RESPONSE OF CASSAVA/MAIZE/GROUNDNUT BASED INTERCROPPING SYSTEMS IN THE DERIVED SAVANNA OF SOUTH-EASTERN NIGERIA

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Abstract

In an attempt to achieving food security for a rapidly growing population in Nigeria, intensification of food production with appropriate and careful cropping system methods is required on the available crop land. In an attempt to improving soil fertility and crop yield with economically viable, environmentally friendly, sustainable and socially accepted cropping system practices, a field study was conducted to evaluate the effect of cassava/maize/groundnut based intercropping systems in the derived savannah of South-eastern Nigeria. Seven treatments including sole cassava, sole maize, sole groundnut, cassava + maize + groundnut, cassava + maize, maize + groundnut and cassava + groundnut were built into a randomized complete block design (RCBD) and were replicated three times. Each test crop were planted at 1m x 1m spacing for the assessment. Parameters measured were on growth and yield components. Results obtained revealed a significant difference on top growth yield, dry matter yield of cassava, dry grain weight yield and 100 seeds yield of maize as well as number of pod, weight of grain and 100 seeds of groundnut. The results show that different cropping pattern caused significant yields and yield components of each crop. However, the productivity of all the intercrops was high with maximum in cassava + maize + groundnut crop combinations. This shows that intercropping of different crop species has enhanced better use of growth resources which could have lost if single crop was planted in the field, resulting in better and increased crop yield. Choice of adequate planting time and plant densities could further improve efficiency of the cropping systems.

Key words: Response, Cassava/maize/groundnut, intercropping, systems, derived savannah.

1.0. **Introduction**

The commonest agro-technique by resource-poor farmers in many parts of the tropics is growing of two or more crops on the same field simultaneously (cf. Steiner, 1991), and this practice is called intercropping. Intercropping therefore, is the simultaneous cultivation or growing of two or more species of crop on the same field in the same growing season. This practice is carried out by famers in order to produce a greater yield, by making use of resources that would otherwise not be utilized by a single crop.

Intercropping or crop mixtures mimic natural eco-system and are more dynamic biologically than sole crops (cf. Law-Ogbomo and Ekunwe, 2011). Crops grown in mixtures have found to utilized resources better than sole crops (cf. Chinaka and Obiefuna, 2000). Mixed cropping is done to ensure food security against total crop failure or with intent to maximize yield and profit by making use of the same labour (cf. Yusuf, Sanni, Ojuekaiye and Ugbabe, 2008). According to Javanmard Mohammadi-Nasab, Javanshir, Moghaddam and Janmohammadi (2009), intercropping is popular because of its advantages over sole cropping which include security of returns and higher profitability due to higher combined returns per unit area of land. In addition, crops under intercropping systems are less susceptible to weeds, pests and diseases, and minimize erosion through water infiltration control (cf. CTA, 1995), as well as increase soil fertility status if properly combined.

With high intensity of cropping, shorter fallow periods and erosion, decline in soil fertility occur. This could be ameliorated by adopting a multi-cropping system that has some capacity to help water infiltration into the soil, minimizes heat and water losses by evaporation during the day, suppress weeds (Bilalis, Papastylianou, Konstantas, Patsiali, Karkanis and Efthimiadou (2010), and recycle nutrients through litter falls in order to sustain land productivity.

Cassava (*Manihotesculenta Crantz*) and Maize (*Zea mays* L.) are amongst the crops widely grown in mixtures, especially in small scale farming because of their productivity and compatibility (cf. Karikari, 1980 and Okigbo, 1978). Maize however, is one of the most widely cultivated cereals and the most intercropping component crops in the derived savannah. According to NAFPP (1977), the nation-wide intercropping technology transfer package developed in Nigeria was cassava/maize intercropped.

Cassava and maize can be planted at the same time in beginning of rain or cassava is planted in relay system in maize plot from four weeks after planting to as late as after physiological maturity, the stage with maximum dry matter (cf. Murreno and Hart, 1979), and cassava based cropping systems are more prevalent because cassava is one of the most important food crops widely grown in several countries in sub-Saharan Africa (cf. Ayoola and Makinde, 2005) as it provides employment, income and food for farm families (cf. Ugwu and Ukpabi, 2002).

