GROWTH AND YIELD OF OKRA *(Abelmoschus esculentus (L) , Moench*) AS AFFECTED BY LOCATION, CROPPING SEASON AND SPATIAL ARRANGEMENTS IN A MAIZE/OKRA MIXTURE IN THE SOUTHERN GUINEA SAVANNA AGRO-ECOLOGICAL ZONE OF NIGERIA.

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ABSRACT

Field experiments were conducted to investigate the effects of three okra densities on the growth and yield parameters of okra in a maize/okra mixture in two location in the southern guinea savannah during the early and late cropping seasons. The two locations are: location 1: university of agriculture teaching and research farm, Makurdi and location 2: kogi state university teaching and research farm Anyigba. Treatments comprises of three okra densities via: S.A 1:1.00m x 0.60m (16,670 Plant/ha); S.A 2:1.00m x 0.50m (20,000 plant/ha) and S.A 3:1.00m x 0.3m (33,333 plant/ha). The cultivar of maize used was Downy mildew streak-resistant, early maturing – yellow (DMSR-EY), while that of okra used for the experiment is NHAe 47-4-a photoperiodic neutral variety sourced from the Nigeria Institute of Horticultural Research and Training (NIHORT), Ibadan, Nigeria. Trials were laid out in a Randomized Complete Block Design (RCBD) with a spilt-plot arrangement, replicated three times. NPK 20:10:10 fertilizer was applied to maize stands at pre-emergence or two Weeks After Sowing (WAS) at the rate of 70kgN ha^{-1}, 35kg P_2O ha^{-1}, 35kgK ha^{-1} using the ring method of fertilizer application, while urea was applied to supply the remaining half of N(70kgN ha^{-1}) at second application for top dressing just before tassel initiation and the onset of okra flowering. A broad spectrum insecticide called BEST- Cypermethrin was applied on weekly basis at the rate of 30g a.i ha^{-1} to control flea beetles. The plant height and the Leaf Area Index (LAI) increased as the intra-row spacing decreased and the planting density increased in sole or intercropped okra, while the number of branches per plant decreased as the spacing decreased and the okra plant decreased and the planting density increased.. Intercropping reduced the yield and yield component of okra (i.e the number and weight of fresh pods per plant) reducing the spacing of okra in order to increase the planting density of okra resulted in reduction of yield both in the sole and intercropped situation of okra plant i.e. it reduced the yield component of okra (number of pods and size of the pod). The highest yield advantage (35%) of intercropping okra and maize together was obtained at the widest spacing of 1.0m x 0.60m (16,670 okra plant per ha), The combined yield of both crops, made intercropping more worthwhile than sole cropping.

Keywords: Okra, sole Cropping, Productivity, Planting Density, Growth

INTRODUCTION

Okra (*Abelmoschus esculentus (L) Moench*) is an important vegetable crop belonging to the mallow family(family malvacea). Okra is an allopolyploid vegetable of uncertain parentage, although the proposed parents include; *Abelmoschus ficulnes, Abelmoschus tuberculatus* and it was also reported diploid" form(i .e may likely be truly wild and cultigens).Okra is grown and consumed throughout Nigeria. Considering the importance of vegetable in the diet of man, this research can not be more justified, particularly when one observes that okra is rich in both minerals and protein which are both vital to man's growth and development, and most often lacking in most African diets. Okra is also one of the most heat-and drought tolerant vegetable species in the world though severe frost do damage the pods. It tolerates poor soils with heavy clay and intermittent moisture. Janidks *et al.(* 1981).

The species is an annual vegetable crop growing up to about 2.Om tail The leaves are 10-20cm long and broad, palmately lobed with 5-7lobes.The flowers are 4-8cm in diameter, With 5 white-yellow petals, often red or purple spot at the base of each petals. The fruit is fibrous-a capsule up to 18cm long, containing numerous white seeds.

