European Journal of Agriculture and Forestry Research
Vol.7, No.1, pp.16-28, March 2019
Published by European Centre for Research Training and Development UK (www.eajournals.org)

EFFECT OF MAIZE/BAMBARA GROUNDNUT INTER-CROP ON SOIL PROPERTIES, GROWTH AND YIELD PARAMETER OF THE INTERCROP SPECIES

Nweke I A and Anene O. H.
Department of Soil Science Chukwuemeka Odumegwu Ojukwu University, Anambra State

ABSTRACT: *The rationale behind the intercropping system is that it is an efficient utilization of land, and other natural resources and economic production system as it increased yield per unit area. Against this back drop, a field trial was carried out at the experimental farm of the Faculty of Agriculture, Chukwuemeka Odumegwu Ojukwu University, Anambra State to evaluate the effect of maize/Bambara groundnut intercropping on soil properties, growth and yield parameters of the intercrop species. The experiment was laid out in randomized complete block design (RCBD) with three treatments consisting of sole maize (SM), sole bambara groundnut (SB), intercrop maize/bambara groundnut (IMB). The treatments were replicated four (4) times and data collected were subjected to an analysis of variance test and mean were separated using least significant difference. The result obtained from the study showed that among the soil parameters tested, avail. P, TN and exchangeable K showed statistically significant difference among the treatments. The value obtained for TN, OC, Mg, EA and ECEC showed 12.50%, 3.2%, 33.33%, 20% and 0.60% increase in IMB relative to SB. The data obtained from the agronomic parameters tested showed that intercropping system greatly influenced the plant height, grain yield, relative and equivalent yield of maize in the intercrop and not effective in the intercrop bambara groundnut. The result obtained also showed an intercrop advantage with land equivalent ratio (LER) of 1.54. With these findings, the farmers in the locality are advised to include bambara groundnut or any other legumes in their crop production systems for efficient and adequate utilization of natural resources and land management*

KEYWORDS: Bambara groundnut, intercropping, maize, soil properties, land equivalent ratio

Print ISSN: ISSN 2054-6319 (Print), Online ISSN: ISSN 2054-6327(online)

INTRODUCTION

The fast rising population in many tropical countries and Nigeria in particular, has led to enormous growing demand for food. This has also led to the increasing urbanization which has affected food production such as roots, tubers, cereals and fruits leading to loss of arable land. Hence land available to be used for agricultural purposes is limited. This available land needs to be improved and properly utilized. To increase production on the limited land, farmers engage on extensive use of fertilizer with its attendant problems. Thus, the rising demand on fertilizer is closely related with the rising demand of food as the population increases. The available land need to be improved and also properly utilized for future generation. Therefore, there is need for not only to increase crop production but also the ability to manage the soil in such a way that it can sustain intensive crop production for agricultural sustainability especially with regard to south eastern soil of Nigeria that are very fragile and suffer various degrees of degradation. Therefore, an alternative to soil productivity improvement and efficient crop production in those small arable lands could be through the farming system of intercropping.

Intercropping is a type of cultivation in which two or more different crops are cultivated on the same plot of land during the same season and commonly utilize limiting resources both soil nutrients and environmental factor efficiently better than the mono-crops grown separately. The idea behind intercropping according to Boller et al. (2004) is that different crops planted are unlikely to share the same insects, pests and disease - causing pathogens and to conserve the soil. Intercropping cereals and grain legumes can be very potential for a farmer. A well planned intercropping system with integration of cereals with legumes can improve the nutritive value of the feed intake, crop residues and animal production as well as enhance soil productivity. Maize has being find to be one of the major component crop in most intercropping systems and one of the major staple food in most African countries were poverty is endemic. The intercrop of maize with a legume will be able to reduce the amount of nutrients taken from the soil as compared to when maize is grown separately. In the absence of nitrogen fertilizer Adu-Gyamti et al. (2007) opined that intercropping legumes will fix nitrogen from the atmosphere and not compete with maize for nitrogen resources. The mixture of nitrogen fixing crop and non-fixing crop give greater productivity than mono-cropping (Seran and Brintha, 2009). In Africa, bambara groundnut crop is very prominent in the traditions and

Print ISSN: ISSN 2054-6319 (Print), Online ISSN: ISSN 2054-6327(online)

culture of the rural communities where it plays a prominent role in the traditional food of the people. Bambara groundnut is one of the most eaten legumes after cowpea and groundnut and in many traditional cropping systems; it is inter-cropped with other root and tuber crops (Brink et al., 2006). Bambara groundnut advantage over cereal and other legume crops according to Thottappilly and Rossel, (1997) is that it yields well under conditions which are too harsh or bad for groundnut, maize and even sorghum. Thus, the objective of this study is to evaluate the growth and yield of maize-bambara groundnut intercrop and its effect on soil properties.

