Effects of Soil Moisture Content and Soil Fertility Amendments on Growth and Yield of Okra Plant (Abelmoschus esculentum (L) moench) in Southern Guinea Savanna Agro-Ecological Zone of Nigeria.

A.M Kwajaffa
Department of Agricultural Science Education,
School of Vocational Education, Federal College of Education (Tech) P.M.B 1013,
Potiskum, Yobe State Nigeria.

Peter Isa
Department of Agricultural Science Education,
School of Vocational Education, State College of Education P.M.B 2
Gashua Yobe State Nigeria.

A.A Olusola
95A, Ayobami Quarters, Oke-Omiru,
Ilesa, Osun State.

***Abstract*- Nhae-40 variety of Okra was evaluated in pot experiment to determined the effects of soil moisture content and soil fertility amendments on growth and yield of Okra plant (abelmoschus esculentum (L) moench) in Southern Guinea Savanna agro-ecological zone of Nigeria. The study was conducted at the pavilion in the orchard yard of horticultural unit, Department of agronomy, Faculty of Agricultural University of Ilorin, Kwara State of Nigeria. Seeds were sown in plastic containers at four (4) moisture levels 25, 50, 75 and 100% field capacities (Fe) which were determined gravimetrically and five(5) levels of soil fertility amendments consisting of different combinations of poultry manure and inorganic manures (N.P.K) at ratios equivalent to 0:0, 100:0, 0:100, 50:50 and 75:25. The experimental design used was 4x5 factorial design in split plot arrangements with four replications. The soil moisture content levels constituted the main plot while the soil fertility amendments constituted the sub plots. Data were collected during growth and harvest stages, and experiment the parameters used were: V13 number of leaves per plant, leaf area per plant, plant height number of flowers per plant and number of fresh fruit length, fresh fruit diameter number of seeds per plant, fresh fruit weight and seed viability. The data collected were subjected to analysis of variance (ANOVA) ($P \leq \alpha 0.05$) in almost all the parameters tested in this study. The interaction effects of soil fertility amendments at the five different levels indicated that there were increases in all the parameters measured in this study. Consequently the significant differences obtained in both soil moisture contents and soil fertility amendments of all the rations have confirmed both soil moisture contents and soil fertility amendments have effects on growth and yield of Okra plant (abelmoschus esculentum (L)moench) in Nigeria.**

I. Introduction

Okra plant *(abelmoschus esculentum (L)moench)*is a valuable crop which provides an excellent income generations to small scale farmers in Nigeria. Indeed it is one of the most important vegetable crop cultivated in almost all parts of the country covering and estimated land area of 1.2 million hectares. FMAWARD (1989). The plant is tolerant to drought stress where supplementary irrigation may be necessary during the extended dry period for satisfactory production. In Nigeria the crop is consumed either fresh or in dried forms and considered as perfect villagers vegetable in dietary fibres and protein as well as lysine and tryptophan amino acids Fatokun and Chedda (1983).

Algeria is the largest producer of Okra in the world approximately 1,039,000 tonnes is produced annually, followed by Cote D'voire, Ghana and others FAO (2008). Okra seed flour could be use to fortify or supplement cereal flour over along time in countries like Egypt for Making better quality dough Adelakun et al (2008). Soil fertility amendments are very important determinants for seed germination, growth and yield developments of Okra because yield performance is highly determined by the availability of soil moisture contents at field capacity during growth and development periods of the crop. Okra plant is also highly sensitive to water stress, therefore shortage of soil moisture content in the soil can lead to drastic floral abortion and subsequent reduction in yield of the crops Tindall (1983).

Reports from researchers in different soil fertility trails showed that Okra plant responses very well to fertilizer because the minerals avoid the organic elements present in the fertilizer play very important role the development of growth and yield of the crop NIHORT (1982). The National Institute of Horticultural Research reported that nutrients requirements of 78kg of N/ha-1, 67kg of p/ha-1 and 45kg of k/ha-1 are adequate for growth and yield where other environmental factors such as weed control, water requirements, pests and diseases control are effective Sulton (1963). In another report trials on responses of Okra plant to nitrogen fertilizer stated that about 20kg of N/ha has significant increase in the yield in

the first harvest, while the yield of the next five harvest ranged from significantly increased by increasing in the rates of fertilizer from 26kg of N/ha-1-78kg of N/ha-1.

