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Full Length Research Paper

Growth and yield response of okra (*Abelmoschus esulentus* (L.)Moench) to NPK fertilizer rates and weed interference in South-eastern Nigeria

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ABSTRACT

Field studies were carried out at the Federal University of Technology, Owerri, Nigeria to determine the response of okra (*Abelmoschus esculentus* (L.)Moench) to NPK fertilizer rates at different weeding regimes. Okra seeds variety, NHAe47-4 were treated to four levels of NPK fertilizer rates (0,100,200 and 300 kgha^{-1}) and five weeding regimes (weedy check, unweeded till 5 weeks after sowing (WAS), weeding once each at 3 WAS and 4 WAS and weed free). The treatment combinations were laid out in a randomized complete block design with three replications. Plant height and leaf area were in the increasing order of 0>100>200>300 kgha^{-1}. More flowers/plant were obtained by applying 300kgha^{-1} of NPK while the least number of flowers/plant aborted was obtained with the application of 200 and 300 kgha^{-1} in both years. Among the weeded plots, okra plots applied with 300kgha^{-1} of NPK fertilizer produced the highest fruit yield (26.50t ha^{-1} in 2007 and 24.34t ha^{-1} in 2008) which were not significantly different with the application of 200kgha^{-1} of NPK fertilizer in both years. Interaction effect between NPK rates and weeding regime was significant (P=5%). Better weed control was achieved by applying 300kgha^{-1} of NPK fertilizer, 85.15 and 84.95% in 2007 and 2008 respectively comparable with those applied with 200kg ha^{-1} of NPK fertilizer and the weed free plots. This study has therefore shown that applying 200kgha^{-1} to okra weeded at 3 WAS is beneficial in this zone.

Keywords: NHAe47-4, NPK fertilizer, South-Eastern Nigeria, weed interference, weed control efficiency, fruit yield.

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is a member of the malvaceae family and is an indigenous crop of Africa cultivated widely in West and Central Africa for its immature fruits used as vegetable (Irvine, 1979; Purseglove, 1984). According to Schippers (2000) it can be found in almost every market all over Africa. The nutritional composition of okra includes calcium, protein, oil and carbohydrates, iron, magnesium and phosphorus (Omotoso and Shittu, 2007) Okra seeds contain approximately 21% protein, 14% lipids and 5% ash (Saveilo *et al* 1980). They also reported that removal of the hulls by grinding and shifting produced a meal with 33% protein, 25% lipids and 6% ash. Most of okra is eaten in cooked or processed form and the young fruits may be eaten raw. Akinfasoye and Nwanguma (2005) noted that the oil in the seed could be as high as in poultry eggs and soybean.

In Nigeria the limiting factors in okra production and other vegetables among others include weed management, fertile soils, tillage practices, low yielding varieties and sub-optimal planting density (Adejonwo *et al.,* 1989; Burnside, 1993; Dikwahal *et al.* 2006; Adeyemi *et al*., 2008; Iyagba *et al*., 2012). Fertilizer application among the various agronomic practices also influenced the growth and green pod yield in okra. Babatola (2006) recorded an increased yield in okra due to NPK fertilizer application. Recommended rates of NPK fertilization for okra vary greatly depending on the variety and environment. While Windham (1966) recommended between 27 and 54 kg ha^{-1} of N for ‘Clemson Spineless’ okra variety depending on the soil type, Majanbu *et al*. (1985) recommended either 35 or 70 kg ha^{-1} of N depending on the variety. According to Kolawole *et al* (2008), application of 30 + 15 + 15 kg ha^{-1} to Clemson Spineless influenced the highest fruit yield, Jokoso 60 + 30 + 30 kg NPK ha^{-1} and Sologo 60 + 30 + 90kg NPK ha^{-1} will be adequate. Several authors have also reported differential responses to fertilizer application for various okra varieties (Blennerhassett and El-Zaftawi, 1986; Rani *et al*, 1989; Khan *et al*., 2002). Omotoso and Shittu (2007) reported that NPK fertilizer application significantly increased growth parameters (plant height, leaf area, root length, number of leaves), yield and yield components with optimum yield of okra at 150 NPK $kgha^{-1}$ in South Western Nigeria.

