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RESEARCH ARTICLE

EFFECT OF CLIMATE ON THE GROWTH AND YIELD OF MAIZE CULTIVARS (ZEA MAYS) IN YOLA

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ABSTRACT

The aim of this study was to examine the effect of climate on growth and yield of maize cultivars in greater Yola. To achieve this objectives an experimental farm was establish in teaching and research farm of department of crop production ModibboAdama University of Technology Yola, which is part of the study area and weather station is found adjacent to the farm was used collect the climatic data. The research involved planting three different maize cultivars namely: cultivar 1 (local maize) cultivar 2 (Admiral Maize) and cultivar3 (premier maize) respectively. These maize cultivars were all planted at the same time on the farm on the onset of rainfall in the study area. The experiment was conducted for one growing season (2011). Data were collected on climatic factors, soil characteristics and data on crop agronomy. Climatic data were collected from the meteorological stations of the ModibboAdama University of Technology, Yola, soil data was collected from the farm, while data on crop agronomy were collected from continuous observation of crop growth and yield performance. Data collected were analyzed using simple averages, analysis of variance (ANOVA) and correlation coefficients as statistical analysis .Rainfall and relative humidity has significant correlation with the plant height (0.759), while maximum and minimum temperature showed a significant but negative correlation (0.780^{xx} and -0.913). Stem diameter, leaf length correlates significantly with all the climatic elements.

INTRODUCTION

Climatic variables govern to a large extent the types of crop that may be grown in a green area at a given time. In spite of the recent technological and scientific advances, weather is still the most important variables in agricultural production. Climate change could dramatically affect farming activities (science daily 2009). Apart from the socio-economic problems facing Nigerians farmers, climatic variability constitutes a major limiting factor in crop production. This is so because the bulk of food production in Nigeria is grown as rain fed (Adebayo 2012). As strategies to increase food production are being evolved, there is the need to appraise climate as a resource affecting food production along with other agronomic factors.

There is scarcely any aspect of agriculture in which weather does not play a vital role. Rainfall is undoubtedly the most important climatic variable that has far-reaching influence on agriculture, especially in the tropics. The role rainfall plays in agriculture, includes the supply of moisture to the plant and to the soil, the replenishment of rivers whose water are used for irrigation, and for the recharge of ground water resources which are tapped by human animal and plant consumption. But for different crops the intensity, distribution and incidence of the rainfall and temptation required vary (Adebayo, 2010). Maize has been in the diet of Nigerians for centuries. It started as subsistence crop and has gradually become a commercial crop on which many agro based industries depends for raw materials (Amusa, 2004). Maize is one of the dominant cereal crops used as staple food by the majority of house hold. It remains an important stable food for many communities worldwide (FAO, 2006). The grain is prepared in different way for consumption as food, animals feeds and as a base for industrial product such as oil, syrup, starch etc. the grain may also be fermented to produce beverages and then distilled to provide wine and alcohol (Vossen and Mkamilo, 2006).

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Study Area

Yola is the capital city of Adamawa State found in the North Eastern part of Nigeria. It lies between latitudes 90^0 23^1N and longitudes 12^0 23^1E. it occupies a land area of about 650,017 square kilometers (Gongola Urban Area Designation order 1985 and Yola Topographical Sheet 48/48A, 1974). Yola has tropical wet and dry climate. Dry season last for about seven months (November to May) while, rainy season starts(May-October). The average annual rainfall is put from about 960mm with the highest occurrence in August and September, when intensity assumes over 20% of the annual value (Adebayo 1999, Zemba 2010). Between January and March relative humidity is extremely low (20-30%) in Yola. It starts

increasing as from April and reaches its peak about (80%) in August and September. Temperature in Yola is generally high throughout the year, the seasonal maximum usually occurs in April reaching as high as 43^0c.

The minimum temperature value for the area can be as low as 15^0c between December and January. A record of evaporation in Yola shows that, the minimum value of about 2.5ml occurs in August while the highest value in March (about 15ml). The record, are presented in Table 1.