However it was observed that 80kg of N/ha-1 and 40kg of N/ha-1 gave a substantial increase in yield of 323.06% and 16.02% over zero nitrogen plots in terms of number of fruits. The greatest yield of 9.5 tones/ha-1 was obtained from plots to which 60kg of N/ha-1 were applied compared to the unfertilized plots in the first harvest by 4-6 days. The importance soil fertility amendments in improving crop performance has been well known Gallager and McSorley (1995), although soil fertility amendments have not been consistent. Manures are best used as soil fertility amendments because of their varing degree of nutrient contents. For instance as the manure aged leached and composed the nutrient content reduces. Any additional amount of soil fertility amendments can attenciates the degradation process of inorganic matter because fresh materials are easily affected by microorganism that died Shiralipour et al (1992).

II. Materials and Methods

Seeds of Nhae-40 Okra variety was used for this study to determine the effects of soil moisture contents and soil fertility amendments growth and yield of Okra plant *(abelmoschus esculentum (L) moench)*. The study was conducted at the pavilion, horticultural unit, Department of Agronomy, Faculty of Agriculture, University of Ilorin Kwara State Nigeria, in southern Guinea Savanna Agro-Ecological Zone of Nigeria, lat $8^0 29^N$ and long $4^0 35E$ between January to May 2012. The average annual perspiration of the area is 1250-1500mm, with temperature ranging from 19^0c and 33^0c and dry periods of seven (7) months usually from November through May of the following season.

The study was conducted during the dry season using supplementary irrigation to ensure adequate supply of moisture throughout the period of the study. The experimental design used was 4x5 factorial experiment in split plot arrangements with four (4) replications. The soil moisture content with low levels constituted the main plots while the soil fertility amendments constituted the sub-plots. The soil moisture levels used were 25, 50, 75 and 100% percent field capacities (FC) while the soil fertility amendments used were organic matter (poultry manure) and NPK at ratios of 0:0, 100:0, 0:100, 50:50 and 75:25kg respectively. Eighty (80) plastic containers of twelve (12) litre capacities were used and laid in 4x5 factorial split-plot arrangements before filled up with five (5) kilogram (kg) of top soil collected from the field adjacent to the parvilion and sieved to remove pebbles, stones and debris. The containers were then irrigated thereafter four (4) seeds were planted at a depth of three (3) centimeters and covered with soil.

The four (4) soil moisture content levels 25, 50, 75 and 100% percent field capacities were determined gravimetrically according to Krammer (1983), which were maintained throughout the period of the study. The soil fertility amendments consisting of organic matter (poultry manure) and NPK. The organic manure (poultry manure) was subjected to laboratory test to determined nitrogen content before incorporated in to the soil two (2) weeks prior to planting at different levels, while the NPK fertilizer was applied side by side replacement and covered with the soil. All agronomic practices were duely carried out through the period of the study. Two (2) plants were randomly selected as a representative samples from each treatment on which data were collected and maintained throughout the period of the study. One of the plant was used to collect data on dry matter, while other was used to collect data on fresh matter and weed control was done manually by hand picking/pulling at regular intervals of three (3) weeks to keep the plant weed free.

Data were collected between two-seven (2-7) weeks after planting (WAP) on plant growth and yield parameters Viz: number of leaves per plant, plant height and leaf area, while the yield parameters included number of flowers per plant, number of aborted flowers per plant, number of fresh fruits per plant, fruit length, fresh fruit diameter and fresh fruit weight respectively. The data collected were thereafter subjected to analysis of variance (ANOVA) using split split-plot model by "**Genstat Discovery for Statistical Package"** and pertinent means were separated using Least Significance Difference *($P \leq \alpha\ 0.05$)* according to Steel and Torrie (1980). Interaction effects between soil moisture content and soil fertility amendments were also determined.

III. Results

Table 1: Effects of soil moisture content and soil amendments on plant height on Okra plant is presented in table 1: below. The results showed that there were significant differences on both soil moisture content soil moisture content and soil fertility amendments was significant only at six (6) and seven (7) weeks after planting while soil fertility amendment was significant throughout the period of growth. Thus soil moisture content is effective only at 6 and 7 weeks after planting, while soil fertility amendments was effective in respect to plant height throughout the period of growth of the plant. The highest plant height was obtained with application of 75%:25% poultry manure and NPK followed by the application of 100% poultry manure only.

TABLE I. Effects of Soil Moisture Content and Soil Fertility Amendment on Plant Height in Okra Plant (Ilorin 2012).