Also NPK fertilizer doses have been reported to cause significant effect on days to germination, fruit weight, fruit volume, number of fruits per vine, vine length and yield of bottle gourd in Pakistan (Jan *et al*, 2000). Despite increase in okra production due to fertilizer application, the problem of weed interference still persists. Excessive weed growth is one of the most serious factors affecting the performance of crops generally and vegetables in particular.

In India, Singh *et al*. (1981) noted 76.5% loss in okra seed yield in unweeded plots while in Nigeria Adejonwo *et al*., (1989) recorded that uncontrolled weed growth throughout the life cycle reduced okra fruit yield between 88 and 90% compared with those kept weed free throughout the growth period.

This study was therefore carried out to determine the response of okra to different rates of NPK fertilizer application at various periods of weed interference.

MATERIALS AND METHODS

Two field experiments in May 2007 and 2008 were conducted at the Federal University of Technology Teaching and Research Farm, Owerri, Nigeria situated between latitudes 5^0 20’N and 5^0 27’N and between Longitudes 7^0E and $7^0$07’E. The area has a bimodal rainfall with annual mean rainfall of 240 and 137mm in 2007 and 2008 respectively. There are two seasons: the wet season from April to October and dry season from November to March with a characteristic of cold dry dust laden wind interval (harmattan) during the months of January to February.

Soil sample was collected before planting, oven dried, ground and sieved through 2mm sieve and the sand, silt and clay contents were determined by the Bouyoucos method (1951). The soil pH was determined using the pH-metre in a 1:2.5 soil/water ratio, total Nitrogen content was by micro-kjedahl method (Jackson, 1962) total phosphorus was by Bray 1 method (Bray and Kurtz, 1945). Calcium (Ca) and Magnesium (Mg) were determined by the Atomic Absorption Spectrophotometer (AAS) and potassium (K) and sodium (Na) by flame emission photometry. The organic carbon was according to Walkey and Black (1934) and the present organic matter was estimated by multiplying the percent organic carbon with a factor of 1.724. The soil has the following characteristics; pH (in H_20) 5.0, organic carbon 1.29%, total N 0.24%; extractable P 4.94mg kg^{-1}, extractable K 0.11, Ca 1.62 and Mg 0.59 in cmol Kg^{-1}. Soil particle distribution was sand 47%, clay 31% and silt 22%. The soil was classified as sandy ultisol (Ibe, 2005). The soils have low mineral reserves and are therefore of low fertility. Climatic data was obtained from the University Meteorological Unit. The land was ploughed and harrowed with the aid of tractor mounted impliments in both years. The okra seeds (variety NHAe47-4) used for the experiment were obtained from the National Horticultural Research Institute (NIHORT) at Mbato, Okigwe, Nigeria.

The seeds were treated with *Pereomie pellucid*a leaf powder at 30g per 100 seeds as recommended by Ibe *et al*. (1988). Three seeds per hole were planted on the flat with a spacing of 0.6mx0.3m between and within the rows respectively and later thinned to one plant per stand. Commercial formulation of NPK fertilizer was applied at the rate of 0, 100, 200, and 300 $kgha^{-1}$. There were five weeding regimes: weedy check, regular weeding up to 5 weeks after sowing (WAS), weeding once at 3 WAS, weeding once at 4 WAS and weed free. Treatments were arranged in split-plot design with NPK fertilizer rates as main plot factor and weeding regime as sub-plot factor with three replications giving a total of 60 plots. Fertilizer was applied at 2 WAS. Chemical spraying with cypermetricin was carried out to check the incidence of insect pests that affect the leaves of okra plant.

Growth and yield parameters determined were plant height, leaf area, number of flowers produced and aborted, fresh fruit yields, weed density, weed dry weight and weed control efficiency. Weed density was measured by a 1 x 1m quadrat thrown at random and the weed species indentified within the quadrat and counted. Weed control efficiency was calculated based on the method suggested by Bhattacharya and Mandal (1988) as follows:

$$\frac{\text{Dry Weed Weight (DWT) of unchecked control} - \text{DWT of Treatment}}{\text{DWT of unweeded Control}} \times 100$$

The data collected were subjected to analysis of variance (ANOVA) and means compared using the Duncan Multiple Range Test (DMRT) at a probability of 5% according to Gomez and Gomez (1984).

