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EFFECT OF INTRA-ROW SPACING AND WEED CONTROL TREATMENTS ON GROWTH AND YIELD OF OKRA (*Abelmoschus esculentus* (L). Moench.) IN IBADAN, SOUTH WEST, NIGERIA

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Abstract

Plant spacing determines availability of resources to crops and by extension its growth and productivity. In assessing suitable spacing and weed control method that will optimize the productivity of Okra, a wet season field experiment between June and August, 2013 at the experimental field of the Federal College of Agriculture, Ibadan (Latitude 7^o 22` N and Longitude $3^o$ 50` E) to determine the effect of intra-row spacing and weed control on the growth and yield of okra. The experimental design was a 3 x 2 factorial laid out in a randomized complete block design (RCBD) and replicated three times. Okra was subjected to three spatial arrangements namely: 60 x 50, 60 x 45 and 60 x 40 cm under manual and chemical methods of weed control; while no weeding treatment served as control. Growth and yield data were collected following standard procedure. Number of leaves, stem girth and plant height were not significantly affected by the manual and chemical control and it was s comparable with the control. Leaf area under chemical control at 60 x 50 cm gave the highest value of 285.43 cm^2 which was comparable with weed control method at 60 x 45 cm. Manual weeding at 60 x 40 cm gave the highest fruit yield of 1005.50g/plot . Since farmers are not usually interested in growth but the yield, it is recommended that okra should be planted using manual weed control at a spacing of 60 x 40 cm in a small scale okra production, and at 60 x 50 cm spacing under herbicide integrated large scale production.

INTRODUCTION

Okra (*Abelmoschus esculentus (L.)Moench)*, is an herbaceous plant, which belongs to the family Malvaceae. It is an annual crop, which originated from West Africa. It grows well in the tropics probably due to its tolerance to heat and drought (Philippe, 1988). In Nigeria, okra contributes substantially to Nigerian diet as main constituent in soup, and as a good source of vitamins and mineral elements, especially calcium and iron which are needed in the body. Okra is mostly produced in Nigeria on small-sized farms characterized by mixed and sole cropping systems. It is usually inter-planted with vegetable crops such as tomato, melon, pepper and leafy vegetables, or with staple food crops such as maize, yam, and cassava. This method of okra cultivation enables

farmers to plant okra seeds haphazardly, which does not allow the plant to make judicious use of available soil nutrients and space, resulting into low fresh pods, which cannot meet the demand of the populace (RCMD, 2002).

Appropriate plant spacing is vital for the interception of enough sunlight necessary for photosynthesis which determines the yield of crops.Weed infestation is one of the factors responsible for this rather low yield (Imeokpatia, 1998; Akobundu and Ahisou, 1995). In the tropics, weed interference is a major constraint to high okra yield. Yield reductions of 40 – 80 % occur in farmer field as results of poor weed control methods have been recorded. (Imeokparia, 1988) and Akobundu (1993) reported that the task of weed scientists in this sustainability frame work is to identify how we can so manage weeds that the quality of our environment is preserved and natural resources are not irreversibly degraded.

According to Moniruzzaman *et al*. (2007), reported that growth and yield of okra, except days to first flowering, days to first harvest, percentage of germination and seed vigour were significantly affected by different plant intra row spacing treatment. The closest spacing (60 x 30cm) forced okra plnts to grow taller and with increase seed yield per hectare but reduced number of mature fruits per plant, length and diameter of mature fruit, number of seeds per fruit, 1000 seed weight and seed yield per plant. The lowest number of matured fruits was obtained from the closest spacing (60 x 20 cm) that produced fruit of the shortest length (15.90 cm) and diameter (1.80 cm). This might be attributed to competition for nutrient and space among the plants owing to from using maximum plant population density. Likewise, Zanin and Kimoto (1988) and Sai (1989) reported that plant spacing varies from one crop to another and must strictly be controlled to prevent overcrowding which may in turn affect growth development and yield of cultivated crop. This study was designed to evaluate the effect of spacing and weed control methods on Okra growth and yield.

