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Effect of Variation in Soil Texture on the Vegetative and Pod Characteristics of Okra (*Abelmoschus esculentus* (L.) Moench

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Abstract: The effect of variation in soil texture on the vegetative and pod characteristics of NH47-4 variety of okra (*Abelmoschus esculentus* (L.) Moench was investigated in the screen house of the Department of Crop, Soil and Pest Management, Federal University of Technology, Akure, Nigeria. Three seeds of the NH47-4 okra variety were sown in each of four soil types which fall under the following textural classes: sandy-clay loam, sandy loam, clay loam and loam. The experimental design adopted is the completely randomized design in which each treatment was replicated five times. Seedlings were thinned to one plant hill per stand three weeks after sowing. Growing plants were adequately watered at an interval of three days. At the stage of flower production, the leaf length, leaf width, plant height, length of leaf stalk and tap root length were measured with a tape graduated in centimeters. Stem thickness was measured with vennier caliper and the number of leaves per stand was counted. Pods were harvested at full maturity and the pod length was measured using a tape graduated in centimeters. Pod thickness was measured with vennier caliper and the number of seeds per pod was counted. Pod weight and seed weight were taken using a weighing balance. Data pooled were subjected to analysis of variance (ANOVA) and means separated using the Least Significant Difference (LSD). All the 12 characters investigated were found to vary according to the texture of the soil.

Key words: Variation, soil texture, characteristics, okra

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench), an important vegetable crop throughout the tropics and sub tropics (Kochhar, 1986) is believed to have its origin in tropical Africa. Though cross-pollination is frequently mentioned in the literature, owing to its floral structure and absence of self-incompatibility, okra produces much of its progeny through selfing. The extent of out crossing ranges from 0-60% and varies according to the variety, the cropping season and the location (Chandra and Bhatnaggar, 1975; Martin, 1983; Tanda, 1985). Okra is an annual crop with numerous cultivars that vary in time of maturity, leaf colour, stem length, fruit shape and other characters. In West Africa, okra is usually interplanted with major food crops like yam, cassava and maize. However, a few farmers in the urban towns plant it as a sole crop (Tindal, 1983). A wide range of soil types give economic yield, but well drained, fertile soils with adequate organic materials and reserves of the major elements give the best yield. The problems of poor germination, limited number of seeds, pest attacks and other damages to the plant have been the most disturbing factors in trials establishment. Germination is sometimes erratic, especially for seeds that are recently harvested. According to Messiaen (1994), okra seeds are normally stored in a cool, dry place and soaked in water for 24 h before sowing in order to hasten the process of germination. Seeds germinate only in warm soils with temperature ranging between 20 and 30°C.

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Okra is used chiefly as a fresh vegetable. The pods are boiled whole or sliced crosswise or diagonally before cooking or frying (FAO, 1968). In the western part of Nigeria, the slices, if not eaten immediately, are sun-dried for a few days to prevent fungal and bacterial attack. The sun-dried slices, now referred to as Orunla is kept in a cool, dry and well aerated place until when needed. When cooked fresh at its edible stage, the tender pod contains about 88 mL water, 2.1 g protein, 0.2 g fat, 8 g carbohydrate, 36 calories, 1.7 g fibre, 175 mg minerals and 232.72 mg vitamins in 100 g of edible portion. Young and tender okra leaves are also eaten by man. The edible leaf contains about 1ml water, 4.4 g protein, 0.6 g fat, 11g carbohydrate, 56 calories, 2.1 g fibre, 602.7 mg minerals and 447.25 mg vitamins per 100 g (FAO, 1968). In Nigeria, the people of the Yoruba tribe use okra fruit to treat intestinal ulcer and haemorrhoids. The sticky liquid of the fruit (mucilage) is most likely to be the characteristic that plays an active medicinal role in this respect.

Ecology, according to Abercrombie *et al*. (1973), is the study of the relations of organisms, particularly of animal and plant communities, to their animate and inanimate surroundings. Many research findings have shown that the size of the vegetative parts of plants vary according to ecological factors. Obermeyer (1962), Hanid (1974) and Marais and Reilly (1978) all reported the influences of ecological factors on the morphological characteristics of the species of *Anthericum* L. and *Chlorophytum* Ker-Gawl. Ngwa (1979) noted that the confused state of the taxonomy of the two plant species was attributed to their quick morphological responses to ecological factors. Akinyele and Oyewole (2002) also highlighted the effects of ecological factors on the morphology and distribution of the Nigerian representativives of *Aloe* Linn. In their investigation, Cornelissen and Tersteege (1989) found that the distribution of epiphytic bryophytes and lichens in dry evergreen forest of Guyana is greatly influenced by ecological factors. The three West African species of *Albuca* L., associated with three distinct ecological areas, namely the savannah, the montane and the sudan vegetation zones, have been found to migrate into West Africa from an ancestry of *Albuca* in an ancestral area, most probably in southern Africa (Oyewole, 1971). The foregoing have, no doubt, shown that morphological characteristics of plants are greatly influenced by ecological factors.

