EFFECTS OF LOCATION, CROPPING SEASON AND SPATIAL ARRANGEMENTS INTERACTIONS ON THE GROWTH AND YIELDS OF MAIZE AND OKRA IN A MAIZE/OKRA INTERCROPPING SYSTEM.

[1]Atebije,S.M., [2]Are, E.C., [3] Ajanya ,S., [2] Audu,A., [2] Joseph, P.O., [4] Omale,.Z.Y.
[1]Department of Crop Production, University of Agriculture, Makurdi, Nigeria
[2]Department of Soil and Environmental Management, Kogi State University, Anyigba, Nigeria
[3]Department of Crop Production , Kogi State University Anyigba, Nigeria
[4]Department of Food, Nutrition, and Home Sciences, Kogi State University, Anyigba, Nigeria.
Email: sundayatebije73@gmail.com

ABSTRACT

Field trials were carried out to evaluate the effects of location, planting season and spatial arrangement interactions on the growth and yield of maize and okra in a maize/okro intercrop in two locations in the Southern guinea savannah during the early and late cropping seasons. The two locations were: location 1: University of Agriculture Teaching and Research farm, Makurdi and location 2: kogi state University Teaching and Research farm Anyigba. Treatments comprised of three okra densities viz: 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. The varieties of both crops are high yielding and show wide adaptation to different environments. 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 per ha^{-1} to control flea beetles. The height of maize plant increased as the spacing of okra plant decreased and the planting density increased. The Leaf Area Index of maize decrease as the okra plant spacing decreased. Intercropping reduced the yield and yield component of okra (i.e the number and weight of fresh pods per plant) and that of maize (I.e the number of cobs, cob length and 100 grain weight also 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).It was concluded that there were significant effects between location and spaial arrangements , between location and cropping season, between cropping season and spatial arrangements and amongst location ,cropping season and spatial arrangements. It was therefore recommended that farmers in the study location should use the appropriate plant spacing and also plant their crops early.

Keywords: Location, Spatial Arrangements, Growth , Yield, Interactions, Maize

INTRODUCTION

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.

Sullivan (2003) established that intercropping or multiple cropping is food production strategy used by farmers in many parts of the world to primarily increase diversity of product and ensure stability of annual output from their farms. He further stated that the presence of multiple crop in a single field will reduce the amount of herbicides or fertilizes applied to that field at any time.

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. In an experiment to study the effect of crop geometry, intercropping systems and integrated nutrient management practices on productivity of corn (*Zea mays L.*) based intercropping systems, Thavaprakaash, *et al* (2005) observed that yield levels of intercrops were higher under closer row geometry (45cm) than 60cm spacing

The aim of this present investigation was to evaluate the interactions amongst location , cropping season and spatial arrangements as they affect growth and yield of maize and okra planted together. with a view to further enhancing the productivity of the maize/okra intercropping system and also to optimize the production of okra in mixture by choosing a suitable spatial arrangement in an intercropping system with maize.

MATERIALS AND METHODS

Field trials was conducted in two locations in the southern Guinea Savannah zone of Nigeria to determine the effects of intra-row spacing of okra on the performance of component crops in maize/okra intercrop during the early and late cropping seasons of 2010. The 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 25-30^0C 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 for soil in locarion 1 for both the early and late cropping were carried out in the Soil Science laboratory of the University of Agriculture, Makurdi . .For location 2(KSU Anyigba), the physico-chemical analysis were carried out in Government Science Secondary School Laboratory, Dekina, Kogi State

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_20_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 days 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 yie1d/yie1d components of maize and okra were obtained 12 WAP.

Four okra plants were also ran4omly 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 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 wire 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 beating the flag1eaf (topmost leaf) where

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. 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 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.

Number of pods per plant 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

Table 1: shows the physical and chemical properties of the two locations (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

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 2. 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.

Manipulation of spatial arrangement 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 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.

Interaction between Location and cropping season on the growth and yield components of maize in the maize/okra mixture.

