EFFECT OF PLANT SPACING AND PLANTING DATE ON THE GROWTH AND YIELD OF OKRA (*Abelmoschus esculentus* L) IN ABAKALIKI

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ABSTRACT
The effect of plant spacing and planting dates on the growth and yield of okra (*Abelmoschus esculentus)* was investigated. The field trial was conducted as a 3 x 3 factorial laid out in Randomized Complete Block Design (RCBD). Three plant spacings (50cm x 25cm, 50cm x 50cm and 50cm x 75cm) and three planting dates (15th May, 15th June and 15th July) were used as treatments. There were four replications of each treatment. Data collected was statistically analyzed for differences between mulching materials and pruning using analysis of variance (ANOVA) and separation of means for significant effect was by the use of Least Significant Difference (LSD) at 5% level of probability. The result showed that the shortest planting distance used (50cm x 25cm) produced the highest number of leaves (30.43), number of branches (13.98), longest number of days to 50% anthesis (57.28days) and heaviest pods (0.17kg). The highest number of pods, length and diameter of pods was recorded at the widest plant spacing (50cm x 75cm). The earliest sowing date (15th May) produced the tallest and most profusely branched plants (13.79), highest number of leaves (31.68), number of pods (22.91) and length of pods (16.09cm). The 15th July sowing gave least values in all the vegetative parameters measured except plant height and number of days to 50% anthesis (flowering).

***Key words*:** Okra, plant spacing, planting dates, vegetative growth and yield

INTRODUCTION

Okra (*Abelmoschus esculentus*) is a popular vegetable which is cultivated in the tropical and sub tropical regions of the world (Baloch, 1994). It is a semi – woody, fibrous annual crop with deep penetrating taproot and dense shallow feeder roots reaching out in all directions in the upper 45cm of the soil. In Nigeria, okra is cultivated either as a sole crop mixture over a total area of about 1.5million hectares (Anon, 1980). The local varieties differ in growth habit such as branching, height, leaf size and arrangement, maturity period and fruit characteristics. During the vegetative phase, growth pattern of okra varieties are similar, although, the more vigorous varieties have higher leaf area and dry matter accumulation (Adelana, 1981). It is a nutritious vegetable which plays an important role in meeting the demand of vegetables in the country when vegetables are scanty (Ahmed, 1995).

Okra is grown for its immature pods which can be harvested over a relatively long period of time. Like squash, cucumber and many other vegetables, the crop must be harvested on a regular basis for best yields. If the pods are allowed to mature on the plant, flowering will be reduced and further pod production will be hindered. The green pods are rich sources of vitamins and minerals. In Nigeria, okra is made into soup with the addition of palm oil, fish and other condiments. It could be boiled as vegetable and served with rice and other foods. Fresh okra fruits may be consumed in the immature stage or they could be sliced, dried and stored for using during the off – season.

In a trial on okra using two sowing dates – 1st April and 15th April, Incalcaterra *et al.* (2000) reported that plant height, number of pods per plant and total number of pods were higher for the 1st April sowing than the 15th April sowing. Yadav and Dhankhar (1999) also observed that plant height, number of fruits per plant and length of fruits was higher for June sowing than August sowing. The effect of three planting dates (3rd Feb, 23rd Feb and 5th March) on the growth and yield of some okra cultivars (Clemenson spineless, Hala and Baby finger) showed that plants sown on 5th March grew taller and produced more leaves compared with plants sown earlier (Al – Harbi, 1999).

Gupta *et al.* (1981) studied the response of an okra cultivar – "Pusa Sawani" to date of sowing and plant spacing. They observed that the earlier sowing date (25th May) generally gave the highest average yield, which decreased with each sowing date until 5th November. They also reported that the closest plant spacing (50cm x 15cm) and the earliest sowing date gave the overall highest yield (110t/ha). Kamalanathan *et al.* (1970) obtained a higher fruit

yield when okra was sown in March to April than from October to January. Sayeed (1988) evaluated three sowing dates for okra (17th March, 2nd April and 17th April). He reported that sowing dates had a very pronounced effect on the yield of okra. He also observed that the earliest sowing date (17th March) produced the tallest plants, highest number of leaves and highest number of pods.

