Effects of Spatial Arrangements of Groundnut-Maize Intercrop on Growth, Yield and Proximate Composition of Groundnut

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Abstract
Field experiment was carried out at University of Ilorin Botanical garden between May and August 2014 to evaluate the influence of different spatial arrangements on groundnut-maize intercrop and proximate composition of groundnut seeds. Experimental layout followed completely randomized block design with three replications. The spatial arrangements investigated were 3 rows of groundnut alternated with 1 row of maize (3:1), 3 rows of groundnut alternated with 2 rows of maize (3:2), 3 rows of groundnut alternated with 3 rows of maize (3:3), sole maize and groundnut. The results indicated that growth characters such as number of leaves and leaf area were enhanced in 3G:1M and 3G:2M spatial arrangement when compared to 3G:3M and their respective sole cropping. Yield was also enhanced in the intercrop compared to their soles. The 3G:3M produced groundnut seeds with increased percentage ash, fibre and crude protein with concomitant reduction of the fat and carbohydrate when compared to other spatial arrangements and sole groundnut. The results showed that 3G:1M and 3G:2M could be considered as appropriate spatial arrangement for enhancing the growth and yield of the intercrop. The study therefore recommends that field trials be conducted outside the University Botanical Garden with the participation of extension agents and farmers to ensure the adoption of the research outcomes.

Keywords: Spatial arrangements, Intercrop, Ash, Fibre, Protein, Yield

1.0 Introduction

Intercrop can be described as the planting of two or more crops simultaneously on the same piece of land during the growing season [1]. The main types of intercropping systems include strip row, relay and mixed row [2]. Spatial arrangement of crops is another type of intercropping where two or more crops are growing in separate rows or alternating rows on the same piece of land. In this arrangement, crops involved compete for growth resources such as light, water, carbon dioxide and nutrients. However, several advantages have been documented for the use of spatial arrangements in lieu of sole cropping. Higher yields have been reported when competition between two species of the mixtures have lower competition than within the same species [3]. Shading by heavier leaf canopy of an intercropping reduces soil temperature and moisture loss, which favour multiplication and growth of some soil microorganisms [4]. In spite of these merits, some of the disadvantages associated with intercropping in mechanized farming is that overall cost per unit production may be higher due to reduce efficiency in planting, weeding and harvesting [2].

Intercropping maize with legumes is one of the common cropping systems in Africa which is currently receiving global attention because of its prime importance in world production. It offers crop growers the opportunity to engage nature's principle of diversity [5]. Cereal-legume intercropping has been reported to be more productive and remunerative compared to sole cropping [6, 7]. It plays an important design in allowance food production in both developed and developing countries, especially in situation of restricted water resources [8]. Maize-legume intercropping systems are able to lessen amount of nutrients taken from the soil in comparison to a maize monocrop [9]. Maize-legume intercropping was more productive system and a less risky technology [10]. Higher crop productivity and efficiency in resource use was observed in maize-bean intercropping systems than in the respective sole cropping [9].

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Arising from the above, the intercropping of maize with legume has proven to be more remunerative than growing each crop alone. Hence, various efforts have been made to identify suitable intercropping system in maize (*Zea mays* L.) for various agro-climatic zones. Therefore, the aim of the present study is to determine appropriate spatial arrangement that will promote growth and yield in groundnut-maize intercrop in Southern Guinea savanna zone of Kwara state. It is also designed to provide information on the effect of this planting ratio on the composition of the groundnut seeds.

2.0 Materials and Methods

2.1 Experimental Site

The experiment was conducted at the Botanical garden of University of Ilorin, Nigeria, between May and August, 2014.The experimental site received total rainfall of 495.5 mm during the cropping season. An average daily temperature range of 24^0C to 35^0C was recorded. The soil was sandy loamy with approximately 80.96% sand, 14.00% silt, 5.04% clay, organic matter 3.74% and pH 8.60.

2.2 Seed Collection and Description

The varieties of the groundnut and maize used for this study were Samnut10 and DMR 10 respectively. They were obtained from the Ministry of Agriculture, Ilorin Nigeria. The groundnut and maize varieties mature between 85-90 and 100 days respectively.

