International Journal of Agricultural Research and Food Production
ISSN: 2536-7331 (Print): 2536-734x (Online)
Volume 3, Number 2, June 2018
http://www.casirmediapublishing.com

EFFECT OF PIGEON PEA ALLEY ARRANGEMENT ON GROWTH AND YIELD OF MAIZE IN INTERCROPPING SYSTEM

Olagunju John Olujobi[1], Dele Olawumi Amujo[1] & Faith Aladi Sale[2]
[1]Department of Forest Resources and Wildlife Management, Ekiti State University, Ado-Ekiti
[2]Department of Forestry and Wildlife, Kogi State University, Anyigba,
E- mail: olujobioj@yahoo.com
Corresponding author: Olagunju John Olujobi

ABSTRACT

Field experiment was carried out to investigate the effect of pigeon pea alley arrangement on growth and yield of maize. Five (5) treatments; consisting of the following pigeon pea/maize row ratio (1:2, 2:2, 1:3, 2:3 and 0:3 row ratios) were arranged in completely randomized design in plots and replicated five (5) times. At two weeks intervals, starting from the fourth week after the planting of maize (WAP); maize growth parameters were measured. At maturity, maize cob was harvested and the yield was determined. The result shows that at 4 WAP, maize in 1:2 treatments has the mean tallest value (24.5 cm) while at maturity (10 WAP), maize in 2:3 treatment has the mean tallest value (187.7cm). Maize mean stem diameters and numbers of leaves in all the treatments were not significantly different ($p < 0.05$) up to 8 WAP. Mean total dry matter yield (180.52 g/plant) was highest in 1:2 treatment while maize in 2:2 treatment has the highest mean grain yield (75.11 g/plant). Correlation between maize yield components was positive for cob length ($r= 0.465$), cob weight ($r = 0.476$) and rachis weight ($r = 0.516$). Consequent upon the results from the study, 1:2 row arrangements was recommended for fodder production and 2:2 row arrangements for grain production by agro forestry farmers.

Keywords: *Alley, growth, intercrop, maize, pigeon pea, yield,*

INTRODUCTION

In tropical Africa, the demand for food to feed the ever increasing human population has led to short fallow periods on available agricultural lands. This trend has led to serious decline in soil fertility particularly in the humid lowland of western Nigeria where farmers had traditionally relied on natural bush fallow for nutrient and soil organic matter build up. Most of the developing countries are facing great challenges to meet input resources such as fertilizer, irrigation and good quality seeds in order to sustain their production (Pervaiz *et al.*, 2009). The use of inorganic fertilizers to improve soil nutrient by smallholder farmers has not been successful in the region because of high cost and unavailability of the input materials during cropping season. Mixed culture of legumes and cereals in cropping systems, either as intercrops or in rotations with other crops for improving soil fertility is a common practice in agro forestry systems and it has become popular among peasant farmers in the tropics (Raoand Mathuva, 2000). The potential benefit of intercropping systems is to; maximize the use of resources such as space, light and nutrient; enhance weed suppression, to increase disease and pest resistance and reduce water run-off (Anil *et al.*, 1998). However, nutrient transfer between companion crops for higher yield in most cases forms the bases for intercropping (Crew and peoples 2004).Growing crops in mixed stands can be more productive than growing them separately. The nature of interactions between the components crops and the productivity of the intercropping system as a whole depends on the morphology, physiology, density and spatial arrangement of the component crops (Anil *et al.,* 1998).Spatial arrangement involves growing two or more crops in separate rows or alternate rows on a piece of land with the component crops competing for growth resources (Fitsum, 2016). Such interactions generally mean that companion crops have both complementary and competitive aspect.

Herbaceous legumes that serve the single purpose of improving soil fertility have not been widely adopted by smallholder farmers because they cannot afford to grow them at the expense of grain legume crops that will provide them with food on their limited land holdings. Dual-purpose legumes such as cowpea (*Vignaunguiculata*L. Walp.), groundnut (*Arachis hypogea* L.) and pigeon pea (*Cajanuscajan*L. Millsp.) That produce food and animal feeds are attractive particularly to small-scale agro forestry farmers who practice mixed cropping systems. Intercropping legumes with non-legumes can be a principal means of intensifying crop production both spatially and temporally to improve crop yields for smallholder farmers (Legwaila *et al.,* 2012). Yield advantage in intercropping is determined by the net effect of positive interactions and negative interactions (Kimaro *et al.,* 2009).Some of the advantages of perennial legumes in intercropping include absence of recurring establishment costs, opportunity to grow crops simultaneously without sacrificing land and improved soil physical conditions and higher water infiltration because of their rooting activity (Rao *et al.,* 1998).