In Nigeria, okra is cultivated either as sole crop or in mixture with other crops in 1.5 million hectares (Anon, 1980). Okra is chiefly used as fresh vegetables in soup and contains high level of vitamin C and protein (Abanzuke 1989). Rao (1985) noted on the bases of the symbolic nature of fruit vegetable, the economic and nutritional value in the diets of Nigerians that the product of raw okra plant are mucilaginous and the nutritional value per 100g (3.5oz) relative to U.S recommendations for adults are: energy 129kj (3lkcal), carbohydrate 7.03g, sugars 1.20g, dietary fiber 3.20g, fat 0.l0g, protein 2.00g, water 90.17g, calcium 8lmg/8%. It could be mixed with other vegetables or used as the principal vegetable as a sauce for meat. The dried powdered form can be used in soups mixed with cheese, it can also be used in salad dressing, ice creams, candies etc. Because of its mucilaginous character, it can be used medically in the cure of ulcer, relief measure to haemorrhoids, as a clarifying agent in sugar cane processing, (Akinlade and Adesiyan, 1982).The antioxidant, antidiebetic , antifatique, antihyperlipidemic, and neuro-protective properties of Okra seed extracts was reported by Watcharaphong *et.al*.,(2019). Rabin *et.al*., (2019) reported that defoliating insects such as Jassids etc reduce yield (pod reduction) of okra.

The basic reason or aim of intercropping is to maximize productivity by intensification of land use with the most economically feasible and possible combination of compatible crops using the most desirable cropping pattern for a given geographical area under the traditional system (Udo-Ekong, 1982). The intercropping of two or more crops has been a common feature of food production practised long ago in many tropical countries of Africa especially in Nigeria, India, and China, (Fawusi, 1985). One of the rationales of intercropping in the traditional farming systems is to efficiently or completely utilize land resources (i.e plant growth environment to produce higher yield) especially where scarcity of land acts as a prompting factor that makes poor resource farmers to grow many crops on a small piece of land. (O Calaghan *et al*, 1994).

In Nigeria traditional cropping systems, okra and maize are usually sown together in mixture in various spatial arrangements (Fawusi 1985) with variable numbers of plants per unit area. Ayeni (1987) reported that about 73% of maize produced in Nigeria is through mixed cropping. Okra has also been intercrop with other crops but not in a definite row arrangement. It could be envisage that with proper row arrangement the overall productivity of the crop in mixture will improve.

.It has been reported that okra yields in maize intercrop has been low due to many factors among which are low plant stand (Fatokun and Chieda 1983) and lack of definite row planting pattern in an intercropping system of the southern guinea agro-ecological zone of Nigeria.

The aim of the present study was to evaluate the growth and yield parameters of okro in sole and intercropped okro and maize .

MATERIALS AND METHODS

Site Description

The experimental locations were: Location 1: University of Agriculture, Teaching and Research Farm, Makurdi, Nigeria located at (Lat 7^{0}42' N and long 8^{0}37'E) at an elevation of 97m above sea level. The area has annual rainfall of 1200 – 1500mm bimodally distributed (Kowal and Knabe 1972, Ikeorgu, 2001). The Meteorological information for Makurdi during January-December, 2010 is shown in table 13 .Location 2: Kogi State University, Teaching and Research Farm, Anyigba, Nigeria located at (Latitude 7^{0}62'N and Longitude 6^{0}4Y'E) also in the Southern Guinea Savanna zone of Nigeria as described by Kowal and Knabe (1972). The Meteorological information for Anyigba during January-December, 2010 is shown in table 12.The climate is hot-humid, characterized by ambient temperature range of 25-30^{0}C with the hottest period of the year extending between February and May. The annual rainfall ranges from 1400 - 1500mm lasting for about 6 – 7 months. The area has two distinct seasons (wet and dry). The experiment was carried out during the early and late cropping seasons of 2011.

Soil Sampling/Analysis

Pre-planting soil samples were collected from a depth of 0-30cm from the two locations using a soil augur and the physico-chemical analysis were carried out in the Soil Science laboratory of the University of Agriculture, The pH of the soil was determined using the pH meter with calomel electrodes (IITA, 1979).Organic carbon was determined using the chromic acid digestion of Walkey-Black(1934).Total Nitrogen in the soil was determined using the regular micro-kjeldahl method (Black, 1965).Available phosphorus was determined using the method of Bray and Kurtz(1945).Using the EDTA titration method to determine Exchangeable Potassium by (Chapman *et al* 1965).