2.3 Experimental Layout and Treatment Details

The experimental design was a randomized complete block with three replications. There were five experimental plots each measured 10.0 m x 6.0 m .The spaces between blocks and experimental units were 2.0 m. The five planting arrangements used were:

$T_{1:}$ sole groundnut (G)
$T_{2:}$ 3 rows of groundnut alternating with 1 row of Maize (3G: 1M)
$T_{3:}$ 3 rows of groundnut alternating with 2 rows of Maize (3G: 2M)
$T_{4:}$ 3 rows of groundnut alternating with 3 rows of Maize (3G: 3M) and
$T_{5:}$ sole maize (M)

2.4 Field Planting

Land preparation was done manually using cutlasses to remove the grasses and hoe was used to make the ridges. The seeds of groundnut and maize were treated with seedrex (33% permethrin + 15% carbonderzine + 12% chlorothalonil) at the rate of 4 kg of seeds/10 g of the chemical shortly before planting to control soil borne pests and pathogens. Sowing was done manually by planting three seeds per hole. The emerged seedling were thinned to one per hole at two weeks after planting (WAP). The maize variety and groundnut was sown at spacing of 40 cm by 40 cm. Hand weeding was done at three weeks interval to keep the experimental site free from weeds. At maturity (15 WAP), harvesting was done by carefully uprooting the groundnut plants from the soil. Harvested pods were cleaned with running water to remove soil particles and the pods were detached manually from the plants. The maize was shelled manually the grains were air-dried to 14% moisture content and groundnut pods to about 12% moisture content.

2.5 Data Collection

Data were collected at three weeks interval on the following growth parameters on maize and groundnut plants: Plant height, number of leaves and leaf area. The leaf area was determined with the use of the formula: 0.5 x L x B (L = length and B = breadth) after measuring the length and breadth of a leaflet of each plant [11, 12]. The yield components such as number of pod/cob per plant, number of seeds/grains per plant, 100-seed weight and 100-grain weight per plant were determined. Seed and grain yield per hectare were also measured.

2.6 Proximate Composition of Groundnut Seeds

Proximate compositions including moisture, ash, fibre, crude fat, crude protein and carbohydrate by difference were determined using the methods of [13].

2.7 Data Analysis

Data collected were subjected to Analysis of Variance at significant level $p < 0.05$. Mean were separated using Duncan Multiple Range Test [14].

3.0 Results

3.1 Plant height

In both groundnut and maize plots plant height increased linearly from the first crop growth stage till the final date of sampling (Fig. 1). Significant differences were not recorded in both crops at different crop growth stages except at 3, 12 and 15 WAP in maize plots. In spite of no statistical differences in the groundnut plots, the sole groundnut and 3G:1M spatial arrangement recorded higher plant height. Plots receiving 3G:3M spatial arrangement recorded lowest plant height beginning from 9 WAP till final date of sampling. In the maize plots, 3G:1M plots showed highest plant at different growth stages with the sole maize showing the least plant height when compared to other spatial arrangements (Fig. 1). The highest plant height recorded from 3G:1M spatial arrangement were observed to be statistically significant at 3, 12 and 15 WAP when compared to other spatial arrangements and its sole maize plots.

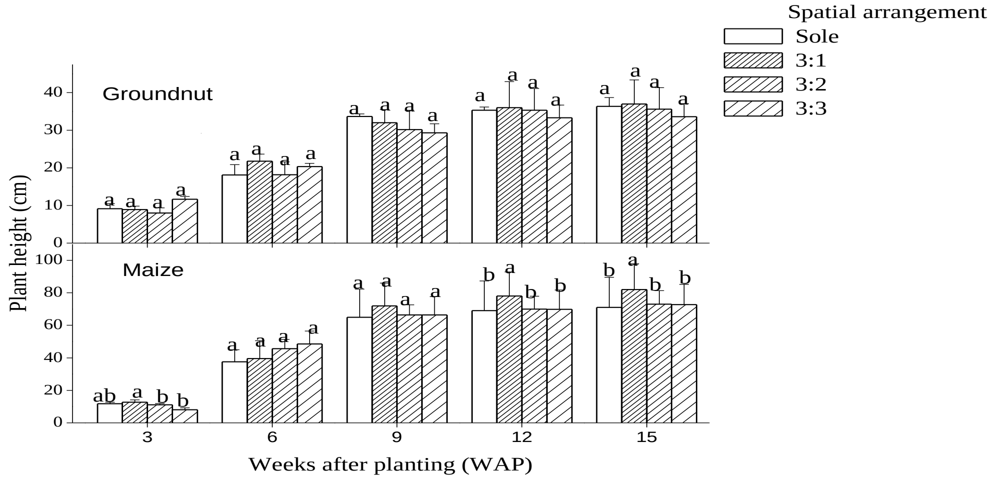

Fig. 1: Plant height as affected by different spatial arrangements in groundnut-maize inter crop. Vertical bars represent treatment means ± SD