Maize (*Zea mays* L.), on the other hand, is the principal cereal crop associated with cassava in the humid tropics due to efficient utilization of resources (cf. Amanulla, Alagesan, Pazhanivelan and Sathyamoothi 2006a). Cassava/maize intercrop has been indicated to be productive and compatible mainly because maize is a short season crop while cassava is a long duration crop (cf. Ikeorgu, 2002). The popularity and wide-spread cassava/maize intercrop in the derived savannah of South-eastern Nigeria is attributed to high compatibility and complementarity of the crop, the fast growing maize exploiting the environment early and the slow growing cassava exploiting it later. Farmers have hold fast to this cropping system and have the need to rationalize intercropping condition (cf. Norman, 1975).

Groundnut (*Arachishypogeae*l.) is very commonly intercropped with maize, sorghum, millet, cotton, castor and cassava in Southeast Asia and Africa (cf. Mutsaers, 1978). Legume – cereal is the one of the most popular intercropping systems in the tropics. Systems that intercrop maize with a legume are able to reduce the amount of nutrients taken from the soil as compared to a maize monocrop. During absence of nitrogen fertilizer, intercropped legume will fix nitrogen from the atmosphere and not compete with maize or other crop for nitrogen resources. This mixture of nitrogen fixing crop and non-fixing crop give greater productivity than mono-cropping. Banik and Sharma (2009) reported that cereal-legume intercropping systems were superior to monocropping.

Intercropping can be seen as the practical application of diversity, competition and facilitation in annual cropping systems. Grain leguminous-cereal mixed intercrops are better at exploiting natural resources as compared to sole crops at different plant species. Grain legume can convert their nitrogen demand from the atmospheric nitrogen (cf. Hauggaard-Nielson, Ambus and Jensen 2001, 2003, 2006) and therefore, in intercropping with cereal and tuber crops compete less for soil mineral nitrogen. Legume-cereal intercrop may produce higher grain and protein yields as compared to monoculture (cf. Hauggaard-Nielson *et al*, 2001) and show greater yields stability across years than when growing grain legume, cereal and tuber crops as monoculture.

The use of fast growing and good cover crop (low growing crops) such as groundnut in particular helps to control erosion. Loss of site productivity on account of bush burning, intensive cropping often without nutrient supplementation, overgrazing and intense rainfall resulting in leaching and erosion of topsoil are important factors that affect crop productivity in Nigeria (cf. Okonkwo, 1995). The significance of intercropping in food security among others brought about the need to study the traditional farming systems in the derived savannah with respect to intercropping (cf. Orkwor, 1983). Since the primary interest of farmers in the area seems to be the diversification when component crops makes complementary demand on space and growth factors, intercropping systems is seen to achieve the goal because it is simple, sustainable and economical to farmers in the zone, particularly in the face of land scarcity encountered from land tenure system, crop intensification, erosion, intense and indiscriminate bush burning. Against this background, this investigation was designed to evaluate the effect of cassava/maize/groundnut based intercropping systems in the derived savannah zone of South-eastern Nigeria.

2.0.Materials and Methods

2.1.Description of the Experimental Site

The experimental was conducted at the Teaching and Research farm of Federal College of Agriculture, Ishiagu during 2010/2011 cropping season. The sites lie within latitude $05^0 56^1$N and longitude $07^0 41^1$E with altitude of 400m above sea level. The climate of the area id humid and is characterized by wet and dry season. The annual rainfall is 1,350mm that spread from April to October with average temperature being 29^0C. The soil is hydromorphic and belongs to the order ultisol, classified as Typic-Haplustult (Clayish loam) (cf. FDALR, 1985). The vegetation is characterized with tall grasses, shrubs and trees. The choice of the experimental site was primarily because of the intensity and diversity of systems of farming due to the climatic and soil conditions of the area.

2.2.Site Preparation

The experimental site was cleared manually and was demarcated into blocks and plots measuring 5m x 5m, which represent plot size. Ridges were constructed base on the plot size. Cross bars were also constructed to prevent run-off water from the field.