Seed Bed Preparation, Planting and Agronomic Practices

In each location, the land was ploughed; harrowed and 1.0m ridges were constructed for both maize and okra on the same plot .Each plot was made up of five rows(ridges).

The cultivar of maize used for the study was downy mildew and streak- resistant early maturing – yellow (DMSR – EY) developed at the international Institute of Tropical Agriculture (IITA), Ibadan, Nigeria while the cultivar of okra used was NHAe 47-4-a photoperiodic neutral variety sourced from the National Horticultural Research Institute (NIHORT) Ibadan , Nigeria. The varieties of both crops are high yielding and show wide adaptation to different environment.

The planting density of maize was kept constant at 40,000 plants/ha at spacing of 1.00mx0.25m, while the planting density of okra was varied as follows: The treatments were Treatment 1- S.A1: 1.00m x0.60m giving a plant population density of 16, 667 plants/ha, Treatment2 - S.A2: l.00m x 0.50m giving a plant population density of 20,000 plants/ha, Treatment 3:S.A3:.00mx0.30m giving a plant population of 33,333 plants/ha.

A mixture of pre-emergence and post-emergence herbicides (primextra Gold and Paraquat(gramozone) was applied for weed control after the ridges were made.

Intercrop with maize. The treatments were; Treatment 1 - S.Al: 1.00m x 0.60m giving a plant population density of 16, 667 plants/ha, Treatment2 - S.A2: 1.00m x 0.50m giving a plant population density of 20,000 plants/ha, Treatment 3:S.A3 :1.00mx0.30m giving a plant population of 33,333 plants/ha, while maize was kept at a spacing of

1.00m x 0.25m giving a constant optimum plant density of 40,000 plants/ha.

To the number of seedling emerging within that interval plus the number of seedling that emerges between the beginning of the test and the end of a particular interval speculated.

NPK (20:10:10) fertilizer was applied to maize stands two weeks after sowing (WAS) at the rate of 70kgN ha^{-1}, 35kg P_2O_5 ha^{-1} and 35kgKha^{-1} using the ring method .while urea was applied to supply the remaining half of N(70kgN ha^{-1}) at second application for top dressing just before tassel initiation and at the onset of okra flowering .Fertilizer was not directly applied to okra crop but in stand replacement treatment, since okra stands would benefit from fertilizer applied to maize stands. Beginning from ten days after swing(DAS) to 70 DAS the okra stands were sprayed with insecticide called BEST - Cypermethrin 10% EC on weekly basis at the rate of 30g a.i ha^{-1} to control flea beetles (*Podagrica sjostedti Jack*,). The spraying was stopped seven day before harvesting.

For both maize and okra, the dilution rate of the chemical formulation in water is 500-1000 litres/ha to control pests such as diamond black moth (spodoptera) for maize, cut worm, stern borer. The insecticide is a broad spectrum insecticide for Agricultural and Horticultural crop to control insect pest. Air =100gm/litre w/v solvent + Emusifiers.

At seven days after emergence, carbofuran (Furadan 3 G) was applied to control stem borers in the maize stands at the rate of 750g a.i ha^{-1} and prometryne at 2.0 kg a.i ha^{-1} to effectively control weeds on the maize/okra field (Onwueme and Singh, 1991) Other weeds were manually removed using hoe to ensure that the plots were kept weed free.

Data Collection

The various relevant biometric observations on growth parameters and yield/yield components of maize and okra were obtained 12 WAP.

Four okra plants were also randomly harvested from two central rows at four-five days interval starting from ten days after the first flower opening. A sample of five plants were selected at random and observations were made and recorded on the growth characters up to twelve (12) weeks after planting when all the vegetative characters of both crops had attained their maximum growth. The following growth parameters, yield and yield components of okra and maize were recorded at 12 weeks after planting. Plant height was determined by measuring the distance between the base or soil surface to the collar or nodes bearing the flag leaf (topmost leaf) where 0.75 crop factor for maize (Duncan and Hesketh,1968). Number of days to 50% Silking or Mid-Tasselling was determined by systematic counting of tasselled or silked stands on the middle rows of each plot

At twelve weeks after sowing (12 WAS), two-five plants of each crop were randomly selected from within the three middle inner rows from the sub-plot. The Five plants randomly sampled per plot were oven dried to a constant weight at 70^0C. These were used in the determination of the total dry matter (TDM) of the above ground portions at harvest.