Table 1. Effect of NPK fertilizer rates ($kgha^{-1}$) and weed interference duration on okra growth and yield parameters in 2007

Treatment	Plant height at harvest (cm/plant)	leaf area/ plant (cm^2)	no. of flower formed/plant	no. of flowers aborted/plant	fresh fruit wt/plant (g)	fruit yield (tha^{-1})
NPK rates ($kgha^{-1}$)						
0	15.7c[2]	14.5c	6.3c	3.2a	4.61c	3.54c
100	43.66a	26.4b	10.6b	3.4a	18.34b	17.35b
200	59.5b	32.9a	12.6a	2.1b	28.12a	25.74a
300	60.2a	33.2a	12.8a	2.1b	28.74a	26.56a
Mean	44.8	26.8	10.5	2.7	19.95	18.30
SE(+)	11.9	4.9	1.9	0.3	6.5	6.2
Weed interference duration						
Weedy check	28.5c	16.1d	6.5c	3.5a	3.37c	2.76c
Weed infested for 3 WAS[1]	56.4b	33.9a	10.6b	2.8b	18.76a	16.54a
Weed infested for 4 WAS	33.2bc	29.4b	8.7bc	3.0a	13.98b	12.32b
Weed free until 5 WAS	42.6b	24.7c	6.9c	3.3a	12.42b	10.14b
Weed free until harvest	63.7a	35.4a	12.6a	2.6b	20.16a	18.68a
Mean	44.9	27.9	9.1	3.0	13.74	12.09
SE(+)	7.4	3.9	1.2	0.6	3.3	3.1

[1]Weeks after sowing [2]values followed by the same letter (s) in a column are not significantly different at 5% level using DMRT

RESULT AND DISCUSSION

Soil characteristics

The result indicated that total N and available P content were very low on a range of 10-12 mg Kg^{-1} (Adeoye and Agboola, 1985) for soils of South Western Nigeria (FMANR, 1990). Also the result obtained showed that exchangeable K was low using the critical levels 0.16 – 0.20 Cmol kg^{-1} as indicated by Agboola and Obigbesan (1974).

Growth Parameters

The results from Tables 1 and 2 showed significant ($P<0.05$) response to different rates of NPK fertilizer application and weed interference duration in 2007 and 2008. Okra plants receiving 300$Kgha^{-1}$ were taller and produced more flowers than those with lower fertilizer application in both years. This is as a result of the higher nitrogen content which induced higher plant height, more leaves and larger leaf area. This agrees with the findings of Babatola *et al*. (2002) and Kolawole *et al* (2008) who reported that increasing the rate of NPK fertilizer led to increase in growth parameters of okra. The tallest plants (60.2 and 59.3cm in 2007 and 2008 respectively) and greater leaf area (33.2 and 32.1 cm^2 in 2007 and 2008 respectively) were produced by the plants that received 300$Kgha^{-1}$ of NPK. Weed interference duration significantly affected okra growth parameters. The shortest plants, smallest leaf size and number of flowers were produced from the unweeded okra plots.

Plant height from the unweeded plots were not significantly different from plots weeded at 4 WAS while leaf area was not significantly different from plots weeded at 3 WAS and the weed free plots in both years. This reveals that weed interference beyond 3 WAS had an adverse effect on these growth parameters. The result also showed that in both years keeping weeds beyond 3 WAS in okra plots caused a higher flower abortion. This is capable of reducing fruit formation and consequently lower fruit yield. This is in line with the findings of other workers that most crops have certain range of tolerance to weed competition and length of period in which they are required to be weed free (Adejonwo *et al*., 1989; Ayeni and Oyekan 1992; Dada and Fayinminnu, 2007; Iyagba *et al*., 2012). It is a known fact that weed interference with crops more than necessary has always led to yield reduction in crops.

Fruit yield

The fruit yield parameters of okra were significantly influenced by the various rates of NPK fertilizer application in 2007 and 2008 (Tables 1 and 2). Application of 300 $kgha^{-1}$ of NPK fertilizer produced

Table 2. Effect of NPK fertilizer rates ($kgha^{-1}$) and weed interference duration on okra growth and yield parameters in 2008