Pigeon pea (*Cajanuscajan*L. Millsp) is multipurpose legume shrubs that have both physiological and morphological attributes that may reduce interspecific competition in mixed culture. The initial slow growth of pigeon pea relative to cereal minimized competition in intercropping system (Snapp *et al.,* 2002). Pigeon pea is useful as an alley crop, thus, it is an important pulse legume grown in agro forestry systems (Dasbak and Asiegbu, 2009). Maize is often planted in intercropping systems for it advantage as insurance against crop failure (Alabi and Esobhawan, 2006; Dania *et al.,* 2014). The relative advantages of intercropping maize with pigeon pea have not being fully exploited by agro forestry farmers in Nigeria. The objective of this study therefore is to determine the effect of pigeon pea row arrangements on growth and yield of maize in intercropping system.

MATERIALS AND METHODS

Site description

This study was carried out at the Teaching and Research Farm, Ekiti State University Ado-Ekiti, in South West Nigeria (Latitude 7°25' and 7°47' N and Longitude 4° 52' and 5°13' E) in the rainforest belt at an elevation of 25 m above sea level. The annual rainfall ranged from 1, 200 mm to 1, 500 mm. Day temperature fluctuates between minimum of 24□ and maximum of 35□ with little variation throughout the year. The annual relative humidity ranges between 65 and 90% during the raining season. The soil is an Oxic Tropudalf (USDA soil taxolomy). The soil is well drained sandy loam texture with moderate fertility [pH (H_2O) – 5.86; Organic Carbon-16.9 $g.kg^{-1}$; Nitrogen-3.8 $g.kg^{-1}$; Available Phosphorus-6.1$g.kg^{-1}$; Potassium-1cmol.kg^{-1}; Calcium-12cmol.kg^{-1}; Magnesium-4.27cmol.kg^{-1}]. Existing weeds on the land include Guinea grass (*Panicum maximum*); Siam weeds (*Chromoleanaodorata*) and Milk weed (*Euphorbia hirta*L.).

Experimental design and plot layout

Net plot size of 400 m^2 (0.004ha) was cleared and divided into 25 plots with buffer of 1.5 m in-between the plots. Five (5) different treatments including control were imposed within the plots. The dimension of the mini plot was as shown in Figure 1. Each treatment was replicated five (5) times. Pigeon pea seeds were sown at 50 cm intervals within the row while maize seeds were sown at 25 cm intervals within the row. Pigeon pea seeds were allowed to grow for six weeks before the planting of maize. Completely Randomized Design (CRD) was used for the experiment. See figure 1 for the plot layout.

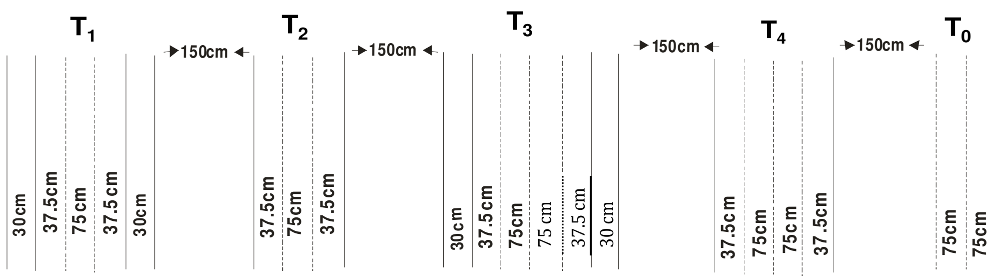

Figure 1. Treatments plot layout

Key: Maize row Pigeon pea row ________

T_1 = Double row of pigeon pea + double rows of maize (2:2 row ratio)

T_2 = Single row of pigeon pea + double row of maize (1:2 row ratio)

T_3 = Double rows of pigeon pea + triple row of maize (2:3 row ratio)

