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Research Paper

The effect of residuals of different legume species on the growth and yield of maize grown at Gombe and Makurdi during the 2020 rainy seasons

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Abstracts. The experiment aimed to evaluate the effect of residuals species on the growth and yield of maize grown at Gombe and Makurdi during the 2020 Rainy Season. The treatments used were groundnut, cowpea, soybeans, Bambara nut residuals, and control was used. The treatments were laid in a randomized complete block design with three replications. Sammaize 14 was used for the experiment and the spacing of 20 x 75 cm was adapted for the work. During the investigation, some physiological variables, such as growth, plant height, the number of leaves, stem diameter, and the number of prop roots per plant, were measured. Other characters like number of cobs, cob length, cob girth, and cob weight, Number of seeds per cob, number of grain rows per cob, 100 gains weight, threshing percentage, and grain yield were also recorded. The results of the investigation revealed that maize generally responded to both legume residual intercrop and spacing. All the parameters studies have significantly ($P \leq 0.05$) responded to the legumes residual effects, the use of groundnut residual was observed to perform higher in both growth character such as plant height (140.12), the number of leaves (15.45) and the number of pop root per plant(4.42) and grain yield (1610.14kg/ha). Maize grown in Benue outgrows those cultivated in Gombe in yield-related character such as the number of cobs (Benue 2.10, Gombe 1.91), cob length (Benue 11.19, Gombe 10.64) and 100 grains weight (Benue 22.16, Gombe 18.21), and overall yield (Benue 1711.17 kh/ha and Gombe 1507.20). Based on the results obtained it can be suggested that the use of groundnut residual will lead to optimum yield.

Keywords: Legumes, residuals, maize, locations.

INTRODUCTION

Maize is one of the most important cereal crops grown in most Africa including Nigeria, where it is grown throughout the country. Nigeria produces more than 45% of all maize grown in West Africa and Central Africa (Ado 2001). Although a large proportion of maize is still produced in the southwest part, there has been a dramatic shift of the dry gain production to the savannah, especially the northern Guinea savannah which is regarded as the maize belt. Despite the increase in maize production, yield is still low, some of the major causes of yield can be linked to soil fertility, location, temperature, relative humidity and appropriate plant population (Bruresh *et al.*, 1994).

Maize is used as a raw material in industries to produce biodegradable plastics, biofuel, and alcohol (Harris *et al.*, 2007). Maize contains 72% starch, 10% protein, 4.8% oil, 5.8% fiber, 3.0% sugar and 1.7% ash (Zilic *et al.*, 2011).

The contribution of legumes in N fixation and soil improvement is well known for several years. Legume residuals contributed to both vegetative growth and yield-related characters reducing the cost of production in the purchase of chemical fertilizer (Ogah *et al.*, 2019).

The work aims to determine, which of the legume residual is and pre-plant treatment is the most appropriate to be used

Table 1. The effect of legumes residuals on plant height of maize grown at Gombe and Makurdi during the 2020 rainy season.

Treatment	Plant height (cm) (WAS)				
	4	6	8	10	At harvest
Residuals (R)					
Soybeans	12.12[b]	18.24[b]	52.41[b]	120.12[b]	135.22[b]
Groundnut	14.68[a]	21.53[a]	57.24[a]	134.11[a]	140.12[a]
Cowpea	10.01[d]	17.11[c]	50.12[c]	115.10[c]	121.12[c]
Bambaranut	11.23[c]	14.23[d]	48.23[d]	113.05[d]	119.91[d]
Control	9.12[e]	15.91[e]	47.91[e]	110.12[e]	115.92[e]
LSD	0.39	0.71	1.44	2.91	1.99
Location (L)					
Benue	15.27[a]	30.21[a]	70.29[a]	120.82[a]	132.85[a]
Gombe	12.42[b]	21.11[b]	62.92[b]	112.[82b]	123.19[b]
LSD	0.29	0.34	0.56	1.23	2.34
Interaction					
R X L	NS	NS	NS	NS	NS

Means followed by the same letters within a treatment group are not significantly different following DMRT.

in maize production and at which location to also determine if there is interaction which will be reported and proper recommendation done to the farmer in such location.