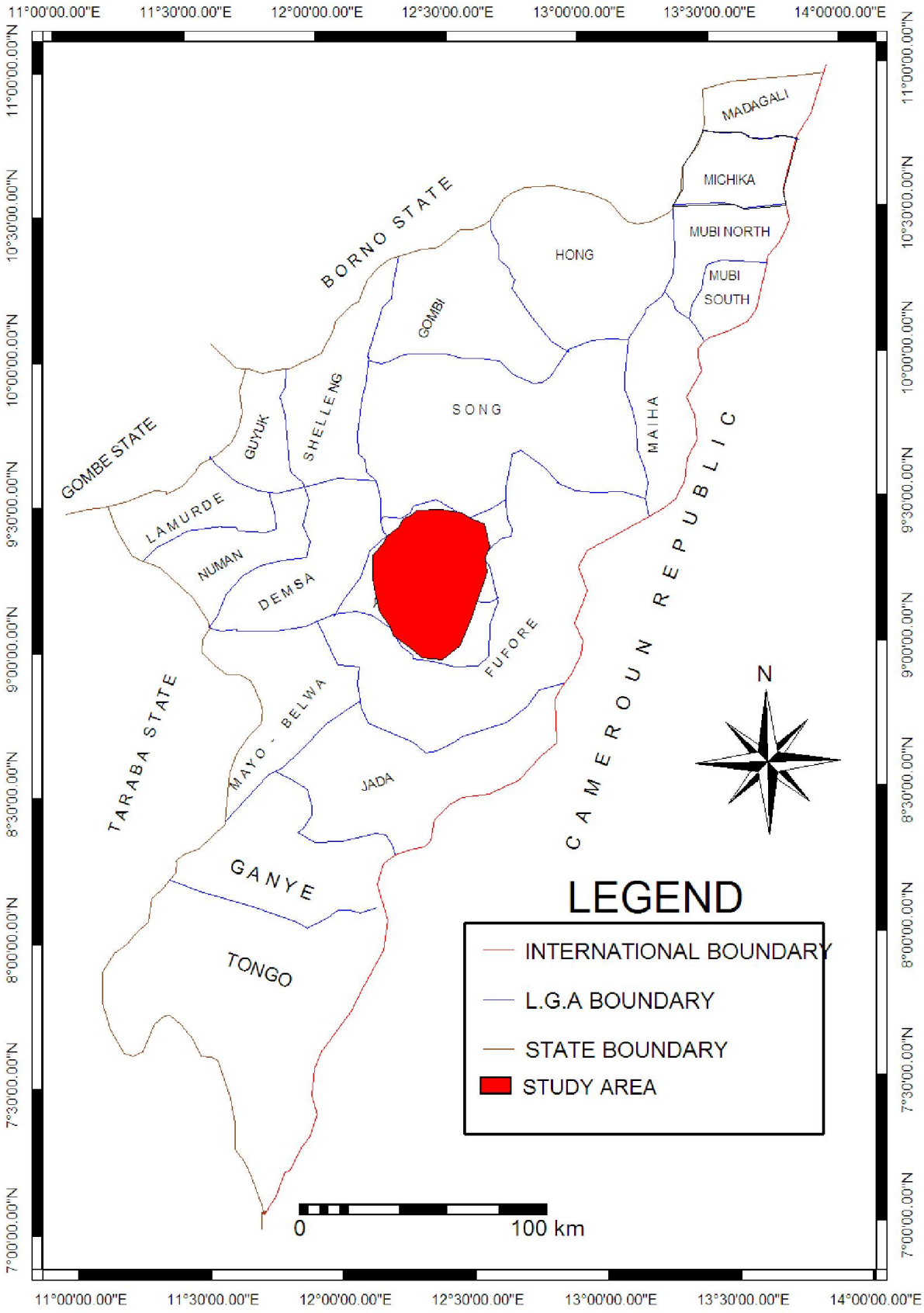

Fig. 1. Map of adamawa showing the study area Source: adamawa in map, 1999

MATERIALS AND METHODS

A field experiment was conducted for 2011 growing season at Yola capital of Adamawa State. The aim of these experiment was experiment was to identify or look at the effect of climate on the growth and yield of three selected maize cultivars in Yola, the maize cultivars used are cultivar one(1), local maize seed cultivar, cultivar two(2), admiral seed and cultivar three(3), premier seed, the selection of the three cultivar is based on the fact that there are the commonly used cultivar of maize in Yola.