MATERIALS AND METHODS

This experiment was carried out at Federal College of Agriculture, Moor Plantation, Ibadan (Latitude 7^0 22 $1/2^1$ N and longitude 3^0 50 $1/2^1$ E, 175 m above sea level). The soil type was sandy loam. The dominant weeds on the plot used before application of treatments were: *Fimbristylis littoralis, Cyperus haspan, Talinum fruticosum, Tridax procumbens and Mimosa invisa.*

Okra variety (Rose finger) was planted at 3 seeds per hole of 2 – 3 cm depth, but was later thinned to 2 seeds per stand. Herbicide (Pri-mextra) was sprayed a month before planting at 75 ml/16 litres of water. Germination was observed at 5 days after sowing and supply of the missing stand was done as necessary. The experiment followed a Randomized Complete Block Design (RCBD) with seven treatments replicated 3 times. Plot size was 3 x 2 m at 1 m between plots and 2m between replicates. Experimental units were raised using three inter-row spacings: 60 x 50 cm, 60 x 45 cm, and 60 x 40 cm under two control of methods, namely: pre-emergence herbicide at 4 weeks before planting and hoe-weeding at 2 and 4 weeks after sowing (WAS) coded as follows:

T_1 - Hoe weeding at 2 and 4 weeks at intra-row spacing of 60 x 50cm

T_2 - Hoe weeding at 2 and 4 weeks at intra-row spacing of 60 x 45cm

T_3 - Hoe weeding at 2 and 4 weeks at intra-row spacing of 60 x 40cm
T_4 - Herbicide weeding at intra-row spacing of 60 x 50cm
T_5 - Herbicide weeding at intra-row spacing of 60 x 45cm
T_6 - Herbicide weeding at intra-row spacing of 60 x 40cm
T_7 - No weeding at intra-row spacing of 60 x 50cm

Data collection began two weeks after sowing (2 WAS). Growth parameters - stem height and number of leaves plant were taken two (2) weeks after sowing (WAS) while stem girth and leaf area (cm^2) were taken 4 WAS. Stem height was measured with meter rule. Number of leaves was done by counting all the functional leaves present on the whole plant, stem girth was taken using venial caliper, while leaf area index was calculated using a constant derived by Asoegwu, (1988) for okra, where leaf area = 0.56 x length of centre lobe (cm) and widest width (cm). Data collected were analyzed using the analysis of variance (ANOVA), while significant means were separated using Duncan Multiple Range Test (DMRT) at 5% level of probability.

RESULTS AND DISCUSSION

Physical and chemical analysis of soil prior to planting

Pre-planting soil analysis of the experimental site was shown in Table 1.The soil was sand loamy and slightly acidic (pH 6.75), with high available phosphorus value 15.36 mg kg^{-1} , organic carbon of 13.8 g kg^{-1} and total nitrogen of 1.4 g kg^{-1} (Table 1).

Table 1: **Physical and chemical analysis of soil prior to planting**

Properties	Value
pH	6.75
Available Phosphorus (mg kg^{-1})	15.36
Sand (g/kg)	880
Clay (g/kg)	68
Silt (g/kg)	52
Textural class	Sandy
Organic carbon (g/kg)	loam
Exchangeable sodium (cmol kg^{-1})	13.8
Exchangeable potassium (cmol kg^{-1})	0.58
Exchangeable hydrogen (cmol kg^{-1})	0.32
Exchangeable magnesium (cmol kg^{-1})	0.06
Exchangeable calcium (cmol kg^{-1})	0.71
CEC ($K^+ + Na^+ + Ca^+ + Mg^+ + H^+$)	12
Sum of exchangeable base and acid (cmol kg^{-1})	13.67
Total Nitrogen (g/kg)	13.69
	1.4