3.2 Number of Leaves

The number of leaves was significantly influenced by spatial arrangements only in groundnut plots except at 3 WAP and 15 WAP (Fig. 2). At 6, 9 and 12 WAP, 3G:2M spatial arrangement in groundnut plots recorded significantly higher number of leaves compared to other spatial arrangements. The sole groundnut plots showed significantly lowest number of leaves production. In the maize plots, in spite of no significant differences at all crop growth stages, higher number of leaves was recorded from 3G:1M plots. The sole maize plots recorded the lowest number of leaves (Fig 2). In all the spatial arrangements and their respective sole, number of leaves increased lineally till final date of sampling.

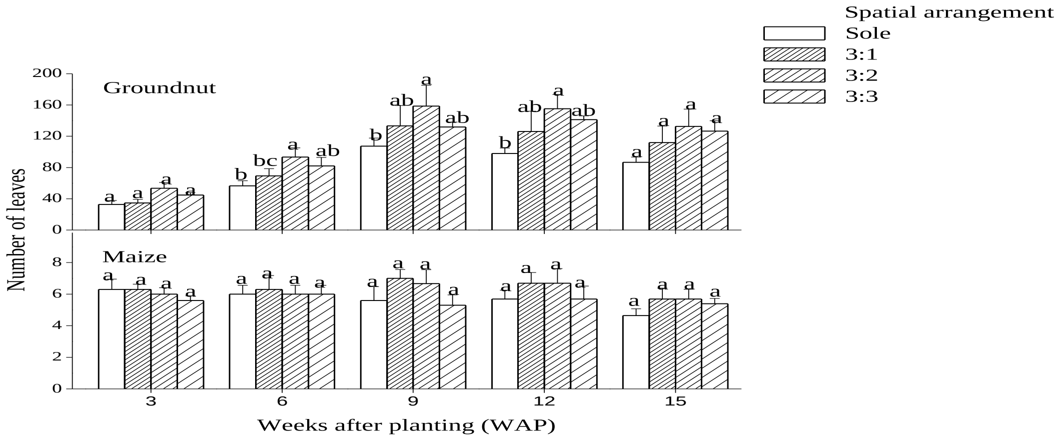

Fig. 2: Number of leaves as affected by different spatial arrangements in groundnut-maize intercrop. Vertical bars represent treatment means ± SD

3.3 Leaf Area

As shown in Fig. 3, leaf area development was not significantly affected by the spatial arrangements in both groundnut and maize plots. Nonetheless, in the groundnut plots, 3G:2M plots had the highest leaf area with the least value recorded in its sole except at 3WAP. In the maize plots, leaf area development did not followed a definite pattern in all the spatial arrangements and its sole. Generally, the sole maize compared well with other spatial arrangements at crop growth stages. However, 3G:3M spatial arrangement showed leaf area production that was higher than other spatial arrangements as the both crops advanced in age (Fig. 3).

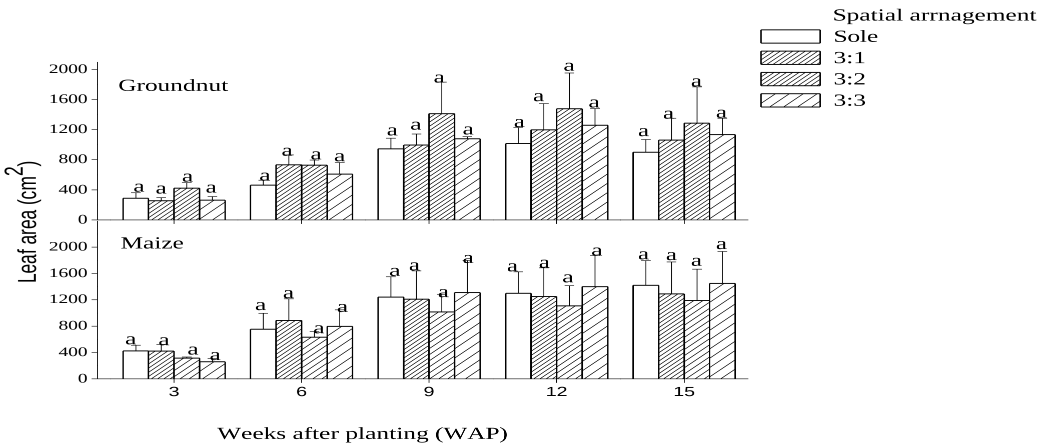

Fig. 3: Leaf area as affected by different spatial arrangements in groundnut-maize intercrop. Vertical bars represent treatment means ± SD