Experimental Farm Treatment and Designs

The treatment consists of three maize cultivars. Two hybrids cultivar 1 (Premier Seeds) and cultivar 2 (Admiral Seeds) then cultivar 3 (local variety). The selection of the maize cultivar was based on the fact that, they are the commonly used cultivars in the state as observed by the researcher himself and confirmed by AADP (2007).

The hybrid varieties (Premier Seeds) was obtained from the department of crop production and horticulture, ModibboAdama University of Technology, Yola and the (Admiral Seeds) was obtained from AADP, Yola a recognized government agency responsible for the handling of agricultural seeds in the state, while the local variety was obtained from the local farmers. An experimental farm with a total size of 20 × 20meter square each was laid out in a randomized completely block design (RCBD) method. The three maize cultivars were planted and replicated three times at the same time on the farm with the onset of rain. All inter and intra rows spacing of the crops were at 75cm and 25cm apart respectively, with plant thinned to one or two seedlings per stand. Each main plot and replicates was separatedby 1m pathway between plots. The total number of plots wasnine, which is three times (i.e 3 × 3=9). The field layout is shown in fig (3).

PLOT DESIGN

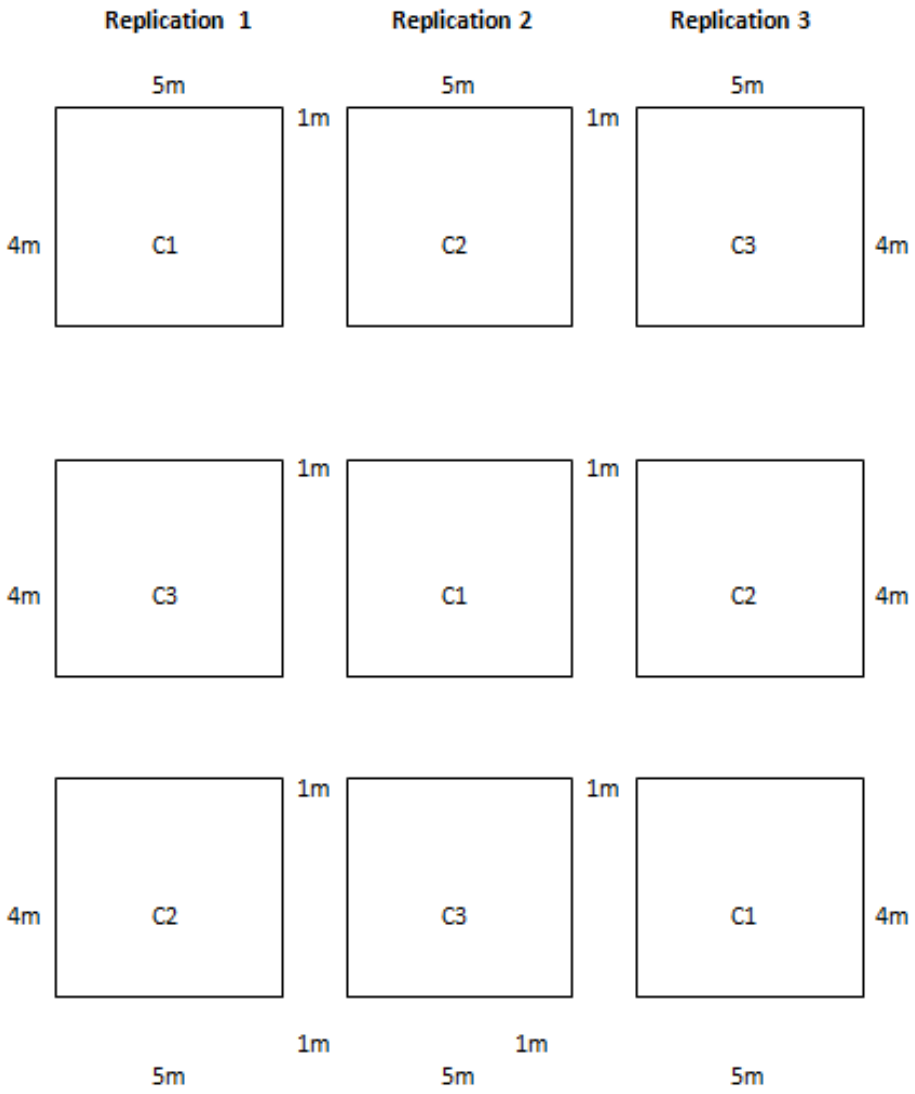

Fig 2:Field layout designed for the experiment involving three cultivars of maize (C1, C2, and C3) arrange in a Randomized Complete Block Design (RCBD) replicated three times

Experimental Farm Management Practices

Uniform cultural farm management practices, were applied to the farm throughout the growing season. Farm was first cleared, ploughed, harrowed and well leveled by tractor in order to get a flat and fine tilts before sowing so as to have easy and uniform seed germination (PROTA, 2009). The local seed cultivar was treated with a chemical (apron plus DS) at the rate of quarter sachet per 1kg of seeds before sowing in order to protect the seed against soil borne diseases. The hybrid seeds were treated with the chemical already. Seeds were sown on a flat and leveled ground after the plots have been demarcated and marked out on the 25th June 2011. Planting commences when the soil moisture and temperature conditions were observed to be suitable for seeds