MATERIALS AND METHODS

This research work was conducted at the experimental field of the Department of Crop Science and Horticulture, Chukwuemeka Odumegwu Ojukwu University Igbariam Campus located at Anambra East LGA of Anambra State. The area lies in the humid tropics and located within the latitude 06 14^{1}N and longitude 06 45^{1}E. The minimum annual rainfall of the area range between 2000 – 2800mm, temperature range of the area is 24 – 35c and relative humidity is between 66.3 – 81.2%. The soil of the study area is classified as ultisol (FDALR, 1985).

Land preparation/ Experimental design and treatment application

An area of land measuring 10m x 19m (190m^2) was mapped out, cleared manually with cutlass, debris clearly removed; soil tilled and raised bed made with hoe. The experiment was laid out in a randomized complete block design (RCBD) with four replicates and the three treatments to give a total of 12 plots, each plot measuring 3m x 4m (12m^2). The plots were separated from each other by 0.5m apart and each block was separated by 1m alley. The treatments consisted of sole maize (SM) as the control, sole bambara groundnut (SB) and intercrop maize bambara groundnut (IMB). The maize seed was planted at the spacing of 25cm x 75cm while that of bambara groundnut was done at the spacing of 20cm x 40cm and the intercrop were planted at spacing of 25cm x 75cm for maize and 50cm x 50cm for bambara groundnut. Two seeds per hole respectively for the crops were planted at the depth of about 5cm in their respective plot. The seeds were sown using hand with a marked planting rope to ensure a straight-line growth of the seedlings. The germinated seeds were thinned to one plant per stand two weeks after germination. 0.4kg of NPK 20:10:10 fertilizer was applied on each plot as blanket treatment to boast vegetative growth of the

Print ISSN: ISSN 2054-6319 (Print), Online ISSN: ISSN 2054-6327(online)

crops. The experimental farm was kept weed free by manual weeding using hoe and hand pulling till harvest. Ten plants per plot were randomly selected and used for the study of plant height at maturity, number of nodules, weight of nodules, weight of pods in tons/ha, bambara groundnut seed yield in tons/ha, maize grain yield in tons/ha of which was determined at 14% moisture content. Land equivalent ratio (LER) was used to evaluate intercrop efficiency in yield to sole crops. The LER was calculated as;

$$LER = \frac{Ymi}{Ymo} \times \frac{Ybi}{Ybo}$$

Where, Ymi = yield of maize in intercropping

Ybi = yield of bambara groundnut in intercropping

Ymo = yield of maize in pure stand

Ybo = yield of bambara groundnut in pure stand.

Equivalent yield of maize and bambara groundnut was calculated as;

$$\text{Maize equivalent yield} = \frac{YSM + (YIB \times PB)}{PM}$$

$$\text{Bambara groundnut yield} = \frac{YSB + (YIM \times PM)}{PB}$$

Where;

YSM = yield of sole maize

YIB = yield of intercrop bambara groundnut

Print ISSN: ISSN 2054-6319 (Print), Online ISSN: ISSN 2054-6327(online)

YSB = yield of sole bambara groundnut

YIM = yield of intercrop maize

PM = price of maize.

PB = price of bambara groundnut

Relative yield of maize was used to evaluate the yields of maize expressed as a sole crop and intercrop.

$$RY = \frac{Ymb}{Ymo}$$

Where Ymb = yield of maize as intercrop in bambara groundnut

Ymo = yield of maize as a sole crop

Relative yield of bambara groundnut was used to evaluate the yields of bambara groundnut expressed as a sole crop intercrop.

$$RY = \frac{Ybm}{Ybo}$$

Where Ybm = yields of bambara as intercrop in maize

Ybo = yields of bambara as a sole crop

Print ISSN: ISSN 2054-6319 (Print), Online ISSN: ISSN 2054-6327(online)

Soil Sample Collection

At the beginning of the study soil samples were randomly collected at the depth of 0 – 25cm from five different spots at the experimental field. The soil samples were thoroughly mixed and bulked to form a composite sample. Also at the end of the study, soil samples were collected at three different spots from each plot. These soil samples were air-dried and sieved through 2mm mesh and used to analyze soil chemical properties of which was determined using the standard procedure described by Black (1965).

