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BREEDING LOCAL ONION (*Allium cepa L.*) FOR HIGH HUMIDITY AND RAINFALL RESISTANCE IN AKWA IBOM STATE, NIGERIA

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Abstract: *Onion belongs to the family of crops known as Alliaceae, which are monocotyledons and biennial in nature and too, reproduces through cross-pollination. Onion is known to be cultivated in varied climatic conditions all over the world. The morphological, physiological, and biochemical functioning of plants are interrupted with onset of high humidity, excessive rainfall, drought and salinity. This study is aimed at breeding local Nigerian onion cultivars for high humidity and rainfall/excess water resistance in Akwa Ibom state of Nigeria and to consider the improvement of local onion cultivars in terms of bulb yield and other yield components parameters such as leaves. Genotypic Coefficient of Variation and Phenotypic Coefficient of Variation together with Pearson's correlation coefficient were determined for seven yield parameters. From the results obtained in this study, it can be deduced that some onion genotypes have the ability to grow under high rainfall and excess water condition and that such genotypes have good potential for breeding program on such water-logged environment considering the high tolerance level.*

Keywords: *Breeding, Humidity, Cultivar, Onion, Yield*

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INTRODUCTION

Excess water in the soil and high humidity are factors that affects crops and some agricultural plants in terms of growth, development and yield through the alteration of the different life processes such as metabolism, physiology and morphology (Diaz et al., 2010).

This alterations may lead to major damages to the cells of the plant through the formation of reactive oxygen species in plant tissues (Sairam and Saxena, 2000) which is an indication of genotypic variation in plants due to alteration in the optimum water requirement. Extended period of high humidity in plants growth environment can affect the rate photosynthesis and consequently resulting in very poor growth and poor yield and economic loss.

The consideration of phenotypic characteristic is an alternative measure in determining genotypes that are tolerant to certain desirerable feature. Also, a study by Mwadzingeni et. al., (2016) on drought stress, concludes that different tolerant levels among different crops can be identified using genotypes. The use of phenotype identification in screening germplasm based on morphology, physiology, biochemistry and yield of crops was employed by Passioura, (2012) and found to be promising.

Blum, (2010) studied grain crops by considering some individual yield parameters such spikelets, tillers, height and time taken for the crop to mature and the results of the observations showed that, the traits can be considered to be of significance in determining varieties for water resistance especially when inadequate. Changes in molecular and physiological responses both within and between crop varieties and germplasm is a phenomenon in crop breeding which have been observed by different researchers as reported by (Aghaie et al., 2018).

Studies have shown that a significant relationship between Onion bulb yield and yield components such as leaves exist with the amount of water available to the crop during growth and development. Although no much literature available on the correlation between different water management levels and variation in species and genetic multiplicity. Although Onions are grown for their leaves and seeds, most farmers embark on onion farming for the bulb yield which is the main part for consumption, thus it should be the major character that desires to be measured when assessing water tolerance together with other physical and chemical components. The level at which Onion bulbs are destroy or rendered unusable is determined by the type of variety of the Onion and level of development and the phenological stage at which water availability ensues (Ghodke et al., 2018).

Considering the numerous and diverse information obtained from the literature, it can be deduced that only, genotypes having wide and prominent characters of high tolerance and good yield when rainfall and humidity are very high should be selected during breeding using both phenotypic and genotypic variables from large collection of gene pool. Accordingly, numerous genotypes should be carefully assessed using the standard and most suitable statistical instrument/software. In plant breeding, the use of principal component analysis and the Multivariate cluster are often considered by breeders in assessing and determining cultivars and genetic variability in different genotypes using performance under different water regiment.

Aim of the Study

One of the most probable ways to overcome the lack of high yield in Onion in Akwa Ibom state due to excess rainfall and high humidity is to produce an improved onion cultivars and /or varieties that has genotypes with good adoptive radiation that includes excess water resistance and high yield through breeding.

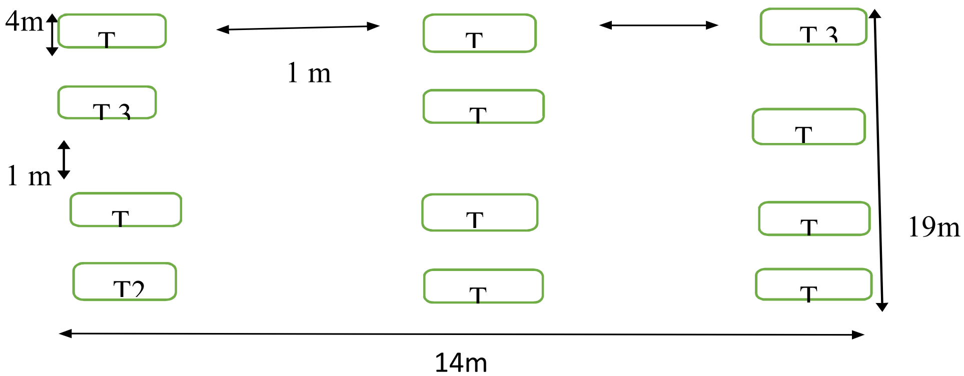
The aim of the study therefore, is to produce a high rainfall and humidity resistant onion variety through breeding and to consider the improvement of local onion cultivars in terms of bulb yield and other yield components parameters such as leaves for higher yield.

