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EFFECT OF GROUNDNUT INTERCROPPED AND FERTILIZER (NPK 15:15:15) APPLICATION ON SOME SOIL NUTRIENTS AND MAIZE YIELD

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ABSTRACT

Experiment was carried out to evaluate the effect of groundnut intercropped with N.P.K. fertilizer application on some soil nutrients and maize yield. Suwan yellow maize and Ex-Dakar groundnut seeds were used with four treatments (Control (Co), groundnut intercropped with maize (GM), groundnut intercropped with maize and NPK fertilizer 60kg/ha (GMF) and maize fertilized with NPK 120kg/ha (MF) and replicated four times. It was arranged in a Randomized Complete Block Design. Data Collected includes yield and yield components and some soil nutrients. Data collected were subjected to analysis of variance and means separated using Duncan Multiple Range Test (DMRT) at 5% level of probability. From the result, groundnut intercropped with fertilizer application at 60kg/ha (GMF) performed best from all characters considered with grain yield (5.83 and 5.94) t/ha, number of seeds/cob (4.02 and 498.12), cob yield (3.46 and 3.68) kg/ha and cob diameter (4.36 and 5.16) cm in the first and second planting seasons. Also, all the soil properties examined (Soil N, Org. C, Avail. P, K, Ca, and Mg) were significantly ($p < 0.05$) increased after intercropping but was better on GMF plots in both seasons. Hence, the use of groundnut intercropped with NPK fertilizer (60kg/ha) GMF should be considered for optimum production of maize and soil restoration in the region of investigation. This will enhance maize production with reduce fertilizer use for resource poor farmers.

KEY WORDS: *groundnut intercropped, N.P.K fertilizer, soil nutrients, yield and maize*

INTRODUCTION

Intercropping, is the growing of two (or more) crops simultaneously on the same area of ground (Willey, 1990). It has potential advantages such as higher overall productivity, better pest and disease control, and enhanced ecological services (Snapp *et al.*, 2010; Finch *et al*., 2012). The most common goal of intercropping is to produce a greater yield on a given piece of land by making use of resources that would otherwise not be utilized by a single crop and it requires taking into consideration factors such as soil, climate, selection of compatible crops and varieties (Seran *et al*., 2009).

Maize (*Zea mays L.*) and groundnut (*Arachis hypogea L.*) are important field food crops used as food for human and animal consumption as well as industrial raw material. Groundnut, a highly valued grain- legume, is grown for its underground pods that are rich in protein for human consumption as well as to improve the fertility of the soil (Karuma *et al*., 2011). Also, (Zuo *et al.*, 2000) concluded that maize/peanut intercropping can significantly alleviate the competition for land between maize and oil crops and achieve synchronous increases in the yields of grain crops and oil crops (Zuo *et al.*, 2000).

Leguminous intercropping with maize crop on the field is an important avenue towards making nitrogen available for crop production in the small holder sector. Thus, helps farmers reduce inputs of commercial fertilizer, thereby increasing the profit margin of the farmer. Intercropping is used widely by smallholder farmers in developing countries to increase land productivity and profitability. The advantages of intercropping include soil conservation, lodging resistance, yield increment (Anil *et al.*, 1998) and weed control (Bani *et al*., 2006) over mono-cropping.

Although, the use of maize/groundnut intercrop are also very cheap and effective as a good source of N for sustainable crop production, its availability remains an important issue due to its proper management, while inorganic fertilizer is no longer within the reach of poor-resource farmers due to its high cost (Oke *et al.*, 2012). Proper intercropping of groundnut with mineral fertilizers at reduced levels will minimize potential environmental impact. Little information, however, is available in Nigeria on the complimentary use of groundnut intercrop and fertilizer (N.P.K) application on some soil nutrients and Maize yield for sustainable maize production especially in the southern part of the nation. With regards to this, an experiment was

conducted on effect of groundnut intercropped and fertilizer (N.P.K) application on some soil properties and maize yield.