The data presented in Table 3 showed that location and cropping season interaction significantly ($P<0.05$) influenced plant height, days to 50% tasselling, total dry weight, number of grains per plant, 100-grain weight in maize evaluated, but did not significantly ($p<0.05$) influence the leaf Area index, number of cobs per plants, and the dry grain yield of maize. The highest plant height (241.25 cm) was obtained at the KSU location during the early cropping season while the UAM location gave highest leaf area index(4.48), days to 50% tasselling (60.28%), total dry weight(99. 14g/plant), number of cobs per plant (1.17), number of grains per cob (525.95), dry grain yield (3.52t/ha), during the early cropping season.

The lowest plant height(228.50cm) was obtained at the KSU location during the late cropping season while the KSU location gave the lowest leaf area index(3.98), days to 50% tasselling (57.09%) during the late cropping season and, UAM location gave the lowest total dry weight(79.80g/plant), number of cobs per plant(0.90),number of grains per cob(222.65) during the late cropping season, 100-grain weight(12.85g), dry grain yield(2.90t/ha), during the late cropping season at both UAM and KSU location.

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.

Table:3 LOCATION AND CROPPING SEASON INTERACTION ON GROWTH AND YIELD COMPONENTS OF MAIZE IN MAIZE/OKRA INTERCROPPING SYSTEM.

Location	Cropping season	Plant Height (cm)	Leaf Area Index	Days to 50% Tasselling	Total dry weight (g/plant)	No. of cobs per plant	No. of grains per cob	100-Grain-weight(g)	Dried Grain Yield (t/ha)
UAM	Early	234.50	4.48	60.28	99.14	1.17	525.95	24.67	3.52
	Late	238.50	4.33	57.35	79.80	0.90	222.65	12.85	2.90
KSU	Early	241.25	4,46	59.40	96.15	1.05	505.90	24.43	3.36
	Late	228.50	3.98	57.09	87.88	1.00	380.90	23.20	2.90
LSD (0.05)		4.748	0.2702	0.1332	0.765	0.7966	1.829	0.2392	0.1601

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

Cropping season and spatial arrangement interaction on the growth and yield component of okra in maize/okra mixture.

Table 8 presents the effect of interaction between cropping season and spatial arrangement on the growth and yield of okra in maize/okra mixture. The interaction between cropping season and spatial arrangement significantly (P<0.05) influence the total dry matter, days to 50% Anthesis number of pods per plants, fresh pod yield(Table 8) but did not significantly influence the plant height, leaf area index, number of branches and pod weight of okra. The highest plant height (74.35cm) were observed during the early cropping season and (72.80cm) during the late cropping season at spatial arrangement (1.00x0.30m), leaf area index (4.45) during the early cropping season and (4.25) during the late cropping season at sole okra, number of branches (2.75) during the early cropping season and (2.55) during the late cropping season at spatial arrangement (1.00m x 0.60m),days to 50% anthesis (52.80%) during the early cropping season and (54.00%) during the late cropping season at spatial arrangement (1.00x0.60m),total dry matter (57.30g/plant) during the early cropping season and (46.40g/plant) during the late cropping season at sole okra, number of pod per plant(11.57) during the early cropping season and (6.73) during the late cropping season at spatial arrangement (1.00x0.60m), pod weight (10.40g) during the early cropping season and (10.10g) during the late cropping season at sole okra, and fresh okra yield (9.95t/ha) observed during the early cropping season and (7.24t/ha) during the late cropping season at sole okra, while the lowest plant height (55.35cm) were observed during the early cropping season and (53.65cm) during the late cropping season at spatial arrangement (1.00x0.60rn), leaf area index (1.20) during the early cropping season and (1.05) during the late cropping season at spatial arrangement(1.00mx0.60m), number of branches (0.75) during the early cropping season and (1.10) during the late cropping season at spatial arrangement (1.00cm x0.30m),days to 50% anthesis (52.05%) during the early cropping season and (49.85%) during the late cropping season at sole okra, total dry matter (29.10g/plant) during the early cropping season and (18.50glplant) during the late cropping season at spatial arrangement(1.00mx0.30m), number of pod per plant(5.25) during the early cropping season and (3.70) during the late cropping season at spatial arrangement (1.00x0.30m),pod weight (9.20g) during the early cropping season and (8.72g) during the late cropping season at the plant population of 33,333 plants/ha with spatial arrangement of 1.00mx0.30m and fresh okra yield (3.28t/ha) obtained during the early cropping season and (2.40t/ha) during the late cropping season at spatial arrangement (1.00x0.60m). 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). 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:4 CROPPING SEASON AND SPATIAL ARRANGEMENT OF OKRA INTERACTION ON GROWTH AND YIELD OF OKRA IN MAIZE/OKRA MIXTURE.