METHODOLOGY

The field materials required to successfully conduct the study includes the following; Hoe, Cutlass**,** Measuring tape**,** Watering can, Water pump and a Digital hand type Refractometer. The study involves 100 different onion genotypes in which 7 distinct genotypes were evaluated using 7 yield and yield components parameters assessed under high rainfall and water-logged environment.

The experiment was be laid out in a Randomized Complete Block Design (RCBD) with three replications and four treatments and a control. Humidity and rainfall are considered on natural conditions.

Rep 1	Rep 2	Rep 3



KEY: T = treatment; Rep. Replication

Cultural Practices

The land preparation involves clearing of bush/grass using available farming tools that are been used in the localities such as hoe, cutlass and rakes. All plant materials and other environmental waste and debris were cleared with the aim of minimizing infestation of weeds in the selected area of plots used. The area was Plough using tractor as a means of tilling to improve percolation and reduce water logging and allow soil microorganism interaction. This is also to comply with local farm practice such that the experiment will be conducted under ideal and natural conditions. This is followed by preparation of nursery beds where the seeds where first broadcasted and nurse before transplant.

After transplanting, regular weeding was carried out at the emergence of weed followed by intermittent application of desirable pest using hand sprayer. Perforated nets were also used, in which it was placed along the borders of each experimental plot to check the activities of rodents. Yield and yield components parameters were measured on the field as mode of data collection before harvest. The harvesting was carried out immediately the onions mature and leaves began falling down through pulling with hand and supporting with a hand hoe such that complete bulb is harvested.

Genetic component analysis

Experimental data was obtained from seven yield and yield components parameters from contrasting onion genotypes for the study and analyzed by determining the phenotypic genotypic correlation. The genotypic coefficient of variation and phenotypic coefficient of variation were also calculated by applying the formula below:

Genetic coefficient of variation (GPC%) = VgX x 100, P

Phenotypic coefficient of variation (PCV%) = VpX x 100.

Statistical Analysis of Data Obtained

The SAS software Version 9.3n was used to carry out a One-way analysis of variance for the data obtained, and a least significance difference (LSD) test was executed at $p = 0.05$ to determine the genotypic divergence of the different onion genotypes. It also applied in the determination of different phenotypic performance of experimental genotypes for different characters under control and the high humidity and rainfall conditions. The data obtained was also used to determine the Pearson's correlation coefficient among the different genotypes using the regular SPSS software.

The following traits were examined during the period of the experiment:

i. Number of Leaves per Plant: Number of leaves will be observed and counted with hands. Five samples will be taken at random per plot.

ii. Bulb Diameter: Bulb diameter will be measured with the use of divider, and a ruler will be used to get the values in centimeter.

iii. Total Yield Per Plot: At harvest the yield will be measured with the use of a weighing scale and recorded in kg per plot.

iv. Plant Height: Plant height will be measured with the use of a ruler and recorded in centimeters.

RESULTS AND DISCUSSION

Excessive rainfall which leads to waterlogging and high humidity in the atmosphere is known to negatively affect crops growth and development and the overall yield output, especially in crops with adventitious roots system such as onion. The response of onions to excess water depends on the genotype of the crop and its level of development (Dubey et. al., 2020). Mortality in the onions is observed in some cultivars under the excess rainfall condition which could be attributed to damages in the shallow roots system which inhibits minerals intake.

TABLE 1. Pearson correlation coefficient among traits in distinct genotypes under High Humidity and rainfall conditions.

Parameter	RL/SL	BY	TSS	PH	NL	LA	LL
SL/RL	1.000	0.299**	0.201*	0.001*	0.191*	0.176**	0.122*
BY		1.000	0.496**	0.499**	0.660**	0.497**	0.431**
TSS			1.000	0.300**	0.391**	0.291**	0.371**
PH				1.000	0.333**	0.259**	0.300**
NL					1.000	0.450*	0.338*
LA						1.000	0.431*
LL							1.000

Key: *Indicates significance at the 0.05 level of significance; **Indicates significance at the 0.01 level of significance; R:S-Root to Shoot Ratio; BY-Bulb Yield; TSS-Total Soluble Solids; PH-Plant Height; NL-Number of Leaves Per Plant; LA-Leaf Area; LL-Leaf Length.

Table 1 Indicates a significantly positive interaction between yield components analyzed which are the plant height, number of leaves, leaf length, leaf area, and bulb yield. The reduction in the root growth due to excess water in the soil negatively affect bulb yield and consequently the total bulb yield, also observed in the root to shoot ratio as presented in the table. Similar result was obtained by Ghodke et al., (2018), in which it was reported that water logging condition resulted in bulb size and total bulb yield when experienced during bulb initiation.

