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Morphological Characteristics of Maize (Zea Mays) Along Altitudinal Gradient in Obudu Plateau, Cross River State, Nigeria

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Abstract: From all indications, there seem to be a very high level of interrelationship between plant growth and the altitude of any particular place. The objective of this study was to examine the relationship between the morphological characteristics of maize and the altitude where it was cultivated. Five grains of maize were planted on each of the altitudinal heights of 100m, 600m and 1200m above sea level. The height of the altitude was measured using the geographical positioning system. On growth, the maize stands were labelled A –E for the purpose of identification and monitoring in each of the altitudinal heights. The heights, size of stem and size of maize cobs were measured with tape, while the number of tarsals, leaves and cobs were counted for each maize stand. The morphological characteristics of maize were used to correlate with the altitude of the area where the maize were planted. The pearson product movement correlation analysis was used to test the hypothesis. At 0.05 level of significance the result indicated a negative correlation between the height, size, number of tarsals, number of leaves, number of cobs and sizes of cobs of maize and the height of the altitude. In other words, as the height of the altitude increases, the morphological characteristic of maize decreases.

Keywords: Morphology, zea mays, altitude, gradient

Introduction

The inseparable interconnections between plant species and the environment cannot be overemphasized. A plant species can not exist without a governing environmental mechanism that controls it from planting to the maturity stage. It is futile to argue whether genetic or environmental factors control the morphology and development of a plant. Both always together determine the nature of the phenotype. Environmental factor such as altitude, climate and soil, being generally visible and readily accessible, are the most obvious and it is natural that most ecologists have been pre-occupied with this study (Barnes, 1997).

Many plant species occupy a considerable portion of the climatic gradient and often differ dramatically in form from one elevation to another (Molles, 1999). For a given physiographic region or specific landform, altitude above sea level is important when the climate associated with it becomes a limiting factor to plant establishment and growth. Altitude is a very rough indicator of climatic factors affecting plants. Climatic factors at a given altitude are dependent essentially on latitude and other physiographic elements (aspect and slope percent) that may have an equal or greater importance than altitude (Dallard, J., Noel, P., Gouesnard, B. and Boyat, A. (2000).

Nevertheless, altitude of a site at a known latitude is often a useful indicator of plant performance when details of specific climatic factors are not known (Chapman and Reiss, 1995). Altitude can cause large temperature variations over short distances. Temperature always goes with altitude, but the rate of decrease, the lapse rate is far from uniform (Lauteensaeh and Bogel, 1956). It not only varies with cloudiness, and therefore, in many areas with the seasons, and between day and night, but also depends on the prevailing topography of the highlands.

The relative significance of highland areas generally and the tropics in particular depend largely on two functions: they bring relief from the oppressive heat of the tropical lowlands and they offer special agricultural possibilities in a region of otherwise rather uniform temperature conditions. Highland stations based primarily on the first function exist in many parts of Nigeria. Some good examples are Obudu Plateau (1576m above sea level), Jos (1850masl) and Gembu (1620m asl).

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The agricultural possibilities of the tropical highlands are caused by the different temperature conditions at various levels: the optimum temperatures for many crops or other forms of agriculture can easily be found by choosing the correct altitude (Doebley, John, 1994). In essence, altitude regulates the performance of crops. This is because of its close relationship with temperature. They both play a very dominant role in not only their physical characteristics but their productivity as well. It is on this basis that this study was undertaken in the mountainous region of Obudu

Study Area

Obudu is one of the 18 Local Government Areas in Cross River State. It was created in 1976. It is located at the Northern extremity of the state closely bordered by Benue in the North, Boki in the South, Obanliku in the East and Bekwarra and Ogoja in the West. It has a population of about 161,475 (NPC, 2006). It is basically a mountainous region with the highest peak of over 1500 metres in Okorshe, Ubong-Bette and Ukpe/Ubang.

Generally, Obudu has a montane climate because of its altitudinal location. Annual temperature ranges between 15^0C - 30^0C and there is pronounced seasonality (stormy, cloudy, wet summers and dry winters). This low temperature provides a soothing condition for the inhabitants of the area. Obudu experiences orographic rainfall. Mountains form barriers over which air flows rises and cools adiabatically to the due point and condensation occurs causing orographic precipitation on the windward slope. Rainfall values of between 1500 – 2000mm are recorded in this area. The dominant winds are the north-east trade winds, which usher in dry stable air that causes harmattan from November to March and the south-west monsoon winds that bring warm unstable air from the coast from April to October. Humidity here is very high usually above 80% in the rainy season and below 40% in the dry season. The area is occupied by savanna vegetation. This is so because of the combined effect of bush burning and shifting cultivation, which has degraded the original forest vegetation, making it a derived savanna. Common tree species found here include mahogamy, Iroko and locust bean tree. These trees provide excellent wood for building. However, there is the existence of gallery forest straddling the length and breath of most rivers such as Abeb, Aya, Echin and Achiribobo.