2.3. Experimental Design and Treatments

The experiment was laid out in a randomized complete block design (RCBD) with seven treatments replicated three times. The treatments used were; sole cassava (SCa), sole maize (SMa), sole groundnut (SGn), cassava + maize (Ca + Ma), cassava + groundnut (Ca + Gn), cassava + Maize + groundnut (Ca + Ma + Gn) and maize + groundnut (Ma + Gn).

2.4. Planting/Planting Methods and Field Maintenance

The test crops making up the treatments were planted at 1m x 1m each at a depth of 3cm and at 3 seeds per hole. The seedlings were later thinned down to 1 plant per stand after 2 weeks of germination. Cassava stems were cut 25cm long with at least 5 nodes each, and were planted at an inclined position of about 45^0 on the crest of the ridge. The thinned down seedlings were spread on the field and was used as mulch materials. Weeds were controlled manually with hoe as at when necessary.

2.5 Data Collection and Analysis on Plant Parameters

The determination of growth parameters were taken at 3 weeks intervals from plant height, leaf number, stem girth and leaf area. At harvest, yield parameters were taken on number of cob, fresh cob weight, dry cob weight, number of pod, weight of pod, number of tubers, weight of tubers, top growth weight and dry matter content. Data collected were subjected to analysis of variance to test the significant effect on treatment as described by Akindele (2004) and Gomez and Gomez (1983).

3.0. Results and Discussion

3.1. Effect of Treatment on Growth and Growth Components of Cassava

The results obtained (Table 1) showed the effect of treatment on growth parameters of cassava plant. The results revealed that there was no significant difference ($P \leq 0.05$) among the treatment used on plant height and leaf number. However, cassava + maize (Ca +

Ma) crop mixture produced the tallest plant (157.31cm) while sole cassava (SCa) produced the shortest plant (151.47cm). The result also shows that, cassava + maize mixture also gave the highest leaf number (18.35) while sole cassava cropping had the least (15.19) leaf number. The different in plant height and leaf number probably reflects the differences in the nature of competition between sole cropping, the crop involved and the crop mixture in the system. The increase in plant and the subsequent leaf number in crop mixture could be attributed to added growth of maize that might have established early thereby intercepting most of the light and therefore induced the cassava plant to grow taller, as was earlier observed by Sinwambaba*et al* (1994).

Results (Table 1) also indicated no significant difference ($P \leq 0.05$) on the stem girth and leaf area of cassava. However, cassava + maize + groundnut (Ca + Ma + Gn) crop combinations produced the biggest stem (8.28cm) and largest leaf area (39.17cm) while cassava sole (SCa) produced the smallest stem (7.60cm) and thinnest leaf area (34.87cm). The increase in the biggest stem and largest leaf area in Ca + Ma + Gn crop combinations could be attributed to well spread plant architecture that have help in the capturing of sunlight for growth and development, as well as groundnut in the combination adding nutrients into the soil. Studies have shown that the introduction of groundnut into cassava cropping system improved cassava growth and yield (Alhassan and Egbe, 2014; Egbe, Kalu and Idoga 2009 and Harderson and Atkins, 2003).

Table 1: **Effect of Treatments on Growth and Growth Components on Cassava, Maize and Groundnut**

Cassava	Maize	Groundnut
TreatmentsPHLNSGLA	PHLNSGLA	PHLNSGLA
Ca+Ma+Gn155.7417.788.2839.17	94.7312.028.96250.80	23.748.234.2362.23
Ca + Ma157.3118.357.8036.95	93.2211.728.94262.04	- - - -
Ca sole151.4015.197.6034.87	----	----
Ma sole----	79.1910.827.95163.16	----
Ma + Gn----	82.1011.968.72183.05	18.6823.374.9366.91
Gn sole ----	----	15.8811.003.5833.56
Ca + Gn153.7216.217.7835.64	----	16.6616.784.8635.42
LSD(P≤0.05)NsNsNsNs	8.74Ns0.0545.06	4.46NsNsNs
CV (%)8.345.700.512.20	13.769.7911.7228.82	8.327.105.3015.76
SE±8.345.700.512.20	2.680.262.2315.63	0.212.412.033.06

PH= Plant height, LN= Leaf number, SG= Stem girth, LA= Leaf area, Ns= Not significant