Cropping season	Cropping system	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	Sole Okra	64.80	4.45	2.10	52.05	57.30	8.55	10.40	84.70	9.95
	1.00x0.60 m	55.35	1.20	2.75	52.80	53.50	11.57	10.15	117.45	3.28
	1.00x0.50 m	65.28	1.70	1.80	52.40	40.65	7.90	9.55	73.95	4.25
	1.00x0.30 m	74.35	2.23	0.75	53.10	29.10	5.25	9.20	46.15	5.35
	Sole okra	63.30	4.25	1.88	49.85	46.40	5.45	10.10	55.30	7.24
	1.00x0.60 m	53.65	1.05	2.55	54.00	45.85	6.73	9.60	49.25	2.40
	1.00x0.50 m	65.35	1.50	1.90	52.55	3l.60	4.45	8.85	34.35	3.85
	1.00x0.30 m	72.80	2.15	1.10	50.98	18.50	3.70	8.72	49.55	3.42
	F-LSD(0.05)	0.979	0.3903	0.5108	1.826	1.328	0.6685	0.4473	3.405	0.6582

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

Effect of cropping season and spatial arrangement interaction on the growth and yield component of maize in Maize/okra intercropping system.

Table:4 presents the effect of interaction between cropping season and spatial arrangement on the growth and yield of maize in maize/okra mixture The interaction between cropping season and spatial arrangement of okra significantly ($P<0.05$) influenced the plant height, total dry weight, number of grains per cob, 100-grain weight, and dry grain yield of maize components but did not significantly($p<0.05$) influenced the leaf area index, days to 50% tasselling and number of cobs per plants in maize. Spatial arrangement (1.00mx0.30m) gave highest plant height(264.50cm), days to 50% tasselling, during the early cropping season, sole maize gave the highest leaf area index (5.25),total dry weight(123.93g/plant),number of grains per cob(573.40),dry grain yield(4.28t/ha) during the early cropping season and (4.95) during the late cropping season . The plant population of 33,333 plants/ha with spatial arrangement of 1.00mx0.30m gave the highest dry matter weight (123.95g/plant), number of cobs per plant (1.48) during the early cropping season and dry matter of 111 .90g/plant during the late cropping season. The plant population of 33,333 plants/ha with spatial arrangement of 1.00mx0.30m also gave highest plant height of 260.00cm during the late cropping season, 100 grains weight (27.35g) in the early cropping season and (260.00cm) during the late cropping season, and dry grain yield (4.28tons/ha) early cropping season and (260.00cm) during the late cropping season at the sole maize situation, while lowest values for plant height (204.00cm), days to 50% Tasselling of 55.90%, dried grain yield of 2.40tons/ha were obtained in sole maize situation during the late cropping season, while the plant population of 33,333 plants/ha also gave the lowest value for LAI (3.55), dried matter weight (60.75g!plant), number of cobs per plants (0.85), number of grains per cobs (286.00), 100 grain weight (14.05g) during the late cropping season of 2010. 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). 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:5 EFFECTS OF CROPPING SEASON AND SPATIAL ARRANGEMENT OF OKRA INTERACTION ON GROWTH AND YIELD OF MAIZE IN MAIZE/OKRA MIXTURE.