A study on the effect of sowing dates on the growth and yield of okra showed that the growth of plants from the early sowing date (1st April) was more vigorous than that of the plants from late sowing date (1st June) (Iremiren and Okiy, 1986). They also found that the number of pods per plant was higher in the earlier sowing date. Okra was sown at the end of July, in mid August and early September as a late season crop in 1999 and at the end of May, in early June and at the end of June as an early season crop in 2000. Olasantan and Bello (2004) observed that okra sown in July in the 1999 late season and those sown in May in the 2000 early season took the longest time (3 – 10days and 2 – 5days respectively) to flower and fruit but these crops controlled weeds and modified the cassava environment better than the rest and gave the highest fresh pod yields and economic returns. It took okra pods longer time to reach marketable size in the late season than early season (5 -9days and 2 – 6days), respectively.

In an experiment on the effect of planting dates and plant spacing on seed production of okra, Singh *et al.* (1986) reported that seed yield was higher in plots sown on the first planting date (15th June) with a plant spacing of 60cm x 30cm. A field trial on okra cultivar (BARI Dheroshs using four sowing times starting from February to May (15th day of each month) and four plant spacing (60cm x 20cm, 60cm x 30cm, 60cm x 40cm and 60cm x 50cm) was carried out by Hossain *et al.* (1999). They reported that the highest seed yield (2.7t/ha) was recorded from 15th April sowing closely followed by 15th March sowing while the best quality seed was obtained from 15th February and 15th March sowing. Plant spacing of 60cm x 40cm produced the highest seed yield of okra.

Okra was grown in monoculture or in mixtures with two contrasting cassava cultivars (TMS 30572 and Odongbo) starting from May 2001and August 2002 using three target sowing dates at two weekly intervals. Olasantan and Olowe (2006) reported that sowing dates significantly affected phenology (time to vegetative growth, flowering, fruiting and harvesting stages). The result showed that early sowings enhanced earliness to maturity and increased pod yield by 2 – 8% in mixed stands while late sowings did so in monoculture. The response of five cultivars of okra – Malav -27, Sabz Pari, Super Green, Pusa Sawani and Punjab to three sowing dates (18th April, 28th May and 8th June) showed that the maximum number of pods (26.22) per plant was produced by plants sown on 28th May while the minimum number of pods (23.17) per plant was produced by plants sown on 8th June (Moniruzzaman *et al*, 2007). Mondal *et al.* (1989) reported that okra sown in April produced the highest number of branches and fruits per plant when compared to seeds sown during the month of June. Similarly, Lee (1990) also observed that the pod yield of okra decreased with delay in sowing time. Iremiren and Okiy (1986) evaluated the effect of sowing dates on the growth and yield of okra. They reported that the growth of plants from the early sowing date(1st April) was more vigorous than that of the plants from the late sowing date (1st June). They also found that the number of pods per plant was higher in the earliest sowing date. Gadakh and Lawande (1990) concluded that variation in sowing dates was the main cause of change in seedling emergence, survival and vigour of seedlings.

Absar and Siddique (1982) noted that plant density is another important factor that affects okra seed production. Suitable plant spacing can lead to optimum seed yield while too high or too low plant spacing could result to relatively low yield and quality. Plant spacing for okra seed production suggested by different authors ranges from 20cm to 40cm and 30cm to 60cm between rows (Thakur and Arora, 1986, Rastagie *et al,* 1987, Khan and Jaisal, 1988., Hossain *et al*, 1999). The effect of three planting densities on okra (28,000, 56,000 and 111000plants/ha) on okra intercropped between or within maize rows showed that .plant height and leaf area index increased as the planting density increased in sole or intercropped okra while the number of branches per plant decreased with increasing planting density(Muoneke and Asiegbu, 2008).