The major occupation of the people of the area is farming. The inhabitants cultivate crops such as yam, cassava, maize, cocoyam, plantain, beans, pepper and tomatoes. These crops are used for local consumption and a little for sale.

Origin and Environmental Requirements of maize

Maize (Zea Mays L, Poaceae) is the most essential cereal in the world after wheat and rice with regard to cultivation areas and total production. The name maize is derived from the South American Indian Arawale – Carib word Maliz. It is also known as Indian corn in America. Maize is known to have originated in Central America, Guatemala and Columbia. The early Spanish explorers took maize from Mexico to Europe. It later spread to North Africa, East and West Africa (including Nigeria) and into Asia in the 16^{th} Century. Maize is currently grown in the tropics and warm temperate zones of the world.

In Nigeria, maize is known and called by different vernacular names depending on locality like 'Agbado', 'Igbado' or 'Yanyan' (Yoruba); 'Masara' or 'Dawar masara' (Hausa); 'Ogbado' or 'Oka' (Ibo); 'Apapa' (Ibira); 'Oka' (Bini and Isha); 'Ibokpot' or 'Ibokpot union' (Efik) 'Igumapa' (Yala) "Ikwula" (Utukwang), Ikwuru (Bekwara) and "Egwu" (Ukelle). There are many varieties of maize planted in Nigeria. They include flint, Dent, Semi-flint, floury, sweet and pop corn.

Maize grows well on well drained, aerated and deeply sandy loam, silt loam or clay-loam soils, which are rich in organic matter and plant nutrients, with PH of 6 to 7 as optimum. Maize requires a lot of heat during its vegetative period. At germination, it requires a minimum temperature of 20^0 C. It requires abundant rainfall of between 600 and 7400mm per annum distributed evenly during the planting period. The growing period requires much rainfall than the tarseling period. Maize matures between 75 – 85 days after planting.

Objectives

(i) To examine the morphological characteristic of maize in the study area

(ii) To determine the nature of the relationship between altitude and the morphological characteristic of maize

Hypothesis

H_o: there is no significant relationship between altitude and the morphological characteristics of maize

H_1: There is significant relationship between altitude and the morphological characteristics of maize.

Methods

Obudu Plateau is noted for the cultivation of great varieties of food crops in which maize is chief among them. A particular mountain range that runs in an East-west direction in the village of Ukwutia was used for this study. The Geographical Positioning

System was used to determine the height of the altitude. Three farms located in the upper, middle and lower altitudes were chosen for this research. It should be noted that in this place, farmers cultivate up to the peak of the mountain. Five heaps or mounds in each farm located in the altitude were chosen for the study. The mounds were planted with 5 grains of sweet maize variety in April, which is the planting season. They were closely monitored during the 75 days of their maturity. Each of the 5 stems of maize in each altitude was marked A – E for the purpose of identification. The height and sizes of stems were measured in centimeters. The numbers of tarsals, leaves and cobs per stand of maize were counted. The Pearson Product Moment Correlation was used to test for the relationship between altitude and the morphological characteristics of maize. It has the form:

$$r = \frac{\frac{1}{10}\sum(x - \bar{x})(y - \acute{Y})}{(\sqrt{x})(\sqrt{y})}$$

Where r = correlation coefficient
Y = altitude
X = morphological characteristics of maize (height, size of stem, number of tarsals, number of leaves, number of cobs and sizes of cobs)
√ = standard deviation

DATA PRESENTATION AND DISCUSSION OF FINDINGS

Table 1 indicates the morphological characteristics of maize that were considered in this study. They include the height of stem, size of stem, number of tarsals, number of leaves, number of cobs per stand and the size of cobs. The 5 maize plants were labelled A - E for the purpose of identification in each altitude. The measurements of the height and size of stem as well as the size of cobs and the counting of tarsals, leaves and cobs were done on individual maize stand in the lower, middle and upper altitude as presented in table 1. The result shows a remarkable variation of maize stand in the morphological characteristics of maize from the lower to upper altitude. With respect to the height, the least height was 170cm (stand B) in the upper altitude and the highest height was 200cm (stand D) in the lower altitude. Maize stand E in the upper altitude had the lowest stem (6cm) size, while the highest were stands C, D and E in the lower altitude (11cm each). Maize stand A in the upper altitude had the lowest number of tarsals (6), while stand E in the lower altitude had the highest number of tarsals (22). The number of leaves per maize stand also varies among altitude and maize stand. Stand E in the lower altitude had 10 number of leaves (the lowest), while the highest number of leaves stand was stand D in the lower altitude. The number of cobs ranges between 1 in the upper altitude to 3 in the lower altitude except for stand C which had 2 numbers of cobs. The sizes of cobs had stand A in the upper altitude as the lowest (8cm), while stand D in the lower altitude had the highest cob size of 23cm.