3.4 Yield Components

Table 1 shows that the cropping systems had no significant effect on the yield components in the intercrops and their respective soles except for 100-seed weight, pod circumference, cob girth and grain weight. In the groundnut plots, significantly highest 100-seed weight (44.13± 2.98 g) was recorded in 3G:2M plots followed in decreasing order of magnitude by those of 3G:1M plots (41.94 ± 0.54 g) and 3G:3M plots (41.09±1.57 g). Sole groundnut recorded significantly lowest value of 100-seed weight when compared to other spatial arrangements (Table 1). In the maize plots, significantly highest grain weight per plant was recorded in 3G:1M plots (90.15 ± 2.53 g) and followed by those of 3G:2M (86.99 ± 3.18 g) and 3G:3M plots (78.29 ± 4.92 g) The results of cob girth and length followed the same pattern of results as recorded for grain weight plant (Table 1). Generally, all the spatial arrangements recorded higher yield components than their respective soles (Table 1).

Table 1: Yield components as affected by different spatial arrangements in groundnut-maize intercrop

Spatial Arrangements	Groundnut				Spatial Arrangements	Maize			
	Pod length (cm)	Pod circumference (cm)	Seed weight/plant (g)	100-seed weight (g)		Cob length (cm)	Cob girth (cm)	Grain weight/ plant (g)	100-grain weight (g)
Sole Groundnut	2.12± 0.14[a]	0.71± 0.06[b]	21.30± 4.75[a]	39.47± 2.52[b]	Sole Maize	15.23± 1.00[a]	10.01± 0.12[c]	51.07 ± 8.23[c]	18.44±1.10[a]
Groundnut + Maize (3+1)	2.96± 0.07[a]	0.85± 0.02[a]	27.60±10.80[a]	41.94± 0.54[ab]	Groundnut + Maize (3+1)	14.23± 1.90[a]	13.11± 1.06[a]	90.15 ± 2.53[a]	20.39±1.60[a]
Groundnut + Maize (3+2)	1.94± 0.08[a]	0.81± 0.02[a]	31.01 ± 6.69[a]	44.13 ± 2.98[a]	Groundnut + Maize (3+2)	14.4 ± 1.57[a]	10.30 ± 0.72[bc]	86.99± 3.18[ab]	18.62±1.60[a]
Groundnut + Maize (3+3)	1.97± 0.12[a]	0.80± 0.06[a]	28.45 ± 7.94[a]	41.09± 1.57[ab]	Groundnut + Maize (3+3)	13.3 ± 0.56[a]	11.68± 0.78[b]	78.29 ± 4.92[b]	18.55±0.60[a]
P-values	0.215	0.036	0.515	0.133	P-values	0.434	0.003	≤ 0.001	0.29

Values within the same column followed by the same superscripts are not significantly different at $p<0.05$

3.5 Grain Yield

Data pertaining to yield in both groundnut and maize plots are presented in Table 2. Seed and grain yields in terms of kilogram per hectare were respectively higher in the intercrop than their soles. In groundnut plots, all the intercrop did not show statistical differences. However, higher yield was recorded in 3G:2M plots (881.01±180.48 kg/ha) when compared to other intercrops. Considering the intercrop in the maize plots, 3G:2M spatial arrangement showed significantly highest yield (4727.95±458.50 kg/ha) while 3G:3M (3371.95±226.62 kg/ha) had the lowest value (Table 2).