Treatments	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP
Percentages (%) of soil moisture contents						
25	7.96	8,82	11.40	16.77	21.14	22.95
50	7.74	8.88	11.67	17.31	22.19	25.14 b

75	6.87	7.92	10.99	20.22	26.52	30.93
100	7.00	7.99	11.80	20.89	30.43	34.04
S.E.D	0.535	0.671	0.895	1.558	1.88a	2.185
Percentage (%) of soul fertility amendments						
Control (zero app)	6.346	6.99c	8.96c	15.45 c	23.24c	26.59 b
100% poultry manure	8.58a	10.19 a	13.97 a	21.91 a	29.03d	32.27 a
100% N.P.K	5.93c	6.57c	8.69c	13.92 c	17.80d	19.78c
50% pm + 50% NPK	8.19a	9.21b	12.62 b	20.60 a	26.17b	29.52 a
75%pm + 25% NPK	7.93a	9.18b	13.08 a	22.12 a	29.1a	33.19 a
S.E.D	0.379	0.495	0.782	1.554	1.456	1.689
L.S.D (0.05)	0.763	0.998	1.576	2.726	2.932	3.401

Table 2: effects of soil moisture content and soil fertility amendments on leaf production in Okra plant is presented in table 2 below. The results showed that there were significant differences in soil moisture content at almost all the periods of growth of the plant except at three weeks after planting (3WAP), while there were significant differences at all the periods of growth of the plant in respect to soil fertility amendments on leaf production. Generally as the number of leaves continue to developed and increased per plant the levels of soil moisture content was also increasing up to hundred percent (100%) from three weeks after planting (3WAP).

TABLE II. EFFECTS OF SOIL MOISTURE CONTENT AND SOIL FERTILITY AMENDMENTS ON LEAF PRODUCTION IN OKRA PLANT ILORIN 2012

Treatments	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP
Percentages % of soil moisture content						
25	5.19	5.9	5.3c	6.0d	7.2d	10.6c
50	5.1a	6.0	5.6c	5.2cd	7.6cd	12.06
75	4.70b	6.4	7.0b	7.6b	9.0b	12.1b
100	4.5b	6.3	8.9a	9.6a	10.1ab	14.5a
S.E.D	0.11	0.23	0.36	0.38	0.51	0.54
Percentage % soil fertility amendments						
Control (zero appl)	4.3	5.41	5.7	6.8	7.4	10.0
100% poultry manure	5.5a	6.90	7.3b	7.6a	8.5a	10.7c
100% N.P.K	4.4d	5.6c	6.9b	7.06	8.4b	11.8bc
50% PM+ 50% NPK	5.0b	6.6ab	7.2a	7.6ab	8.8a	14.16 a
75% PM + 50% NPK	4.8c	6.2b	7.0a	7.8a	9.4a	14.9a
S.E.D	0.185	0.264	0.301	0.40	0.56	1.07
L.S.D D α0.05	0.37	0.53	0.61	0.81	1.13	2.15

Note: means flowed by same letter(s) is//are insignificant at ($P \leq 0.05$)

Table 3: Effects of soil moisture content and soil fertility amendment on leaf area on Okra plant is presented in table 3 below: The results showed that there were significant differences in both soil moisture content and soil fertility amendments in respect to leaf are at all stages of growth of the plant and at all levels of applications throughout the period of the study. The lead area measured showed an increase in increasing percentages of soil moisture content and soil fertility amendments. The highest leaf area was obtained at hundred percent (100%) soil moisture content with seventy five percent

poultry manure and twenty five percent NPK (75%pm + 25% NPK) while the lowest leaf area was obtained at zero level of application of soil fertility amendments respectively.

TABLE III. EFFECTS OF SOIL MOISTURE CONTENT AND SOIL FERTILITY AMENDMENT ON LEAF AREA ON OKRA PLANT ILORIN 2014.