MATERIALS AND METHODS

Field trials were conducted at Oyo State College of Agriculture and Technology, Igbo-Ora spanning from 2019 - 2020 cropping seasons. Igbo-Ora, is in Ibarapa zone. It is in the northern part and is a derived savannah zone of South Western Nigeria. It is located between 7°15'- 7°33'North, and 3°56'- 3°57' East. The site was cleared of existing vegetation using cutlass and debris were removed. A total land area of 418m^2 was used for the experiment. The field was laid out in Randomized Complete Block Design (RCBD) with four treatments and replicated five times. The plot size was 3m x 3m and separated from one another by 1m apart. Plots were prepared with hoes. The treatments were: groundnut intercropped with maize (GM), groundnut intercropped with maize plus 60kg/ha NPK fertilizer (GMF), Maize plus 120kg/ha fertilizer (MF) and control (Co). The treatments were replicated five times given a total of twenty experimental plots.

The planting distances for groundnut and maize were 60 x 60 cm and 25 x 75cm respectively. Suwan yellow maize and Ex-Dakar groundnut seeds varieties were used. Seed rates of two per hole and at 5cm depth were sown in all plots. Two weeks after germination of both groundnut and maize, thinning was carried out while those that failed to germinate were replaced to maintain optimum plant population. After thinning, fertilizer application was carried out using NPK 15:15:15 fertilizer. Weeding was done three weeks intervals with the use of hand to remove weeds till harvest. Cobs of maize were harvested after drying. The cobs were dehusked, shelled and dried while grain yield was determined at 14% moisture content. The groundnuts were uprooted at harvesting for further processing to remove seeds for drying.

Prior to land preparation, soil samples (0- 15cm) were collected randomly from 120 spots in the experimental site with the use of an auger. Samples were bulked, air dried and ground to pass through a 2mm sieve. The soil samples were analysed for physico-chemical properties as follows: soil particle size were evaluated by Bouyoucos method (Bouyoucos, 1962). Soil pH in H_20 (1:1) was determined using the standard laboratory apparatus as specified by (I.I.T.A, 1982). Soil organic carbon was determined by Walkley black modified method (Black, 1965). Available phosphorus and total nitrogen were determined separately by Technicon method, while

exchangeable Ca, Mg, K, Na and effective C.E.C in soils were determined by use of atomic absorption spectrophotometer (Tel *et al*., 1984).

Data collected includes grain yield, number of seeds/cob, cob yield (t/ha), and cob diameter (cm) in 2019 planting season while same data were taken in 2020 after repeating the trial without treatment application but the plots were maintained to examine the residual effect of the treatments added in 2019 planting season.

All the data collected from the field and laboratory were subjected to Statistical Analysis System for Agricultural Science. Significant means were separated by Duncan Multiple Range Test (DMRT) at 5% level of probability.

RESULTS AND DISCUSSION

The sole application of NPK fertilizer, groundnut maize intercrop and their integration ($p<0.05$) significantly increased maize yield and their components (Tables 2 and 3). From the result, the use of groundnut intercrop and NPK fertilizer application increased grain yield and number of seeds/cob in 2019 and 2020 respectively. The plots with GMF gave the highest grain yield (5.83t/ha and 5.94t/ha) and number of seeds/cob (402.00 and 498.12) for the two years 2019 and 2020 cropping seasons. Yield increase were (155.70 % and 185.58%) and (27.62% and 80.48%) respectively to the control in 2019 and 2020 for both grain yield and number of seeds/cob. The higher performance shown by GMF in both years for both yield and yield components evaluated in both years of this study is consistent with the findings of (Bello *et al*., 2018), who found that the complementary application of organic manures (poultry manure) and inorganic fertilizer (NPK) gave significant effect on Sweet pepper production compared with the untreated plots. The use of GMF gave the highest result for all the yield characters considered throughout the period of investigation. However, the MF followed GMF in 2019, followed by GM while the control had the least result in that cropping seasons. In 2020 cropping season order of performance is thus, GMF > GM > MF > Co indicating the use GM had higher residual effect compared with MF. There was no significant difference with the use of GM and MF in Cob yield (t/ha) and Cob diameter in 2019 respectively. This increased in maize yield and its components associated with complementary use of GMF, MF and GM is consistent with the observation of (Zuo *et al*., 2000) that Maize /Peanut intercropping can significantly alleviate the competition for land between Maize and oil crops and achieve synchronous increases in the yields of grain crops and oil crops. The greater maize

yield in intercropping systems improved land productivity, resulting in obvious yield advantages for intercropping thus, confirm the work of (Postma *et al*., 2012).

