EFFECT OF INTERCROP AND PHOSPHORUS LEVELS ON QUALITY AND FORAGE YIELD OF MAIZE (*Zeamayz*L) AND GROUNDNUT (*Arachis hypogea*) IN NORTHERN GUINEA SAVANNAH

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ABSTRACT

The study investigated the **Effect of Intercrop and Phosphorus Levels on Quality and Forage Yield of Maize (*Zeamayz*L.) and Groundnut (*Arachis hypogea*) in Northern Guinea Savannah** at the National Animal Production Research Institute Shika, Zaria. The experiment was arrangement factorially in 5x4 with Randomized Complete Block Design (RCBD) which was replicated 3 times. The treatments consisted of five intercropping pattern sole maize (M), sole groundnut (G), 1:1 M-G, 1:2 M-G and 2:1M-G) and four phosphorus levels (0 kg/ha, 10 kg/ha, 20 kg/ha and 30 kg/ha). Forage yield and proximate compositions were determined at 14 weeks after sowing (WAS). Intercropping significantly ($P<0.05$) affected fresh forage yield of maize and dry forage yield of maize and groundnut. Fresh forage yield of groundnut was significantly ($P<0.05$) affected by phosphorus levels. The highest fresh forage yield of maize and dry forage yield of maize and groundnut (20.33, 8.63 and 6.53 t/ha) were obtained at 1:2 M-G intercrops. The percentage proximate composition and fibre fractions were significantly ($P<0.05$) affected by intercropping and phosphorus levels. The crude protein and crude fibre ranges between 6.60 – 7.30 % and 19.46 – 22.81 %, respectively. This study reveals that intercropping maize and groundnut at 1:2 M-G ratio produced the highest forage yield of the herbage. Phosphorus levels of 30 kg/ha produced the highest fresh forage of groundnut and improved percentage composition of DM, CP and CF. Therefore intercropping of maize and groundnut at 1:2 M-G at 30 kg/ha phosphorus levels is recommended for farmers and livestock producers in Northern Guinea Savanna of Nigeria.

Key words: Maize, Groundnut, intercrop, phosphorus, forage.

INTRODUCTION

Low agricultural productivity in sub Saharan Africa is caused by low soil fertility, limited availability of resources to farmers, nutrient mining and drought (Monica *et al.*, 2010). Fertilizer is essential to improve agricultural production in densely populated region; this was acknowledged during the African fertilizer summit held in Abuja, Nigeria in 2006. Mineral fertilizer prices continue to increase. A way to minimize the use of fertilizer and increase crop productivity is by intercropping legumes and cereals. Nyimas *et al*. (2015) reported that, intercropping system can improve the productivity of agricultural land and crops if the types of plants that are combined in this system do not compete with each other in terms of sunshine, taking water and nutrients.

Another advantage gained from intercropping planting patterns are ability to provide the balance of nutrients, control of weeds, maintaining of soil fertility, prevent erosion and the tendency of increase in pests and reduce the risk of harvest crop failure. A suitable combination is maize and groundnut intercrop due to the compatibility of several properties owned by these plants (Nyimas*et al*., 2015). Maize plants require high light intensity for photosynthesis, grow tall, erect, unbranched and loose canopy allows for other plants growing underneath.

Fibrous root system of maize plants need nitrogen in large quantities. Groundnut plants are shade-tolerant plants, grow short, erect and with a taproot system forming nodules capable in symbiotic Nitrogen (N) fixation by *Rhizobium* sp. Mehdi (2013) also reported that intercrops of legumes in cereals are a better choice to increase the quality of cereal fodder. However, intercropping gave higher crude protein yields than pure maize. Legumes can transfer fixed N to intercropped cereals during

their together growing cycle and this N is an important resource for the cereals. The presence of a cereal, exploiting the soil mineral N, may even stimulate legumes to fix N (Monica *et al*., 2010).
Groundnut plant is sensitive to nutrient phosphorus (P) deficiency and currently has been addressed with superphosphate fertilizer (Nyimas*et al*., 2015). It is an annual legume crop grown in semi-arid regions of the world. It is the world's fourth most important source of edible oil and third most important source of vegetable protein (Govindaraj *et al*., 2009). The smallholder farmers grow groundnut for income to cater for the health, education and other needs of the family is intense. The objectives of the study is to evaluate the forage quality and yield of double-red maize and Samnut-22 planted in different intercropping pattern, receiving different levels of phosphorus.