Treatments percentage % soil moisture content	3 WAP	5 WAP	7 WAP
25	406c	746c	963d
50	473bc	836c	1050c
75	503b	883b	1182a
100	649a	1090a	1437b
S.E.D	50.7	71.1	53.3
L.S.D σ0.05	114.6	1160.8	120.5
Soil fertility amendments			
Control	238c	469c	643c
100% PM	541b	979a	1235b
100% NPK	569a	962b	1305a
50% PM+50 NPK	536b	947a	1216b
75%PM+25%NPK	655a	1087a	1391a
S.E.D	53,4	93.2	100.0
L.S.D *σ0.05*	107.5	187.8	201.5

Table 4: Effects of soil moisture content and soil fertility amendments on flowering and fruit on Okra plant is presented in table 4 below: The results showed that there significant differences in number of flowers and fruits developed per plant at different periods Viz: number of days to first flowering (DFFL), number of days to fifty percent (50%) flowering, (D50%FL) number of days to first fruiting (DFFRT) and percentage aborted flower (PAFL) were significant at all soil moisture content levels due to the fact soil moisture content and soil fertility amendments have effects on flowering fruiting in Okra plant. It was observed that the date to first flowering (DFFL) was linearly decreasing as a result of increasing in soil moisture content levels. The shortest date to flowering was achieved with the application of 50% PM + 50% NPK soil fertility amendments while lowest percentage of aborted flower was achieved with application of 100% NPK. The date to first fruiting and the highest number of flowers developed per plant were recorded with the application of 75% PM + 35% NPK of soil fertility amendments respectively.

TABLE IV. EFFECTS OF SOIL MOISTURE CONTENT AND SOIL FERTILITY AMENDMENTS ON FLOWERING AND FRUIT ON OKRA PLANT ILORIN 2014.

Treatments percentage % soil moisture content	DFFL	D50FL	NFL	PAFL	DFFRT
25	38.55	42.80	2.55d	18.1	40.40
50	38.00	42.35	2.85c	18.2	40.05
75	37.35	40.42	3.60b	12.0	39.30
100	37.00	40.03	4.65a	13.3	38.70
S.E.D	0.905	0.681	0.221	4.57	0.978
L.S.D σ0.05	75	75	0.501	Ns	ns
Percentage of soil fertility amendment					
Control	39.25a	42.0a	3.25a	22.4	41.2a
100% PM	37.88ab	42.6a	3.56a	16.4	39.62a
100% NPK	38.62	40.2b	3.44ab	11.1	40.50a
50% PM+50%NPK	36.69b	39.9b	3.39ab	15.3	38.50bc

75%PM+25%NPK	36.25b	42.1a	3.62a	11.9	37.94c
S.E.D	0.971	0.787	0.353	4.92	1.002
L.S.D σ0.05	1.953	1.588	0.710	Ns	2.014

Table 5: Effects of soil moisture content and soil fertility amendments on yield and yield components in Okra plant is presented in table 5 below: The results revealed that there were significant differences in the characters measured Viz: fresh fruit weight (FFWT), fruit length (FL), fruit dry weight (FDWT) and percentage seed viability (PSV), while fruit diameter (FD) and number of seeds per plant (NSP) were significant in respect of soil moisture contents while soil fertility amendments were significant for almost all the characters studied except for fruit diameter. The result also showed that number of fresh fruit weight number of viable seed, fruit length, dry fruit weight and percentage seed viability were at increase with increasing levels of soil fertility amendments, while fruit diameter showed a quadratic response at a peak of 50% soil moisture content. The highest value for number of fruits, fruit length, viable seed, fresh fruit weight and dry fruit weight were obtained at 75%PM + 25% NPK of soil fertility amendments. So also the highest value for number of viable seeds per plant was obtained at 50% PM + 50% NPK and the highest value for fruit diameter was obtained at 100% NPK respectively.

TABLE V. EFFECTS OF SOIL MOISTURE CONTENT AND SOIL FERTILITY AMENDMENTS ON YIELD AND YIELD COMPONENTS IN OKRA PLANT (ILORIN 2012).

Treatments percentage soil moisture content	FRTN	FFWT(g)	FDRWT(g)	FDIA(cm)	NOSD	PVIAB	FL
25	3c	29.4c	4.16b	7.3	48	65.5c	6.1c
50	2c	35.0bc	4.33b	7.9	50	75.4b	6.8
75	4d	60.7a	7.29a	7.9	51	76.76	8.0a
100	5a	73.5a	8.95a	7.9	52	85.8a	8.6a
S.E.D	0.2484	7.82	0.906	0.307	2.442	3.02	0.262
LSD σ0.05	0.6442	20.09	2.330	ns	Ns	6.80	0.592
Percentage fertility amendments							
Control	1d	36.2c	5.10s	6.3	466	71.0d	6.9c
100% PM	3b	49.9c	5.59c	7.7	520	75.36c	7.9a
100% NPK	2c	52.66	6.41b	8.3	47b	75.5bc	7.5b
50%PM+50% NPK	2c	45.2d	5.21cd	7.6	55a	74.2cd	7.8a
75%PM+25% NPK	4a	65.1a	8.70a	7.3	50b	23.3a	8.1a
S.E.D	0.2605	1.485	0.331	0.374	2.115	3.85	0.32o
L.S.D	0.5254	2.995	0.558	ns	4.26	7.76	0.644