Table 2: Average Groundnut and Maize Yield as affected by different spatial arrangements

Spatial arrangements	Groundnut Seed yield (kg/ha)	Spatial Arrangements	Maize Grain yield (kg/ha)
Sole Groundnut	596.04 ± 179.11^{a}	Sole Maize	2852.46 ± 75.70^{d}
Groundnut + Maize (3:1)	807.35 ± 249.09^{a}	Groundnut + Maize (3:1)	4727.95 ± 458.50^{a}
Groundnut + Maize (3:2)	881.01 ± 180.48^{a}	Groundnut + Maize (3:2)	4133.93 ± 152.08^{b}
Groundnut + Maize (3:3)	813.55 ± 186.70^{a}	Groundnut + Maize (3:3)	3371.95 ± 226.62^{c}
p-values	0.392	p-values	≤ 0.001

Values within the same column followed by the same superscripts are not significantly different at $p<0.05$

3.6 Proximate Composition of Groundnut Seeds

Spatial arrangements significantly influenced the proximate composition of groundnut seeds as presented in Table 3. The intercrop significantly enhanced higher percentage moisture and protein compared to sole groundnut. The results of ash and fibre followed similar trend as recorded for protein except that 3G:1M arrangement was at par with the sole groundnut. Fat (47.522%) and carbohydrate (8.93%) were significantly higher in sole groundnut compared to the intercrop and followed in decreasing order of magnitude by those of 3G:1M, 3G:2M and 3G:3M spatial arrangements.

Table 3: Proximate Composition of groundnut seeds as affected by spatial arrangements

Spatial arrangement	Moisture	Protein	Ash	Fat	Fibre	Carbohydrate
Sole groundnut	9.57 ± 0.17^{ab}	28.07 ± 0.029^{d}	1.80 ± 0.08^{c}	47.52 ± 0.42^{a}	4.11 ± 0.07^{c}	8.93 ± 0.43^{a}
Groundnut + Maize (3:1)	9.47 ± 0.02^{b}	28.98 ± 0.08^{c}	1.80 ± 0.03^{c}	47.29 ± 0.48^{ab}	4.17 ± 0.02^{c}	8.29 ± 0.39^{ab}
Groundnut + Maize (3:2)	9.72 ± 0.08^{a}	29.67 ± 0.21^{b}	1.94 ± 0.07^{b}	46.53 ± 0.24^{b}	4.53 ± 0.04^{b}	7.61 ± 0.21^{bc}
Groundnut + Maize (3:3)	9.52 ± 0.09^{b}	30.99 ± 0.10^{a}	2.10 ± 0.02^{a}	45.29 ± 0.59^{c}	4.69 ± 0.05^{a}	7.40 ± 0.61^{c}
p-value	0.031	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001

Values within the same column followed by the same superscripts are not significantly different at $p<0.05$

4.0 Discussion

The results of this study showed that higher growth characters were recorded in 3G:1M and 3G:2M spatial arrangement when compared to 3G:3M and sole cropping. The reason could be due to low interspecific competition coupled with moderate soil coverage provided by the maize plants which lower the soil temperature. This observation is in line with the findings of Magaguda *et al*. [15], where it was reported that intercrop helps preserve soil micro-climate. In the same vein, other researchers also reported that differences in the canopies of crops appear to provide more efficient light use by spatial arrangements than sole crop [2].

The remarkable increase in yield components in the intercrop could be due to facilitated effect of groundnut. It has been reported that groundnut can uptake part of its nitrogen requirements through symbiotic biological nitrogen fixation thereby reducing the overcharge pressure on soil nitrogen stock [16]. In this study, the maize plant benefited from intercropping due to nitrogen fixing ability of groundnut roots and transfer of N-fixed to maize. Also, the extensive root system of maize for absorption of water and nutrients may also be an added advantage for the observed grain yield in the intercrop than the sole crop most importantly at 3G:1M and 3G:2M spatial arrangements. Similar observations have been reported by other researchers in the studies of legume-cereal intercropping [16, 17]. Other investigators have reported that intercropping of Poaceae and Fabaceae produced higher seed yields than either pure crop [18, 19]. In this regard, there is an opportunity for improving the harvest of the two crops if they were intercropped at 3G:1M and 3G:2M planting ratios. This is because these ratios provide enabling environment for improved utilization of growth resources and partitioning of same for higher yield than their sole crops.