Treatment	Plant height at harvest (cm/plant)	leaf area/ plant (cm^2)	no. of flower formed/plant	no. of flowers aborted/plant	fresh fruit wt/plant (g)	fruit yield (tha^{-1})
NPK rate ($kgha^{-1}$)						
0	14.3c[2]	13.6c	6.0b	3.1a	3.89c	3.20a
100	40.9b	25.3b	10.2a	3.2a	16.42b	16.61b
200	58.6a	31.4a	11.2a	2.0b	26.64a	22.98a
300	59.3a	32.1a	11.9a	2.1b	26.89a	24.34a
Mean	43.3	25.6	9.8	2.6	18.46	16.78
SE(+)	12.2	5.2	2.8	0.9	6.28	11.20
Weed interference duration						
Weedy check	26.8d	15.8c	6.2c	3.2a	3.04c	2.41d
Weed infested for 3 WAS[1]	55.3b	31.4a	9.4b	2.4b	17.49a	15.30a
Weed infested for 4 WAS	31.6d	27.8b	7.9bc	2.9a	12.86b	11.67b
Weed free until 5 WAS	40.7c	23.6b	6.3c	3.2a	11.79b	8.81c
Weed free until harvest	62.1a	34.0a	11.8a	2.4b	18.54a	17.94a
Mean	43.30	26.5	8.8	2.8	12.74	11.23
SE(+)	7.6	3.6	1.2	0.5	3.08	3.02

[1]Weeks after sowing [2]values followed by the same letter (s) in a column are not significantly different at 5% level using DMRT

Table 3. Cumulative weed flora composition of the experimental site in 2007 and 2008

Weed types	Plant family	Growth form	Degree of occurrence
Amaranthus spinosus	Amaranthaceae	ABL	XX
Celosia loxa	Amaranthaceae	ABL	XX
Ageratum conyzoides	Asteraceae	ABL	XX
Aspilia africana	Asteraceae	PBL	XX
Chromoleana odorata	Asteraceae	PBL	XXX
Tridax procumbens	Asteraceae	ABL	XX
Commelina benghalensis	Commelinaceae	PSB	XX
Conmelina diffusa	Commelinaceae	PSB	XX
Cyperus rotundus	Cyperaceae	PS	XXX
Cyperus tuberosus	Cyperaceae	PS	XX
Euphorbia heterophyila	Euphorbiaceae	ABL	XXX
Phyllantus amarus	Euphorbiaceae	ABL	XX
Mimosa pudica	Leguminosae	PBL	X
Sida acuta	Malvaceae	PBL	X
Boerhavia diffusa	Nyctaginaceae	PBL	XX
Axonopus compressus	Poaceae	PG	XXX
Cynodon dactylon	Poaceae	PG	X
Eleusine indica	Poaceae	AG	XX
Eragrostis atrovirens	Poaceae	PG	XX
Paspalum conjugatum	Poaceae	PG	XX
Panicum maximum	Poaceae	PG	X
Sporobalus pyramadalis	Poaceae	PG	XX
Talinum triangulare	Portulacaceae	PBL	XX
Diodia scandiens	Rubiaceae	PBL	X
Mitracarpus villosus	Rubiaceae	ABL	XX
Physalis angulata	Solanaceae	ABL	X
Laportea aestuans	Urticaceae	ABL	XX
Starchytopheta cayenensis	Verbenanceae	PBL	XX

ABL= Annual Broad Leaf, PBL = Perennial Broadleaf, PSP = Perennial Spiderwort, PG = Perennial Grass,
PG = Perennial Grass, PS = Perennial Sedges, AG= Annual Grass, X = Low weed occurrence,
XX = Medium weed occurrence, XXX = High weed occurrence

Table 4. Effect of NPK fertilizer rates (Kgha^{-1}) and weed interference duration on weed dry weight, weed density and Weed control efficiency in 2007 and 2008

Treatments:	**Weed dry weight (kgha^{-1})**		**Weed density (no/m^2)**		**Weed control efficiency (%)**	
	2007	2008	2007	2008	2007	2008
NPK rates (kgha^{-1})						
0	388a[2]	405a	25a	26a	33.79c	32.27c
100	118b	233b	23b	24b	62.21b	61.04b
200	91b	111c	20c	23b	84.47a	81.44a
300	87b	90c	20c	21b	85.15a	84.95a
Mean	171.0	209.8	22.0	23.5	66.41	64.93
SE(+)	145.3	144.5	2.4	2.1	24.20	24.17
Weed interference duration						
Weedy check	586a	598a	33a	33a	-	-
Weed infested for 3 WAS[1]	317b	330b	15c	17b	76.22a	74.82a
Weed infested for 4 WAS	322b	327b	18c	19b	51.89b	51.16b
Weed free until 5 WAS	360b	378b	27b	28a	38.57bc	36.79bc
Weed free until harvest	0c	0c	0d	0d	100.00a	100.0a
Mean	317	326.6	18.6	19.4	57.46	56.73b
SE(+)	209.0	213.9	11.5	12.7	28.56	29.11