germination the planting was done on the 30th June 2011. Seedlings are thinned or reduced to one or two plants per stand two to three weeks after sowing giving rise to a total number of plants standing ranging from 100-120. Weeding frequently using hand hoe was maintained at time interval of 4,8 and 12 weeks periods after sowing, (in addition to herbicide applied earlier) in order to maintain weed free condition up to harvest on the farm. Fertilizer in the farm of a mixture of N.P, K and urea were used to supply nutrients in two- three equal application at the rate of 10kg, 20kg, and 30kg respectively for the period date of sowing to maturity. Fertilizers were applied manually using hand by the side of the crops about 1.5cm away from crops and not directly on it.

Data Collection

This study used daily weather data and several parameters used in crops, some of these parameters were derived directly from the experimental farm.

Data used and recorded for this study included weather data (Daily maximum and minimum temperatures, total monthly rainfall, relative humidity and sunshine hours) soil data describing the physical and chemical properties of the soil of the experimental farm and crop data relating the genetic response of crops performance on the farm. These data were collected for 2011 growing season. See table one

Soil Data

Soil sample was collected on the farm before the onset of the rains. Soil sample collection procedure involved digging of holes in five different locations on the farm randomly; holes were dug to a depth of 0-20cm and 20 40cm using soil auger. Soil sample collected were therefore analyzed at the laboratory of soil science department of ModibboAdama University of Technology, Yola.

Climatic Data

Daily weather data such as maximum and minimum temperature, monthly rainfall, relative humidity and radiation (sunshine hours) were derived for the period of the growing season from (June-October) and used for this study. These data were collected from meteorological stations of the ModibboAdamaUniversity of Technology, Yola for thefarm located on the school premises.

Statistical Analysis

Statistical analysis such as the use of tables, mean percentages, and correlation analysis was used to summarise the climatic parameters and the yield of maize on different cultivar of maize planted.