MATERIALS AND METHODS

The experiment was conducted during the rainy season of 2020 at the Teaching and Research Farm, the University of Agriculture, Makurdi (7° 41'N and 8° 37'E) and in Tal at (9° 50'N and 11° 09'E) Billiri Local Government of Gombe State. The average climatic condition of the two places is (Makurdi 27-30°C and Gombe 28-32°C) and soil condition(Makurdi loamy sandy soil and Gombe sandy-loam soil) (Appendix 1). The experiment that was laid in a randomized complete block design (RCBD) with three replicate, a $4m^2$ plot was laid out with 1m between plots and 0.5m between blocks. There were 10 plots each within a block which gave the total number of 30 plots for the study for the two locations. The treatment where; Spacing at 20 × 75 cm and the legumes residuals used were (cowpea, groundnut, soybean, Bambara nut and control). Agronomic practice such as land clearing, 1 seed per hill was planted at 20 × 75cm, weeding was done manually at 2 and 6 weeks after planting to ensure a weed free plots application of fertilizer at planting and top dressed at 6weeks after planting at the rate of (N100 kg/ha, P60 kg/ha K60 kg/ha) and harvesting and threshing was done manually, all the data were collected within the net plot of $4m^2$, where a total of 5 plants were tagged for data collection within each net plot. The parameters recorded were plant height (was taken with the aid of measuring tape from the base of the plant to the tip), the number for leaves (were counted fortnightly) from 5 plants that were tagged and the average used fortnightly, stem girth and number of prop roots per plants were measured. Other characters like number of cobs (were counted), cob length (taken with the aid of measuring tape), cob girth (with the aid of a vernier caliper), and cob weight (with the aid of digital weighing balance), number of seeds per cob (were counted), number of grain rows per cob (were counted), 100 gains weight, threshing percentage and grain yield in kg was recorded. All data collected were subjected to analysis of variance (ANOVA) Gensat version 17, while the least significant difference (LSD) at 5% level of probability was used in separating the means.

RESULTS AND DISCUSSION

Table 1 shows the effect of legumes residuals on plant height of maize grown at Gombe and Makurdi during the 2020 Rainy Season. A significant difference was recorded at $P < 0.05$ with groundnut recording taller plants in all the weeks considered when compared with other legume residuals. On the other hand, control recorded the least. The result might be attributed to the fact that legume residuals have effects significantly on plant growth, the performance of maize plant height in groundnut might be as the result of residual soil fertility improved by the legumes or the nodule formation by the roots compared to control. This result is in line with those of Balasubramaniyan and Palaniappan, (2001) who recorded the same trend in their work, adding that

Table 2. The effect of legume residuals on the number of leaves of maize grown at Gombe and Makurdi during the 2020 rainy season.

Treatment	Number of leaves/plant (WAS)				
	4	6	8	10	At harvest
Residuals (R)					
Soybeans	5.30[b]	8.14[b]	11.41[b]	13.12[b]	14.22[b]
Groundnut	6.12[a]	9.13[a]	12.24[b]	14.11[a]	15.45[a]
Cowpea	6.01[c]	7.11[c]	10.02[c]	12.00[c]	13.11[c]
Bambaranut	5.00[d]	7.02[d]	9.98[d]	11.63[d]	12.01[d]
Control	4.82[e]	6.51[e]	8.51[e]	10.63[d]	11.98[e]
SE (+)	0.11	0.14	0.14	0.15	0.19
Location (L)					
Benue	6.17[a]	9.23[a]	10.89[a]	12.89[a]	14.89[a]
Gombe	4.12[b]	7.12[b]	8.52[b]	10.24[b]	12.89[b]
SE (+)	0.29	0.34	0.39	0.43	0.94
Interaction					
R X L	NS	NS	NS	NS	NS

Means followed by the same letters within a treatment group are not significantly different following DMRT.

residual gotten from groundnut add significantly in plant height and growth in general.

On location, a significant difference ($P < 0.05$) was recorded with Benue recording taller plant than Gombe, this could be attributed to soil condition, climatic faction aiding to the decomposition of residuals thereby affecting plant height positively (Table 12 and Appendix 1). This finding is in agreement with the finding of Ojiem *et al.* (2006) who had the same result, starting that plant height is influence by nutrients availability, climatic factor, plant population and agronomic practice.