Plant height of okra was determined by measuring the distance between the base or soil surface to the nodes bearing the flag leaf where the flower begins using measuring tape. From the four middle rows, five plants were randomly selected to be used in the measurement of plant heights and the mean of height measured, expresses the plant height in cm

The leaf area of okra was determined using the regression equation y = 0211+0.6 x (r = 0.98*) developed by measuring the products of the length and breadth (X) of leaves.

The leaf area of okra was determined using the regression equation y = 0211+0.6 x (r = 0.98*) developed by measuring the products of the length and breadth (X) of leaves.

The number of branches per okra stand was obtained by physically counting the of the branches produced by okra stand in the two middle rows of each plot after harvesting.

This was determined by systematic counting of flowered plants on the middle rows of each plot when almost half of the plants had flowered. (TDM) per plant. At twelve weeks after sowing (12 WAS), two-five plants of each crop were randomly selected from within the three middle inner rows from the sub-plot. The Five plants randomly sampled per plot were oven dried to a constant weight at 70^0C These was used in the determination of the total dry matter weight of the above ground portion (TDM) at harvest.

Yield Components of okra ; was obtained by physically counting the pods in the two middle rows of each plot after harvesting.

pod weight was determined by weighing the pod produced by okra stand from two middle rows of each plot, bulked together using weighing scale the mean weight are recorded in g. Fresh pod yield per hectare was determined by using weighing scale to weigh fresh pods collected from each treatment plot ,weight are expressed in tons ha^{-1}

Experimental Design and Treatments

The experiments were laid out in a Randomized Complete Block Design with a 2x2x3 split plot arrangement of treatment, replicated three times in a gross plot size of 25.00m x 10.00m and a net plot size of 4.00m x 3.00m. In each location and season, the spatial arrangement (intra-row spacing) of okra constituted the main plots.

Treatment consisted of three spatial arrangements of okra and their corresponding plant population densities per hectare in both sole and intercrop with maize. The treatments were; Treatment 1 - S.Al: 1.00m x 0.60m giving a plant population density of 16, 667 plants/ha, Treatment2 - S.A2: 1.00m x 0.50m giving a plant population density of 20,000 plants/ha, Treatment 3:S.A3:1.00mx0.30m giving a plant population of 33,333 plants/ha, while maize was kept at a spacing of 1.00m x 0.25m giving a constant optimum plant density of 40,000 plants/ha.

Statistical Analysis

All data collected on okra and maize were subjected to statistical analysis using GENSTAT 5 Release 3.2 (1995) following the analysis of variance procedures (Gomez and Gomez, (1984) for a randomized complete block Design as described by Steel and Torrie (1980). Treatment means were separated using by Least Significant Difference (LSD) at p<0.05 described by Gomez and Gomez, (1984)

RESULTS AND DISCUSSION

Soil Analysis

Pre-planting soil samples were collected from a depth of 0-30cm from the two) location using soil Auger. The physico-chemical analysis were carried out. Table 1: shows the physical and chemical properties of the experimental sites (UAM and KSU) The soil for location 1 was . characterized as sandy loam with a pH of 7.40 in water, organic carbon 2.2 1%, total Nitrogen 0.69%, available phosphorus (Bray's P1) 34.O0ppm, exchangeable potassium 0.12 meq $100g^{-1}$ of soil for both early and late cropping season .For location 2(KSU Anyigba), the soil was also characterized as sandy loam with a pH of 7.0 in water, organic carbon 2.19%, total Nitrogen 0.73%, available phosphorus (Bray's P1) 32.50ppm, exchangeable potassium 0.16 meq $100g^{-1}$ of soil for both early and late cropping.

Table 1: Physical and Chemical Properties of the soils of the two experimental locations.