Materials and Methods

Location of the Study Area

The experiment was conducted during the 2016 wet season, at the Experimental Farm of the Feeds and Nutrition Research Programme, National Animal Production Research Institute (NAPRI) Shika Zaria, Kaduna State. Shika is located on Latitude 11^0 12'W. Longitude 07^0 33'E and altitude 660m above sea level (Ovimaps, 2012), 22km along the Sokoto road North-West of Zaria in the Northern Guinea Savannah zone of Nigeria. Wet season starts from April to early May and ends in late September to early October. Long-term annual rain fall ranges from 1110 to 1580mm with a maximum temperature of 30^0C and relative humidity of approximately 70% (IAR, 2016).

Sources of Experimental materials and Experimental design

Groundnut variety SAMNUT 22 seeds for the experiment were obtained from the Institute for Agricultural Research (IAR), Samaru-Zaria. Maize variety (Double-red) seeds were obtained from the Kaduna State Agricultural Development Project (KSADP). The experiment was laid out in a randomized complete block design (RCBD) with a split-plot arrangement. It contained a 5x4 factorial arrangement, with three replications. There were five treatments (intercropping pattern); sole maize (M), sole groundnut (G), 1:1alternate rows (M: G), 1:2 alternate rows (M: G) and 2:1 alternate rows (M: G), and four phosphorus levels (0, 10, 20 and 30 kg/ha). Intercropping pattern was the main plot and phosphorus level was the sub-plot factor. There was a total 60 net plots measuring 4.8 m^2 with 50 cm inter-plot walk path. The field was cleared, ploughed by tractor and ridged before planting. All experimental plots received uniform application of 120 kg/ha of fertilizer at two split doses. The first dose was 60 kg/ha of NPK (15; 15; 15) at planting and the second dose was 60 kg/ha of Urea (46; 0; 0) at four weeks post-planting after the first weeding.

Data collection and Forage Yield Determination

Sampling for yield estimation in each plot was carried out by cutting plants within a $0.5m^2$ quadrant with hand sickle to the height of 15 cm above the ground level. The total fresh forage was determined and sub sample of (150-200g) was weighed and oven dried at 65^0C for 48 hours and reweighed to estimate dry matter yield as described by Tarawali*et al.,* (1995).

Chemical analyses

Samples of the forage materials harvested were taken to laboratory for chemical analysis at the Department of Animal Science, Ahmadu Bello University, Zaria. The dried samples of forages were milled using a simpler mill and passed through 1-2mm sieve. Proximate analysis was done to determine Nitrogen (N) for crude protein determination (Nx6.25), crude fibre (CF), Ether Extract (EE), Nitrogen Free Extract (NFE) and ash content according to. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined by method of (AOAC, 2005). The constituent of acid detergent fibre and neutral detergent fibre were determined as described by AOAC, (2005)

Statistical Analyses

The general linear model procedure (Proc. GLM) of SAS (2005) was used to analyze all variables. Significant ($P<0.05$) differences among treatment means was compared using the Duncan Multiple Range Test (DMRT) of the SAS package (Duncan, 1955).

Results

Proximate compositions of maize and groundnut forage and their intercropped mixtures

The effect of intercropping and phosphorus levels on proximate composition of maize, groundnut and their intercrops is presented in Table 1.

Table 1: Effect of intercropping and phosphorus levels on proximate composition of maize and groundnut forage and their intercrop mixtures.