T_4 = Single row pigeon pea + triple row of maize (1:3 row ratio)

T_o = Triple rows maize (0:3 row ratio)

Data collection and analysis

Starting from the fourth week after planting, growth variable of maize were measured at two weeks interval for a period of ten weeks. At maturity maize cob was harvested, the length and diameter of the cob were measured with tape and vennier caliper respectively. The cob was shelled and the grains were oven dried to constant weight. Maize plant were uprooted and separated into leaf, stem and root. Each component part was dried to constant weight to determine dry matter yield. Data collected were subjected to one-way analysis of variance with statistical program SPSS-vol.01 at 5% level of significance to determine differences in the treatment effect. New Duncan Multiple Range Test (NDMRT) was used to separate the means.

RESULTS

Growth of maize as influenced by pigeon pea alley pattern

Result in Figure2 shows that at 4 WAP, maize mean height for all the treatments were not significantly different ($p < 0.05$). At 6 WAP, the maize in 1:3 pigeon pea/maize row treatments has the tallest mean height (60 cm), while maize planted in 1:2 pigeon pea/maize row treatments has the least mean height value of 45.5 cm. At 8 WAP, maize in 2:2 pigeon pea/maize row treatments has the tallest mean height of 111.8 cm followed by maize in 2:3 pigeon pea/maize row treatments with mean height of 98.8 cm. At 10 WAP, maize in 2:3 pigeon pea/maize row treatments has the highest mean height value of 187.7 cm, while Maize in 0:3 pigeon pea/maize row treatments (sole maize) has the least mean height value of 89.8 cm.

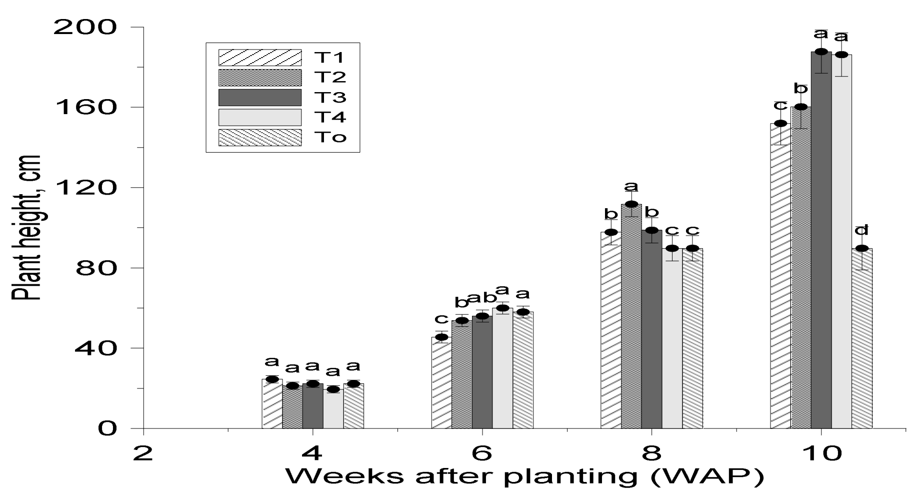

Figure 2: Maize height during growth cycle

1:2 row ratio = (T1)

2:2 row ratio = (T2)

2:3 row ratio = (T3)

1:3 row ratio = (T4)
0:3 row ratio = (To).
Bars with different letters differed significantly at 5% level of probability

Result in Figure3 indicates that at 4, 6, and 8 WAP; stem diameter for all the treatments were not significant different ($p < 0.05$). The result however, shows that at 10 WAP, maize in 1:2 and 2:2 pigeon pea/maize row treatments has significantly highest mean stem diameter of 2.36 cm each, while maize in 1:3 pigeon pea/maize row treatment has significantly least stem diameter of 1.81cm.