Physical Properties	Makurdi	Anyigba
% Sand	9.40	9.30
% Silt	69.70	70.00
% Clay	20.90	20.70
Textural class	7.00	6.00
Chemical properties		
% Organic Carbon	2.21%,	2.19%,
% Total Nitrogen	0.69%,	0.73%,
Available P(ppm)	34.00	32.50
Ca (meq/100g)	1.50	1.50
Mg (meq/100g)	1.00	0.98
Exch. K (meq/100g)	0.55	0.57
Exch. Al3+ (meq/100g)	0.03	0.04
Extr. Zn (ug g^{-1})	9.40	9.30
p^H in H_2O	7.40	7.00
p^H in C_aCl_2	5.00	5.10

Effects of location, cropping season, and spatial arrangement of okra on the performance and yield component of okra in maize/okra intercrop in the Southern Guinea Savanna of Nigeria.

The effects of location, cropping season and spatial arrangements are presented in Table 2. The location had significant (p<0.05) influence on the plant height, days to 50% anthesis, total dry weight, pod weight(g), fresh pod yield of okra evaluated but did not significantly influence the leaf area index, number of branches, number of pods per plant. UAM location had highest value for plant height(65.00cm),leaf area index (2.40),number of branches (l.88),days to 50% anthesis (53.76%), number of pods per plant(6.74) while KSU location gave the highest total dry weight(42.82glplant), pod weight(9.80g),fresh. pod weight(64.81g/plant), fresh pod yield(5.41t/ha).while the lowest value for plant height(63.73crn),leaf area index (2.23),number of branches(l.83),days to 50% anthesis (50.67%),number of pod per plant(6.66 t/ha) were observed in the KSU location and UAM location gave the lowest total dry weight(37.90g/plant),pod weight(9.34g) fresh pod weight(62.86g/plant), fresh pod yield(4.52t/ha).

The cropping season significantly (p<O.O5) influenced all the growth and yield parameters evaluated. Early cropping season gave the highest values for plant height(64.95cm),leaf area index(2.40), dry matter weight per plant(45. 14 g/plant),number of pod per plant(8.32) pod weight(9.83g) fresh pod yield (80.56g/plant),fresh pod yield (5.71 ton/ha) while the late cropping season gave the highest number of branches(1 .86) and days to 50% anthesis (52.59%).

Significant (p>0.05) influence of spatial arrangement was obtained on all the growth and yield parameters evaluated .The plant population of 33,333 plants/ha with Spatial arrangement of 1.00m x 0.30m gave the highest value for plant height(73 .58cm) and was significantly different(p>0.05) from a plant population density of 20,000 plants/ha with spatial arrangement of (1.00mx0.50m) with height 63.32cm and sole okra crops with height 64.05cm while, Okra with a plant population density of 16, 667 plants/ha spatial arrangement of 1.00mx0.60m had the shortest plants .The variation in row spacing had significant effect on the plant height .The closest intra-row spacing(0.30m) induces taller plants than the widest intra — row spacing(0.60m) in both early and late cropping season of 2010 at UAM and KSU locations. Generally, intercropping tends to increase the height of okra plants when compared with sole cropping. The sole maize gave highest leaf area index(4.35), pod weight (10.25g/plant),fresh pod yield(8.59t/ha) of okra, while spatial arrangement of 1.00mx0.60m gave the lowest value for plant height(54.5 cm), leaf area index (1.1 3), fresh pod yield (2.84t/ha). Also, spatial arrangement of 1.00mx0.60m had the highest number of branches (2.65), days to 50% anthesis(53.40%), number of pods per plant(9.15), fresh pod weight(83.35g,/plant), days to 50% tasselling (57.22%) total dry weight (83.84g/plant), number of cob per plant (0.95), number of grains per cob(3 01.78), 100-grain weight (18.03g),and dried grain yield(2 .90 tons/ha) were observed during the late cropping season.

The spatial arrangement of okra in maize /okra mixture significantly($p<0.05$) affected the plant height, leaf area index, days to 50% tasselling, total dry weight, number of cobs per plant, number of grains per cob,100-grain weight and did not significantly influence the dry grain yield of maize. The plant population of 33,333 plants/ha with spatial arrangement of 1.00mx0.30m gave the highest values for plant height(262.25cm),and Cropping season gave the highest value for plant height (237.88cm), leaf area index (4.47), days to 50% tasselling (59.84%), total dry weight (97.65g/plant), number of cob per plant (1.12), number of grains per cob (515.93), 100-grain weight (24.55g), and dried grain yield (3.44 tons/ha) were observed during the early cropping season, while the lowest value for plant height (233.50cm), leaf area index (4.15), days to 50% tasselling days to 50% tasselling (60.08%), while sole maize gave the highest values for leaf area index (5.10), total dry weight (117.92g), number of cobs per plant (1.29), number of grain per cob (448.), 100-grain weight (24.38g) and dried grain yield (3.34 t/ha). The height of maize increased as the plant spacing of okra decreased. In both early and late cropping seasons at the two different locations, the sole maize plants were shorter in height than that of maize intercropped with various intra-row spacing of okra