In a trial on okra using three rates of phosphorus – 0, 33 and 60kg$P_2 0_5$ /hand three planting densities – 11100, 37000 and 55500plants/ha, Amjad and Mohammed (2001) reported that the lowest planting density (37000plants/ha) resulted in maximum seed yield per plant while seed yield per hectare was highest at the highest planting density. Two high yielding okra cultivars - "Pusa Sawani" and " Ibk – 2" was grown at different population densities. Fatokun and Chheda (1975) observed that at 108,000plants/ha which was the highest plant population used, yield was increased by 675% when sown early in the season and by 365% when sown late in the season. The number and weight of fruits per plant as well as the number of the vegetative branches per plant decreased significantly with increase in population density.

The effect of sowing densities (0.50m x 0.50m, 40,000plants/ha), (0.25m x1.00m, 20000plants/ha) and (0.25m x 0.50m, 80000plants/ha) on two okra cultivars – Koto and Tomi showed that 0.5 x 1.0m, 20000/ha produced the highest number of fruits while the least was at 0.25m x 0.50m, 80000plants/ha (Kouame and Djidji, 1999).Four planting densities – 1184plants/ha, 1538plants/ha, 1575plants/ha and 2844plants/ha were tested to determine the optimum planting density of okra. Hiyane and Kawamura (2001) reported that dry matter production and leaf area index for

1538plants/ha was higher than that of other planting densities. The effect of row spacing on the yield and yield components of okra and groundnut showed that the productive nodes increased with increasing row spacing. Row spacing of 90cm x 50cm had 77% nodes while row spacing of 75cm x 50cm and 60cm x 50cm had 69% and 66% nodes respectively. The closest row spacing (30cm x 50cm) suppressed weeds better, had low fruit yield when compared to other plat densities (Ibeawuchi *et al*., 2005). Olasantan (2001) also reported that okra planted at densities of 25000, 35000 and 50000plants/ha took the longest time to flower at 50000plants/ha.

Different cultivars of okra require different sowing times and plant spacing. A good cultivar which is sown at an improper time will give very poor yield. Proper plant spacing and suitable date of sowing is critical to increased production of okra. The objective of this study is to determine the most suitable sowing time and plant spacing for optimum production of okra in Abakaliki.

MATERIALS AND METHODS

A field trial was carried out at the experimental field of the Faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki from 15th May to 30th August, 2009. Ebonyi State is in the derived savanna zone of Nigeria located at latitude 06^0 4^1N and longitude 08^0 65^1E, at an altitude of 447.2 meters above mean sea level (Ebonyi State University metrology station).The soil in the experimental area is classified as ferallitic well drained sandy loam. The experimental field measured 22m long by 11mwide, giving a total of $242m^2$. Raised field beds which were manually tilled was used. The experimental field was divided into four equal blocks and each block consisted of 9 plots, giving a total of 36 sub – plots. Each plot measured 2m x 2m with 0.5m between adjacent plots.

The experiment was conducted as a 3 x 3 factorial laid out in Randomized Complete Block Design (RCBD). Each treatment was replicated four times and the treatments comprised three planting dates (15th May, 15th June and 15th July) and three plant spacing (50cm x 25cm, 50cm x 50cm and 50cm x 75cm). Two seeds of the cultivar - Clemenson Spineless was sown per hole and after two weeks, it was thinned down to one seedling per stand. Fertillizer (NPK 15 : 15 : 15) was applied at the rate of 90kg/ha. The plots were weeded four times and harvesting of the matured fruits commenced at the 10th week after sowing. Data was collected on the following parameters – plant height, number of branches, number of leaves, number of days to 50% anthesis(flowering), number of pods, weight of pods, length and diameter of pods.

Statistical Analysis

Statistical analysis of data collected was based on the procedure for Randomized Complete Block Design (RCBD) for factorial experiment as outlined by Steel and Torrie (1980). Data collected was statistically analyzed for differences between plant spacing and planting date using analysis of variance(ANOVA). Separation of treatment means for significant effect was by the use of Least Significant Difference (LSD) as described by Obi (1986).

RESULTS

The result showed that plant spacing, planting dates and their interaction had no significant effect on plant height (Table 1). However, plant height increased as the plant spacing increased from 50cm x 25cm to 50cm x 50cm beyond which there was a decrease in plant height. The tallest plants were obtained at 50cm x 50cm while the shortest were at 50cm x 25cm.