Table 1. Result for Soil Sample of the Experimental Farm

pH	OM (%)	TN (%)	Na	K	Ca	P	Mg	EC(mmho/cm)	CEC	Clay (%)	Sand (%)	Silt (%)
0.07	0.58	0.23	0.25	3.50	0.31	4.80	9.15	0.10	11.4	13.5	66.1	20.4

Table 2. Mean Monthly Climatic Elements for 2011

Month	T. max (^{0}C)	T.min (^{0}C)	T.mean (^{0}C)	RF(mm)	R.Hum(%)	SS (hrs)
Jan	39.8	23	31.4	0.0	55.3	4.2
Feb	38	26	32	0.0	60.7	5.7
Mar	40.4	26.6	35.5	0	56.3	8.0
Apr	36.4	28.8	32.6	2.8	54.8	5.3
May	35.4	27.0	31.2	62	74.3	4.8
Jun	32.4	25.1	28.7	59.7	72.6	7.3
Jul	31.5	25	28.5	61.5	78.5	11.6
Aug	28	23.7	25.8	142.3	82.4	7.8
Sep	30	24.4	27.2	79.8	83	4.8
Oct	32.5	25.5	29	28.7	81	6.8
Nov	35.5	22	28.7	0.0	68.5	8.4
Dec	34.5	22.5	28.5	0.0	52	9.1

Table 3. Correlation Coefficients of Climatic Factors with Growth and Yield Parameters of Maize Cultivar

	Plant Height	Stem Diameter	Leaf Length	No of Leaf	Plant Stand Count	COB Diameter	COB Length	Yield
Rainfall	0.759**	0.489	0.469	0.227	0.012	-0.085	0.154	0.012
Max. Temp.	-0.780**	0.785**	0.760**	-0.328	0.035	0.417	0.244	-0.035
Min. Temp.	-0.913	0.827**	0.574*	-0.544*	0.038	0.209	0.269	-0.038
Sunshine Hour	-0.316	0.488	0.781**	0.113	0.037	0.156	0.337	-0.037
Rel. Humidity	0.759**	0.745**	0.781**	0.324	0.038	-0.097	0.296	0.038

Source Field Survey 2011: *Significant at 0.05; **Significant at 0.01

RESULTS AND DISCUSSION

Plant Height

The result of the correlation analysis between plant heights and climactic elements shows that. Rainfall with plant height has a positive significant correlation of (0.759). This indicates that there is adequate rainfall for the plant height. The primary aim of rainfall in most agricultural systems is to recharge the soil profile so that water and nutrients become available to the roots (Sivakumar, 1990). One is quite evident that at twenty 21 days after sowing the amount of rainfall recorded was adequate for plant growth. Rainfall informs of moisture plays a vital role in crop growth and development. It is the medium by which chemicals and nutrients are carried from the soil to the various parts of crops. (PROTA, 2006). Maximum and minimum temperature showed a negative correlation with plant height of (-0.780 and -0913) respectively. This indicates that the temperature was very high and the higher the temperature the slower the rate of growth of a plants, consequently it will affect the height of the plant, and thus poor yield will be recorded.

The optimum temperature for growth and development of maize are 25^0C to 30^0C (Romain, 1985). At 31 days after sowing, it shows that the temperature was above the optimum temperature required for maize growth and this was the period when we recorded a dry spells of 15 days. However, when breaks in-between rains are prolong, plant may wilt and die or have reduced yield (Adebayo, 1994). Relative humidity showed a positive significant correlation with plant height 0.759 significant levels. This indicates that rainfall and relative humidity play a similar role in plant growth both of them showed a significant correlation at p=0.01 confidence level with the plant height. According to Nieuwolt (1978) relative humidity is an attribute of the human environment most generally recognized by its important role in determinant of plant growth. At 51days, 61days, 71 days, 81days and91days respectively, there was high amount of relative humidity saturated in the atmosphere this signify the positive correlation exhibit between it and the parameters of growth.