TABLE 1: PRE SOIL ANALYSIS

Elements	Pre-planting Analysis
pH(H_20) 1:1	6.67
Organic C%	1.56
Total N%	0.16
C/N ratio	9.75
P($mgKg^{-1}$)	17.6
Exchangeable-cation	
Ca ($cmolKg^{-1}$)	3.3
Mg ($cmolKg^{-1}$)	0.40
K ($cmolkg^{-1}$)	0.31
Na ($cmolkg^{-1}$)	0.37
Acidity H^+	0.42
Mn ($cmolkg^{-1}$)	0.2
CEC ($cmolkg^{-1}$)	4.58
Particle Size – Analysis (g/kg)	
Sand	744
Silt	136
Clay	120
Texture Sandy loam	

TABLE 2: EFFECT OF GROUNDNUT INTERCROPPED AND NPK FERTILIZER ON GRAIN YIELD (T/HA) AND NUMBER OF SEEDS/COB.

Treatment	Grain yield(t/ha)		Number of seeds/cob	
	2019	2020	2019	2020
Control	2.28d	2. 08d	315.00d	276.00d
GM	2.75bc	3.45b	347.31c	396.28 b
GMF	5.83a	5.94a	402.00a	498.12a
MF	3.68b	3.25c	362.00b	325.00c

Means followed by the same letters in the columns and rows are not significantly different at 5% level of probability by DMRT

Co= control, GM = groundnut maize intercropped, GMF = groundnut maize intercropped with NPK fertilizer application (60kg/ha) and MF = maize + NPK fertilizer application (120kg/ha).

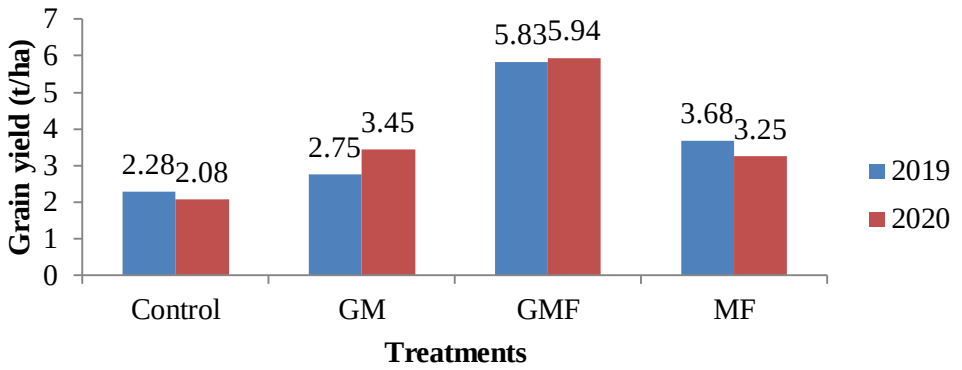

FIGURE 1: EFFECT OF GROUNDNUT INTERCROPPED AND NPK FERTILIZER ON GRAIN YIELD (T/HA)

TABLE 3: EFFECT OF GROUNDNUT INTERCROPPED AND NPK FERTILIZER ON COB YIELD (T/HA) AND COB DIAMETER (CM)

Treatment	Cob yield (t/ha)		Cob diameter (cm)	
	2019	2020	2019	2020
Control	2.83c	2.64d	3.87b	3.42d
GM	3.00b	3.25b	3.93ab	4.36b
GMF	3.46a	3.68a	4.36a	5.16a
MF	3.08b	3. 12c	3.93ab	3.76c

Means followed by the same letters in the columns and rows are not significantly different at 5% level of probability by DMRT

Co= control, GM = groundnut maize intercropped, GMF = groundnut maize intercropped with NPK fertilizer application (60kg/ha) and MF = maize + NPK fertilizer application (120kg/ha).