Okra seeds sown on 15th May (earliest planting date) produced the tallest plants while the shortest plants were obtained from seeds sown on 15th June.

Plant height was highest at 50cm x 50cm when the seeds were sown on 15th May and least at 50cm x 25cm on plants whose seeds were sown on 15th June.

Table 1. Effect of plant spacing and planting dates on plant height (cm).

	Plant spacing (cm)			
Planting dates	50 x 25	50 x 50	50 x75	Mean
15th May	41.42	45.47	36.05	40.98
15th June	31.05	34.57	37.17	34.26
15th July	34.90	33.17	38.67	35.58
Mean	35.79	37.73	37.29	

F – LSD (P = 0.05)
Plant spacing = NS
Planting dates = NS
Plant spacing x planting dates = NS

The effect of plant spacing, planting dates and their interaction on the number of branches produced was non – significant at P = 0.05 (Table 2). The most profusely branched plants were obtained at the closest plant spacing (50cm x25cm) while the least was at 50cm x 75cm.

The number of branches was highest on the earliest planting date (15th May) while the least number of branches was recorded on plants whose seeds were sown on 15th July.

Plant spacing of 50cm x 25cm and planting date of 15th May produced the highest number of branches while the least was obtained at 50cm x 50cm on plant whose seeds were sown on 15th July.

Table 2. Effect of plant spacing and planting dates on the number of branches.

	Plant spacing (cm)			
Planting dates	50 x25	50 x 50	50 x 75	Mean
15th May	6.87	5.06	5.60	13.79
15th June	5.21	5.83	4.88	12.66
15th July	5.72	4.69	5.20	12.14
Mean	13.98	12.45	12.21	

F- LSD (P = 0.05)
Plant spacing = NS
Planting dates = NS
Plant spacing x Planting dates = NS

Plant spacing had no significant effect on number of leaves produced (Table 3). However, number of leaves decreased as the plant spacing increased from 50cm x 25cm to 50cm x 75cm. Number of leaves was highest at 50cm x 25cm and least at 50cm x 75cm.

The effect of planting dates on number of branches was non – significant. Okra seeds sown on 15th May produced the highest number of leaves while the least number of leaves was recorded on plants whose seeds were sown on 15th July.

Plant spacing x planting date interaction was non – significant. Although, the highest number of leaves was obtained at 50cm x25cm on plants whose seeds were sown on 15th May while the least was at 50cm x 75cm on plants whose seeds were planted on 15th July.

Table 3. Effect of plant spacing and planting dates on the number of leaves

	Plant spacing (cm)			
Planting dates	50 x 25	50 x 50	50 x 70	Mean
15th May	14.30	13.36	12.08	31.68
15th June	12.18	11.38	12.70	27.79
15th July	11.86	11.76	11.35	27.40
Mean	30.43	28.66	28.56	

F – LSD (P = 0.05)
Plant spacing = NS
Planting dates = NS
Plant spacing x planting dates = NS

The effect of plant spacing on the number of days to 50% anthesis was significant(P = 0.05)(Table 4). Number of days to 50% anthesis was shortest at 50cm x 75cm (widest plant spacing) while it was longest at 50cm x 25cm and they differed significantly. Number of days to 50% anthesis recorded at 50cm x 25cm was significantly higher than that recorded at 50cm x 50cm.

Number of days to 50% anthesis was statistically significant at different planting dates. Okra plants whose seeds were sown on 15th May had the earliest bud break while the longest number of days to 50% anthesis was obtained on plants whose seeds were planted on 15th June and they differed significantly. However, number of days to 50% anthesis recorded on plants whose seeds were sown on 15th June and 15th July were statistically similar.

Plant spacing x planting dates interaction on the number of days to 50% anthesis was significant at P = 0.05. Number of days to 50% anthesis was longest at 50cm x 50cm when seeds were sown on 15th June while the earliest bud break was obtained at 50cm x 75cm on plants whose seeds were sown on 15th May and they differed significantly. Number of days to 50% anthesis at 50cm x 50cm which was recorded on plants whose seeds were sown on 15th June was significantly higher than all other treatment combinations but days to 50% anthesis recorded at 50cm x 50cm on plants whose seeds were planted on 15th June and 50cm x25cm when seeds were sown on 15th June did not differ among themselves.