Table 1: Morphological characteristics of maize

Altitude	maize stand identification	Heights of stem (cm)	Size of stem (cm)	No. of tarsals	No.of leaves	No.of cobs per stand	Size of cobs (cm)
Upper slope 1200m (asl)	A	180	8	16	12	1	8
	B	170	8	18	12	1	10
	C	171	7	18	11	1	12
	D	181	7	20	11	1	13
	E	172	6	21	10	1	14
Middle slope 600m (asl)	A	184	8	18	14	2	16
	B	188	9	22	12	2	18
	C	180	9	19	12	2	15
	D	183	8	20	14	2	16
	E	185	9	18	12	2	15
Lower slope 100m (asl)	A	180	10	18	14	3	22
	B	186	10	20	12	3	18
	C	193	11	20	14	2	18
	D	200	11	21	16	3	23
	E	190	11	19	12	3	20

Source: Author's Field Survey, 2013

As seen in table 2, the average height of maize varies between 190cm in the lower altitude to 176cm in the upper altitude. The size of stem varies between 11cm in the lower altitude through 9cm in the middle altitude to 7cm in the upper altitude. The average numbers of tarsals per maize stand also vary between

20 in the lower altitude to 19 in the middle and upper altitude. The number of leaves per stand also shows a remarkable variation between 14 in the lower altitude through 12 in the middle altitude to 11 in the upper altitude. The average number of cobs per maize stand in the study sites ranges between 3 in the lower altitude to 1 in the upper altitude. Finally, the sizes of maize cobs also vary in the study area from 20cm in the lower altitude to 11 cm in the upper altitude.

It should be noted that since temperature is greatly tied to elevation, owing to the lapse rate principle, this may seem to have profound influence on the morphological characteristics of maize in the area as evident in the height of stem, sizes of stem, number of tarsals, number of leaves, number of cobs per stand and the size of cobs per maize stand which tend to decrease in magnitude with increasing height.

Table 2: Average values of morphological characteristics of maize

Altitudinal height	Height of maize	Size of stem	No. of tarsals	No. of leaves	No. of cobs	Size of cobs
Upper altitude 1200m	176	7	19	11	1	11
Middle altitude 600m	180	9	19	12	2	16
Lower altitude 100m	190	11	20	14	3	20

Source: Author's Field Survey, 2013.

As seen in table 3, there was a negative correlation between the height of altitude in the study area and all the morphological characteristics of maize. The height of altitude correlated with height of stem at -0.39 correlation coefficient, size of stem at -0.30, number of tarsals at -0.28, number of leaves at -0.23, number of cobs per stand at -0.25 and size of cobs at -0.38. In otherwords, as the slope increases in height, the height of stem, size of stem, number of tarsals, number of leaves, number of cobs per stand and the size of cob of maize decreases.

Also, altitude explains 15% of the variation in height of stem, 9% of size of stem, 28% of the number of tarsals, 5% of the number of leaves, 6% of the number of cobs and 14% of the sizes of cobs of maize. The remaining percentages of 85% of height of stem, 91% of the size of stem, 72% of the number of tarsals, 95% of the number of leaves, 94% of the number of cobs and 86% of the sizes of cobs of maize were unexplained. And this unexplained variation in the morphological characteristics of maize may be attributed to soil condition, rainfall slope aspect and cloud cover.

Table 3: Result of Correlation analyses of height of altitude with morphological characteristic of maize

Morphological characteristics of maize	Correlation coefficient	Coefficient of determination
Height of stem	-0.39	15
Size of stem	-0.30	9
Number of tarsals	-0.28	28
Number of leaves	-0.23	5
Number of cobs per stand	-0.25	6
Size of cobs	-0.38	14

Conclusions

The height and shape of the land can play a very significant role in the growth and development of crops. Even very small changes in altitude can be very important throughout the various stages of crop growth and maturity. One of the variables that work closely with altitude to cause changes in crops growth and development is temperature. Temperature decreases with increasing altitude and this scenario goes a long way to affect crops growth and productivity. Most crops grow with certain temperature ranges so that as the height of the altitude becomes increasingly high and the temperature decreases, it ultimately becomes very vulnerable for them to thrive to full capacity. This may explain the reason for stunded growth. This stem and low level of cob formation as seen with maize plant in this study area. This therefore calls for an investigation into the right altitudinal location that is most suitable for the growth of crops like maize in order to guarantee full capacity both in structural formation and productivity.

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