

Yield Components of Maize as Influenced by Intercropping of Two Legumes (*Vignasubterranean* (L.) Verdo and *Arachis Hypogea* (L) in Nutrient Depleted Soil

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Abstract

The teaming population need increase of food supply but the available land for crop production threatened and require maximum utilization to meet this challenge. Will there be significant increase in maize yield under maize intercrop with groundnut and *Bambara* groundnut without fertilizer? Hence, a field trial was conducted to assess the effect of two leguminous crops on the growth and yield of late maize season production in year 2017. The experiment was conducted at Teaching and research farm, Michael Otedola College of Primary Education (MOCPED) Epe. The research farm is sand-loamy soil and has being under continuous cultivation for years. Each experimental plot (3.0 m²) with treatments was laid in a randomized complete block design. The treatments were; two cropping systems (mono cropping and intercropping) and two varieties of *Bambara* groundnut (white and red), groundnut and maize as the test crops for the trial. All treatments were replicated three times. Data collected are; number of leaves-NL, plant height-PH(cm), cob weights-C_w(g/plot) and maize Grain-MG (g/plot). All data collected were subjected to Analysis of variance ANOVA (Pr ≤ 0.05). It was observed that at 4 weeks after sowing the PH and NL ranged from 45 to 50 and 5 to 7, respectively. This showed that the planting system had no significant influence on the growth parameters of maize (P ≤ 0.05). However, the grain yields were significantly higher under intercropping particularly groundnut. The highest C_w (992.0) and MG_w (801.2) both were obtained under intercropping of both legumes. This shows that cropping system that can be adopted by farmers to increase maize grain yields is intercropping with legumes. It can therefore be recommended that maize should be intercropped with legumes in order to increase the net yield of maize as well as that of legumes.

Keywords: *Maize-legumes, Intercropped, Nutrient depleted soil, Yields*

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Background to the Study

Food production per capita has decreased drastically in the past decades in many parts of the tropics, but population has increased significantly in the same period. This high population increase poses a number of problems notably: the provision of adequate food, management of the resource base; the soil to support this food production, the development of appropriate technology for agricultural production and changes in the socio-economic environment. These and many others are the prerequisites for increased food production, and meeting the challenges of intensive agriculture (Olugbemi and Falade, 2014).

Farmers practice different cropping systems to increase productivity and sustainability, such as intercropping which is the simultaneous growing of two or more crops in the same field. Various cropping systems have long been in practice among the local farmers for managing soil nutrients and to increase total productivity per unit area through maximum utilization of the available resources. Mixed cropping and intercropping increase the interactions between various crops on field at point of growth to create modified micro environment (Sullivan, 2012). Hence, it is the key to achieving a continuous supply of foods. Furthermore, arable crops such as maize, cassava, cowpea, groundnut, *bambara* groundnut among others common annual crops are used for these practices to modify the cropping environment that is conducive for promoting crop yield (Bagayako, Buekert, Lung, Bationo and Romheld, 2000).

Combination of two or more crops at the same time on the same piece of land is referred to as intercropping (Sullivan, 2012), is an age-old, widespread practice of crop production system especially in the tropics (Agboola, Aggarwa and Morris, 2011). This practice allows maximum utilization of natural resources available for crop production. The interest of growing two or more crops at the same time on the same piece of land is on high side because of the potential to increasing productivity (Barker, 2008). While intercropping has been practiced for centuries, the interest of agricultural scientists in such crop production systems has only recently increased (Amujoyegbe, 2013). Conflicting reports exist about whether a non-legume benefits from N supplied by an intercropped legume. In some instances, the N contribution of the intercropped legume to maize has been estimated to be up to 40 kg ha⁻¹ while other investigators did not find any evidence for such N benefits (Agboola *et al.*, 2011). According to Ahmad, Cheng, Meng, Liu, Wang, Ejaz and Wasila (2013) mono cropping system had negative impacts on soil physical properties and structure and intercropping system is the better option to address problem of soil structure. Legume can transfer fixed nitrogen to intercropped cereals during their joint growing period and this nitrogen is an important resource for the cereal. Cereal-legume intercropping has potential to provide nitrogen depends on densities of crop, light interception, crop species and nutrients (Aziz and Khan, 2007).