Stem Diameter

The correlation results shows that maximum temperature has a significant positive correlation with the stem diameter of (0.785 and 0.827) respectively at p=0.01 confident level. This shows that at this period of time the temperature was normal for the growth of the plant, At 51 days, 61 days, 71 days, 81 days and 91 days respectively this days after sowing shows that the temperature range is between 22^0C to 30^0C (Romance, 1985) and this is the optimum temperature range required for maize growth and yield. All crops have minimal optimal and maximal temperatures limits for each of their stage of growth and development. Also from the table, relative humidity with stem diameter shows a significant positive correlation at (0.759) confident level. This indicates that relative humidity at this period of time is adequate and was favorable for the plant growth and this will support the stem diameter and the bigger the stem diameter the better the yield is expected. There is a close relationship between rainfall and humidity since both are inform of moisture which plays a vital role in crop growth and development. Moisture is the medium by which chemicals and nutrients are carried from the soil to various parts of crops (Montheith 1990).

Leaf Length

Leaf length with almost all the climate elements shows a significant correlation. Maximum and Minimum temperature was significant of (0.766 and 0.57) respectively with the leaf length this shows that at this period of time the temperature was adequate and within the range of maize growth as observed from appendix one. Sunshine hours with leaf length showed a significant correlation at (0.781) 0.01% confident level. This indicates that the solar energy received at this period was optimum for the leaf and the growth of the maize. Indeed solar radiation aid in proper growth of a plant. Plant growth and development depends on several features of radiant energy is the principal determinant of photosynthesis rates and therefore biomass accumulation (Montheith 1981).The result for correlation analysis of leaf length with relative humidity showed a significant correlation at (0.759) at p=0.01% significant level. This indicates that relative humidity plays a vital role in leaf length of the plant by providing adequate moisture to the plant. Relative humidity is one of the climate elements which determine the potential evapotranspiration of crops. The longer the length of the leaf, the better the vegetative growth of the crop, the better the yield of the crop (Montheith and Elston 1993).

Number of Leaf

Minimum temperature correlation significant with the number of leaf of (0.574) this shows that the higher the temperature the ranges the lower the yield the number of leaf interacts positively with rainfall sunshine hour and relative humidity. Number of leaf per plant indicate how effectively and well established a crop is no farm (Romain, 2001).

Plant Stand Count

Plant Stand Count interacts well with all the climatic elements; however, there was no significant correlation between the plant stand counts with the climatic elements. The essence of determining plant stand count of each crop is to obtain a uniform plant stand count .to obtain a high yield a uniform crop stand is very important, as the telling capacity of maize is limited (PROTA 2006).

Cob Diameter

The interaction between cob diameter and the climatic element in table 4.1, shows that correlation analysis result has no significant relationship with any of the climatic elements.

Cob Length

Also from the table, the cob length result of correlation analysis shows no significant relationship with all the climatic elements. However, the longer the cob length the better the yield of a plant (Abubakar, 2011).

Yield

The yield performance with the climatic factors shows a negative correlation with both maximum and minimum temperature and sunshine hours.This indicates that high temperature reduced yield as recorded from the experimental farm land observed by the researcher and confirmed by (Abubakar, 2011)

Conclusion

The major conclusion drawn from this study is that climatic factors such as temperature and sunshine has effect on the growth and yield of maize cultivars while rainfall and relative humidity indicate a positive response to the growth and yield of the maize cultivars. Most of the Climatic elements interact significantly with plants height, stem diameter, leaf length and number of leaf respectively while, temperature shows significant negative correlation with the plant height. Yield correlated negatively with almost all the climatic elements this shows the low yield recorded during the harvest while the soil condition and variability in climate also affected the maize performance despite the fertilizer applied to the crops. It is also noted from the study that there is variation interms of their performance on the growth and yield of the three cultivars of maize grown in the study area with each of the cultivar, showing not much difference in terms of their yield performance. However, from the result of analysis of variance discussed in this research work among the three cultivar of maize harvested, maize cultivar two (admiral variety) shows a better performance in terms of growth and yield follow by maize cultivar one (localvariety).

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