Table 2 shows the effect of legume residual on the number of leaves of maize grown at Gombe and Makurdi during the 2020 rainy season. A significant difference was recorded at $P < 0.05$ with groundnut recording the highest number of leaves in all the weeks in consideration when compared with other legume residuals. On the other hand, control recorded the least. This might be the result of residual soil nitrogen contents by the legumes incorporation and decomposition. The results are consistent with that of Arif *et al.* (2011) whose study was to check maize growth (vegetative and yield) stating that leaves initiation is a product of nutrients leading to solar radiation interception for photosynthetic activities and other metabolic activities which later translate to yield.

On location, the results show a significant difference ($P < 0.05$) with Benue having the highest number of leaves than Gombe, this is not far from the fact that climatic factor, rainfall and decomposition of legume residual could have led to that, Niringye *et al.* (2005) In his work agrees with the above accretion reporting that nutrients, rainfall and climatic factor can lead to crop vegetative growth.

Table 3 shows the effect of legume residual on stem girth and the number of pop roots of maize grown in Gombe and Makurdi during the 2020 rainy season, where a significant difference ($P < 0.05$) was recorded with groundnut having the widest girth and number of pop roots. This could be attributed to the fact that groundnut shed more leave and leaves more residues than other source legumes residuals. This work is in agreement with the findings of Shah *et al.* (2003) who reported that groundnut has many residues and decomposition starts early thereby releasing its nutrients when compared with legumes like cowpea and Bambaranut, as such lead to the development of bigger or wider girth and also pop roots in maize. Kumar and Goh (2000) also reported that girth and pop roots are products of assimilation from both floral plant parts and absorption of nutrients from the plant roots.

A significant difference ($P < 0.05$) was also observed in the two locations under consideration where Benue recorded wider girth and pop roots when compared with Gombe, this could be as a result of temperature, rainfall and decomposition of the residual leading to the development of pop roots and wider or bigger girth as support by Stefan and Christian (2002) in their work on maize.

Table 4 shows the effect of legume residual on cob weight, 100gain weight, cob girth, the number of cob per plant of maize grown at Gombe and Makurdi during the 2020 rainy season, where the significant difference ($P < 0.05$) was recorded with groundnut residual recorded highest in all the above-listed characters, this is not far from the fact that leguminous crop plays an important role

Table 3. The effect of legume residual on stem girth and number of pop roots of maize grown at Gombe and Makurdi during the 2020 rainy season.

Treatment	Stem girth (cm) (WAS)				No. of pop roots/plant
	4	6	8	10	
Residuals (R)					
Soybean	3.11[c]	4.61[b]	4.62[b]	4.64[b]	3.22[b]
Groundnut	3.42[a]	5.13[a]	5.24[a]	5.61[a]	4.42[a]
Cowpea	3.28[b]	4.03[c]	4.32[c]	4.45[c]	3.12[c]
Bambaranut	3.02[d]	3.89[d]	4.00[d]	4.32[d]	3.10[d]
Control	3.00[e]	3.26[e]	3.99e	4.02[e]	3.01[d]
SE (+)	0.04	0.08	0.08	0.05	0.04
Location (L)					
Benue	3.17[a]	4.83[a]	5.79a	5.98	4.99[a]
Gombe	3.02[b]	3.11[b]	4.02b	4.82b	3.79[b]
SE (+)	0.05	0.09	0.10	0.10	0.14
Interaction					
R X L	NS	NS	NS	NS	**

Means followed by the same letters within a treatment group are not significantly different following DMRT.

Table 4. The effect of legume residual on yield and yield-related characters of maize grown at Gombe and Makurdi during the 2020 rainy season.

Treatment	Cob weight (g)	100gain Weight (g)	Cob girth (cm)	No.of cob per plant	Cob length (cm)
Residuals (R)					
Soybean	48.22[b]	19.89[b]	3.59[b]	1.12[b]	10.49[b]
Groundnut	57.11[a]	22.89[a]	3.99[a]	2.54[a]	11.12[a]
Cowpea	45.22[c]	18.11[b]	3.22[b]	1.08[c]	10.11[c]
Bambaranut	42.12[d]	17.23[d]	3.00[d]	1.00[d]	9.81[d]
Control	40.23[d]	16.81[d]	2.91[e]	0.90[e]	9.01[e]
SE (+)	2.33	0.32	0.09	0.02	0.12
Location (L)					
Benue	53.12[a]	22.16[a]	3.99[a]	2.10[a]	11.19[a]
Gombe	40.22[b]	18.21[b]	3.11[b]	1.91[b]	10 64[b]
SE (+)	8.92	2.02	0.05	0.06	1.00
Interaction					
R X L	NS	**	NS	**	NS