Maize is the third most important cereal crop in the world and many subsistence farmers are practicing intercropping of it with legumes due to land scarcity and in order to enhance production. Intercropping system is being practiced in many areas of Africa.

Bambara groundnut *Vigna subterranean* (L.) var *verdo* is an Africa legume valued for its drought tolerance and resistance to pests and diseases. It consists of two botanical forms: *varsspontanea* comprising the wild forms and *varsubterranea* comprising the cultivated forms found in many parts of the tropics particularly sub-Saharan Africa (Richard *et al.*, 2004). Bambara groundnut is commonly called earth pea. It is a leguminous plant that is grown for its underground seeds only (Olugbemi and Adebosin, 2014). It grows best in well drained soils with moderate nutrients, high temperatures at least for four months free from frost and frequent rains to grow best. The plant is highly adaptable and tolerates harsh conditions better than most crops. It matures between three to four months, depending on cultivars and the climatic conditions. The seeds contain 14 to 24% protein and, about 60% carbohydrate and oil within the range of 6 to 12% (NRC, 2006). The immature seeds may be eaten raw, because the seeds become hard when mature and can be roasted or boiled and milled into nutritious flour (Olugbemi and Adebosin, 2014).

Similarly, groundnut is also a member of the legume family *Fabaceae* with pods under the ground. It is an important crop in Nigeria that is grown under different farming systems and rain fed conditions. It constitutes a major source of protein and dietary oil as well as cash income for both subsistence farmers and urban dwellers (Aziz and Khan, 2007).

If the cultivation of groundnut plant is continually successful, the need for fertilizers would be reduced since groundnut is a nitrogen – fixing legume (Amujoyegbe, 2013).

The main uses of groundnut are: peanut butter, peanut candy, salted peanuts, roasted nuts in the shell and boiled groundnuts.

The available farm lands are threatened with population pressure and land degradation among other factors. Hence, diverse farming practices are being employed to sustain crop production. In spite of increased demand for food and agitation for low chemical input for crop production, will there be any significant difference in the yields of maize, groundnut and *bambara* groundnut under intercropping on nutrient exhausted soil? Besides, to what extent can this intercropping improve production among local farmers in terms of maize, groundnut and *bambara* groundnut production? Hence, this research aimed at assessing the yields of maize, groundnut and *bambara* groundnut under intercropping and sole cropping systems in nutrient depleted soil.

Materials and Methods

Description of Experimental Plot: The experiment was conducted at Michael Otedola College of Primary Education teaching and research farm (MOCPE, TRF) which is located at Noforija 7 km, Epe/Ijebu-Ode road, Lagos state with coordinate; Latitude 6.6306° N and Longitude 3.9858° E. It is bounded by two villages; Eredo to the north and Poka to the south. The farmland used for this research has been under continuous cultivation for years and the soil is sand-loam, moderately fertile (Table 1).

Experimental Plot layout and Preparation: The experimental site was manually prepared by clearing the land with cutlass and hoe, and the packing of debris before layout was done. The beds were prepared with minimum tillage operation. Each bed measured 1.0 m by 3.0 m (3.0 m²) for sowing test crops.

The experimental plot consisted of twenty-one (21) micro beds of (3.0 m²) with a walk way of 0.5 m² in between the beds. Thus the total land area covered a total length area of 11.0 mand width of 7.0 m² (total area of 77.0 m²). The maize was intercropped with groundnut and the two cultivars of *bambara* groundnut (white and red) at 90 cm by 30 cm (16 plants each per micro plot).

Experimental Design: The experiment was laid in a randomized complete block design (RCBD) with three blocks. The experiment consisted of the following factors (treatments) two cropping systems (sole and inter cropping), two cultivars of *bambara* groundnut, groundnut and a cultivar of maize.

Experimental Treatments Combinations: The treatments combinations are as follow:

- a. Maize inter crop Red *bambara* groundnut (Rbg)
- b. Maize inter crop White *bambara* groundnut (Wbg)
- c. Maize inter crop groundnut (Gnut)
- d. Sole crop maize
- e. Sole crop Red *bambara* groundnut (Rbg)
- f. Sole crop White *bambara* groundnut (Wbg)
- g. Sole crop groundnut (Gnut)

Both crops were intercropped in two rows of legume and two within rows of maize (2:2 arrangement). The experimental site received adequate sunlight and adequate water supply.

