduction

MAIZE is a cereal crop that belongs to the plant family Gramineae (Poaceae). It is one of the most important food crops in the savannah zones of Nigeria and a major crop grown in the northern and southern Guinea Savannah zones. However, it is second to sorghum in Sudan Savannah. It is adapted to a wide range of environment but essentially a crop of the warm environment. According to FAO (2006), the area under production of maize in West Africa has increased from 3.2 million ha in 1961 to 8.9 million ha in 2005. Accordingly, this phenomenal expansion of land area devoted to maize resulted in increased production from 2.4 million tons to 10.6 million tons within the same period. Despite its importance and higher yield potential than either sorghum or pearl millet, maize productivity is limited by several production constraints in the region, among which is drought.

Drought stress at silking, tasselling and grain filling has been reported to be more drastic on grain yield in maize than stress during vegetative phase [10] (Grant et al., 1989). Annual maize yield loss of about 15% has been attributed to drought in sub- Saharan Africa and biomass production generally decreases with decreasing water availability. Yield reduction of 70 to 90% has also been reported under mild to severe water stress [2]. Drought tolerant or resistant maize varieties developed from diverse sources of germplasm through wide testing may represent good sources of materials for on-farm trials [6,15]. Hybrids and open pollinated varieties have been reported to perform better than farmers' local varieties, for grain yield and indeed for other traits, in the presence and absence of moisture deficits [6]. Although several maize varieties and hybrids that escape or tolerate drought have been developed by the International Institute of Tropical Agriculture in collaboration with National Programmes, most of these varieties were not evaluated in the Sudan Savannah of Kano state.

In most parts of North-eastern Nigeria, rain fed crop production is widely practiced with less emphasis on supplemental irrigation. Knowledge of water use by crops such as maize among other crops within the area of study is a prerequisite to a better planning and design of irrigation systems, and on which this study revolves.

Moreover, the rising costs of irrigation and the problems of management, cost recovery, and the maintenance of existing systems limit the further expansion of irrigation. Such events will impose demands for crops with improved resistance to drought and diseases. Some of the recommendations of the draft Bulgarian climate change action plan include: development of winter crops that can develop winter hardiness at higher winter temperatures, development of crops with improved drought tolerance especially at stages of fertilization and grain filling, and development of crops that can grow at higher carbon dioxide concentrations. Maize is now the third most important source of calories for human kind after rice and wheat.

Even though the challenge of developing drought tolerant crop varieties has generated an immense amount of literature, most practical breeding efforts remain focused on increasing productivity under favorable conditions where genetic variance, heritability and therefore breeding progress for grain yield are greatest. Apart from adapting crop phenology to rainfall patterns, multi-environment trials (METs) including trials grown under random drought conditions are often the only systematic approach exploited to increase yield

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stability of new crop varieties in drought-prone environments [10, 12].

Genotype-by environment interactions are common under drought and make breeding progress difficult. Interactions may originate from environmental variation in the timing and severity of water deficits, genetic variation in flowering time, and nutrient deficiencies and toxicities whose occurrence and severity interact with water deficits[1]. Also, high error variances such as induced by variable plant stand or variable soil water holding capacity are intrinsic to many field trials grown under drought and impede selection decisions, particularly as such trials are often conducted far from breeding stations which tend to be placed at more favorable locations. This study was conducted to assess ten (10) varieties of maize that are drought tolerant.

The broad objective of this research is to evaluate maize variety tolerance to water stress condition and to assess the selection criteria for identifying drought tolerance variety.

II. Materials and Methods

The research was conducted at Kano University of science and Technology farm during period of 2012/2013. The KUST Research Farm located at Gaya Local Government area of Kano State. The area which is on latitude 11 ^{0} 52N and longitude 9 ^{0}20E and it is about 60 kilometers away from Kano city of the Sudan Savanna agro-ecological zone. The climate of the study area is characterized as tropical wet, dry climate and cold, the temperature is from warm to hot with cold period from November to February, the mean annual temperature is 26^{o}C with average of 800mm annual rainfall and 400m to 430m above sea level soil type is sandy loam.

III. Procedure for Paper Submission

Experimental Materials

The following varieties were used in the experiment.

S/N	varieties	S/N	varieties
1	Extra early yellow hybrid – 3	6	30G 19
2	Extra early yellow hybrid – 15	7	SDM 1
3	Extra early yellow hybrid -16	8	SYN-EE-Q PM-STR-DT
4	Extra early yellow hybrid – 17	9	TZEE 129 *x* TZEE 137 *x* TZEE 49
5	SAMMAZ – 17	10	KAIKAI

A. Field Plot Technique

The varieties were collected from International Institute for Tropical Agriculture (IITA) Kano branch and were sown in Gaya farm in a screen house. All the treatments were laid out in a Randomized Complete Block Design (RCBD) with three replications, making total of forty (40) entries in the experiment.

The pots were arrange 2x2 feet size between row and column. Three seeds were planted per pot at3cm depth and later thinned to two plants per pot after germination. Irrigation schedule included watering twice in a week for treatment and thrice in a week for control after full seedling germination respectively. Weeds were controlled manually with hand throughout the growing period of the crop.

Fertilizer application N P K (15:15:15) was applied two weeks after sowing while Nitrogenous (urea) was applied four weeks after first application respectively using ring method as recommended.