Cropping season	Cropping system	Plant Height (cm)	Leaf Area Index	Days to 50% Tasselling	Total dry weight (g/plant)	No. of cobs per plant	No. of grains per cob	100-grain-weight (g)	Dried Grain Yield (t/ha)
Early	Sole maize	204.50	5.25	58.70	123.93	1.48	573.40	27.35	4.28
	l.00mx0.60m	229.83	4.72	59.30	104.80	1.00	516.70	24.43	3.35
	1.00mx0.50m	252.67	4.20	60.20	82.95	1.00	491.40	23.65	3.12
	1.00mx0.30m	264.50	3.70	61.15	78.90	0.95	482.20	22.75	3.00
Late	Sole maize	204.00	4.95	55.90	111.90	1.10	322.95	21.40	2.40
	1.00mx0.60m	226.00	4.25	56.85	59.20	0.95	302.20	19.40	3.10
	1.00mx0.50m	244.00	3.85	57.13	73.50	0.90	295.95	17.25	3.10
	1.00mx0.30m	260.00	3.55	59.00	60.75	0.85	286.00	14.05	3.00
	LSD(0.05)	2s.949	0.4858	0.6205	0.984	0.3939	0.934	0.3788	0.5116

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

The effect of location, cropping season and spatial interaction on the growth and yield component of Okra in Maize/okra intercropping system.

Table 6 presents the effect of interaction between location, cropping and spatial arrangement on the growth and yield of okra in maize/okra mixture. The interaction of location, cropping season and spatial arrangement of Okra significantly (P<0.05) influence the plant height, Days to 50% Anthesis, Dry matter weight, pod weight, and fresh pod yield of Okra but did not significantly affect, LAI, NQ of branches, and No of pods per plants and the fresh pod of Okra. However, the highest value for plant height (74.70), were obtain at spatial arrangement of (1.00m x 0.30) during the Early cropping season at UAM location the highest value for dried matter weight (62.20g/plant) and fresh pod yield (9.96tons/ha) were observed in the sole Okra situation during the Early cropping season at UAM, the highest value for this to 50% Anthesis (59.50%) at the spatial arrangement (1.00m x 0.60m) and LAI (4.50) at the sole Okra situation during the late cropping season at the UAM location.

While the highest values for No of branches (2.80) No of pods per plant (12.13) and fresh pod yield (129.90g/plant) were observed at the spatial arrangement (1.00m x 0.60m) during eh early cropping season at the KSU location. Whole the highest values for pod weight (11.40) were observed at (sole okra situation during the Early cropping season at KSU location. The lowest values for plant height (50.80cm), leaf Area Index (0.90), Days to 50% Anthesis (48.50) were observed at spatial arrangement (1.00mx0.60m) of okra Dry matter weight (26.60g/plant), during the late cropping at spatial arrangement (1.00m x 0.30m), during the late cropping season at KSU location. While the lowest values for pod weight (8.30), Fresh pod yield (32.70 g/plant) were observed at spatial arrangement (1.00mx0.50m), No of pods per plant (3.70) and fresh pod yield (1.84 tons/ha) were observed at spatial arrangement (1.00m x 0.30m) during the late cropping season at the UAM location.

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 could probably be the main cause for the differences in yield levels in the two locations of the study.

Francis *et al* (1978) reported the complex factors

Table 6: EFFECTS OF LOCATION, CROPPING SEASON AND SPATIAL ARRANGEMENT OF OKRA INTERACTION ON GROWTH AND YIELD OF OKRA IN MAIZE/OKRA MIXTURE

