GROWTH AND YIELD OF CASSAVA AS INFLUENCED BY MAIZE AND COWPEA POPULATION DENSITY IN SOUTH EASTERN, NIGERIA

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Abstract
Two field trials were conducted at the research farm of the National Root Crops Research Institute (NRCRI) Umudike, Igbariam sub-station ($06^{0}15^{1}$N, $06^{0}52^{1}$E) in 2013/2014 and 2014/2015 cropping seasons to determine the growth and yield of cassava as influenced by maize and cowpea population densities. Cassava at a density of 10,000 plants per hectare was intercropped with maize at 13,333, 20,000 and 40,000 plants/ha, and cowpea at 16,666, 22,222, 33,333 plants/ha, respectively. Cassava was planted in monoculture and intercropped with maize and cowpea. The experiment was arranged in a Randomized Complete Block Design (RCBD) with three replications. The results revealed that increasing maize population beyond 13,333 plants/ha significantly reduced growth and yield parameters of cassava. Also, growth and yield attributes of cassava significantly increased as cowpea density increased from 16,666 to 33,333 plants/ha. However for optimum growth and yield of cassava in cassava/maize and cassava/cowpea mixtures respectively, cassava at 10,000 plants/ha + maize at 13,333 plants/ha or cassava at 10,000 plants/ha + cowpea at 33,333 plants/ha are recommended in the study area.

Keywords: Cassava, maize, cowpea, planting density, growth, yield and intercropping

Introduction

Cassava-based cropping systems are most prevalent because cassava (*Manihot esculenta* crantz) is one of the most important food crops widely grown in several countries in sub-Saharan Africa. It is well suited to intercropping with short-duration crops such as maize, cowpea, melon, okra and several leafy vegetables. The crops are selected on the basis of differences in growth habits and can be combined in either simple or complex mixtures. Maize is the principal cereal associated with cassava in the humid tropics probably due to efficient utilization of resources by the crops as a result of morphological differences in mixture component though cassava growth could be initially retarded. It is however, possible to get a high relative yield of the sole crop (Amanullah *et al*., 2006). Cassava is often left to continue growing after the other short duration crops such as maize have been harvested in the early season. Some farmers, however, plant a few stand of okra and other vegetables in the cassava farm in the later season when canopy has not closed. A leguminous crop like cowpea (*Vigna unguiculata L. Walp*) could also be cultivated in the later season because of their inherent advantages such as short growth period, low canopy plant structure, drought tolerance as well as ability to fix atmospheric nitrogen in the root nodules, which make it highly advantageous to grow in relay or mixed cropping systems (Amanullah *et al.*, 2006). However, optimal population density in the cassava, maize and cowpea intercrop system is important to exploit maximum natural resources such as nutrient, sunlight and soil moisture to ensure satisfactory yield (Ayoola and Makinde, 2008). This could be achieved by modifying crop populations. This paper therefore assessed the growth and yield of cassava as influenced by maize and cowpea population density.

Materials and Methods

Brown seeded vegetable cowpea (Akidi ani), an early maturing and spreading variety that mature within 3 months after planting was sourced from local market. Seeds of (Oba-super 2), an early maturing hybrid maize cultivars that matures within 3 months after planting, was collected from the National Seed Council, Umudike. Also. an improved cassava variety (TME 419) with erect stem that

matures within 12 months after planting was obtained from the National Root Crops Research Institute (NRCRI), Igbariam sub-station. The experiment was carried out in two cropping seasons (2013/2014 and 2014/2015) at Igbariam sub-station of the National Root Crops Research Institute, which is on latitude $06^0$15N, longitude $06^0$52E, and attitude 81m above sea level. The soil was a sandy loam with acidic reaction. The characteristics of the soil in the two cropping seasons were as follow: Soil pH: 4.80 and 5.10, organic carbon: 0.24 and 0.89%, total N: 0.04 and 0.08%, available P(mg/kg): 25.40 and 24.22 (mg/kg), and exchangeable K: 0.22 and 0.20 cmol/kg for 2013 and 2014 experiments, respectively (Table 1).