Adjustment of spatial arrangements of component crops in mixture plays vital roles in the reduction of competition for growth resources in multiple cropping (Olufajo, 1995). Plant responses arising from these may differ according to locations or eco-typic environments. The result of this study revealed a consistent significant ($p>0.05$) influence of location, cropping season and spatial arrangement on the height of maize and though the height of maize was about three to four times taller than that of okra. Similar results were reported by Muoneke and Asiegbu *et al.*, (1997). This may probably be as result of greater shading effect from the maize component on the okra which may have reduced the ability of okro to tap solar radiation for the formation of photosythetates. Generally, it is expected that crops grown in close spatial arrangement would compete for the available growth resources at some point as the seedling grows (Hay and Walker, 1989). The primary effect of this competition is that it will increase the level of gibberellins -a plant growth hormone, thus promoting the extension of the leaf sheath and blade and in-turn accelerate growth and development processes including increase in plant height. Obasi (1989) and Orkwor *et al.,* (1991) opined that in maize/okra mixture maize uses its height advantage to successfully compete with okra for light as it has its foliage at the higher canopy layer. Palaniappan (1985) and Orasantan and Lucas (1992) noted that canopy height is one of the vital features that determines the competitive ability of plant for light interception. Palaniappan (1985) also observed that in an intercropping situation where there are height differences such as maize/okra mixture, the taller component intercepts major share of the incident light on the plant. The growth rate of maize component whose foliage canopy is at the higher layer and okra whose foliage is at lower canopy layer is proportional to the quantity of the photosynthetically active solar radiation they intercepted. In the present study, maize was about three to four times taller than okra as it displays its foliage at higher canopy and shaded okra .The leaf area index of maize was also higher than that of okra.

Table 2: EFFECTS OF LOCATION, CROPPING SEASON AND SPATIAL ARRANGEMENT OF OKRA ON THE GROWTH AND YIELD COMPONENTS OF OKRA IN MAIZE/OKRA MIXTURE.

Treatments	*Plant Height (cm)*	*Leaf Area Index*	*No. of branches*	*Days to 50% An thesis*	*Total dry weight (g/plant)*	*No. of pods per plant*	*Pod weight (g/plant)*	*Fresh pod weight (g/plant)*	*Fresh and yield (t/ha)*
LOCATION									
AM	65.00	2.40	1.88	53.76	37.90	6.74	9.34	62.86	4.52
KSU	63.73	2.23	1.83	50.67	42.82	6.66	9.80	64.81	5.41
LSD(0.05)	0.235	0.4814	0.1091	0.295	2.329	0.4044	0.0528	4.316	0.5651
Topping season									
Early	64.95	2.40	1.85	52.59	45.14	8.32	9.83	80.56	5.71
Late	63.78	2.24	1.86	51.85	35.59	5.08	9.32	47.11	4.22
LSD (0.05)	0.231	0.3913	0.3647	1.582	1.219	0.2539	0.4240	3.187	0.2423
Spatial									
Arrangement	64.05	4.35	1.99	50.95	51.85	7.00	10.25	70.00	8.59
Sole okra									
1.00 x 0.50m	54.50	1.13	2.65	53.40	49.67	9.15	9.88	83.35	2.84
Intercrop									
1.00 x 0.50m	65.32	1.60	1.85	52.47	36.12	6.18	9.20	54.15	4,05
Intercrop									
1.00x 0.30m	73.58	2.19	0.93	52.04	23.80	4.48	8.96	47.85	4.38
Intercrop									
LSD(0.05)	0.789	0.1595	0.3537	1.093	0.730	0.5271	0.2294	1.800	0.5201

KEY:
UAM=University of Agriculture Makurdi
KSU=Kogi State University, Anyigba.