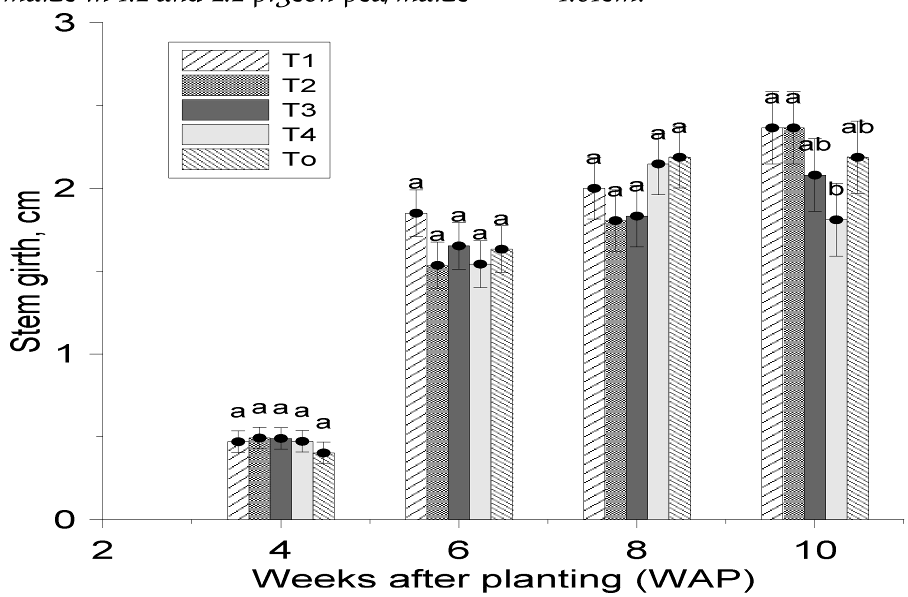

Figure 3: Maize stem diameter during growth cycle
1:2 row ratio = (T1)
2:2 row ratio = (T2)
2:3 row ratio = (T3)
1:3 row ratio = (T4)
0:3 row ratio = (To)
Bars with different letters differed significantly at 5% level of probability.

The numbers of leaves produced by maize at 4, 6 and 8 WAP for all the treatments were not significantly different ($p < 0.05$) (Figure4). However, at 10 WAP the result shows that maize in 2:3 pigeon pea/maize row treatments has the highest mean number of leaves (16.7), while the least value was obtained in 0:3 pigeon pea/maize row treatment with the mean value of 13.0.

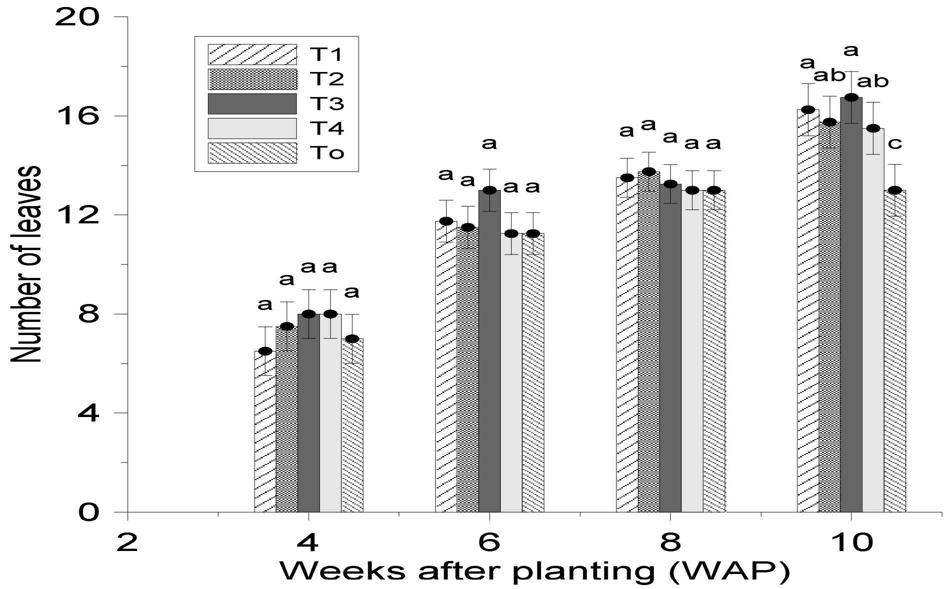

Figure 4. Leaf number of maize during growth cycle
1:2 row ratio = (T1)
2:2 row ratio = (T2)
2:3 row ratio = (T3)
1:3 row ratio = (T4)
0:3 row ratio = (To).
Bars with different letters differed significantly at 5% level of probability.