Note figure with some letter(s) is/are significant at (P<0.05)

IV. Discussions

Many aspects of growth and yield are known to have been affected by soil moisture contents and soil fertility amendments. Results from this study revealed that plant height in Okra plant is highly influenced by soil moisture contents at different levels. It was observed that there was reduction in plant height at 25% and 50% levels of soil moisture contents as compared to 75% and 100% levels of soil moisture contents, which were in consonance with the reports of Moss and Downey (1971) who stated that reduction in plant height is highly associated with water stress. Similarly Bayer (1970) confirmed that increase the rate of leaf senescences, (leaf shedding) and reduction in leaf area have been attributed to occurrences of water stress and low level of soil moisture contents.

The high rates of flower abortion observed in this study were due to influences of moisture contents and soil fertility amendments which is in line with the study of Aderolu (2000) who reported that there were large percentages of floral abortion and for open flowers in cowpea as a result of low levels of soil moisture contents and soil fertility amendments. However, the high values obtained for number of fresh fruit, fresh fruit weight, fresh fruit weight, fruit dry weight and percentage seed viability obtained with the application of soil fertility amendments at 75% PM+25% NPK is in accordance of the report by Ahmad (2002) on inheritance of qualitative characters in Okra plant and confirmed that flowering and fruiting stages are the most sensitive stages of yield development that are influenced by soil moisture contents and soil fertility amendments, while the interaction effects observed has been very critical because of soil moisture content and soil fertility amendments jointly influenced the growth and yield of the plant studied.

V. Conclusion

The results obtained from this study revealed that Okra plant can extremely do well and can utilize the best available soil moisture contents at 75% and 100% field capacities (FC) for optimal growth and yield, while soil fertility amendments at 75% PM + 25% NPK has been found to be superior for growth and development of flowering, marketable fruits, fresh fruit weights and fruit dry weight. Hence soil moisture contents and soil fertility amendments have joint effects on growth and yield in Okra Production in Nigeria.

References

[1] Aboyomi (1992) comparative effects of water stress on wheat and sugar beet. Ph.D thesis university of water, Bangor U.K.

[2] Aderolu A.M (2000). The Effect of water stress of different growth stages on yield and seed quality of cowpea varieties.

[3] Ahmad S. (2002) Inherence is some characters in Okra under drought Cenditancs Ph.D Thesis Sinah Agriculture University.

[4] Boyer J.S (1970) Leaf enlargement and metabolic rates in corn, soya bean, and sunflower at various leaf water potentials. Plant physiology 46: 236-239.

[5] F. A. O. (2008) food and agriculture organization; corporate documents repository optimizing soil moisture for plant production Pp. 131-142.

[6] Fatokun C.A and Cheddar H.B (1983). The effect of N and P on yield and chemical composition of Okra, pepper presented at the 6th African H.O symposium Ibadan Nigeria.

[7] FMDRRD (1989) fertilizer use and management practices for crop in Nigeria, serves No 2, W-O Enwezor et al (eds). Fertilizer procurement and distributed division. Fed Min of Agriculture Water resources and Rural Development Lagos.

[8] Mc Sarly and Gallahar J. (1995b). The integrated use of organic and chemical fertilizer. SFCAAS (eds) proceedings of international symposium on balanced fertilization Chinese agric press Pp-390-396.

[9] Moss G. I. and L. D. Dawney (1971). Influence of drought stress on female genotype development of corn and subsequent grain yield. Crop Sc: 11: 368-372.

[10] Shiralipour M.S (1995) Residual effect of organic manure P and zypsm application in proceeding groundnut on soil fertility and productivity Indian J. Agron 47: 487-494.

[11] Steel, R.G.D and J.H Torrie (1980). Principles and procedures of statistics. A biometrical approach 3nd Ed. McGraw-Hill book coy: 633 pp.

[12] Sulton P. (1963). The effect of N.P.K on yield of Okra production. Florida State, Hort Sci 79: 146-149.

[13] Tundal, aH.D (1983). Commercial vegetable growing Oxford tropical hard books Oxford University Press Ibadan.