[1]Weeks after sowing [2]Values followed by the same letter(s) in a column are not significantly different at 5% level using DMRT

Table 5. Interaction between NPK fertilizer rates and weed interference duration on growth and yield parameters in 2007

Treatment	**Plant height at harvest (cm/plant)**	**leaf area/ plant (cm^2)**	**no. of flower formed/plant**	**no. of flowers aborted/plant**	**fresh fruit wt/plant (g)**	**fruit yield (tha^{-1})**
0 (kgha^{-1}) Weedy check	12.6d[2]	10.6d	5.3d	3.7a	3.61d	2.36d
Weed infested for 3 WAS[1]	18.9b	16.5b	7.4a	2.6c	7.16b	5.09b
Weed infested for 4 WAS	16.5c	15.8b	7.0b	2.5c	6.49b	4.46b
Weed free until 5 WAS	15.6c	12.4c	6.3bc	3.5ab	5.88c	3.35c
Weed free until harvest	20.3a	18.7a	7.9a	2.6c	9.67a	7.63a
Mean	16.8	14.8	6.8	3.0b	6.56	4.58
SE(+)	1.4	1.6	0.4	0.2	1.20	1.00
100 (kgha-^{1}) Weedy check	14.3d	19.3c	6.0c	3.6a	6.36	6.55d
Weed infested for 3 WAS	20.1b	26.4a	9.8a	2.5c	16.59	14.95a
Weed infested for 4 WAS	18.3c	23.7b	9.3b	2.4c	14.24	12.87b
Weed free until 5 WAS	17.5c	20.7c	7.6c	3.4ab	12.36	10.55c
Weed free until harvest	23.0a	28.6a	10.6a	2.4c	18.83	16.79a
Mean	18.6	23.7	8.7	2.9	13.68	12.34
SE (+)	1.7	2.1	0.8	1.0	2.41	2.01
200 (kgha-^{1}) Weedy check	17.9cd	22.5c	6.5d	3.6a	8.65	8.21c
Weed infested for 3 WAS	21.4b	36.6a	10.6a	2.4b	24.67a	21.73a
Weed infested for 4 WAS	20.3b	30.4b	9.6b	3.3a	22.84b	20.56b
Weed free until 5 WAS	19.7c	26.8b	8.0c	3.4a	20.46	18.91b
Weed free until harvest	24.2a	40.3a	11.2a	2.4b	25.51a	23.87a
Mean	20.7	31.3	9.2	3.0	20.43	18.66
SE (+)	1.2	3.7	0.9	0.3	3.42	3.06
300 (kgha-^{1}) Weedy check	18.5c	23.2d	6.9d	3.5a	9.16c	8.54d
Weed infested for 3 WAS	22.7a	37.7b	11.8a	2.2b	26.98a	24.88a
Weed infested for 4 WAS	20.7b	32.3c	10.4b	3.2a	23.44a	22.96b
Weed free until 5 WAS	20.2b	27.9d	8.5c	3.6a	22.70b	20.70bc
Weed free until harvest	23.6a	42.4a	12.8a	2.3b	26.82a	24.34a
Mean	21.1	32.7	10.1	3.0	21.82	20.28
SE (+)	1.2	3.9	1.1	0.2	3.67	3.39

[1]Weeks after sowing [2]values followed by the same letter (s) in a column are not significantly different at 5% level using DMRT

Table 6. Interaction between NPK fertilizer rates and weed interference duration on growth and yield parameters in 2008