Cassava, maize and cowpea were both planted on 6th May, 2013 and 2014 respectively. Cassava cuttings of about 25cm long with 5 to 7 nodes, obtained from 12 months old cuttings of uniform sizes were planted on the crest of the ridges at 1m x 1m giving a plant population of 10,000 plants/ha. Maize and cowpea seeds were planted mid-way between the crest and furrows at the spacing of 0.25 x 1m, 0.50m x 1m, 0.75 x 1m for maize, and 0.30m x 1m, 0.45m x 1m and 0.6m x 1m for cowpea respectively at one plant per stand to obtain plant densities of 40,000, 20,000 and 13,333 plants/ha for maize and 33,333, 22,222 and 16,666 plants/ha for cowpea in sole and intercrop. The plot size was 3 m x 6 m (18 m^2) each containing three ridges. Randomized complete block design with three replicates was used. Data on plant height, number of leaves, stem girth, leaf area index, number of marketable roots/plant, total number of roots/plant, weight of marketable roots/plant, marketable root yield (tons/ha) and total root yield (tons/ha). The data collected were subjected to analysis of Variance (ANOVA) and treatment means were compared with Fisher's least significant differences (FLSD) at 0.05 level of probability.

Results and Discussion

Cassava growth

Cassava plants as sole crop were significantly ($p<0.05$) taller, with more number of leaves per plant, thicker stem and higher leaf area index than when they were intercropped. The observed less vigour on the cassava stands under intercrop system maybe attributed to inter-specific competition for growth resources from maize and cowpea. Also the size variability of plants within a population increases with density such that not only is the mean plant size smaller at higher densities, but the distribution of plant sizes around the mean becomes more skewed and unequal.

However, increasing maize population in the cassava/maize intercrop beyond 13,333 plants/ha significantly ($p<0.05$) reduced plant height, number of leaves per plant, stem girth and leaf area index of cassava in 2013/2014 and 2014/2015 cropping seasons. This observation can be ascribed to increased incidence of inter-specific competition among cassava and maize crops for growth resources such as air, water, sunlight, space and nutrients with increasing maize planting density. The inter-specific competition, consequently prevented cassava crops from putting forth much vegetative growth, which perhaps, resulted in reduced supply of photosynthates to the sink. This result was corroborated by the findings of Sas (2002), Tiffen (2004), Orallo (2006), Ait (2007) and Rye (2007) who reported decreased growth and yield of cassava with increasing maize planting density in a cassava/maize mixture.

Also increasing cowpea population in the cassava/cowpea intercrop from 16,666 to 33,333 plants/ha significantly ($p<0.05$) increased plant height, number of leaves per plant, stem girth, and leaf area index in 2013/2014 and 2014/2015 cropping seasons. This is probably due to the fact that the growth habits of the two crops differed - while cowpea is low growing, cassava is tall and erect. Also, the increased leaf area index as a result of the increase in plant density, is a pointer to increased photosynthate production potential of the cassava stands under cowpea intercrop. The observed positive effect of increased cowpea density on cassava growth agreed with the findings of Njoku and Muoneke (2008), Njoku *et al.* (2010) and Ekpo and Ndaeyo (2011) who observed enhancement of cassava growth with increase in cowpea density.

Cassava yield and yield components

Number of marketable roots/plant, total number of roots/plant, weight of marketable roots/plant, marketable root yield (tons/ha) and total root yield (tons/ha) were all significantly ($p<0.05$) higher in sole cropped than in the intercropped cassava, probably as a result of intense inter-specific competition for growth resources. Among the intercrops in 2013/2014 and 2014/2015, yield and yield components of cassava decreased as the maize population increased. This may be due to stiffer competition for growth resources in high density planting. Also, the poor growth of cassava, characterized by reduced leaf area resulted in low yield and yield components of cassava based on the premise that the growth of crops is positively correlated with their yield (Nyende, *et al*., 2001). Similar results were reported by Osundare (2010) and Adeniyan *et al*., (2014) in cassava/maize intercrop, who observed that yield and yield components of cassava reduced with increase in maize population.