Planting Operation: *Bambara* groundnut and groundnut were sown a week before maize was sown in October 2017. The maize seeds and nuts were sown at two seeds per hole and latter thinned to one per stand.

Cultural Practices: Weeding was done manually with hand and hoes at regular time interval before the flowering of the two legumes. No chemical (herbicide or pesticide) were applied for pests and diseases control. No fertilizer application since the soil nitrogen of the soil is moderate (as indicated in soil test result) for raising legumes and maize.

Harvesting: Both *bambara* groundnut, groundnut and maize were harvested manually by uprooting the plant at end of twelve weeks while the maize was harvested at physiological maturity. The yield parameters from these crops were used to generate data.

Data collection and analyses: During the growing period, data were collected on various growth parameters at 2, 3 and 4 weeks after sowing (WAS) for both crops. Data collected are: plant height and number of leaves. At physiological maturity maize cob and grain, *bambara* groundnut and groundnut podswere weighed and used for yields determination. All data collected were subjected to Analysis of Variance (ANOVA, $\alpha_{0.05}$) and standard error (S.E) and the means were compared using the least significant difference were F ratios were significant.

Results and Discussion

Table 1: The Physical and Chemical Properties of the soil used for the Experiment

Soil Variables	Values
pH (H ₂ O)	6.8
Organic C (g/kg)	0.4
Total N (g/kg)	0.4
Available P (mg/kg)	4.0
K (cmol/kg)	0.1
Ca (mol/kg)	1.3
Mg (Cmol/kg)	0.5
Na (Cmol/kg)	0.1
Particle size distribution (g kg ⁻¹)	
Sand	79.0
Silt	10.8
Clay	10.2
Textural Class (USDA)	Sandy loam soil

Though the soil was sandy loam soil, with low levels of the major plant nutrients for arable crop production especially having nutrient levels that were low in Nitrogen (0.4g/kg), available phosphorus (4.0 mg/kg) and potassium (0.1 cmol/kg) but moderate for groundnut production (Table 1).

Table 2: Maize plant height (cm) at 2, 3 and 4 weeks after planting as influenced by *bambara* and groundnut intercropping

Treatments	Weeks After Planting		
	2	3	4
RBG + maize	10	20	27
WBG + maize	9	21	26
Gnut + maize	10	20	30
Sole maize	10	22	30
SE (df = 11)	1.3 _{ns}	1.6 _{ns}	4.2 _{ns}

Source: 2017, Field experiment

Legend

RBG = Red *bambara* groundnut

WBG = White *bambara* groundnut

Gnut = Groundnut

SE = Standard Error

ns = no significant difference

Table 3: Number of leaves of intercrop maize plant at 2, 3 and 4 weeks after sowing

Treatments	Weeks After Planting		
	2	3	4
RBG + maize	6	6	9
WBG + maize	5	7	10
Gnut + maize	5	7	10
Sole maize	6	7	10
SE (df = 11)	0.7 _{ns}	1.1 _{ns}	1.0 _{ns}

Source: 2017, Field experiment

Legend

RBG = Red *bambara* groundnut

WBG = White *bambara* groundnut

Gnut = Groundnut

SE = Standard Error

ns = no significant difference

From the table above, the number of leaves of maize plant at 2, 3 and 4 weeks after sowing (WAS), there is no significant different at ($\alpha_{0.05}$).