Data analysis

The data collected from the study was subjected to the analysis of variance (ANOVA) based on randomized complete block design (RCBD) and treatment means were separated using least significant difference (LSD0.05).

Results

On farm observation

Five days after planting, it was noticed that birds prone to the area uprooted some of the maize seedlings, however they were later scared away with scare crow and constant visit to the experimental field. Supplies were made on those uprooted seedlings. At the same time, young insect pest beetle were found feeding on leaves of bambara groundnut. Pesticide endo force was applied at the ratio of 65ml to 10 litres of water. It was applied at 2 weeks interval. It was also observed that the plant population by counting was higher in the sole crops plot compared to the intercrop, because the survival rate of the crops was higher in the sole crops, probable because of the birds pest attack that were more pronounced in the intercrop plots.

Initial soil properties

The chemical characteristics of the studied soil indicated low level in all the parameters tested, except for base saturation (BS) value.

Print ISSN: ISSN 2054-6319 (Print), Online ISSN: ISSN 2054-6327(online)

Table 1 Initial soil properties

Parameter	Value
Sand	770gkg^{-1}
Silt	780gkg^{-1}
Clay	152gkg^{-1}
pHH2O	6.46
Avail. P	26.10mgkg-1
TN	0.126%
OC	0.77%
OM	1.32%
Ca	5.60 Cmolkg-1
Mg	2.40Cmolkg-1
K	0.118comlkg-1
Na	0.096cmolkg-1
EA	0.40cmolkg-1
ECEC	8.614cmolkg-1
BS	95%

Print ISSN: ISSN 2054-6319 (Print), Online ISSN: ISSN 2054-6327(online)

Agronomic parameters

The result presented in Table 2, showed that the number of bambara groundnut nodules, weight of pods and weight of nodules were not significantly influenced by the intercropping system. The values obtained for the three parameters were highest in sole cropping with a value of 58, 1.44g and 0.58 tha^{-1} respectively as against 54.88, 1.27g and 0.14 tha^{-1} respectively from intercrop bambara groundnut. The result of the plant height indicated that intercropping system significantly ($P < 0.05$) influenced the plant height of maize. The intercrop maize was taller as it recorded the highest mean value of 211.95 cm compared to SM of 195.98 cm. The sole bambara groundnut though not significantly different from intercrop bambara groundnut was observed to be higher in value with 24.34 cm compared to 23.56 cm of IB.

Table 2 Effect of intercropping on the yield component of intercrop species at 10WAP

Treatment	Number of Nodules	Weight of Nodules (g)	Height (cm)	Weight of Pods (tha^{-1})
Sole Bambara	58.00	1.44	24.34	0.58
Intercrop Bambara	54.88	1.27	23.56	0.14
Sole Maize	-	-	195.98	-
Intercrop Maize	-	-	211.95	-
$LSD_{0.05}$	NS	NS	9.24	NS

NS = Not significant, WAP = Weeks after planting

The yield result in Table 3 showed that intercropping system greatly influenced significantly the grain yield of maize in the intercrop, while not effective in the yield of bambara groundnut in the intercrop. The SB performed significantly better than the IB to the tune of 494.23% increase in yield over the IB yield. The SM and IB relatively gave the same yield which is still an indication that the effect of intercropping system was not effective on the yield of the bambara groundnut. The relative and equivalent yield of maize in the intercrop was highest compared to that of bambara groundnut in the intercrop. Thus showing that maize plant benefit greatly from the intercropping system than the bambara groundnut. The land equivalent ratio was found to be 1.54 and this indicated intercrop advantage.

Print ISSN: ISSN 2054-6319 (Print), Online ISSN: ISSN 2054-6327(online)

Table 3 effect of intercropping on the yield, relative and equivalent yield and land equivalent ratio (LER) of the intercrop species.