Effect of intra-row spacing and weed control on the growth of okra

There was no significant difference in plant heights of Okra (*Abelmoschus esculentus*) at 8 weeks after sowing (Table 2). However, tallest plant of 61.03cm was obtained under herbicide treatment and a spacing of 60 x 40cm. This tally with the work of Moniruzzaman *et al.*

(2007) where closer spacing forced plant to grow taller in response to competition for light, among other needs, posed by higher plant density. There was no significant difference in the number of leaves of okra (*Abelmoschus esculentus*) by spacing or by method of weed control (Table 2). Although plants under wider spacing tend to produce more leaves because of reduced competition than those sown more closely, they are not different significantly from each other. There was no significant different between the treated and the control plot on stem girth of okra (Table 2). The highest stem girth was obtained from the okra treated with herbicides at the intra-row spacing of 60 x 50cm (1.83cm), hence, wider spacing support better growth of the crop. Leaf area tend to increase with wider spacing because of reduction in plant competition and better access to light energy for proper growth of the foliage. Leaf area was best under herbicide treated plant at 60 x50cm with the value of 285.43 cm^2 which is comparable with manual weeding at the same spacing while the control plot produced smallest leaves in response to weed competition (Imeokparia, 1988).

Table 2: **Effect of intra-row spacing and weed control method on growth of okra at 8 weeks after sowing (WAS)**

Treatment / Spacing (cm)	Height (cm)	No. of leaves/plant	Stem girth (cm)	Leaf area index
Manual Weeding @ 60 x 50	50.68	12.42	1.41	262.60ab
Manual Weeding @ 60 x 45	40.95	13.17	1.59	225.07abc
Manual Weeding @ 60 x 40	39.57	11.25	1.44	199.95bc
Herbicide @ 60 x 50	50.30	11.50	1.83	285.43a
Herbicide Weeding @ 60 x 45	44.98	10.75	1.47	217.06abc
Herbicide Weeding @ 60 x 40	61.03	11.33	1.81	281.83ab
Control (No weeding) 60 x 50	48.89	8.50	1.39	168.10c
	Ns	Ns	Ns	

Ns: not significant at p = 0.05 WAS: Week after Sowing
Means with same letter(s) in a column are not significantly different at 5% level of probability by Duncan Multiple Range Test (DMRT)

Effect of intra-row spacing and weed control on number of fruit/plot of okra

There was no significant different among the treatment means. Therefore, the yield of okra did not respond to any of the treatment applied (Table 3). However, the highest yield was obtained from the treatment subjected to manual weeding at the intra-row spacing of 60 x 40 cm, under highest population density of 63.33 fruits/ plot. The result is at variance with the work done by Moniruzzaman *et al*. (2007) who observed that closer spacing encourage taller plants with reduced number of matured fruits per plant. However, according to Zanin and Kimoto, (1980) there was no significant difference between 60 x 50cm and 60 x 60cm spacing with respect to number of mature fruits per plant, length and diameter of mature fruits because the difference in the

intra-row spacing was not wide enough for an appreciable change in productivity. Control plots gave the least value of 21.00 fruits/ plot (Akobundu, 1987).

Effect of intra-row spacing and weed control on fruit yield of okra

The result in Figure 1 shows the effect of intra-row spacing and weed control (chemical and manual) weeding on weight of okra (*Abelmoschus esculentus*). It was observed that there was no significant different in the fruit (kg) weight/plot among plant subjected to manual weeding at 60 x 50 cm, 60 x 45 cm and 60 x 40 cm spacing. However, manual weeding at 60 x 40 cm significantly gave the higher yield which is significantly higher than herbicide treatment and the control plot. This is in line with the work of Moniruzzaman *et al.* (2007) who also observed that closer spacing encourage taller plants and increased seed yield per hectare.