Interaction between location and cropping season on some growth and yield components of okra in a maize/okra mixture.

The interaction effects between location and cropping season are presented in Table 3. The interaction between location and cropping season significantly ($p<0.05$) influenced the plant height, days to 50% anthesis, total dry weight, number of pods per plant, Fresh pod yield of okra but did not significantly($p<0.05$) influenced the leaf area index, number of branches and pod weight of okra. UAM location gave the highest plant height (65.07cm), dry matter weight(47.60g/plant) during the early cropping season, number of pods per plant(8.18) were obtained in UAM location during the early cropping season, while the highest values for leaf area index(2.45), number of branches(2.02), and days to 50% anthèsis (54.49%), were obtain in UAM location during the late cropping season. The highest values for pod weight (10.18g), fresh pod yield (83.63g/plant and 5.89tons/ha) were observed in the early cropping season at KSU location. Also, the lowest values for plant height (62.63 cm), leaf area index (2.03), number of branches (1.70), number of pods per plant (4.87), fresh pod yield (48.23g/plant) were all observed during the late cropping season in 2010.

Intercropping depressed the leaf area index, total plant dry matter, as well as the yield of okra and maize when compared to that of the sole crops. The depressive effects of intercropping on yield was more expressed on the plots with the closest intra-row spacing of okra. Yield depression was higher in okra than in maize. This result was similar to that reported by Ofori and Stem (1987) in a maize/cowpea intercrop where the relative time of sowing of the components was studied.

The yield reduction in okra were 44%, 50% and 48% while that of maize were 18%, 23% and 24% for the three intra-row spacing of okra via: 0.60m x 1.0m (16,670 plants/ha); 0.50m x 1.0m (20,000 plants/ha and 0.30m x 1Mm (33,330 plants/ha). Bake *et.al*., (2017) a spacing of 60cm by 60 cm as optimum for growth ,yield and quality pods , they further stated that that number of leaves is influenced by plant spacing. There was a clear substantial season to season variation in okra yield probably due to variation in rainfall. The results are in conformity with those of Bisaria and Shamshery (1979) who reported that early sown okra out- yielded the late sown okra crop probably as a result of some physiological stress from a periodic dry spell. Lai Cruishan and Singh (1969) reported that late sowing adversely affected plant growth, vigour, and consequently reduced number of pods, and pod size, and total fresh pod yield

Table 3: INTERACTION BETWEEN LOCATION AND CROPPING SEASON ON SOME GROWTH AND YIELD COMPONENTS OF OKRA IN A MAIZE/OKRA MIXTURE.

Cropping season	Plant Height (cm)	Leaf Area Index	No. of branches	Days to 50% Anthesis	Total dry weight (g/plant)	No. of pods per plant	Pod weight (g)	Fresh pod yield(g/plant)	Fresh pod yield(t/ha)
Early	65.07	2.35	1.75	53.03	47.60	8.18	9.48	77.50	5.52
Late	64.93	2.45	2.02	54.49	28.20	5.30	9.21	48.23	3.51
Early	64.83	2.44	1.95	52.15	42.68	8.46	10.18	83.63	5.89
Late	62.63	2.03	1.70	49.20	42.98	4.87	9.43	48.23	4.94
	0.244	0.2213	0.3617	1.576	1.850	0.3326	0.4233	3.771	0.4477

KEY:
UAM=University of Agriculture, Makurdi.
KSU=Kogi State University, Anyigba.
LSD0.05=Least Significant Difference at 5% level of probability.

Location and spatial arrangement interaction on the growth and yield of okra in maize/okra intercropping system