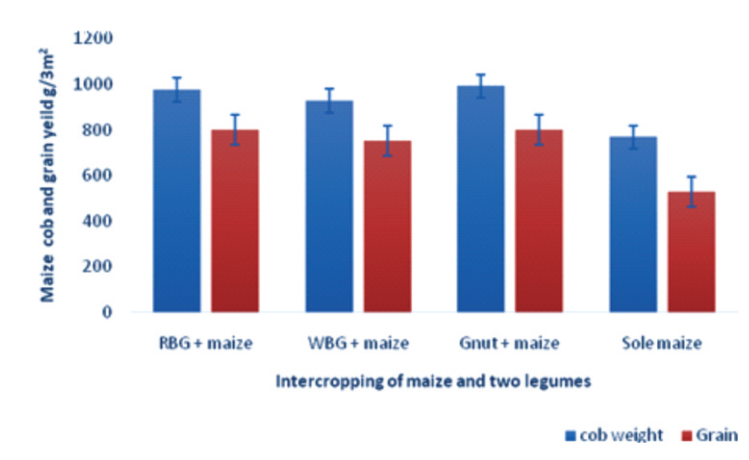


Figure 1: The weight of maize cob (g/plot) and total grain weights at harvest

Legend

RBG = Red *bambara* groundnut

WBG = White *bambara* groundnut

Gnut = Groundnut

Bars = Standard Error

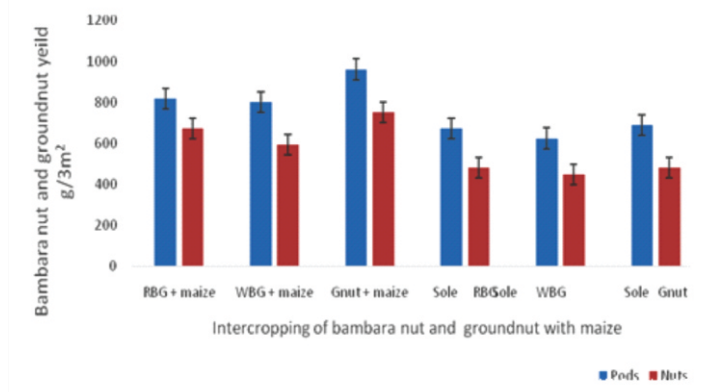


Figure 2: The weights of *bambara* and groundnut pods (g) at harvest

Legend

RBG = Red *bambara* groundnut

WBG = White *bambara* groundnut

Gnut = Groundnut

Bars = Standard Error

Discussion on Growth and Yield Parameters

The growth performances of the of maize plants showed clearly that the cropping system did not significantly affect the vegetative growth of maize under the sole and intercropping systems when compared. There was no significant difference in terms of number of leaves and plant height. All the growth parameters that were observed have similar values with no significant difference ($\alpha_{0.05}$) at early stage of growth when compared (Tables 1, 2 and 3). There was no significant difference ($\alpha_{0.05}$) among all the cropping systems; sole and intercropping. However, at 3 weeks after sowing, sole maize was observed to have the highest value (20 cm) and which was not significantly different from others (Table 1).

Similarly, it was observed that the number of leaves per cropping system showed that there is no significant difference ($\alpha_{0.05}$) among all the plants throughout the growing periods including the sole cropped maize (Table 2). Similarly, the number of maize leaves at 2, 3 and 4 weeks after sowing (WAS) followed the same patterns as observed in plant height. At 2 WAS, the number of maize leaves range from (5 – 6; ± 1.3) and at 3 WAS similar strength was observed, but at 4 WAS, the number of leaves ranged from 9 ± 1.1 – 10 ± 1.0 (Table 3).

The maize cob weights ranged from 768.0 to 992g where the yield from sole maize has the least value. This shows that there is no significant different among the treatments but there is significant difference ($\alpha_{0.05}$) with the yield from sole cropped plots. Similarly, as observed in the total cob weight of maize, the highest grain yield (801.2 g) was obtained from maize intercropped with red *bambara* which has no significantly different compared with yield obtained from white *bambara* nut intercropped with maize but was highly significant compared with sole maize (Figures 1).

It was observed from the study that higher yields were obtained from the two the cultivars of *bambara* nut intercropped compared to their sole crops. This shows that there is high significant difference between the yields from the two cropping systems. Similarly, as observed in the total pod yields of the intercropped *bambara* nuts, the highest grain weights were also gotten from intercropping (Figure 2). Among the two legumes, groundnut was observed to have the highest pod weight; the total pod weight of groundnut was increased compared to its sole crop (Figure 2).

In conclusion, was observed from the study that the mean yields of the legumes under intercropping system increased as compared to sole cropped legumes yield. The highest yield was recorded when groundnut was intercropped with maize intercrop groundnut compared to compared to what was obtained under sole cropping system.

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