3.2 Effect of Treatment on Growth and growth Components of Maize

Results obtained (Table 1) shows the effect of growth and growth components of maize parameters. There was significant difference (P≤0.05) among the treatments on plant height, stem girth and leaf number. However, cassava + maize + groundnut (Ca + Ma + Gn) crop combinations produced the highest growth parameters while sole maize produced the least parameters. The reduction in growth parameters in sole maize could be attributable to high rate of evapo-transpiration which expose sole maize to harsh environmental conditions. The increase in growth component of maize could be attributed to greater soil moisture conservation under intercropping which might have promoted greater absorption of soil nutrients. This view agreed with Oginda and Walker (2005), who reported that intercrops have been identified to conserve water

3.3. Effect of Treatment on Growth and Growth Components of Groundnut

Results (Table 1) indicated the effect of treatment on growth components of groundnut. The result shows that there was no significant difference ($P \leq 0.05$) among the treatments on leaf number, stem girth and leaf area, except on plant height. However, cassava + maize + groundnut crop mixtures produced the tallest plant (23.78cm), highest leaf number (48.97cm), biggest stem girth (4.23cm) and leaf area (62.23cm) while the shortest plant, lowest leaf number, smallest stem and smallest leaf area at 15.88cm, 11.00cm, 3.58cm and 33.56cm, respectively. The increase in growth parameters might be links to the greater resource utilization in the system. The higher values revealed complementation in resource utilization by the component crops indicating that the land resource was efficiently utilized. This agree with the work of Reddy and Willey (1980), who stated that the introduction of groundnut between the traditionally wide – spaced cassava and maize planting increase the production efficiency of cassava as well as conserving soil moisture and fertility.

3.4. Effect of Treatment on Yield on Yield Components of Crop

Results obtained (Table 2) indicated the effects of treatment on yield and yield components of cassava, maize and groundnut. The results as presented in table 4 indicated that the effects of cropping pattern on yield and yield component of respective crop largely depended on the cropping systems. The results show that there was significant difference ($P \leq 0.05$) among the treatment on cassava top growth and dry matter content, maize dry grain weight and groundnut number of pod and weight of grain after shelling.

Table 2: **Effect of Treatment on Yield and Yield Components of Cassava, Maize and Groundnut at Harvest**

Cassava		Maize				Groundnut	
Treatments	NOT	RTY (t/ha)	TG (kg)	DM (%)	FCW	DGW	100S
		NOP	WOG	100S			
Ca + Ma + Gn	4.95	18.66	22.53	29.10	5.79	3.73	2.60
	182.50	81.00	25.70				
Ca + Ma	4.31	16.17	25.58	23.26	4.68	2.83	1.73
	-	-	-				
Ca sole	5.67	19.17	22.08	24.26	-	-	-
	-	-	-				
Ma sole	-	-	-	-		4.78	2.38
	0.54	-	-	-			
Ma + Gn	-	-	-	-		4.82	2.46
	0.84	176.02	74.40	12.60			
Gn sole	-	-	-	-		-	-
	-	173.00	73.75	11.60			
Ca + Gn	6.42	17.02	22.10	24.11	-	-	-
	176.00	75.50	12.40				
LSD ($P \leq 0.05$)	ns	ns	0.85	2.99	ns	0.48	0.02
	19.72	19.61	0.54				
CV (%)	24.34	32.78	9.45	19.08		16.70	19.47
	5.30	11.08	25.62	12.00			
SE±	0.31	1.45	0.53	1.22	0.22	0.15	0.09
4.93	4.96	0.23					

Ns = Not significant, NOT = Number of tubers, RTY = Root tuber yield, TG = Top growth, DM = Dry matter, FCW = Fresh cob weight, DGW = Dry grain weight, 100S = one hundred seeds, NOP = Number of pod, WOG = Weight of grain.