Means followed by the same letters within a treatment group are not significantly different following DMRT.

in nitrogen fixation which in turn affect plant grown in the field positively in term of yield and yield-related characters. Chikowo *et al.* (2006) reported that maize is grown after groundnut had higher yield when compared with other leguminous crops and fields that have not been cultivated with legumes. Behera *et al.* (2007) reported that groundnut starts shading its leaves early leading to incorporation into the soil, decomposition and release of nutrient for plant absorption fast, adding to cob weight, 100gain weight, cob girth, number of cob per plant are a product of nutrient absorption and utilization by the plant which was gotten from groundnut residual plots. The results are in agreement with Muhammad *et al*. (2005), who reported that yield contributing characters such as cob weight, 100gain weight, cob girth, number of cob per plant with groundnut residual in combination with manure resulting in higher yield. In control plots, the lower number of cob weight, 100gain weight, cob girth, number of cob per plant were reported by Muhammad *et al.* (2005), and the possible reason was the unavailability

Table 5. The effect of legume residual on yield and yield-related characters of maize grown at Gombe and Makurdi during the 2020 rainy season.

Treatment	No. of grain rows/cob	No. of grain per cob	Shelling (%)	Grain weight per cob (g)	Grain yield (kg/ha)
Residuals (R)					
Soybean	12.02[b]	180.34[c]	76.32[b]	36.23[b]	1470.08[b]
Groundnut	15.22[a]	202.21[a]	77.88[a]	41.65[a]	1610.14[a]
Cowpea	10.66[c]	189.41[b]	75.11[b]	34.01[c]	1318.12[c]
Bambaranut	9.81[d]	177.12[d]	73.91[d]	31.62[d]	1258.91[d]
Control	9.61[e]	172.12[e]	72.12[e]	30.00[e]	1213.19[e]
SE (+)	0.33	2.04	1.02	1.01	58.12
Location (L)					
Benue	12.22[a]	190.61[a]	78.99[a]	42.0[3a]	1711.17[a]
Gombe	11.20[b]	180.78[b]	75.43[b]	31.00[b]	1507.20[b]
SE (+)	5.21	0.02	5.67	3.51	45.41
Interaction					
R X L	NS	**	NS	**	**

Means followed by the same letters within a treatment group are not significantly different following DMRT.

Table 6. Interaction between location and legumes residual on the number of pop root grown at Gombe and Makurdi during the 2019 rainy season.

Location	Maize/legumes intercrop (10WAS)				
	Control	Groundnut	Cowpea	Soybeans	Bambaranut
Benue	3.30[a]	4.00[a]	3.84[a]	3.46[a]	3.50[a]
Gombe	3.01[b]	3.69[b]	3.60[b]	3.46[b]	3.29[b]
SE	0.04	0.5	0.07	0.05	0.23

Means followed by the same letters within a treatment group are not significantly different following DMRT.

of nutrient and less dry matter accumulation.

On location Benue recorded high in cob weight, 100gain weight, cob girth, number of cob per plant when compared with Gombe, this is true because climatic factors, soil microbial activities maybe have led to decomposition and release of nutrients for plant utilization lead to increase in cob weight, 100gain weight, cob girth, number of cob per plant. This work is in agreement with the findings of Gadgil *et al.* (2002) who attributed the finding to climatic factors, soil microorganism activities, rainfall and cultural practices.