Observation Some yield and root parameters such as plant height, number of leaves, corn length, number of corn, number of seed per corn, number of root length of corn weight of 100 seeds were observed and measured for all the varieties.

B. Statistical analysis

All the data collected were subjected to analysis of variance (ANOVA) using the computer program Statistics (SPSS 16 Version). The treatment means were compared and separated using Duncan's Multiple Range Test at 5% level of probability.

IV. Results Presentation

Number of leaves per plant

The result shown in table 1 indicated that water stress has significantly affected all the varieties both the treatment and control. Varieties TZEE-129, SDM-1 and 30G-19 have less effect of water stress on number of leaves compared with control.

Cob length

Cob length observed in TZEE-129 has the highest mean value followed by EEYH-17 and EEYH-3 as compared with control, this is an indication of water stress tolerance in these varieties (Table. 2)

Number of seeds per cob

Varieties TZEE-129 followed by EEYH-3 and EEYH-17, were observed to have shown the highest number of seeds per cob significantly at ($P \geq 0.05$) which shows they tolerated drought more than other varieties. (Table 3)

100 seed weight

100 seed weight observed in all the treatment as shown in Table 4, has a significant different at ($P \geq 0.05$). It was reported elsewhere according to Farshad et al. [8] SDM-1 maize variety had a maximum of 148g under normal moisture and 139g under moisture stress. The result obtained in this study for 100 grain weight is 247.27g which is far above that which was reported even under normal rainfall suggests water stress tolerance.

Number of root

In Table 5, the result of the effect of water stress on root numbers showed that variety TZEE-129, EEYH-3 and EEYH-16 have the highest with a significant difference ($P \geq 0.05$). as compared with control.

Root length

The highest value of root height was discovered in variety EEYH-16, followed by SDM-1 with significant differences ($P \geq 0.05$) In Table 6, while KAIKAI and 30G-19 have the lowest values

Root Girth

In Table 7, the influence of water stress on root girth was observed with a significant difference at ($P \geq 0.05$). Varieties EEYH-17, 30G-19 and EEYH-16 have the highest values and varies with the lowest compared with control

Root weight

The varieties SYN-EE-Q TZEE-129 and EEYH-17 have highest mean value with a significant difference ($P \geq 0.05$). Compared with control as shown in Table 8

V. Discussion

Maize production in Kano Nigeria is met with a lot of problems; these problems include insufficient water which has a significant influence on maize yield. Several studies have shown that seed yield and yield components of maize, was markedly affected by irrigation treatments [3,5 and 7]. In a similar experiment the effects of drought stress on Maize varieties were significantly affected either the growth and yield parameters.

Therefore, to find suitable stress resistance maize variety for screening of cultivars under drought condition, grain yield of cultivars under both non-stress and stress conditions were measured for calculating different sensitivity and tolerance. Based on the water stress tolerance and grain yield in two conditions, TZEE-129, EEYH-15, EEYH-3, SDM-1, were found to be drought tolerance with highest grain yield under both irrigation conditions, while SYN-EE-Q and KAIKAI displayed the lowest amount of yield for irrigation condition. Other cultivars were identified as semi-tolerance or semi-sensitive to drought stress (Table 2). [8]. A lot of studies have confirmed stress at early stages of crop development to be devastating on yield according to [10, 11 and 12] Since drought stress has been reported to be more detrimental on maize crop during silking and tasselling [10], varieties which tassels and produce silks early in the season will be of utmost advantage in a drought endemic environments because they could escape drought. The varieties TZEE-129, EEYH-15, EEYH-3, have shown to tassel and silk earlier and could be drought escaping compared to the other entries. These varieties therefore, could have the potential to escape drought stress in drought prone areas. In addition to early tasselling and silking of TZEE-129, it has also shown the potential for producing high grain yield. Maize has been reported elsewhere according to Farshad et al. [8] under water stress condition. The grain yield obtained in this maize variety, is quite remarkable and recommendable, in addition to breeding for grain yield in crops. However, the results of 100 grains weight reported elsewhere according to Farshad et al. [8] in maize had a maximum of 350.39g under normal moisture (control) and 322.32g under moisture stress. This result obtained is a breakthrough and these varieties could be recommended for breeding heavier grain yields in maize. Variation among the varieties in 100 grain weight and grain yield therefore, could be ascribed to the impairment of many important metabolic and physiological processes in plants during moisture stress. Similar results have been reported elsewhere by [13,15].

VI. Conclusion and Recommendations

The revision has identified several varieties that performed excellently well in many of the yield and yield traits. The variety TZEE-129 flowered earlier indicating the inherent genetic potential for early maturity and drought escape mechanism. These varieties therefore, could have genes that confer drought escape among maize varieties. In another development, TZEE-129, EEYH-15, EEYH-3, were found to have excelled in grain yield. Most varieties that produced higher 100 grain weights were among those with higher grain yields. However, this study has designated that maize can actually be grown and produced successfully in these environments, considering the excellent performance of the maize variety evaluated.

This study, recommends that these promising varieties be further evaluated in a multi- location across Kano State and some parts of northern Nigeria that share similar agro-ecology. These varieties could be incorporated in the crops recommendation for the State's Agricultural Development Program, other related institutions such as IAR and Ministry of Agriculture for farmers to benefit.

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