Table 4 presents the effect of interaction between location and spatial arrangement on the growth and yield of okra in maize/okra mixture. The location and spatial arrangement had significant (p>0.05) influence on the days to 50% anthesis, total dry weight, number of pods per plant ,pod weight ,fresh pod yield of okra, but did not significantly (p>0.05) influence the plant height ,leaf area index, and number of branches of okra. The spatial arrangement(1.00mx0.30m) gave the highest plant height (74.45cm g), sole okra gave the highest leaf area index (4.45 at sole okra), at spatial arrangement of 1.00m x 0.60m gave the highest days to 50% anthesis (56.45) at UAM location, spatial arrangement of 1.00m x 0.60m gave the highest number of branches (2.65) for both UAM and KSU location; while sole okra have the highest total dry weight (57.20g/Plants) at KSU location, spatial arrangement of 1.00m x 0.60m gave the highest , number of pods per plant (9.35) at KSU location), sole okra gave the highest pod weight (10.75g) and fresh pod yield (8.85) t/ha at the KSU location, spatial arrangement of 1.00m x 0.60m gave the highest fresh pod yield (97.5oglplant) at the KSU location. The maximum yield observed showed that great diversity of environmental condition influence the yield component of crops in the area under test.

Francis *et al* (1978) reported the complex factors that influence yield of crops to include water supply, temperature, solar radiation, nutrient, damage by pests and disease, adverse radiation, adverse weather conditions, these factors varies from one location to another. But, the most complicated factor apart from climatic condition is water supply as this is dependent on the soil type, and the amount of water available in the soil for plant uptake. Where there is a considerable difference in yield in the same ecological zone, that may be caused by difference in water supply as a result of possible difference in soil types. Differences in weather conditions during the growing seasons (Table 13 and 14) could probably be the main cause for the differences in yield levels in the two locations of the study.

Observation shows that maize has the height advantage than okra and has the tendency to intercept more of the photosynthetically active solar radiation than okra. This result tallies with the conclusion made by Obasi (1989) and Orkwor *et al*, (1991) that in maize/okra mixture, maize which has its foliage at the higher canopy layer can be termed a more aggressive competitor for light. Adelana (1984) reiterated that maize shows a shading effect on okra due to its height advantage and larger LAI.

Table 4: LOCATION AND SPATIAL ARRANGEMENT INTERACTION ON THE GROWTH AND YIELD OF OKRA IN MAIZE/OKRA INTERCROPPING SYSTEM

Location	Spatial arrangement	Plant Height (cm)	Leaf Area Index	No. of branches	Days to 50% Anthesis	Total dry weight (g/plant)	No. of pods per plant	Pod weight (g)	Fresh pod yield (g/plant)	Fresh pod yield/t/ha
UAM	Sole Okra	64.85	4.45	2.03	51.40	46.50	7.55	9.75	75.20	8.34
	1.00x0.60m	55.40	1.20	2.65	56.45	49.85	8.95	9.60	69.20	2.41
	1.00x0.50m	65.28	1.70	1.90	54.45	35.20	6.15	9.00	52.85	3.86
	l.00x0.30m	74.45	2.25	0.95	52.73	20.05	4.30	9.02	54.20	3.47
KSU	Sole Okra	63.25	4.25	1.95	50.50	57.20	6.45	10.75	64.80	8.85
	1.00x0.60m	53.60	1.05	2.65	50.35	49.50	9.35	10.15	97.50	3.27
	1.00x0.50m	65.35	1.50	1.80	50.50	37.05	6.20	9.40	55.45	4.24
	1.00x0.30m	72.70	2.13	0.90	51.35	27.55	4.65	8.90	41.50	5.30
	LSD(0.05)	0.972	0.3641	0.4358	1.345	1.761	0.6713	0.2819	3.363	0.6923

KEY:
UAM=University of Agriculture, Makurdi.
KSU=Kogi State University, Anyigba.
LSD(0.05=Least Significant Difference at 5% level of probability

CONCLUSION AND RECOMMENDATIONS

Conclusion

Okra population at the spatial arrangement of 1.0m x 0.6m (16,670 plants ha- 1) gave the highest yield value indicating advantage of intercropping at low okra density; followed by spatial arrangement of 1.0m x 0.50m (20,000 plants ha-1) and 1.0m x 0.30m (33,340 plants ha-1) respectively.

The yields of both crops were better during the early planting seasons than in the late planting seasons.

Intercropping increased the combined yield as the planting density of okra increased from medium-highest especially when the yields of both components crops in the mixture is high.

Recommendations

The best spatial arrangement to recommend for farmers in the UAM/KSU is 1.00m x 0.60m (16,670 plants ha-1). Intercropping should be encouraged in the two experimental locations . The outcome of this study is worth further investigation.

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