In this study, spatial arrangement was found to influence nutritional composition of groundnut seeds. The moisture values recorded in this study could be considered as high when compared to values recorded for several groundnut cultivars [20]. This implies that harvested seeds under these planting ratios may be prone to microorganism attack and consequently shorter shelf life [21]. In light of this, the seeds had to be properly handled during storage. Ash content values of the harvested seeds were very low considering the values recorded by Grosso and Gruzman [22] among 29 cultivars of groundnut. The observed variance could be due to varietal difference as well as agronomic practices [23]. It should be noted that the ash content is a reflection of the mineral elements preserved in any food materials [24]. The spatial arrangements favoured higher fibre contents when compared to the value reported by Atasie *et al*. [25], but lower to the values recorded in some other studies [23,26]. Sample with low fibre contents may not be a good source of roughages which plays important role in peristaltic movement [23,25,27]. Crude protein content in the range of 28.07–30.99% is in agreement with previous results [20]. Proteins are essential component of diet needed for the survival of animals and human being. The basic function is to supply adequate amounts of required amino acids for nutrition [28]. The planting ratios recorded higher crude protein than sole cropping. In this regards, the harvested seeds could be used as food, food supplements for human nutrition as well as livestock feeds. The results of the fat and carbohydrate were significantly enhanced in sole crops which may be due lack of intra-specific competition which resulted in low nutrient uptake by the plants.

5.0 Conclusion and Recommendation

This investigation had shown that intercropping maize and groundnut is more effective compared to sole cropping. Depending on the crop, 3G:2M and 3G:1M could be said to be the most productive system planting ratios. The intercrop was also found to promote ash, fibre and protein contents of groundnuts seeds. The study therefore recommends the replication of similar trials on farms with the participation of field level extension agents to allow for the effective adoption of the research outcome.

References

[1] Palaniappan, S.P. (2000). Cropping System in the Tropic, New Delhi, Wiley Eastern Limited.

[2] Dwomon, I.B. and Quainoo, A.K. (2012). Effect of Spatial Arrangement on the Yield of Maize and Groundnut Intercrop in the Northern Guinea Savanna Agro-ecological Zone of Ghana. International Journal of Life Sciences Biotechnology and Pharmaceutical Research, Vol. 1, No. 2, pp. 78-85.

[3] Vandermer, J.H. (1990). Intercropping Agroecological, New York, McGraw–Hill Inc.

[4] Petersen, R.G. (1994). Agriculture Field Experiment Design and Analysis, New York, Marcel Dekaker Inc.

[5] Sullivan, P. (2003). Intercropping Principles and Production Practices: Appropriate Technology Transfer for Rural Areas Publication. Available at http://www.attra.ncat.org.

[6] Li, L., Tang, C., Rengel, Z. and Zhang, F. S. (2003). Chickpea facilitates phosphorus uptake by intercropped wheat from an organic phosphorus source. Journal of Plant and Soil, Vol. 248, pp. 297-303.

[7] Lithourgidis, A.S., Vasilakoglou, I.B., Dhima, K.V., Dordas, C.A. and Yiakoulaki, M.D. (2006). Forage Yield and Quality of Common Vetch Mixtures with Oat and Triticale in Two Seeding Rations. Field Crops Research, Vol. 99, pp. 106-113.

[8] Zhang, F. and Li, L. (2003). Using Competitive and Facilitative Interactions in Intercropping Systems Enhances Crop Productivity and Nutrient-Use Efficiency. Plant and Soil, Vol. 248, pp. 305-312.

[9] Tsubo, M., Walker, S. and Ogindo, H.O. (2005). A Simulation Model of Cereal-Legume Intercropping Systems for Semi-Arid Regions. Field Crops Research, Vol. 93 No. 1, pp. 10-22.

[10] Kamanga, B.C., Waddington, G.S.R., Robertson, M.J. and Giller, K.E. (2010). Risk Analysis of Maize-Legume Crop Combinations with Small Holder Farmers Varying in Resource Endowment in Central Malawi. Journal of Experimental Agriculture, Vol. 46, pp. 1-21.

[11] Pearcy, J.W., Ehleringer, J., Money, H.A. and Rundel, P. W. (1989). Plant Physiological Ecology: Fields Methods and Instrumentation, London, Chapman and Hall, pp. 320.

[12] Njoku, K.L., Akinola, M.O. and Oboh, O.B. (2009). Phytoremediation of Crude Oil Contaminated Soil: The Effect of Growth of *Glycine max* on the Physico-Chemistry and Crude Oil Contents of Soil. Nature and Science, Vol. 7, No. 10, pp. 79–87.