Table 3: Effect of intra-row spacing and weed control method on number of fruits/plot of okra

	Harvesting Time							
Treatments	1st	2nd	3rd	4th	5th	6th	7th	Cumulative
Manual Weeding @ 60 x 50 cm	0.67	0.67	7.00	14.33	13.00ab	10.33	5.33	51.33
Manual Weeding @ 60 x 45 cm	2.33	3.67	10.33	14.50	12.67abc	10.00	6.67	55.33
Manual Weeding @ 60 x 40 cm	3.00	3.33	9.33	8.00	20.00a	13.67	6.00	63.33
Herbicide @ 60 x 50 cm	1.00	3.67	6.67	9.00	13.67abc	9.67	5.67	49.33
Herbicide Weeding @ 60 x 45 cm	6.00	5.33	5.33	5.67	10.00bc	9.00	4.67	46.00
Herbicide Weeding @ 60 x 40 xm	0.67	1.67	3.33	8.67	9.67bc	9.33	5.00	38.33
Control (No weeding) 60 x 50 cm	2.00	1.67	3.67	2.33	4.00c	6.67	0.67	21.00
	ns	ns	ns	ns	*	ns	ns	ns

Means with same letter(s) in a column are not significantly different at 5% level of probability by Duncan Multiple Range Test (DMRT)
ns; F test not significant at p=0.05, * significant at p=0.05

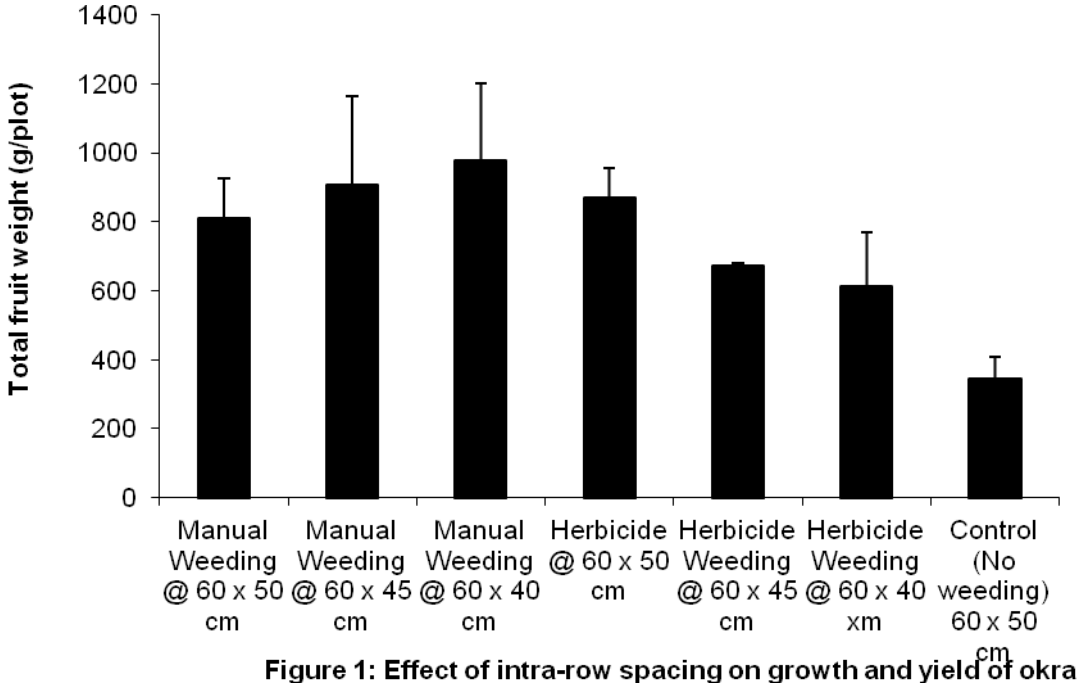

Figure 1: Effect of intra-row spacing on growth and yield of okra

Effect of intra-row spacing and weed control on weed population and weed weight in okra