Table 4. Effect of plant spacing and planting dates on the number of days to 50% anthesis.

	Plant spacing (cm)			
Planting dates	50 x 25	50 x 50	50 x 75	Mean
15th May	52.80	47.41	40.55	46.92
15th June	60.90	61.65	56.22	59.59
15th July	58.16	50.00	52.11	53.42
Mean	57.28	53.02	49.62	

F- LSD (P = 0.05)
Plant spacing = 3.40
Planting dates = 6.23
Plant spacing x planting dates = 0.94

Plant spacing, planting dates and their interaction had no significant effect on the number of pods produced at P = 0.05 (Table 5). The number of pods increased as the plant spacing increased from 50cm x 25cm to 50cm x 75cm. The number of pods produced was highest at the widest plant spacing (50cm x 75cm) while the least was at 50cm x 25cm. Number of pods produced was highest on plants whose seeds were planted on 15th May while the least was recorded on plants whose seeds were sown on 15th June.
The highest number of pods (24.75) was obtained at 50cm x 25cm when okra seeds were sown on 15th May while the least was at 50cm x 25cm on plants whose seeds were planted on 15th June.

Table 5. Effect of plant spacing and planting dates on the number of pods produced.

	Plant spacing (cm)			
Planting dates	50x 25	50 x 50	50 x 75	Mean
15th May	24.75	21.50	22.50	22.91
15th June	15.00	17.25	23.00	18.41
15th July	17.50	19.25	20.50	19.08
Mean	19.08	19.33	22.00	

F- LSD (P = 0.05)
Plant spacing = NS
Planting dates = NS
Plant spacing x planting dates = NS

The effect of plant spacing on the weight of pods was non – significant (Table 6). Weight of pods decreased as the plant spacing increased from 50cm x 25cm to 50cm x 75cm. However, the closest plant spacing (50cm x 25cm) produced the highest weight of pods while the least was at 50cm x 75cm.
Planting dates had no significant effect on the weight of pods produced. Weight of pods was highest when seeds were sown on 15th July and lowest on seeds sown on 15th June.
Spacing x planting date interaction was non – significant. Although, weight of pods was highest at 50cm x 25cm when seeds were planted on 15th July and lowest at 50cm x 75cm on seeds sown on 15th June.

Table 6. Effect of plant spacing and planting dates on weight of pods (kg)

	Plant spacing (cm)			
Planting dates	50 x 25	50 x 50	50 x 75	Mean
15th May	0.10	0.12	0.09	0.10
15th June	0.08	0.09	0.06	0.08
15th July	0.33	0.07	0.09	0.16
Mean	0.17	0.09	0.08	

F- LSD (P = 0.05)
Plant spacing = NS
Planting dates = NS
Plant spacing x planting dates = NS

The length of pods produced was statistically non – significant at different plant spacing and planting dates (Table 7). The longest pods was obtained at 50cm x 75cm while the shortest was recorded at 50cm x 50cm. Seeds sown on 15th May (earliest planting date) produced the longest pods while the shortest pods was recorded on seeds sown on 15th June.

Spacing x planting dates interaction on the length of pods was non – significant. However, the longest pods was obtained at 50cm x 75cm when seeds were sown on 15th May while the shortest was recorded at 50cm x 25cm on seeds sown on 15th July.

Table 7. Effect of plant spacing and planting dates on the length of pods (cm).

	Plant spacing (cm)			
Planting dates	50 x 25	50 x 50	50 x 75	Mean
15th May	17.06	15.34	15.89	16.09
15th June	14.93	14.64	14.95	14.84
15th July	13.72	15.93	15.80	15.15
Mean	15.23	15.13	15.54	

F- LSD (P = 0.05)
Plant spacing = NS
Planting dates = NS
Plant spacing x planting dates = NS

Pod diameter was not statistically significant(P= 0.05) at different plant spacing, planting dates and their interaction (Table 8).The highest pod diameter was obtained at 50cm x 75cm while the lowest was at 50cm x 50cm. Plants whose seeds were sown on 15th May produced the highest pod diameter while the least was on seeds sown on 15th June. The highest pod diameter was recorded at 50cm x 75cm when seeds were sown on 15th May while the lowest pod diameter was obtained at 50cm x 50cm on plants whose seeds were planted on 15th June.