Table 5 shows the effect of legume residual on yield and yield-related characters of maize grown at Gombe and Makurdi during the 2020 rainy season, where a significant difference ($P < 0.05$) was recorded in both residual effects and season of growth. Where groundnut residual was recorded, there was a higher number of grains row per cob and number of grains per cob, shelling percentage, grains weight and overall yield when compared with other legumes residual considered for the experiment, this could as a result that yield-related characters are highly influenced by nutrient utilization by plants leading to higher yield recorded. This work collaborates with the findings of Shah *et al.* (2003) who reported that maize yielded high when planted in a field with legume residual particularly from groundnut and soybean, the same trend was also reported by Giller *et al.* (1997) who stated that field where maize is plated after groundnut cultivation produced higher yield and yield-related character due to nitrogen fixation. These findings are also in agreement with the results of Malik *et al.* (1991) who conducted an experiment on the residual effect of legumes such as pigeon pea, mungbean and cowpea on cereals (maize) and found increasing total grain yield significantly. Abate *et al.* (1992) experimented on the forage legumes and revealed that forage legumes improve soil fertility, increase crop yields, improve yields suppress weeds and combat erosion. Drinkwater *et al.* (2000) observed that legume-based cropping patterns increase the organic matter content consequently result in sustainable yields of crops.

Discussion on interactions

Table 6 suggests that Makurdi had a more favourable

Table 7. Interaction between location and legumes residual on 100g weight grown at Gombe and Makurdi during the 2019 rainy season.

Location	Legumes residuals (at harvest)				
	Control	Groundnut	Cowpea	Soybaens	Bambaranut
Benue	19.22[a]	22.00[a]	20.34[a]	19.53[a]	19.45[a]
Gombe	18.00[b]	20.59[b]	19.10[b]	18.73[ba]	18.32[b]
SE	1.44	1.52	1.97	1.11	1.00

Means followed by the same letters within a treatment group are not significantly different following DMRT.

Table 8. Interaction between location and legumes residuals on the number of cobs grown at Gombe and Makurdi during the 2019 rainy season.

Location	Legumes residuals (at harvest)				
	Control	Groundnut	Cowpea	Soybean	Bambaranut
Benue	.62a	2.00a	1.74a	1.66a	1.69a
Gombe	1.00b	1.05b	1.10b	1.15b	1.02b
SE	0.04	0.02	0.05	0.02	0.01

Means followed by the same letters within a treatment group are not significantly different following DMRT.

Table 9. Interaction between location and legumes residuals on grain weight per cob grown at Gombe and Makurdi during the 2019 rainy season.

Location	Legumes residual (at harvest)				
	Control	Groundnut	Cowpea	Soybean	Bambaranut
Benue	38.12[a]	45.19[a]	42.58[a]	41.21[a]	40.12[a]
Gombe	34.01[b]	41.32[b]	38.11[b]	39.21[b]	36.02[b]
SE	2.54	2.52	2.67	2.12	2.81

Means followed by the same letters within a treatment group are not significantly different following DMRT.

environment for maize growth than Gombe. This is probably because it has favourable climatic conditions and soil available nutrients for maize production (Appendix 1), the climatic temperatures allowing for pop root growth and development, this is in agreement with the work of Gadgil *et al.* (2002) who reported climatic condition and soil condition might have led to that.

Table 7 recorded interaction between legumes residuals and locations. Groundnut residuals and Makurdi had a perfect interaction and probably more favourable environment and rainfall distribution for maize growth than Gombe as recorded by Table 13 and Appendix 1, reported the same trend where he attributed it soil nutrient, decomposition of organic manure by microbial activities, adequate/distributed rainfall received and cultural practice.

Table 8 shows an interaction between legume residual and location on the number of cobs, where a perfect interaction was recorded between Benue and groundnut residuals having the higher number of cob, this could be attributed to the ability of the plant to absorb the available nutrient gotten from groundnut residual more than the other residuals used in the work, more number of cob might be due to more photo-assimilates production in Benue than in Gombe. Optimum supply of nutrients from the residuals had affected yield components and overall yield as reported by Muhammad *et al.* (2005).

Table 9 recorded an interaction between location and legume residuals on grain weight per cob, where a perfect interaction was observed between Benue location and groundnut residuals; this could be attributed to the fact that grain weight is the product of assimilation of nutrients which was gotten from groundnut residual. This work is not in conformity with the work of Nazifi (2004) who reported that for legume residual to add to crop yield chemical nutrients need to be applied to aid the uptake of nutrients by plant and also add to the weight and overall yield of the crop.

Table 10 shows an interaction between legume residual and location on grain per cob, where groundnut residuals and Benue location had a perfect interaction, this is not far from the fact that soil nutrients, rainfall distribution and cultural practices might have led to a higher number of grains. Abate *et al.* (1992) carried out an experiment of legumes residuals and revealed that groundnut residuals improve soil fertility, higher grains

Table 10. Interaction between location and legumes residuals on the number of gain per cob grown at Gombe and Makurdi during the 2019 rainy season.