However, increasing cowpea population from 16,666 to 33,333 plants/ha significantly ($p<0.05$) increased the entire yield and yield components of cassava in 2013/2014 and 2014/2015 cropping seasons. This is probably due to the wide maturity gap between cowpea (about 90 days) and cassava (about 365 days), and the slow initial growth of cassava enhanced the compatibility of cassava and cowpea as intercrops (Udealor and Asiegbu, 2005). Also cowpea is a legume and therefore has fixed nitrogen from which cassava must have benefited immensely from. Also, the organic matter added by cowpea residues after its harvest must have enhanced the root yield of cassava and its components.

Conclusion

Conclusively, in intercrop, cassava growth and yield decreased with increase in density of maize but increased with increase in density of cowpea. However, for optimum growth and yield of cassava in cassava/maize and cassava/cowpea mixtures respectively, optimum population of maincrop cassava at 10,000 plants/ha + maize at 13,333 plants/ha or cassava at 10,000 plants/ha + cowpea at 33,333 plants/ha is recommended in the study area.

Table 1: Some physical and chemical properties of the soils of the experimental site at Igbariam, sub-station of National Root Crops Research Institute (NRCRI), in 2013 and 2014

Soil properties	2013	2014
Physical properties		
Sand (%)	75.80	72.40
Silt (%)	11.40	11.40
Clay (%)	12.80	16.20
Texture	Sandy loam	Sandy loam
Chemical properties		
pH (H_20)	4.80	5.10
Organic carbon (%)	0.24	0.89
Organic matter (%)	0.41	1.53
Total N(%)	0.04	0.08
Available p (mg/kg)	25.40	24.22
Ca (Cmol/kg)	4.80	2.40
Mg (Cmol/kg)	1.60	1.60
K (Cmol/kg)	0.22	0.20
Na (Cmol/kg)	0.29	0.35
Exchangeable Acidity (Cmol/kg)	0.64	0.88
ECEC (Cmol/kg)	7.55	5.64
Base saturation (%)	91.52	84.48

Table 2: Effects of maize and cowpea plant densities on growth attributes of cassava at Igbariam, Nigeria in 2013/2014 and 2014/2015 cropping seasons

Treatments	Plant height at harvest		Number of leaves		Stem girth		Leaf area index	
	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015
Sole cassava 10,000 plants/ha	243.00	247.00	121.00	123.00	9.00	7.50	18.66	17.85
Cassava, 10,000 plant/ha + maize, 13,333 plants/ha	217.00	221.00	108.00	110.00	6.00	5.00	15.26	15.13
Cassava, 10,000 plant/ha + maize, 20,000 plants/ha	192.00	196.00	96.00	98.00	5.00	4.50	11.16	12.42
Cassava, 10,000 plant/ha + maize, 40,000 plants/ha	166.00	170.00	83.00	85.00	4.00	4.00	8.28	10.39
Cassava, 10,000 plant/ha + cowpea, 16,666 plants/ha	174.00	178.00	87.00	89.00	5.00	5.50	8.88	11.06
Cassava, 10,000 plant/ha + cowpea, 22,222 plants/ha	202.00	207.00	101.00	103.00	6.00	6.00	11.95	13.31
Cassava, 10,000 plant/ha + cowpea, 33,333 plants/ha	231.00	253.00	115.00	117.00	7.00	7.00	16.72	16.29
LSD 0.05	**1.05**	**1.03**	**0.55**	**0.61**	**0.61**	**0.19**	**0.10**	**0.09**

Table 3: Effects of maize and cowpea plant densities on yield and yield components of cassava at Igbariam, Nigeria in 2013/2014 and 2014/2015 cropping seasons