Table 8. Effect of plant spacing and planting dates on the diameter of pods (cm).

	Plant spacing (cm)			
Planting dates	50 x 25	50 x 50	50 x 75	Mean
15th May	8.51	8.05	9.65	8.73
15th June	6.60	6.65	6.70	6.65
15th July	7.45	7.55	8.85	7.95
Mean	7.52	7.41	8.40	

F- LSD (P= 0.05)
Plant spacing = NS
Planting dates = NS
Plant spacing x planting dates = NS

DISCUSSION

Plant height increased as the plant spacing increased from 50cm x 25cm to 50cm x 50cm beyond which there was a decrease in plant height. This is in conformity with the report by Ibeawuchi *et al* (2005) who observed that the productive nodes of okra and groundnut increased with increasing row spacing. The number of branches, number of leaves and days to 50% anthesis decreased as the plant spacing increased from 50cm x 25cm to 50cm x 75cm. This observation does not agree with the report by Muoneke and Asiegbu (2008) who found that the number of branches of okra intercropped with maize decreased with increasing planting density. The widest plant spacing consistently gave least values in all the vegetative parameters measured except plant height.

The tallest and most profusely branched plants and plants with the highest number of leaves was recorded on the 15th May sowing. This may be attributed to more growing duration in the early sowing date than the late sowing. Results of similar findings was reported by Iremiren and Okiy (1986)

who observed that early sowing produced more vigorous plants as compared to late sowing. Similarly, Mondal *et al.*(1989) reported that okra sown in April produced the highest number of branches and fruits per plant when compared to seeds sown in June. Kamalanathan *et al.* (1970) also noted that the earliest sowing date (17th March) produced the tallest plants, highest number of leaves and highest number of pods among the three sowing dates. The 15th July sowing gave the least values in all the vegetative parameters measured except plant height and days to 50% anthesis.

The number and diameter of pods was highest at the widest plant spacing (50cm x 75cm). This may suggest that there was less competition for nutrient and space among the plants. Similar observation was made by Amjad *et al.* (2001) who reported that the lowest planting density (37000plants/ha) resulted in maximum number of matured pods per plant, highest weight of matured pods and highest seed yield per plant. The length and weight of pods was highest at the closest plant spacing (50cm x 25cm).

The highest number and length of pods was recorded on the 15th May sowing. This may suggest that the 15th May sowing had longer harvest duration than other sowing dates. Olsantan and Olowe(2006) observed that early sowing enhanced earliness to maturity and increased pod yield by 2 – 8%. Mondal *et al* (1989) also found that okra sown in April produced the highest number of fruits per plant and had more yield when compared to seeds sown during the month of June. Similar observation was made by Incalcaterra *et al.* (2000) who reported that plant height, number of pods per plant and total number of pods were higher for the 1st April sowing than the 15th April sowing. Lee (1990) also observed that the pod yield of okra decreased with delay in sowing time. Gupta *et al.* (1981) reported that an earlier sowing date (25th May) gave the highest average yield of okra than other later sowing dates. The 15th June sowing date consistently gave least values in all the yield parameters measured.

The closest plant spacing (50cm x 25cm) and the earliest sowing date (15th May) produced the highest number and length of pods. This is similar to the observation made by Gupta *et al* (1981) who reported that the closest plant spacing (50cm x 50cm) and the earliest sowing date (25th May) produced the highest yield of okra.

CONCLUSION

The study showed that in Abakaliki, South East agroecological zone, okra seeds (Clemenson Spineless) sown on 15th May with a plant spacing of 50cm x 75cm produced the highest number of pods. Farmers who may embark on large scale production of this okra cultivar should sow their seeds early in the rainy season using a plant spacing of 50cm x 75cm to ensure maximum yield of the crop.

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