Location	Cropping Season	Spatial arrangement	Plant Height(cm)	Leaf Area Index	No. of branches	Days to 50% Anthesis	Dry mater weight (g/plant)	No. of pods per platn	Pod weight(g)	Fresh pod yield(g /plant)	Fresh pod yield (t/ha)
UAM	Early	Sole Okra	66.60	4.40	2.20	52.30	62.20	9.10	9.40	90.00	9.96
		l.00x0.60m	54.30	1.20	2.70	53.40	55.80	11.00	9.60	105.00	2.95
		1.00x0.50m	64.67	1.60	1.80	53.00	42.70	7.70	9.70	73.00	4.08
		1.00x0.30m	74.70	2.20	0.50	53.40	29.70	4.90s	9.20	42.00	5.10
	Late	Sole Okra	63.10	4.50	2.07	50.50	30.80	6.00	10.10	60.40	6.71
		1.00x0.60m	56.50	1.20	2.60	59.50	43.90	6.90	9.60	33.40	1.86
		1.00x0.50m	65.90	1.80	2.00	55.90	27.70	4.60	8.30	32.70	3.63
		1.00x0.30m	74.20	2.30	1.40	52.07	10.40	3.70	8.83	66.40	1.84
	Early	Sole Okra	63.00	4.50	2.20	51.80	52.40	8.00	11.40	79.40	9.94
		1.00x0.60m	56.40	1.20	2.80	52.20	51.20	12.13	10.70	129.90	3.61
		1.00x0.50m	65.90	1.80	1.80	51.80	38.60	8.10	9.40	74.90	4.41
		1.00x0.30m	74.00	2.27	1.00	52.80	28.50	5.60	9.20	50.30	5.59
	Late	Sole Okra	63.50	4.00	1.70	49.20	62.00	4.90	10.10	50.20	7.76
		1.00x0.60m	50.80	0.90	2.50	48.50	47.80	6.57	9.60	65.10	2.93
		1.00x0.50m	64.80	1.20	1.80	49.20	35.50	4.30	9.40	36.00	4.06
		1.00x0.30m	71.40	2.00	0.80	49.90	26.60	3.70	8.60	32.70	5.00
		LSD(0.05)	1.379	0.4834	0.6667	2.231	2.009	0.9459	0.5151	4.503	0.9512

Location, cropping season and spatial arrangement interaction on the growth and yield of maize component in the maize/okra intercropping system.

Table 7 presents the effect of interaction between location cropping season and spatial arrangement on the growth and yield of maize in maize/okra mixture. Interactions between location, cropping season and spatial arrangement of okra had significant ($P<0.05$) influence on the plant height, days to 50% tasselling, total dry matter weight, and number of grains per cob, 100-grain weight of maize, and did not significantly influence the leaf area index, number of cobs per plant, and dry grain yield of maize. The population density of 33,333 plants/ha with spatial arrangement of 1.00m x0.30m gave the highest plant height (259.00cm) in the early cropping season and (268.00cm) during the late cropping season at UAM location. Also, the spatial arrangement (1.00m x0.30m) gave the highest plant height (270.00cm) in the early cropping season and (252.00cm) during the late cropping season at KSU location. Sole maize gave the highest leaf area index (5.20) in the early cropping season and (5.10) during the late cropping season at UAM location .Also, Sole maize gave the highest leaf area index (5.30) in the early cropping season and (4.80) during the late cropping season, at KSU location. The spatial arrangement(1.00m x0.30m) gave the highest for days to 50% tasselling (6 1.70%) in the early cropping season and days to 50% tasselling (59.20%) during the late cropping season at UAM location .Also, the spatial arrangement(1.00m x0.30m) gave the highest for days to 50% tasselling (60.60%) in the early cropping season and for days to 50% tasselling (58.80%) during the late cropping season at KSU location. Similarly, Sole maize gave the highest total dry matter weight (128.57g/plant) in the early cropping season and (108.50g!plant) during the late cropping season at UAM location .Also, Sole maize gave the highest total dry matter weight (1 19.30g/plant) in the early cropping season and (115.30g/plant) during the late cropping season at KSU location. Sole maize gave the highest, number of cobs per plant (1.67) in the early cropping season and (1.10) during the late cropping season at UAM location .Also, Sole maize gave the highest, number of cobs per plant (1.00) in the early cropping season and (1.00) during the late cropping season at KSU location. Sole maize gave the highest number of grains per cob, (584.80) in the early cropping season and (253.30) during the late cropping season at UAM location .Also, Sole maize gave the highest number of grains per cob, (506.00) in the early cropping season and (392.60) during the late cropping season at KSU location. Sole maize gave the highest 100-grains weight (28.20g) in the early cropping season and (16.50g) during the late cropping season at UAM location. Also, Sole maize gave the highest 100-grains weight (26.50g) in the early cropping season and (26.30g) during the late cropping season at KSU location.. Sole maize gave the highest dry grain yield (4.47t/ha) in the early cropping season and (3.401/ha) during the late cropping season at UAM location. Also, Sole maize gave the highest dry grains yield (4.10t/ha) in the early cropping season and (3.80t/ha) during the late cropping season at KSU location. Sole maize gave the lowest plant height (201.00cm) in the early cropping season at the UAM location, days to 50% tasselling (55.60%) in the late cropping season at KSU location. Spatial arrangement (1.00m x 0.30m) gave the lowest leaf area index (3.40), number of cobs per plant (0.60), number of grains per cob (206.70) in the late cropping season at the KSU location. Also, the lowest total dry matter weight (51.50g/plant), 100-grain weight (8.80g), and dry grain yield (2.40t/ha) were observed at spatial arrangement (1.00m x 0.30m) in the late cropping season at the UAM location.