Research studies carried out on okra so far have focused majorly on its genetics, its yield, characterization of its various accessions and the effects of environmental factors on its growth and development where climatic factors have been given considerable prominence. Very little attention has been paid to the effect of edaphic factors on the morphology of okra but even then, the influence of soil texture on its vegetative and pod characteristics has not been addressed. The aim of this research, therefore, is to investigate, biometrically, the effect of soil texture on the vegetative and pod characteristics of okra.

Materials and Methods

The seeds of NH47-4 (early maturing) variety of okra used in this investigation were collected from the National Institute of Horticultural Research and Training, Ibadan, Nigeria. Four soil types collected from different locations were subjected to particle size analysis according to the method of Daym (1967). A small sample of each soil type was later subjected to some routine laboratory analyses. The pH of a soil type was determined by pouring 2 mL of distilled water into a McCartney bottle already containing 10 g of air-dried soil sample. The set-up was stirred and allowed to stand for 30 min with occasional stirring. Reading was then taken using the pH meter. Total soil Nitrogen was determined by micro-kjeldahl method and organic matter according to the method of Walkley and Black (1934). Exchangeable Potassium was first extracted with neutral 1 M Ammonium acetate and determined according to the method of AOAC (1970). Available Phosphorus was determined according to the method of Bray and Kurtz (1945).

Three seeds of okra were planted in a 6 L plastic bucket already filled with soil. Each soil type was replicated five times, making a total of 20 buckets. The experiment was carried out in the screen-house of the Department of Crop, Soil and Pest Management, Federal University of Technology, Akure, Nigeria, using the Completely Randomized Design (CRD). Three weeks after planting, the number of seedling per bucket was thinned to one. Throughout the period of experimentation, the growing okra plants were watered adequately. At the stage of flower production, the leaf length, leaf width, plant height, length of leaf stalk and tap root length were measured with a tape graduated in centimeters. Stem thickness was measured with vennier caliper and the number of leaves per stand was counted. Pods were harvested at full maturity and the pod length was measured with a tape graduated in centimeters. Pod thickness was measured with vennier caliper and the number of seeds per pod was counted. Pod weight and seed weight were taken using a weighing balance. Data pooled were subjected to Analysis of Variance (ANOVA) and means separated using the Least Significant Difference (LSD).

Results and Discussion

The four soil types analyzed fall under the following textural classes: sandy-clay loam, sandy loam, clay loam and loam. Results of the various soil analyses are presented in Table 1 and 2, while the results of analyses of data collected from seven vegetative and five pod characters of okra are presented in Table 3 and 4, respectively.

The moisture characteristics of the soil such as permeability, infiltration rate and water holding capacity are of great importance in agriculture. Also of importance are the plant nutrient supplies in the forms readily available to plants (Wynne and Marlowe, 1980). The extent of mineralization of Nitrogen from soil organic matter and the amount of other nutrients in the soil available for plant

Table 1: Soil particle size analysis

Soil types	% Sand (0.02-2 mm)	% Silt (0.002-0.02 mm)	% Clay (<0.002 mm)	Textural classes
A	52	27	21	Sandy-clay loam
B	60	30	10	Sandy loam
C	34	15	51	Clay loam
D	40	40	20	Loam

Table 2: Analysis of soil chemical properties

Soil types	pH	Organic carbon (%)	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Sandy-clay loam	6.70	0.36	0.05	2.60	0.26
Sandy loam	6.60	1.07	0.06	2.50	0.20
Clay loam	6.72	1.08	0.04	2.00	0.23
Loam	6.89	1.13	0.07	3.80	0.30