Treatment	Plant height at harvest (cm/plant)	leaf area/ plant (cm^2)	no. of flower formed/plant	no. of flowers aborted/plant	fresh fruit wt/plant (g)	fruit yield (tha^{-1})
0 ($kgha^{-1}$) Weedy check	11.4d[2]	9.4d	4.7c	3.4a	3.43d	2.10d
Weed infested for 3 WAS[1]	17.5b	14.8b	6.3a	2.3b	6.86b	4.87ab
Weed infested for 4 WAS	15.3c	14.3b	5.8b	2.3b	6.25b	3.64bc
Weed free until 5 WAS	14.3c	10.6c	5.9b	3.1a	5.24c	2.86c
Weed free until harvest	19.6a	16.9a	6.2a	2.4b	8.34a	6.78a
Mean	15.6	13.4	5.8	2.7	6.02	4.05
SE(±)	1.6	1.5	0.2	0.3	0.91	0.91
100 (kgha-1) Weedy check	12.6d	17.3c	5.2c	3.4a	5.87	5.91c
Weed infested for 3 WAS	18.4b	24.7a	9.5a	2.2b	15.66ab	13.65a
Weed infested for 4 WAS	16.5c	22.1b	9.1a	2.2b	13.48b	11.94b
Weed free until 5 WAS	16.8c	18.9c	7.3b	3.1a	11.43c	8.67b
Weed free until harvest	21.7a	26.7a	9.7a	2.2b	17.92a	15.82a
Mean	17.2	21.9	8.2b	2.6	12.87	11.20
SE (±)	1.6	2.1	0.8	0.3	2.30	1.97
200 ($kgha-^{1}$) Weedy check	16.4d	21.6d	6.3cd	3.3a	7.81c	7.46c
Weed infested for 3 WAS	20.6b	35.2a	8.8b	2.2b	22.01a	22.58a
Weed infested for 4 WAS	19.4b	29.6b	7.3c	3.1a	19.46b	19.67b
Weed free until 5 WAS	17.9c	25.4c	7.2c	3.2a	18.67b	17.84b
Weed free until harvest	22.6a	38.8a	10.4a	2.2b	23.81a	24.65a
Mean	19.4	30.1	8.0	2.8	18.35	18.38
SE (±)	1.1	3.6	0.8	0.3	3.12	3.44
300 ($kgha-^{1}$) Weedy check	17.8c	21.5d	6.3d	3.3a	8.16c	7.84c
Weed infested for 3 WAS	21.8a	35.8b	11.1a	2.1c	24.53a	23.04a
Weed infested for 4 WAS	19.6b	31.4c	9.3c	3.0b	22.20ab	20.43b
Weed free until 5 WAS	19.3b	25.8d	10.7b	3.3a	20.91b	18.35b
Weed free until harvest	21.8a	40.9a	11.8a	2.1c	25.33a	25.68a
Mean	20.1	31.1	9.2	2.8	20.23	19.07
SE (±)	0.5	3.8	1.1	0.2	3.43	3.42

[1]Weeks after sowing [2]values followed by the same letter(s) in a column are not significantly different at 5% level using DMRT

higher okra fruit yield though not statistically different in fruit yield/plant and fresh fruit yield/ hectare by applying 200$kgha^{-1}$ in both years. Fresh fruit yield/plant and fresh fruit yield/hectare were lowest without the application of NPK fertilizer in 2007 and 2008. These results are in consonance with the findings of Babatola *et al* (2010), Omotosho and Shittu (2007) and Kolawole *et al*. (2008) that increasing the rate of NPK fertilizer would cause an increase in the performance of okra. According to Dademal *et al*. (2004) higher NPK fertilizer dose will cause an increase in the uptake of N, P and K nutrients. Nitrogen has been known to enhance leaf production while phosphorus enhances flowering, fruiting and seed formation. Therefore increasing the rate of NPK fertilizer will lead to higher metabolic activities and consequently higher fresh fruit yield in okra.

Weed control

The commonest weeds at the experimental size in 2007 and 2008 were by Asteraceae, Cyperaceae, Euphorbiaceae, Poaceae and to a lesser degree Urticaceae and Verbanaceae families (Table 3).

Weed dry weight, weed density and weed control efficiency were significantly affected by the application of the fertilizer (Table 4). Applying 300$kgha^{-1}$ of NPK fertilizer caused better weed control (85.15 and 84.95% in 2007 and 2008 respectively) though not significantly different with plots applied with 200$kgha^{-1}$ of NPK fertilizer. Better weed control will reduce competition from the weeds for better utilization of the growth resources thereby leading to higher fruit yield. No significant differences were recorded in weed control efficiency with weeding at 3 WAS (76.22 and 74.82% in 2007 and 2008 respectively) and keeping the plots weed free till harvest.