In the plots involving mixtures of okra and maize, observation from the data collected shows that the height of maize was about three to four times taller than that of okra.

The location and cropping season, interaction significantly($p<0.05$) influence the plant height, Days to 50% anthesis, dry matter weight, number of pods per plant, fresh okra and show no significant difference($p<0.05$) in the leaf Area Index, number of branches, and pod weight of okra(Table 3). However, the highest value for plant height(65.07cm), total dry matter weight(47.60), number of pods per plant(8. 18) were observed in the 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% anthesis (54.49), were observed also in the UAM location but in the late cropping season. The highest values for pod weight (10.18g), fresh pod yield (83.63glplant and 5.89t/ha) were obtained in the early cropping season at the KSU location. Also, the lowest values for plant height (62.63cm), Leaf area index (2.03),number of branches(1 .70),number of pods per plant(4.87g), fresh pod yield (48.23g/plant) were all observed in KSU location during the late cropping season, while the lowest values for total dry matter weight(28.20g/plant) ,pod weight (9.21g),fresh pod yield(48.23g/plant and 3.5ltons/ha) were observed .in UAM location during late cropping season. .

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.

. The productivity of this system can be improved by modification in the spatial arrangement and relative population densities especially for okro. This productivity enhancement could be achieved with the spatial arrangement and relative plant density of okro at 1.00mx0.60m (16,667plant/ha), 1.00mx0.50m(20,000plants/ha), 1.00mx0.30m(33,333 plants/ha) with maize kept at its optimum of 40,000plants /ha with spatial arrangement of 1.00mx0.25m.

Table:7 LOCATION, CROPPING SEASON AND SPATIAL ARRANGEMENT OF OKRA INTERACTION ON GROWTH AND YIELD OF MAIZE IN MAIZE/OKRA INTERCROPPING SYSTEM.