Table 3: Measurements of okra vegetative characters

Soil types	Leaf length (cm)	Leaf width (cm)	Plant height (cm)	No. of leaves/ plant	Length of leaf stalk (cm)	Stem thickness (cm)	Tap root length (cm)
Means							
A (Sandy-clay loam)	10.00	8.00	13.50	5.50	6.00	1.50	15.00
B (Sandy clay)	17.80	24.00	35.60	6.00	9.83	2.00	26.00
C (Clay loam)	22.50	30.30	34.00	7.60	11.00	2.50	32.00
D (Loam)	25.00	35.33	42.00	8.00	15.00	3.20	30.00
LSD (0.05)	2.62	4.01	8.40	1.07	1.73	1.04	4.22
Mean difference							
1 and 2	7.80	16.00	22.10	0.50*	3.83	0.50*	11.00
1 and 3	12.50	22.30	20.50	2.10	5.00	1.00*	17.00
1 and 4	15.00	27.33	28.50	2.50	9.00	1.20	15.00
2 and 3	4.70	6.30	1.60*	1.60	1.17*	0.50*	6.00
2 and 4	7.20	11.33	6.40*	2.00	5.17	1.20	4.00*
3 and 4	2.50*	5.03	8.00*	0.40*	4.00	0.70*	2.00*

*Mean difference not significant

Table 4: Measurements of okra pod characters

Soil types	Pod weight (g)	No. of seeds/pod	Seed weight (g)	Pod length (cm)	Pod thickness (cm)
Means					
A (Sandy-clay loam)	10.00	35.00	2.93	3.00	8.00
B (Sandy loam)	11.40	47.80	3.60	6.00	10.00
C (Clay loam)	20.90	47.00	3.60	4.00	10.86
D (Loam)	12.70	49.00	4.00	9.00	10.90
LSD (0.05)	1.95	2.63	0.21	1.15	0.96
Mean difference					
1 and 2	1.40*	12.80	0.67	3.00	2.00
1 and 3	10.90	12.00	0.67	1.00*	2.86
1 and 4	2.70*	14.00	1.07	6.00	2.90
2 and 3	9.50	0.80*	0.00*	2.00	0.86*
2 and 4	1.30*	1.20*	0.40*	3.00	0.90*
3 and 4	8.20	2.00*	0.40*	5.00	0.04*

*Mean difference not significant

uptake are greatly dependent on the amount of water available in the soil. According to Wiersum (1982), the availability of soil nitrogen to plant, under similar environmental conditions, usually increases as the texture becomes finer. Woodruff (1980) also observed that the supply of water to plants is usually greater in soil of moderately fine texture than in soil of coarse texture in a humid environment. It follows, therefore, that the success or failure of crop production is, to a large extent, dependent on the texture of the soil. Water is retained by soils as film which coats the surfaces of the particles; as wedges held in the angles between grains and as moisture imbibed by colloids. In fine-textured soils, there are aggregate surfaces to accommodate films, more angles to hold water and more colloidal material to imbibe moisture. Consequently, more water can be held per unit volume of soil in fine-textured soil than in coarse-textured soil. These reasons, no doubt, account for the large sizes observed in the characters sampled from okra plants grown in sandy loam, clay loam and loam soil types. It is also observed that the performance of the okra plants is best in the loam soil. This may be due to the presence of adequate organic materials which is characteristic of loam soil.

The poor performance observed in the okra plants grown in sandy-clay loam soil may also be attributed to the limited amount of organic materials in the soil. The environment of an organism is the sum total of the external conditions which affect the growth and development of that organism (Allard, 1960). In its broadest sense, Hudson (1960) sees the environment as including both the soil factors and the climatic factors. In wholly artificial environments, it is possible to bring all external factors under control. This infers that the effect of the variation of any one factor or any group of factors can be studied while the other ones are kept constant (Heywood, 1970). In this study, the okra plants were raised in the screen-house to provide common environmental factors except for the soil which varies mainly in the texture. To study the effect of the environment, Wellensick (1960) opined that any effects of variation in the genetic constitution of the organism under investigation must, first of all, be excluded. This has been taken care of by using pure lines of NH47-4 variety of okra.

Altogether, 12 characters were investigated in this study and it is observed that all the characters are affected by the soil type. According to Abercrombie *et al*. (1973), it is possible for plants to have the same genotype but different phenotypes owing to environmentally-produced variation. This, as earlier argued, may account for the significant differences observed in all the characters investigated. The extent of variation in such characters depends on the phenotypic plasticity, which varies from one plant species to the other (Heywood, 1970). After consideration of all information provided by data amassed in the course of this study, there is sufficient evidence to conclude, as earlier observed, that the vegetative and pod characteristics of okra are greatly influenced by the soil texture. Hence, the heritability of all the characters considered in this study is most likely to be low.

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