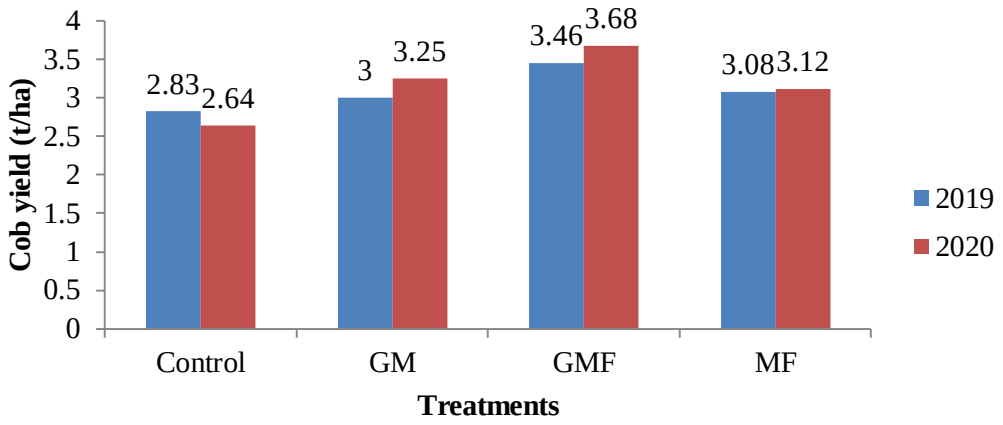

FIGURE 2: EFFECT OF GROUNDNUT INTERCROPPED AND NPK FERTILIZER ON COB YIELD OF MAIZE (T/HA)

Tables 4 and 5, showed that groundnut intercropped and NPK fertilizer had significantly (P< 0.05) higher effect on soil pH, Org. C (%), total N%, Avail. P, Calcium, Magnesium and K compared with the control in both planting seasons (2019 and 2020). NPK fertilizer application significantly reduced soil pH in both seasons and increased N and P content of the soil. The observed result is in-line with the work of (Bello *et al.*, 2022) that combined applications of poultry manure and NPK fertilizer had significantly (p <0.05) increased soil N, P, K, Ca and Mg.

The reduction in pH value with NPK fertilizer application supported the assertion of (Nnaji *et al.*, 2005) findings that soil pH was increased by combined application of mineral fertilizer NPK with Cow-dung manure and attributed this to the release of some cations from decayed organic amendments. The decline in pH of plots treated with inorganic fertilizer in this study could be attributed to the rapid rates of release of nutrient, that are immediately used up by plants, leading to poor accumulation of exchangeable bases that neutralizes soil acidity. The addition of NPK fertilizer on maize plot (MF) gave (5.8 and 5.62), combined intercropped maize /groundnut with NPK fertilizer (GMF) recorded (6.6 and 7.40) and groundnut intercropped with maize (GM) had (6.9 and 7.6) while the control gave (6.0 and 5.8) pH respectively. Thus, NPK gave significantly (p< 0.05) lower pH in 2019 and 2020 compared with groundnut maize intercropped.

Relative to no fertilizer treatment, groundnut intercropped with maize (GM), maize NPK fertilized plot (MF) and combination of groundnut intercropped with NPK fertilizer at 60kg/ha (GMF) significantly ($p < 0.05$) increase soil organic (SOC) with GMF producing the highest values (1.68 and 1.72) in 2019 and 2020 respectively while sole application of 120kg/ha NPK caused a decrease in SOC. The maize fertilizer plot (MF) and the ground nut intercropped (GM) increased total nitrogen above the control in 2019 and 2020 with combined groundnut intercropped plot with fertilizer (GMF) giving the highest average N value of 0.195g/kg for the two years. Available P was increased above control by all the treatments in both seasons. The observed result corroborated with the work of (Bodena, 2018) who concluded that growing cereals in association with legumes offers the best opportunity for conserving soil fertility through nitrogen fixation and returning greater amounts of organic matter to the soil, thus, improving its cation exchange capacity (CEC) and physical conditions. The result also fell in line with the work of (Vesterenger *et al*., 2008) on the influence of maize – cowpea on soil parameters and similar with (Dahmrhdeh *et al*., 2010) who concluded that increased amount of N, P and K content of the intercrop maize compared to sole maize.