Location	Cropping Season	Spatial arrangement	Plant height (cm)	Leaf area index	Days to 50% tasselling	Dry matter weight (g/plant)	No. of cobs per plant	No. of grains per cob	100-Grain-weight(g)	Dry grain yield (t/ha)
UAM	Early	Sole Maize	201.00	5.20	58.70	128.57	1.67	584.80	28.20	4.47
		1.00x0.60m	226.67	4.70	59.90	107.60	1.00	527.40	24.17	3.50
		1.00x0.50m	251.33	4.20	60.80	80.90	1.00	502.90	23.50	3.10
		l.00x0.30m	259.00	3.80	61.70	79.50	1.00	488.70	22.80	3.00
	Late	Sole Maize	205.00	5.10	56.20	108.50	1.30	253.30	16.50	3.40
		1.00x0.60m	230.00	4.50	57.40	93.40	1.00	218.60	14.40	3.10
		l.00x0.50m	251.00	4.00	56.60	65.80	0.90	212.00	11.70	3.00
		1.00x0.30m	268.00	3.70	59.20	51.50	0:80	206.70	8.80	2.40
	Early	Sole Maize	208.00	5.30	58.70	119.30	1.20	562.00	26.50	4.10
		l.00x0.60m	233.00	4.73	58.70	102.00	1.05	506.00	24.70	3.20
		1.00x0.50	254.00	4.20	59.60	85.00	0.87	479.90	23.80	3.13
		1.00x0.30m	270.00	3.60	60.60	78.30	0.70	475.70	22.70	3.00
	Late	Sole Maize	203.00	4.80	55.60	115.30	1.00	392.60	26.30	3.80
		1.00x0.60m	222.00	4.00	56.30	85.00	0.85	385.80	24.40	3.10
		1.00x0.50m	237.00	3.70	57.67	81.20	0.75	379.90	22.80	3.00
		1.00x0.30m	252.00	3.40	58.80	70.00	0.60	365.30	19.30	2.80
		LSD(0.05)	5.012	0.6639	0.8733	1.255	0.7513	1.739	0.5066	0.7266

.

.

CONCLUSION AND RECOMMENDATION

Conclusion

The study showed that there were significant effects of interactions between location and spatial arrangements, between location and cropping season ,between spatial arrangements and cropping season and amongst location ,cropping season and spatial arrangements**.**

Okra population at the spatial arrangement of 1.0m x 0.6m (16,670 plants ha- 1) gave the highest growth and yield 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.

Intercropping increased growth and yield as the planting density of okra increased from medium-highest especially when the yields of both components crops in the mixture is high such as it was obtained in this present study.

The study showed a disadvantage of growing okra and maize together at the highest okra planting density of 33,340 plants ha-1.

Recommendations

The best spatial arrangement to recommend for farmers in the UAM/KSU is 1.00m x 0.60m (16,670 plants ha-1). But this may be worthy of further investigation.

Farmers in the two study locations are adviced to use the appropriate spatial arrangements and also plant at the early planting seasons

REFERENCES

Ayeni, A.O. (1987). Maize production in Nigeria: Problem and prospects. Journal of food and agriculture, 2:123-129.

Bisavia A. K., and Shamshery, A.P. (1979). Effect of different seasons on growth and yield attributes in Okra (Abel/moschus esculentus (L) moench) HaryanaJ. of Agric. Sci. 8: 156-157.

Black, C.A. D.D., Evans, J.L. White, L.E. Ensminger, and F.E. Clark, (Ed) 1965. Method of soil analysis. Part 2. ASA. Madison, W.I.

Chapman, S.R. and Carter L.P (1997) crop production principles and practices. Published by W.H. Freeman and Company. San Francisco.

Duncan, W.G. and Hesketh, J.D.(1968).Net photosynthetic rates ,relative leaf growth and leaf number of 22 races of maize grown at eight temperatures .Crop Science 8:670-674..

Fatokun, C.A. and H..R. Cbheda, (1983). The effects of nitrogen and phosphorus on yield and chemical composition of okra *(Abelmoschus esculentus (L.) moench). Acta Horticulture.* 23:283-290).

Fawusi, M.O.A. (1985). Influence of spatial arrangement on the growth, fruit and grain yields and yield components of intercropped maize and okra. *Field Crop Research.* 17(4):345-352.

Francis, C.A., Flor. C.A. and Pragar, M. (1978), Effect of bean association on yield and yield components of maize. Crop Sci. 18:760-764.

Gomez, K.A. and Gomez A.A. 1984. Statistical procedures for Agricultural research, 2nd edition John Willey, and sons, New York. Pp. 693.

Hay, R.K.M. and J.A. Walker (1989). An introduction to the physiology of crop yield. Longman Group UK. Ltd.p.292.

Haynes, J.L. and Sayre, J .D . (1956). Response of corn to within rows competition *Agronomy Journal* 48:362-364.