Treatments	Number of marketable roots/plant		Total number of roots/plant		weight of marketable roots/plant (kg)		marketable root yield (tons/ha)		Total root yield (tons/ha)	
	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015
Sole cassava at 10,000 plants/ha	12.00	11.00	14.00	12.00	3.21	3.18	32.10	31.80	35.07	34.50
Cassava, 10,000 plant/ha + maize, 13,333 plants/ha	10.00	9.00	12.00	10.00	3.09	3.07	30.90	30.70	34.20	33.80
Cassava, 10,000 plant/ha + maize, 20,000 plants/ha	7.00	6.00	10.00	9.00	2.57	2.55	25.70	25.50	29.53	29.10
Cassava, 10,000 plant/ha + maize, 40,000 plants/ha	5.00	3.00	8.00	7.00	2.07	2.04	20.70	20.40	26.40	24.60
Cassava, 10,000 plant/ha + cowpea, 16,666 plants/ha	5.00	3.00	7.00	5.00	2.39	2.36	23.90	23.60	28.27	27.40
Cassava, 10,000 plant/ha + cowpea, 22,222 plants/ha	8.00	6.00	10.00	8.00	2.58	2.56	25.80	25.60	29.77	28.60
Cassava, 10,000 plant/ha + cowpea, 33,333 plants/ha	11.00	9.00	12.00	11.00	2.94	2.92	29.40	29.20	32.67	30.10
LSD 0.05	**1.26**	**1.28**	**1.21**	**1.25**	**0.30**	**0.29**	**3.03**	**3.02**	**2.34**	**2.33**

References

Adeniyan, O.N., Aluko, O.A., Olanipekun, S.O., Olasoji, J.O. and Aduramigba-Modupe, V.O. (2014). Growth and yield performance of cassava/maize intercrop under different plant population density of maize. *Journal of Agricultural Science.* 6(8): 35-40.

Ait, F.A. (2007). Effects of varying maize planting density in a cassava/maize mixture and N.P.K fertilization on growth and yield of cassava. *Field Crops Research.* 13: 904-909.

Amanullah, M.M., Alagesan, A., Vaiyapuri, K., Pazhanivelan, S. and Sathyamoorthi, K. (2006). Intercropping and Organic manure on the growth and yield of cassava (Manihot esculenta crantz). *Research Journal of Agriculture and Biological Sciences.* 2:183-189.

Ayoola, O.A. and Makinde, E.A. (2008). Influence of Cassava population density on the growth and yield performance of cassava-maize intercrop with a relayed cowpea. *Tropical and Sub-tropical Agroecoystem.* 8(3): 235-241.

Ekpo, T.U.U. and Ndaeyo, N.U. (2011). Effects of akidi (*Vigna unguiculate* sub spp. Sesquipedalis) planting density on growth, yield and land use efficience of akidi/cassava intercrop. *Agric. Biol. J.*

Njoku, D.N. and Muoneke, C.O. (2008). Effect of cowpea planting density on growth, yield and productivity of component crops in cowpea/cassava intercropping system. *Journal of Tropical Agriculture, Food, Environment and Extension.* 7(2): 106-113.

Njoku, D.N., Afuape, S.O. and Ebeniro, C.N. (2010). Growth and yield of cassava as influenced by grain cowpea population density in Southeastern Nigeria. *African Journal of Agricultural Research.* 5(20): 2778-2781.

Nyende, P.J.S., Tenywa, J. and Oryokot, M.K. (2001). Vpeed profiles and management assessment for increased finger millet production in Uganda. *African Crop Science Journal.* 9(3): 507-516.

Orallo, T.F.P. (2006). Evaluation of the productivity of Cassava/Maize intercropping systems in Europe. *Crop Husbandry Research*. 18: 1117-1123.

Osundare, B. (2010). Effects of increasing maize planting density in a cassava/maize mixture and weeding frequency on the performance of cassava in Ado-Ekiti, South Western Nigeria. *Journal of Agricultural Science and Environment.* 10(1): 1-9.

Rye, A.Y. (2007). The productivity of cassava/maize mixture through the determination of the optimal maize planting density. *Crop Ecology.* 6(3): 188-194.

Sas, I.F. (2002). Understanding plant density effects on maize growth and development: An important issue to maximize grain yield. *Ciercia Rural.* 31(1): 159-168.

Tiffen, J.S.M. (2004). Effects of varying maize planting density in cassava/maize mixture and nitrogen application on yield of cassava. *Root and Tubers.* 6(4): 528-534.

Udealor, A. and Asiegbu, J.E. (2005). Effect of cassava genotypes and planting pattern of vegetable cowpea on the growth, yield and productivity of cassava/vegetable cowpea intercropping system. *Nigerian Agricultural Journal.* 36: 88-96.