From the result presented in Table 2., Very low performance was observed from the combined mean square of the yield components parameters studied. This is similar to the observation reported by Ploschuk, et. al., (2017), in a study with Prairie grass (*Bromus catharticus*) in Australia.Table 2. Combined ANOVA (Mean Square) for Yield Parameters Under High Humidity and Rainfall Conditions.

SOV	DF	RS/SL	BY	TSS	PH	NL	LA	LL
Year	1	0.016*	60.17*	3.51*	150.10*	33.11*	261.41**	10.33**
Replication	2	0.001	2.411	0.001	1.001	1.016	4.170	2.611

Environment	1	0.016**	203.16**	69.21**	604.20**	116.41**	801.10**	721.13**
Genotypes	7	0.012**	27.66**	1.913**	97.31**	1.913**	26.17**	20.01**
Year x Environment	1	0.011*	18.02*	3.16*	10.01*	2.067*	1.010*	14.30*
Year x Genotypes	7	0.002*	12.30**	0.601**	25.41**	1.991**	12.17**	27.17**
ENV x Genotypes	7	0.016**	17.30**	0.911**	6.010**	2.170**	11.10**	13.33**
Year x ENV x Genotypes	7	0.005*	2.61*	1.011**	2.910**	1.011**	1.410**	10.10*

Key: * Indicates significance at the 0.05 level of significance; ** Indicates significance at the 0.01 level of significance; DF-Degree of Freedom; R:S-Root to Shoot Ratio; BY-Bulb Yield; TSS-Total Soluble Solids; PH-Plant Height; NL-Number of Leaves Per Plant; LA-Leaf Area; LL-Leaf Length.

Although very low yield was recorded during the experiment as a result of excess water during the crop growth as presented in table 2, it also confirmed that some Onion genotypes are capable of surviving under excessive water stress and high humidity conditions which gives it very good potential for breeding of water-logged resistant onion varieties capable of producing high yield using appropriate genotypes when careful selection breeding is undertaken.

TABLE 3. Percentage Contribution of Various Parameters Seven (7) Distinct Genotypes

Parameter	CONTRIBITION (%)
SL/RL	02.20
BY	08.31
TSS	02.13
PH	05.11
NL	00.10
LA	09.11
LL	04.40

R:S-Root to Shoot Ratio; BY-Bulb Yield; TSS-Total Soluble Solids; PH-Plant Height; NL-Number of Leaves Per Plant; LA-Leaf Area; LL-Leaf Length.

The low bulb yield observed in the study could be due to the low contribution of the various yield components parameters as presented in Table 3. The movement of sugar during photosynthesis was hindered due to the osmotic pressure caused by the excess water in the tissues.

TABLE 4. Estimate of Genetic Parameters For 7 Quantitative Traits of Onion Genotypes.

SOV	GCV	PCV	H	GA	GA%
SL/RL	07.11	07.13	0.61	0.16	20.11
BY	22.51	21.11	0.52	4.51	66.11

TSS	01.50	02.01	0.51	0.51	05.11
PH	03.22	03.61	0.51	2.23	06.61
NL	10.30	11.11	0.56	0.91	23.16
LA	07.13	03.11	0.66	3.12	13.51
LL	0.301	05.41	0.54	2.03	09.11

GCV-Genetic Coefficient of Variance; PCV-Phenotypic Coefficient of Variance; GA- Genetic Advance; H^2-Heritability; R:S-Root to Shoot Ratio; BY-Bulb Yield; TSS-Total Soluble Solids; PH-Plant Height; NL-Number of Leaves Per Plant; LA-Leaf Area; LL-Leaf Length.

The study of genetic component (Table 4) such as heritability, Genetic coefficient of variation and Phenotypic coefficient of variation and Genetic Advances is necessary so as to understand the traits required to achieve successfully high yield under excess water and humidity conditions. Genotypes that are able to withstand these conditions and have better yield can be selected as a parent stock and bases as undertaken in the current study. This is in agreement with Singh et at., (2018), in a similar study using wheat in which stable genotypes were selected for breeding based on the association between the yield and yield contributing traits.

Conclusion

From the results obtained in this study, it can be deduced that some onion genotypes have the ability to grow under high rainfall and excess water condition and that such genotypes have good potential for breeding program on such water-logged environment considering the high tolerance level. Such varieties/genotypes with better survival tendency and yield can be selected for the breeding of resistant varieties. Among the 100 cultivars for the study, the local red LR 10 was observed to be the best in terms of water-logged tolerance and yield while the Ex-Borno 17 is the least tolerant with no bulb yield. Multidimensional breeding of this red cultivar can lead to producing good variety with high yild capable of adopting to the high rainfall pattern of Akwa Ibom State of Nigeria.

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