The residual response during the second cropping season indicated that GMF recorded the highest result from most of the soil characteristics considered (Org C., Total N, Avail P, K, Ca, and Mg) with the exception of pH where GM gave the highest value (7.60) during 2020 cropping season. This result affirmed the work of (Bodena, 2018) who discovered that intercropping groundnut with maize generally ensures crop yield stability, proper resource utilization, benefiting the succeeding crop from the residuals, efficient land use system, maintain diversity and ecological balance. The result also ascertained the work of (Nweke *et al*., 2019) that productivity of maize as a major crop can be sustained with Bambara ground nut intercrop. Thus, the system will help to maintain the fertility status of the soil.

TABLE 4: EFFECT OF GROUNDNUT INTERCROPPED AND NPK FERTILIZER ON PH, ORG. C (%), TOTAL N % AND AVAIL. P CONTENT OF THE SOIL

Treatments	pH(H_2O)		Org. C (%)		Total N%		Avail. P($mgkg^{-1}$)	
	2019	2020	2019	2020	2019	2020	2019	2020
Initial	6.7	-	1.56	-	0.16	-	17.6	-
Co	6.0	5.8	0.96	0.92	0.12	0.10	15.8	15.2
GM	6.9	7.60	1.45	1.47	0.16	0.17	18.2	18.8
GMF	6.6	7.40	1.68	1.72	0.19	0.20	19.6	20.86
MF	5.8	5.62	1.52	1.56	0.17	0.18	17.8	18.42

Co= control, GM = groundnut maize intercropped, GMF = groundnut maize intercropped with NPK fertilizer application (60kg/ha) and MF = maize + NPK fertilizer application (120kg/ha).

TABLE 5: EFFECT OF GROUNDNUT INTERCROPPED AND NPK FERTILIZER ON K, CA AND MG EXCHANGEABLE BASE OF THE SOIL

Treatments	Exchangeable bases (C.mol/kg)					
	K		Ca		Mg	
	2019	2020	2019	2020	2019	2020
Initial	0.31	-	3.36	-	0.40	-
Control	0.29	0.27	2.8	2.6	0.22	0.21
GM	0.30	0.31	4.1	4.2	0.44	0.45
GMF	0.31	0.32	4.5	4.7	0.52	0.53
MF	0.30	0.29	4.3	3.8	0.42	0.43

Co = control, GM = groundnut maize intercropped, GMF = groundnut maize intercropped with NPK fertilizer application (60kg/ha) and MF = maize + NPK fertilizer application (120kg/ha).

CONCLUSIONS

The study showed that intercropped groundnut with maize played a vital role on restoration of poorly degraded soil. Although, the integration of intercropping of maize groundnut with fertilizer (GMF) application had an added advantage on both yield and soil improvement. All the soil properties considered (Soil N, Org. C, Avail. P, K, Ca and Mg) were significantly increased after intercropping activity but were better with integration of intercropping and fertilizer in both seasons. Similarly, there was increased grain yields of maize in all plots treated with groundnut and maize but the integration of groundnut maize intercropping with fertilizer application gave a better performance compared to others. The response of groundnut and maize intercropping with regards to improving soil chemical properties and grain yield of maize was in the order of GMF > MF > GM > Co in the first planting season while the residual effect gave another pattern of response as GMF > GM > MF > Co. Thus, the more organic, the better the residual response. Hence, the integration of groundnut intercropped maize with NPK fertilizer application at 60kg/ha or groundnut intercrop with maize is recommended for resource poor farmers for soil restoration and sustainable productivity.

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