Treatments	DM	CP	CF	EE	Ash	NFE
Sole M	91.16^{b}	6.44^{c}	19.46^{d}	0.43^{bc}	4.99^{b}	68.77^{a}
Sole G	92.16^{b}	7.30^{a}	21.04^{c}	0.40^{c}	5.03^{b}	66.24^{c}
1:1 M/G	94.12^{a}	6.60^{c}	20.85^{c}	0.57^{a}	5.44^{a}	66.54^{b}
1:2 M/G	94.42^{a}	6.19^{d}	21.98^{b}	0.46^{b}	4.69^{d}	66.66^{b}
2:1 M/G	94.52^{a}	6.92^{b}	22.81^{a}	0.42^{bc}	4.71^{c}	65.20^{d}
SEM	0.27	0.11	0.13	0.02	0.09	0.11
P-Value	0.0190	0.0001	0.0001	0.0223	0.0219	0.0001
P_1 (0 Kg/ha)	92.57^{b}	5.92^{c}	20.62^{c}	0.48^{a}	5.31^{a}	67.51^{a}
P_2 (10 Kg/ha)	93.20^{ab}	6.80^{b}	21.43^{ab}	0.46^{ab}	4.87^{b}	66.44^{b}
P_3 (20 Kg/ha)	93.50^{a}	6.69^{b}	21.25^{b}	0.43^{b}	4.83^{b}	66.26^{b}
P_4 (30 Kg/ha)	93.84^{a}	7.34^{a}	21.60^{a}	0.45^{ab}	4.87^{b}	66.51^{b}
SEM	0.34	0.13	0.16	0.02	0.11	0.13
P-Value	0.0120	0.0001	0.0162	0.0155	0.0404	0.0001

^{abc}Means with different superscripts within columns differed significantly, * significant at P<0.05, NS = Not significant, SEM = Standard error of mean, LOS = Level of significance, I = Intercrop, P = Phosphorus level, M = Maize, G = Groundnut.

Effect of intercropping: proximate composition was significantly (P<0.05) affected intercropping. The result showed that dry matter was significantly higher (94.52 %) in 2:1 M-G than sole G and sole G, but similar to that of 1:2 and 1:1 M-G. the crude protein was higher (7.30 %) in sole G than 2:1 and 1:2 M-G which were at par but significantly (P<0.05) higher than that of 1:1 M-G and sole M. the crude fibre was higher (22.81 %) in 2:1 M-G followed by 1:2 M-G and sole M and least in 1:1 M-G and sole G which were similar (P>0.05). The highest ether extract (0.57 %) and Ash (5.44 %) content were observed in 1:1 M-G and least in sole G (0.40 %) and 2:1 M-G (4.71 %) respectively. The nitrogen free extract (68.77 %) content was higher in sole M then followed by 1:2 and 1:1 M-G which were similar and least in 2:1 M-G and sole G which were at par.

Effect of phosphorus levels: there was significant (P<0.05) effect of phosphorus levels on proximate composition of maize and groundnut forage and their intercrops. The result showed that the highest dry matter was 93.84 kg, which was similar (P>0.05) to P_3 and P_2 but at par with P_1. The crude protein (7.34 %) and crude fibre (21.60 %) were higher in P_4 followed by P_3 and least in P_1 (P_4>P_3>P_1). The ether extract observed at P_1 was similar to that of P_2 and P_4 but at par with that of P_3 which was also similar to that of P_2 and P_4. Ash and nitrogen free extract showed similar trend (P>0.05).

Fresh and dry matter yield of double red maize and SAMNUT-22 groundnut forage and their intercropped mixtures

The effect of intercropping and phosphorus levels on fresh and dry matter yield of maize, groundnut and their intercrops is presented in Table 2.

Effect of intercropping: intercropping significantly (P<0.05) affected fresh forage yield of maize and fresh and dry matter yield of maize and groundnut. The highest (20.33 t/ha) fresh forage yield of maize was observed at 2:1 M-G which is not significantly (P>0.05) different from 18.83 and 18.57 t/ha observed at 1:1 and 2:1 M-G respectively, but they were both at par with 15.53 t/ha observed at sole M. Dry matter yield of maize recorded at 1:2 M-G and 2:1 M-G were at par but higher than that of sole M which was similar to that of 1:1 M-G. The same trend was observed in dry matter yield of groundnut at 1:2 and 2:1 M-G but that of 1:2 M-G was similar to (P>0.05) that of sole G and 1:1 M-G.

Effect of phosphorus levels: fresh forage yield of groundnut was significantly (P<0.05) affected by phosphorus levels. The result showed that fresh forage yield was similar at P_1, P_2 and P_4 which were at par with that of P_3. Interaction had no significant (P>0.05) effect on fresh and dry forage yield of maize, groundnut and their intercrops.

Table 2: Effect of intercropping, phosphorus and their interactions on fresh and dry matter yield of

maize and groundnut.