[13] A.O.A.C. (2000). Association of Official Analytical Chemists. Methods of Analysis (17th Edition). Vol. 1. Maryland.

[14] Duncan, D.B. (1995). Multiple Range and Multiple t-test. Biometrics, Vol. 11, pp. 1-42.

[15] Magaguda, G.T., Haque, I. Godfrey, W., Fendu, I. and Masina, G.T. (1979). Intercropping Studies in Swaziland: Present Status and Future Projections. In: Proceedings of International Workshop on Intercropping 10-13 Jan., 1979, Hyderabad, India, pp. 98-104.

[16] Mehdi, D. (2013). Intercropping two Varieties of Maize (*Zea mays* L.) and Peanut (*Arachis hypogaea* L.): Biomass Yield and Intercropping Advantages. International Journal of Agriculture and Forestry, Vol. 3, No. 1, pp. 7-11.

[17] Chen, C., Wescott, M., Neill, K., Wichman, D. and Knox, M. (2004). Row Configuration and Nitrogen Application for Barley-Pea Intercropping in Montana. Agronomy Journal, Vol. 96, pp. 1730-1738.

[18] Mpairwe, D.R., Sabiiti, E.N. Ummuna, N.N., Tegene, A. and Osuji, P. (2002). Effect of Intercropping Cereal Crops with Forage Legumes and Source of Nutrients on Cereal Grain Yield and Fodder Dry Matter Yields. African Crop Science Journal, Vol. 10, pp. 81-97.

[19] Mucheru-Muna, M., Pypers, P. Mugendi, D., Kung'u, J., Mugwe, J., Merckx, R. and Vanlauwe, B. (2010). A Staggered Maize-Legume Intercrop Arrangement Robustly Increases Crop Yields and Economic Returns in the Highlands of Central Kenya. Field Crops Research, Vol. 115, pp. 132-139.

[20] Musa, A.K., Kalejaiye, D.M., Ismail, L.E., and Oyerinde, A.A. (2010). Proximate Composition of Selected Groundnut Varieties and their Susceptibility to *Trogoderma granarium everts* Attack. Journal of Stored Product and Post-Harvest Research, Vol. 1, No. 2, pp. 13-17.

[21] Adeyeye, E. and Ayejuyo, O. (1994). Chemical Composition of *Cola acuminata* and *Garcinia kola* Seeds Grown in Nigeria. International Journal of Food Sciences and Nutrition, Vol. 45, pp. 223-230.

[22] Grosso, N.R. and Guzman, C.A. (1995) Chemical Composition of Aboriginal Peanut (*Arachis hypogea* L.) Seeds from Peru. Journal of Agriculture and Food Chemistry, Vol. 43, pp. 102-105.

[23] Etejere, E.O. and Olayinka, B.U. (2013). Influence of Weed Management Strategies on Proximate Composition of two Varieties of Groundnut (*Arachis hypogaea*). Annals of Food Science and Technology, Vol. 14 No. 2, pp. 286-273.

[24] Iniaghe, O.M., Malomo, S.O. and Adebayo, J.O. (2009). Proximate Composition and Phytochemical Constitution of Leaves of Some *Acalypha* Species. Pakistan Journal of Nutrition, Vol. 8, pp. 256-258.

[25] Atasie, V.N., Akinhanmi, T.F. and Ojiodu, C.C. (2009). Proximate Analysis and Physicochemical Properties of Groundnut (*Arachis hypogaea* L.).Pakistan Journal of Nutrition, Vol. 8, pp.194-199.

[26] Quass, C.F. (1995). Guidelines for the Production of Cowpeas. National Department of Agriculture, Pretoria, South Africa, pp. 1-17.

[27] Olayinka, B.U., Ayanduro, E.T. Abdulrahaman, A.A. and Etejere, E.O. (2016). Effects of Salinity and Ethylenediamine Tetra Acetic Acid (EDTA) on the Germination of Tomato (*Solanum lycopersicum* L.) Seeds. Science World Journal, Vol. 11, No. 4, pp. 1-3.

[28] Pugalenthal, M., Vadivel, V., Gurumoorthi, P., Janardhanam, K. (2004). Comparative Nutritional Evaluation of Little Known Legumes *Tamarandus indica*, *Erythrina indica*, *Sesbania bispinosa*. Tropical and Subtropical Agroecosystem, Vol. 4, pp. 107-123.