Dry matter yield of maize at harvest

Dry Stover yield of maize plant part shows that leaf has the highest dry matter yield followed by root and stem respectively in all the treatments (Table1). The result however, shows that maize in 1:2 pigeon pea/maize row treatment has the highest overall total dry matter yield (180.52 g/plant) followed by maize in 2:2 pigeon pea/maize row treatment (163.16 g/plant). Maize in 0:3 pigeon pea/maize row treatment has significantly (p >0.05) least total dry matter yield (129.28 g/plant).

Table 1: Dry matter yield of maize plant parts and total biomass at harvest

	Root	**Leaf**	**Stem**	**Total biomass**
Treatments	-------------------------------- **g/plant**	------------------------------------		
1:2 row ratio	59.46±0.02b	80.74±0.01a	40.31±0.15a	180.52±0.03a
2:2 row ratio	63.41±1.80a	75.17±4.58ab	24.58±1.05b	163.16±5.26bc
2:3 row ratio	58.45±0.02b	72.33±0.03b	25.53±0.02b	156.31±0.03bc
1:3 row ratio	51.83±0.85bc	72.52±0.12b	25.30±0.02b	149.66±0.86c
0:3 row ratio	43.78±0.32c	63.62±2.72c	21.89±0.93c	129.28±2.15d
SEM	0.521	1.374	0.363	1.485

Values with different letters in each column differed significantly ($p > 0.05$).
SEM: Standard Error of Mean

Grain and other yield components of maize at harvest

Table 2 shows that maize in 2:2 pigeon pea/maize row treatments has the highest mean grain yield (56.1 g/plant) followed by maize in 1:2 and 2:3 pigeon pea/maize row treatments with 55.56 g/plant and 55.75 g/plant respectively. The result also shows that maize in 0:3 pigeon pea/maize row treatments (control) have the least mean grain yield of 29.32 g/plant. Also the result shows that mean rachis weight was highest in maize plant under 1:2 pigeon pea/maize row treatment while cob weight was significantly higher in maize under 2:2 pigeon pea/maize row treatment (75.11 g/plant). The result also shows that maize cob diameter for all the treatments were not significantly different $p < 0.05$), while cob length was longer for maize in 1:3 pigeon pea/maize row treatment (13.03cm).

Table2. Maize yield components at harvest

	CL	CD	GW	RW	CW
Treatment	----------cm----------		-----------------------g/plant---------------------		
1:2 row ratio	12.94±0.95ab	3.70±0.27a	55.76±6.97b	19.31±2.43a	75.07±14.85b
2:2 row ratio	12.44±0.50b	3.74±0.61a	56.10±9.74a	19.01±2.93a	75.11±11.14a
2:3 row ratio	11.53±0.53c	3.60±0.46a	55.57±10.64b	17.72±5.48b	73.29±12.48c
1:3 row ratio	13.03±0.25a	3.69±0.16a	42.47±0.00c	19.15±2.57a	61.62±12.40d
0:3 row ratio	10.92±0.11d	3.33±0.17a	29.32±9.36d	9.95±1.71c	39.27±7.80e
SEM	0.27	0.19	1.64	4.15	5.98

CL: cob length; CD: cob diameter; RW: rachis weight; GW: grain weight; CW: cob weight
Values with different letters in each column differed significantly ($p > 0.05$).
SEM: Standard Error of Mean

Correlation analysis between maize yield components

Result in table 3 revealed that grain weight is strongly and positively correlated with total dry matter yield (0.695), cob weight (0.767) and rachis weight (0.650) at ($p < 0.01$) level of significant. The result also shows that there is moderate positive correlation between cob length (0.465), cob weight (0.476) and rachis weight (0.516) at ($p <0.05$) level of significant.

Table 3.Pearson correlation analysis between maize yield components

Yield Components	Grain Weight	Total Biomass	Cob Length	Cob Diameter	Cob Weight	Rachis Weight
Grain Weight	1	0.695**	0.267	0.107	0.767**	0.650**
Total Biomass		1	0.653**	0.418	0.675**	0.689**
Cob Length			1	0.465*	0.476*	0.516*
Cob Diameter				1	0.124	0.135
Cob Weight					1	0.835**
Rachis Weight						1

Correlation is significant at the 0.01 level (2-tailed); *Correlation is significant at the 0.05 level (2-tailed)