Manual and herbicide weeding at intra-row spacing of 60 x 50 cm, 60 x 45, 60 x 40cm had no significant effect on the number of weed species in the treatment plots as well as the weed weight but it is significantly lower than the control plot (Table 5). However, manual weeding at 60 x 50 cm had the least number of weed/plot probably because of the ability of the crop to fully exercise its growth potential because of the wider spacing at the expense of the weed. Also, lowest weed weight exhibited by manual weeding at 60 x 45 cm could be as a result of better competition for available resources by the okra because of increased plant population.

Effect of intra-row spacing and weed control on weed frequency and weed density in okra

It was observed that in all the experimental plots *Talinium fruticosum* had the highest frequency (i.e. occurring most in each plot) while *Tithonia diversifolia* had the highest density (i.e. occupy large space) in the experimental site (Table 6).

Table 5: **Effect of intra-row spacing and weed control method on weed population and weed weight of okra at 6 WAS**

Treatment / Spacing (cm)	Number of weed / Plot	Weed weight (kg/plot)
Manual Weeding @ 60 x 50	38.33b	1.07b
Manual Weeding @ 60 x 45	41.00b	0.73b
Manual Weeding @ 60 x 40	43.67b	1.40b
Herbicide @ 60 x 50	46.33b	1.23b
Herbicide Weeding @ 60 x 45	46.33b	1.40b
Herbicide Weeding @ 60 x 40	53.00b	1.23b
Control (No weeding) 60 x 50	70.33a	4.30a

Means with same letter (s) in a column are not significantly different at 5% level of probability by Duncan Multiple Range Test (DMRT)

Table 6: **Effect of intra-row spacing and weed control on weed frequency and weed density**

Scientific names/Family	Weed frequency (%)	Weed density
*Eclipta alba (*Asteraceae)	23.81	2.81
Cyperus haspan (Cyperaceae)	38.10	4.30
Fimbristylis littoralis (Cyperaceae)	38.10	4.24
Talinum fruticosum (Portulacaceae)	47.62	5.67
Trianthema portulacastrum (Aizoaceae)	23.81	2.52
Boerhavia diffusa (Nyctaginaceae)	9.52	0.95
Spigella anthelmia (Loganiaceae)	19.05	1.90
Cyperus esculentus (Cyperaceae)	14.30	2.14
Anxonopus compressus (Poaceae)	19.05	2.14
Melastomastrum capitatum (Melastomataceae)	14.30	1.43
Pentodon pentandrus (Rubiaceae)	4.76	0.24
Aspila africana (Asteraceae)	9.52	2.14
Mimosa invisa (Leguminosae-Mimosoideae)	38.10	4.30
Tridax procumbens (Asteraceae)	38.10	5.38
Celosia leptostachya (Amaranthaceae)	4.76	0.48
Centrosema pubescens (Fabaceae)	4.76	0.76
Tithonia diversifolia (Asteraceae)	33.33	7.91
Panicum maxicum (Poaceae)	14.30	2.05

Conclusion

The number of leaves, stem girth and stem height of okra were not significantly affected by manual and herbicide weeding as the effects is comparable except with the control plot; unlike in leaf area where herbicide weeding at of 60 x 50 cm gave the highest value which is comparable weed control method at 60 x 45 cm. The best fruit yield of okra was obtained from manual weeding which gave the highest fruit (1005.5kg/plot) yield. It was observed that the planting of okra at the closer spacing of 60 x 40 cm gave the highest okra yield This is in line with the work of Moniruzzaman *et al.* (2007) who also observed that closer spacing

encourage taller plants and seed yield. Since many farmers are not usually interested in growth but the fruit yield, it is recommended that okra should be planted using manual weed control at a closer spacing of 60 x 40 cm in a small scale okra production while herbicide use at 60 x 50 cm spacing could be considered in large scale production.

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