Ikeorgu J.E.G. (2001). Determination of Compatible Components population in Yam minisett/soybean inter crop in the southern Guinea Savannah of Nigeria J. Applied Chem. Agric. Res. 7:75-79.

Irvine, F.R. (1969) West African Crops Oxf. University Press, London. Pp. 117-118.

Janicks, J. Robert, W.S., Frank W. Woods and Vamon W.R. (1981) Plant Science: An Introduction to World Crops. 3rd ed. W.H. Freeman and Company. P. 572-573.

.Kowal, J.M., and Knabe, D.T. (1972). An Agricultural Atlas of Northern States of Nigeria, Ahmadu Bello University, Press.

Kurt, G.S 1984. Intercropping in tropical smallholder Agriculture with special reference to West Africa. GTZ pp.1-233.

Lai Cruishan and R.P. Singh (1969) Effects of sowing time and nitrogen levels on seed yield of 3hindi. Plant Science 11: 69-99.

Muoneke C.O, Asiegbu J.E(1997)Effects of Okra planting density and spatial arrangement in intercrop with maize on the growth and yield of the component species. J. Agron. Crop Sci. 179:201-207.

O. Callaghan J.R., Maende C., Wyseure GCL (1994). Modelling the intercropping of maize and beans in Kenya comp. Electron. Agric 11:351-365

Obasi, M.O. 1989;some studies on the Growth, Development and Yield of Ground bean (kerstingella geocarpa Harms) in Derived savanna environment of Southern Nigeria. Ph.D. thesis .University of Nigeria,Nsukka.pp.3 75.

Ofori, F., and R. Stern, 1987. Relative sowing Time and Density of Component Crops in a maize/cowpea intercrop system, Expl. Agric, 23;41-52.

Olofintoye, J.A. and B.O. Olaoye, 1992, A Study on Sorghum-Rice Intercropping system with a particular Reference to Component population and Stand Geometry, J. Agric. Sci. & Techn 2;125-130.

Olufajo, O.O. (1992). Response of soybeans to intercropping with maize in a sub-humid tropical environment. *Tropical oil Journal*. 23:25 – 33.

Onuwerne, I.C. and T.D. Singh, (1991). Field Crop production in tropical Africa, Principles and practice. CTA, Ede, the Netherlands pp. 480.

Orkwor, G.C.O.U. Okereke, F.O.C. Ezedinma, and H.C. Ezumah (1991). Critical Period of weed interference in maize (zea mays L.) Intercropped with yam (Dioscorea rotundata poir), Okra (Abelmosch esculentus L. Moench) and sweet potato (Ipornoea batatas L. Lam O, Niger. Agric.J.26 :61-70

Palaniappan, S.P 1985. Cropping systems in the Tropics, Principles and management, Willey Eastern Ltd.india.pp2 15

Rao, P.U. (1985). Chemical Composition and Biological evaluation of okra *(Hibiscus esculentus) seeds and their Kernels: Qualitas Plant arum, plant foods for human nutrition.* 35(4): 389-396..

Roy, R.K. and Singh, K.S.P. (1986). Response of popcorn *(Aea mays Agronomy Journal* 51: 575-578..

Steel, G.D. and Torrie, J.H. (1980). Principles and Procedures of Statistics, McGraw Hill Book Company Inc. New York, Pp. 481.

Sullivan P. (2003). Intercropping principles and production practices. National sustainable agricultural information service. (13 Arkansas, AR 72702), Butte, Montana and Davis, California.

Thavaprakaash, N; Velayudham, K. and Muthukumar (2005). Effects of crop geometry, intercropping systems and Integrated nutrient management practices intercropping systems, *Research journal of Agricultural and Biological Sciences* 1(4): 295-302, 2005 Insinet publication.

Udo – Ekong, C.R. (1982). Evaluation of performance of rice and soybeans as companion crops on up and condition. M.Sc. thesis GUAF, Phillipines, pp. 1- 15.

Walkey, A. and Black, I.A. (1934), An examination of the pagtiareff method for determining soil organic matter and a proposed modification of chronic acid titration method. Soil science 120: 212 – 218.