Also there was no significant difference in weed density between the unweeded okra plots and the plots weed free till 5 WAS.

Interactive effects between the NPK fertilizer rates and weed interference duration were significant (Tables 6 and 7). The plots with weeds infested till harvest produced the

Table 7. Interaction between NPK fertilizer rates (kgha^{-1}) and weed interference duration in weed dry weight, weed density and weed control efficiency in 2007 and 2008

Treatments	Weed dry weight (kgha^{-1})		Weed density (no/m^2)		Weed control efficiency (%)	
	2007	2008	2007	2008	2007	2008
0 kgha^{-1} Weedy check	660a[2]	679a	21a	22a	-	-
Weed infested for 3 WAS[1]	401b	423b	14b	15b	39.24b	37.70b
Weed infested for 4 WAS	463ab	480ab	14b	15b	29.85b	29.30b
Weed free until 5 WAS	642a	654a	19a	21a	2.73c	3.68c
Weed free until harvest	0c	0c	0c	0	100a	100a
Mean	443.2	447.2	13.6	14.6	42.96	42.67
SE (+)	266.8	273.7	4.2	4.8	28.33	30.86
100 kgha^{-1} Weedy check	630a	668a	22a	24a	-	-
Weed infested for 3 WAS	360b	372b	14b	15bc	49.21b	44.31b
Weed infested for 4 WAS	483ab	491a	15b	16b	23.33b	26.50bc
Weed free until 5 WAS	601a	639a	18a	19b	4.60c	4.34b
Weed free until harvest	0c	0c	0c	0d	100a	100a
Mean	414.8	434.0	13.8	14.8	44.29	43.79
SE(+)	255.3	270.3	4.3	4.5	41.40	40.89
200 kgha^{-1} Weedy check	590a	625a	32a	32a	-	-
Weed infested for 3 WAS	103b	118b	12c	14c	82.54a	81.12a
Weed infested for 4 WAS	263b	275b	14c	16c	55.42b	56.00b
Weed free until 5 WAS	415a	430a	24b	25b	29.66c	31.12b
Weed free until harvest	0c	0c	0d	0d	100a	100a
Mean	274.2	289.6	16.4	17.4	66.91	67.08
SE(+)	267.7	247.9	6.2	6.4	30.86	29.95
300 kgha^{-1} Weedy check	573a	589a	30a	30a	-	-
Weed infested for 3 WAS	109b	126b	10c	10c	80.98a	78.61a
Weed infested for 4 WAS	221b	240b	10c	12c	61.43b	59.25b
Weed free until 5 WAS	384a	402a	22b	23b	32.98c	31.75bc
Weed free until harvest	0c	oc	0d	0d	100a	100a
Mean	257.4	271.4	14.4	15.0	68.85	67.40
SE (+)	226.5	231.2	6.4	6.7	28.63	29.02

[1] Weeks after sowing [2]Values followed by the same letter(s) in column are not significantly different at 5% level using DMRT

lowest fruit yields at each NPK fertilizer application rate while the highest fruit yield was obtained with plots that were weed free. Both weeds and okra benefited from the NPK fertilizer but with increasing degree of weed infestation growth resources became reduced thus causing competition between weeds and okra plants, the weeds which area the natural inhabitants of the soil normally compete better than the crops when such situation arises. It has been noted that higher weed infestation brings about severe competition for light which will reduce the stomata number, photosynthetic ability of the crop and consequently the yield (Fabro and Rhodes, 1980). Application of NPK fertilizer at 300kgha-^{1} had a better weed control and higher fruit yield than the other rates of fertilizer application when weeded at 3 WAS. This might be due to the nutrients which were made available to the okra plants throughout the growth stages with little or no competition from the weeds at this weeding regime. Dada and Fayinminni (2007) opined that the weeding might have coincided with the phase when nutrients needed for metabolic activities are provided and utilized for food manufacture. Fruit yields and nutrient uptake of okra plants can be boosted substantially through the application of adequate quantities of NPK fertilizers (Kolawole et al, 2008).

CONCLUSION

While Omotosho and Shittu (2007) suggested application of 150 NPK kgha-^{1} for appropriate okra fruit production in South-western zone of Nigeria, this work has shown that application of 200kg ha-^{1} of NPK fertilizer will be adequate for okra cultivation in the South-Eastern zone of Nigeria with weeding carried out at 3 WAS.

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