Treatment	Yield (tha^{-1})	Relative yield	Equivalent yield	Land Equivalent Ratio
Sole Bambara	3.09	-	-	-
Sole Maize	0.57	-	-	-
Intercrop maize	2.85	0.93	1.39	-
Intercrop Bambara	0.52	0.60	1.07	1.54
$LSD_{0.05}$	1.49	-	-	-

Chemical properties

The result of soil chemical properties presented in Table 4, showed that apart from Avail. P. total nitrogen and exchangeable potassium that showed statistically significant ($P < 0.05$) difference among the treatments, every other parameter tested were non – significant among the treatments. The intercrop treatment show higher values in total nitrogen, organic carbon, magnesium, exchange acidity (EA) and effective cation exchange capacity (ECEC) over the SB and SM values, while S B recorded higher values in avail. P, exch. K, Ca and base saturation compared to their values recorded in IMB and SM. The percentage increase in TN, OC, Mg, EA and ECEC in IMB relative to SB, were 12.50%, 3.2%, 33.33%, 20% and 0.60% respectively and 19.20% (OC), 16.67% (Mg); 10% (Ca); 53.15% (K); 1.74% (ECEC) respectively relative to SM.

Print ISSN: ISSN 2054-6319 (Print), Online ISSN: ISSN 2054-6327(online)

Table 4 Effect of maize/bambara groundnut intercrop on soil chemical properties

Treatment	pH H_2O	Avail. P	N	OC	Ca	Mg	K	Na	EA	ECEC	B
		$Mgkg^{-1}$	%	%	→		cmolkg-1		←		%
IMB	6.49	19.70	0.112	1.25	4.0	2.40	0.143	0.061	0.40	7.004	94
SB	6.64	23.30	0.098	1.21	4.80	1.60	0.164	0.078	0.32	6.962	95
SM	6.78	20.60	0.112	1.01	3.60	2.00	0.067	0.087	0.40	6.152	94
LSD0.05	NS	1.09	0.007	NS	NS	NS	0.021	NS	NS	NS	NS

IMB = Maize/Bambara groundnut Intercrop; SB = Sole Bambara groundnut; SM = Sole maize

DISCUSSION

The initial soil analyses of the studied site showed that the studied soil is deficient in chemical nutrients, apart from avail. P, ECEC and Ca that showed moderate levels and high content of BS, the low values recorded could suggest weathering and leaching due to high temperature and rainfall, rapid organic matter degradation and general poor management of the soil. The high level BS obtained may suggest the influence of high content of SOM in the soil surface.

The non – significant effect recorded in numbers of nodules, weight of nodules, weight of pods in sole and intercropped bambara groundnut could be attributed to competition for soil nutrients and light there by making the intercropping system not to be effective on the three parameters. The shedding of bambara groundnut by the maize plant in the intercrop may have also influenced the result so obtained. The weight of pod result however agrees with the findings of Atilola (2007) and Alom *et al.* (2009), who reported non – significant effect of groundnut intercropped with maize on yield parameters of groundnut and considerable reduction in pod yield of groundnut respectively. The intercrop system was very effective on the plant height of maize. This probable may be that maize derive much of its nitrogen from the bambara groundnut fixes from the atmosphere, nitrogen helps and propels the vegetative growth of plants. Ennia *et al.*, (2002), observed increase in plant height of maize when intercropped with soya bean. Conversely height of sole bambara groundnut and that of intercrop show statistically similar value though

Print ISSN: ISSN 2054-6319 (Print), Online ISSN: ISSN 2054-6327(online)

quantitatively the sole recorded higher value. This corroborates with the findings of Nweke *et al.*, (2013), when they reported that the intercropping system of groundnut/ maize/okra did not influence the plant but the groundnut sole cropping recorded the highest value for height.

The statistical significant difference observed in the seed and grain yield result is evidence that intercropping system influenced the parameter assessed. The reduction in grain yield of maize recorded in the sole compared to the intercropping situation could be attributed to competition for water and all that dissolved there in, nutrients in the rhizophere, light and other environmental factors. However, additional yield from bambara groundnut not only compensated the deficit but also gave extra income as was indicated in the relative yield result. The land equivalent ratio (LER) was 1.54 which indicated intercrop advantage regardless of the intercrop yield parameter result.