DISCUSSION

This study revealed that height exhibited by maize in all the treatments at 4 WAP of growth cycle was not significantly different. This observation could be attributed to the fast growth rate exhibited by maize compared to slow growth rate exhibited by pigeon pea at this growth stage. Thus it could be asserted that during this period pigeon pea does not compete with maize for growth resources either in the above or below ground. This assertion is in agreement with the findings of Egbe and Kalu (2009) who similarly reported higher growth in sorghum in a pigeon pea/sorghum intercropping study. The slow growth observed in maize height at 6 WAP in 1:2 and 2:2 pigeon pea/maize row treatments might probably be due to competition for below ground resources (water and nutrient) between maize and pigeon pea. At this growth period, pigeon pea been a higher demander of nitrogen (N) could inhibit the N uptake of maize by competing for the soil mineralized N via root to root interaction; thereby depriving maize access to sufficient N uptake and consequent reduction in growth.

The significant higher maize height observed in 2:3, and 1:3 pigeon pea/maize over that of 1:2 and 2:2 pigeon pea/maize row treatments at 6 WAP could probably be due to less influence of pigeon pea on maize in these treatments (especially the middle row maize). Because of the wide gap between the pigeon pea alley and middle row maize in these treatments there is less interaction for below and above ground resources. Thus, maize in these treatments like the sole maize has ample opportunity to sun light for effective photosynthesis and consequently higher vegetative growth. This assertion is in consonance with the report by Lingaraju and Chandrashekar (2008) who observed better growth performance in maize under 3:1 maize/pigeon pea row treatment than maize in 2:2 maize/pigeon pea row treatment. The observed significant higher growth advantage exhibited by maize plant in all the intercropped treatment at maturity (8 and 10 WAP), over that of 0:3 pigeon pea/maize row treatments (sole maize) could be attributed to better nourishment due to improvement in nutrient status of the soil through N-fixation by pigeon pea alley. This submission corroborates the findings of Egbe and Adeyemo (2006), Silwana *et al.* (2007) who in their studies reported higher growth advantage in maize intercropped with pigeon pea than sole maize. This study revealed that stem diameter and number of leaf per maize plant were not significantly different for all the treatments up to 8 WAP of maize growth cycle, this observation is an indication that there is a great compatibility between maize and pigeon pea in intercropping systems. This assertion corroborates the submission by Abuna (2015).

The observed significant higher dry stover yield obtained for maize plant in all the intercropping treatments compared to that of mono-cropped maize in this study, could probably be attributed to improvement in soil nutrient by pigeon pea and consequent better nourishment for rapid vegetative growth and accumulation of dry matter. This submission is in consonance with the findings of Lingaraju and Chandrashekar (2008) who reported that maize intercropped with legume and those grown in soil improved with legume litter produce higher dry matter yield than mono-cropped maize. The significant higher grain yield and other yield variables obtained for maize in all intercrop treatments over that of mono-crop maize in this study could be linked to better performance in term of vegetative growth. Also it could be attributed to soil moisture conservation as influenced by legume cover, since the experiment was conducted towards the end of raining season. This assertion confirms earlier reports by Ofosu-budu *et al.* (1993) and Rathod *et al.* (2004) who in separate studies reported that maize intercropped with legume gave better yield than sole maize in moisture stressed condition. In conclusion, the results from this study have shown that irrespective of pattern of row arrangement, pigeon pea does not negatively affect the growth of maize at the early growth stage. However, at maturity (8-10 WAP) all the maize in intercropping treatments shows significant better performance in term of physiological growth than mono-crop maize. Also all the maize plant in intercropping treatments performed better in term of dry matter and grain yield than mono-crop maize. Generally, result from this study has shown that there is high level of compatibility between pigeon pea and maize when grown as companion crops in agro forestry system. Based on the result from the study, it is recommended that 1:2 pigeon pea/maize row arrangements should be adopted for fodder production while 2:2 pigeon pea/maize row arrangements is recommended for grain production by agro forestry farmers.

REFERENCES

AbunaWG (2015).A Study of the Effect of Intercrop Row Arrangement on Maize and Haricot bean yield on residual soil. *International Journal of Agro forestry andSilviculture.*2 (4): 127-134

Alabi RA and Esobhawan AO(2006). Relative Economic Value of Maize Okra Intercrops in Rainforest zone in Nigeria. *Journal of Central European Agriculture.*7 (3): 433-438.