3.4.1 Effect of Yield and Yield Component of Cassava

The effect of intercropping cassava with maize and groundnut in the number of tubers, root tuber yield, top growth and dry matter yield were observed in both sole and crop mixtures at harvest. Results obtained (Table 2) revealed significant difference ($P \leq 0.05$) on root tuber yield, top growth and dry matter yield except on number of tubers. However, cassava sole (Casole) had the highest number tubers (5.87) while cassava + maize (Ca + Ma) had the least number of tubers (4.31).Tuber root yield (t/ha) was high in cassava sole, low in cassava+ maize mixture. Results (Table 4) also revealed that cassava + maize (Ca + Ma) crop mixture produced the highest top growth while cassava sole produced the least top growth yield whereas cassava + maize + groundnut (Ca + Ma + Gn) combination produced the highest dry matter yield (%) while cassava + maize (Ca + Ma) mixture had the least. The increase in top growth could be attributable to the presence of leguminous crop introduction in the system and favourable environmental conditions. The reduction in tuber number and dry matter yield in cassava + maize mixture could be as a result of increase in top growth yield at the expense of the tuber yield. This indicated that cassava plant might use up the resources for growth only rather than reserving the available resources for tuberization. Dry matter yield in an important index in crop production.

The reduction in dry matter yield in cassava + maize mixture could be as a result of much shade in the system, which probably led to decreased in photosynthesis in the plant, hence he the reduction in dry matter production. However, the increase in dry matter yield in cassava sole and cassava + maize + groundnut could be attributable to the presence of leguminous plant and the removal of other crops at maturity leaving all the available nutrients at the disposal of the cassava. Anyaegbu, Ezeibekwe, Amaechi and Omaliko, (2009) reported that when resources are limited in an intercrop system, one species of the mixture may be able to remove the needed resources sooner or later than the other, indicating the depression in yield of the other species caused by competition. Moreover, intercropped groundnut increased the yield of cassava by supplying additional nitrogen from nitrogen fixation. The reduction in number of tubers and root tuber yield of cassava in cassava crop mixtures than in sole could be attributed to shading effect by maize at the early stages of growth. Adeniyan, Aluko, Olanipekun, Olareji and Aduramigba-Modupe (2014), reported that intercropping of cassava with maize at different plant population density at early stage (second to fourth month after plant) had effect on cassava yield due to above ground competition for light. The is suggesting that, the competition of cassava with maize for light resulted in the reduction in dry matter (DM) formation, and the stems to attain greater height would assimilate less. Hunt, Wholey and Cock (1977) however, reported that under condition of low photosynthesis caused by low light levels, the supply of carbohydrate in low as the proportion of dry matter in the root in decreased.

3.4.2 Effect of Treatment on Yield and Yield Components of Maize.

The results (Table 2) revealed that cassava + maize+ groundnut produced the highest fresh cob weight and dry grain weight, while cassava + maize produced the least fresh cob weight. Maize role produced the least dry grain weight at harvest. This could be attributable to competition for growth resources which affected the reproduction growth. Intercropping could result in competition for growth resources when the component crops are in intimate contact, especially with increasing plant density of any of or all the crops in mixture (Muoneke and Asiegbu, 1977).

3.4. 3. **Effect of Treatments on Yield and Yield Components of Groundnut**

The results as presented in Table 2 indicated that crop combination of Ca + Ma + Gnhad the highest number of pods, weight of grain and weight of 100 seeds than the sole groundnut. The increase in yield of groundnut in crop combinations could be attributable to conservative ability of the crop in combinations in the system for growth resources which might have facilitated the growth of the intercropped groundnut causing higher yield and yield than in sole crop. This result is contrary to the work of Kou (1975), who reported that in maize / groundnut combination groundnut yield is readily depressed by competition from the maize. Anyaegbu *etal* (2014) reported that introduction of groundnut into cropping systems improved cassava root yield irrespective of the number of rows.

4.**Conclusion/Recommendation**

From the results obtained, it can be concluded that it is advantageous to intercrop cassava, maize and groundnut where the level of complementarities between the crop species will be high. The intercropping farmers achieve not only the full production of the base crop (cassava) but also an additional yield bonus associated with the other crop components. It is obvious from the results that, groundnut + cassava + maize intercropping are more effective in improving soil water and nutrients compared to sole cassava and maize. On the strength of the present results, intercropped crops can be advocated as a promising production system and therefore recommended for farmers to effectively enhance land use and higher yield in the cropping system in the derived savannah.

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