The results presented in Table 4 showed that apart from Available P, %N and exch. K intercrop system have no effect on the chemical parameters assessed in this study by the virtue of their non significant result. Though in most of the recorded values intercrop showed higher values than the sole crop. The influence of maize – cowpea on soil chemical parameters was investigated by Vesterenger *et al.*, (2008) and Dahmarhdeh *et al.*, (2010) and their findings showed increased amount of N, P and K content of the intercrop maize compared to sole maize. In another experiment with mucuna intercrop with maize Shave *et al.*, (2012) recorded positive effect on the chemical properties of soil especially when it was introduced 6 WAP of maize and that clay, OM, TN, P and CEC were improved by 8 – 14, 25 – 27, 43 – 50, 70 – 83 and 24 – 26% respectively as compared with control, whereas sand and soil pH declined by 17 – 4 and 6 – 3% respectively during the study.

CONCLUSION

The findings of this study have shown that the productivity of maize as a major crop in the study area can be sustained with bambara groundnut intercrop. The system will help to maintain the fertility status of the soil, while the yield of bambara groundnut will be an added advantage that will complement for any loss or deficit in yield of maize.

Print ISSN: ISSN 2054-6319 (Print), Online ISSN: ISSN 2054-6327(online)

REFERENCE

Adu – Gyamfi JJ, Myaka FA, Sakala WD, Odgaard R, Vesterager JM, Hoghjensen H. (2007). Biological nitrogen fixation and phosphorus budgets in farmer – managed intercrops of maize – pigeon pea in semi – arid southern and eastern Africa, Plant soil 295: 127 – 136.

Alom MS, Paul NK, Quayyum MA. (2009). Performance of different hybrid maize (Zea mays L.) and varieties under intercropping system with groundnut (Arachis hypogeae L.), Bangladesh J. Agron. Res. (34 - 94): 585 – 595.

Atilol NCP. (2007). Effect of interplant groundnut with maize on soil organic carbon and yield of groundnut. Soil Fertility Res. 16: 81 – 86.

Black CA. (1965b). Method of soil analysis II chemical and microbiological properties. Am. Soc. Agron. Madison Wisconsin, 1572p.

Boller E, Hani F, Doehling (2004) (eds). Ecological infrastructures Idea book on functional biodiversity at the farm level, 10BC, OILB, Mathenbach AG Winterthur, Switzerland

Brink M, Ramolemana GM, Sibuga KP. (2006). Vigna subterranean (L) Verdc. Received from protabase, Brink, M. and Belay, G. (eds) PROTA, (Plant Resources of Tropical Africa), Wageningen, Netherlands, http:www.prota4u.org.

Dahmardeh MA, Ghanbari BA, Syahsat Ramordi M (2010). The Role of Intercropping Maize (Zea Mays L) and Cowpea (Vigna unguicualte L) on yield and Soil chemical properties African J Agric. Res. 5: 631 – 636.

Ennin SA, Clegg MD, Francis CA. (2002). Resource utilization in soybean/maize intercrops Afr. Crop Sci. J. 10: 251-261

FDALR (1985). Reconnaissance soil survey of Anambra State, Nigeria Soil Report FDALR, Kaduna.

Nweke IA, Ijearu SI, Igili DN. (2013). The growth and yield Performance of Groundnut in Sole Cropping and Intercropped with Okra and Maize, Agric. Vet. Sci. 2(3): 15 – 18.

Seran TH, Brintha I. (2009). Studies on determining a suitable pattern of Capsicum (Capsicum annum L.) – vegetable cowpea (Vigna unguiculata L.) intercropping Karnataka J. Agric. Sci. 22: 1153 – 1157.

Shave Paul Akal, Ter –Rumuim Avav, Enoch Magani Istifanus (2012). Effects of Time of Intercropping of Mucuna (Mucuna Cochinchinevises) in Maize (Zea Mays L) for Wood and Soil Fertility Management. J. Agric. Biol. 14 (3). P 469.

Thottappilly G, Rossel HW. (1997). Identification and characterization of viruses infecting bambara groundnuts (Vigna subterrenean) in Nigeria. J. Pest Mgt 43: 177 – 185.

Print ISSN: ISSN 2054-6319 (Print), Online ISSN: ISSN 2054-6327(online)

Vesterager JM, Nielson NE, Hoghjensen H. (2008). Effects of cropping history and phosphorous source on yield and nitrogen fixation in sole and intercropped Cowpea –Maize systems nutrient cycling Agro –Acosyst. 80: 61- 73.

Print ISSN: ISSN 2054-6319 (Print), Online ISSN: ISSN 2054-6327(online)