Anil L, Park J, Philips RH and Miller FA (1998).Temperate Intercropping of Cereals for Application on Weed Control and Performance of Cassava and Maize. *Field Crops Res.* 39: 63-69.

Crew TE and Peoples MB (2004). Legume Versus Fertilizer Source of Nitrogen: Ecological Trade-offs and Human Needs. *Agriculture Ecosystem and Environment* 102: 279-297

Dania SO, Fagbola O and Alabi RA (2014).The Yield and Farmer's Economic Advantage of Maize/Pigeon Pea Intercrop as Affected by the Application of Organic Based Fertilizer. *European Scientific Journal*10 (25): 357-374.

Dasbak MAD andAsiegbu JE (2009). Performance of Pigeon Pea Geneotypes Intercropped with Maize under Humid Tropical Ultisol Conditions. *Journal of Animal and Plant Sciences.* 4 (2): 329-340.

Egbe OM and Adeyemo MO (2006). Estimation of the Effects of Intercropped Pigeon Pea on the Yield and Yield Components of Maize in Southern Guinea, Savannah of Nigeria. *Journal of Sustainable developmentin Agriculture and Environment* 2 (1):107-118

EgbeOM and Kalu BA (2009). Evaluation of Pigeon Pea [Cajanuscajan (L.) Millsp Genotypes for Intercropping with Tall Sorghum (*Sorghum Bicolar*)(L.) Moench) in Southern Guinea Savanna of Nigeria. *Journal of Agricultural and Biological Science*4 (4): 54-67

Fitsum M (2016). Effect of Population Density and Spatial Arrangements of Pigeon Pea (*Cajanuscajan* L. Millsp) on Productivity of Maize-Pigeon Pea

Intercropping. *World Sci News.*53 (3): 216-229.

Kimaro AA, Timmer VR, Chamshama S and Kimaro DA (2009). Competition between Maize and Pigeon Pea in Semi-arid Tanzania: Effect on Yield and Nutrition of Crops. *Agriculture Ecosystem and Environment* 134 (1&2): 115-125.

Legwaila GM, Marokane TK and Mojeremane W (2012). Effects of Intercropping on the Performance of Maize and Cowpeas in Botswana. *International Journal of Agriculture and Forestry* (6): 307-310

Lingaraju BS and Chandrashekar SS (2008). Studies on Intercropping of Maize and Pigeon Pea under Rainfed Condition in Northern Transitional Zone of Karnataka. *Karnataka Journal. Agric. Sci.* 21(1): 1-3

Ofosu-budu KG,Sumiyeshi HA and Fujita K (1993). Significance of Soil Nitrogen on Dry Matter Production and Nitrogen Balance in Soybean/Sorghum Mixed Cropping System. *Soil Science and Plant Nutrition.* 39: 33-42.

Pervaiz ZH, Tehrim S, Rabbani MA, Masood MS and Malik SA (2009). Diversity of Major Seed Storage Proteins of Rice Landraces of Pakistan. *Pakistan Journal ofBiology*43 (3): 1612-2011.

Rao MR and Mathuva MN (2000). Legumes for Improving Maize Yields and Income in Semi-arid Kenya. *Agriculture Ecosystem and Environment.* 78: 123-137

Rao MR, Nair PKR and Ong CK (1998). Biophysical Interactions in Tropical Agro Forestry Systems .*Agro Forestry Systems.* 38: 3-50

Rathod PS, Halikatti SI,Hiremath SM and Kajjidoni ST (2004). Influence of Different Intercrops and row Proportions on Yield and Yield Parameters of Pigeon Pea in Vertisols of DHARWAD. *Karnataka Journal. Agric. Sci..* 17: 652-657.

Silwana TT, Lucas EO and Olaniyan AB (2007). The Effects of Inorganic and Organic Fertilizers on the Growth and Development of Component Crops in Maize/Bean Intercrop in Eastern Cape of South Africa. *Journal of Food Agriculture and Environment*5 (1): 267-272.

Snapp SS, Rohrbach DD, Simtowe F and Freeman HA (2002). Sustainable Soil Management Options for Malawi: can Small Holders Farmers Grow More Legumes? *Agriculture Ecosystem and Environment* 91. 159-174.