Treatment	Fresh Forage Yield (t/ha)		Dry Forage Yield (t/ha)	
	Maize	Groundnut	Maize	Groundnut
Sole M	15.53[b]	0.0	6.34[c]	0.0
Sole G	0.0	20.23	0.0	5.40[b]
1:1 M/G	18.83[a]	20.23	7.18[bc]	5.16[b]
1:2 M/G	20.33[a]	20.40	8.63[a]	6.53[a]
2:1 M/G	18.57[a]	18.57	7.53[b]	5.37[b]
SEM	1.16	1.06	0.49	0.45
P-Value	0.0001	0.2168	0.0001	0.0004
P_1 (0 Kg/ha)	13.87	16.32[a]	5.31	4.36
P_2 (10 Kg/ha)	13.55	17.79[a]	5.53	4.67
P_3 (20 Kg/ha)	14.77	13.73[b]	6.52	4.19
P_4 (30 Kg/ha)	16.43	15.71[a]	6.47	4.75
SEM	1.45	1.31	0.62	0.56
P-Value	0.5297	0.0001	0.4159	0.8891

[abc]Means with different superscripts within columns differed significantly, * significant at P<0.05, NS = Not significant, SEM = Standard error of mean, LOS = Level of significance, I = Intercrop, P = Phosphorus level, M = Maize, G = Groundnut.

Discussions

Proximate compositions of maize and groundnut forage and their intercropped mixtures

The higher percentage of herbage dry matter content of 94.52 %DM (Table 4.5) was observed in the intercropping than in sole maize and groundnut. This could be due to competitive ability of the species and better utilization of environmental resources (Abdul-Rahman, 2010).

The values of crude protein (CP) recorded for maize and groundnut in this study (Table 1) were below that reported by Ali*et al.* (2016) and Melesse*et al*. (2013), respectively. The values of CP and CF of groundnut were in agreement with the report of Ososanya (2012). The values of EE and NFE of groundnut obtained in this study were less than and greater than that reported by Ribadiya*et al*. (2015), respectively. The value for Ash of groundnut in this study was less than that observed by Adamu (2015). The values of CP, Ash and NFE for maize observed in this study were similar to 6.9 %, 4.6 % and 52.6 %, respectively as reported by Maw *et al.* (2016). The crude fibre content obtained in this study was higher than that of 18.50 % reported by Hassan *et al.* (2016).

The values for crude protein as affected by phosphorus levels in this study increased with an increased in the amount of phosphorus applied. There was 19 % increase in CP. This result was in agreement with the report of Alagma (2016) who recorded an increased in CP when phosphorus level was increased from 30 – 60 kg/ha. The values for Ash were similar to that reported by Akpensuen (2012) in both West Atlantic seed alliance1 (WASA1) and Shika maize (SHIMAZ).

Fresh and dry matter yield of double red maize and SAMNUT-22 groundnut forage and their intercropped mixtures

Fresh forage yield is a major determinant of herbage yield. The fresh and dry matter yield obtained in this study (Table 2) as influenced by intercropping was less than that observed by Mehdi (2013) who intercropped improved varieties of maize and groundnut in Iran. The DM of maize was within the range of 4.20 to 14.77 t/ha reported by Ali*et al.* (2016). However, it was slightly higher than the range of 8.7 to 14.5 t/ha fresh weight equivalent to 7.0 – 8.7 t/ha DM reported by Ishiaku (2016).

The yields of the intercropping are higher than the sole cropping system. This was in agreement with the report of Lithourgidis*et al*. (2006). The difference in yield between the sole and intercrops may be attributed to efficient utilization of environmental resources such as solar radiation, water and nutrient (Abdul-Rahman, 2010). The DM yield of groundnut obtained in this study was within to the range of 2.3 to 7.4 t/ha dry weight recorded by Mehdi (2013).The significant effect of phosphorus levels on fresh forage yield of groundnut recorded in this study was in agreement with the report of Kamara (2010).

Conclusions and Recommendation

Intercropping maize and groundnut at 1:2 M-G ratio produced the highest forage yield of the herbage (20.33 t/ha M on fresh basis, 8.63 DM t/ha M and 6.53 DM t/ha G). Phosphorus levels of 30 kg/ha recorded the highest fresh forage and improved percentage composition of DM, CP and CF. Farmers

should adopt intercropping ratio of 1:2 M-G at phosphorus levels of 30 kg/ha for better intercropping advantages, forage yield and better nutrient content of the herbage.

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