Location	Legumes residuals (at harvest)				
	Control	Groundnut	Cowpea	Soybean	Bambaranut
Benue	138.62[a]	206.19[a]	197.63[a]	182.11[a]	141.01[a]
Gombe	126.01[b]	190.99[b]	166.01[b]	172.82[b]	128.12
SE	3.54	3.52	3.67	3.12	3.01

Means followed by the same letters within a treatment group are not significantly different following DMRT.

Table 11. Interaction between location and legumes residuals on grain yield grown at Gombe and Makurdi during the 2019 rainy season.

Location	Legumes residual (at harvest)				
	Control	Groundnut	Cowpea	Soybean	Bambaranut
Benue	1438.62a	1646.79a	1537.93a	1517.22a	1481.12a
Gombe	1336.01b	1440.39b	1436.31b	1411.83b	1388.90b
SE	71.54	72.52	54.67	69.64	70.12

Means followed by the same letters within a treatment group are not significantly different following DMRT, SE = Standard error.

Table 12. 2020 rainfall pattern, temperature and relative humidity of the two experimental locations of Benue and Gombe.

Months	Benue				Gombe			
	Rainfall (mm)	Temp (OC).	Temp (OC)	Rel. Hum (%)	Rainfall (mm)	Temp. (OC)	Temp (OC)	Rel. Hum. (%)
Jan	0.0	18.2	34.3	37.2	0.0	19.2	33.2	19.1
Feb	0.0	21.2	36.8	51.9	0.0	20.2	35.9	18.9
Mar	0.4	22.5	35.4	51.9	0.0	21.3	36.6	18.2
Apr	134.5	31.3	61.8	21.9	23.8	29.7	48.7	21.2
May	162.1	21.5	30.2	73.2	69.4	25.6	31.4	68.9
vJun	168.9	20.3	29.9	74.4	123.3	24.9	30.9	70.9
Jul	351.4	20.2	28.4	79.9	268.5	21.4	29.4	75.5
Aug	343.2	20.1	29.6	78.9	398.7	20.9	29.2	78.8
Sept	192.1	20.1	29.9	79.9	312.2	20.2	30.1	79.1
Oct	200.1	19.9	30.2	76.7	96.2	20.7	31.2	84.9
Nov	10.23	19.3	31.2	69.9	0.0	21.2	32.2	35.9
Dec	0.0	13.9	30.2	40.1	0.0	18.2	20.8	20.3
Total	1290.2				1562.93			

Source: Nigerian Meteorological Agency, Tactical Air Command Headquarters, Airforce base, Makurdi and Meteorological Agency, Synoptic Office, Gombe.

lead to an increase in yield-related characters and improve overall yields suppress weeds and combat erosion. Drinkwater *et al.* (2000) observed that legume-based cropping patterns increase the organic matter content consequently result in sustainable yields of crops. Gadgil *et al.* (2002) reported that high microbial activities leading to decomposition and overall yield can be obtained with the introduction of legume-based cropping patterns.

Table 11 shows an interaction between legumes residuals and locations, where groundnut and Benue location residual recorded a perfect interaction, this is not far from the fact that decomposition of shaded leaves, soil microbial activities and soil composition/ nutrient might have contributed to the overall yield. These findings are in agreement with the results of Malik *et al.* (1991) who conducted an experiment on the residual effect of legumes such as groundnut, pigeon pea, mungbean and cowpea on cereals (maize, wheat) and found increasing total grain yield.

REFERENCES

Abate CA, Giller KE, Mafongoya PL, Swift MJ (1992). Management

of organic matter in the tropics: translating theory into practice. Nutrient cycling in agroecosystem, 61:63-75. Int. J. Agric. Agric. p. 85.

Ado MA (2001). Improving nitrogen use efficiency for cereal production. J. Agron. 91:357-363.

Arif GI, Rashid A, Miraj G, Arif M, Shah H (2011). On-farm seed priming with zinc Sulphate solution-A cost-effective way to increase the maize yield of resource-poor farmers. Field Crop Res. 102:119-127.

Balasubramaniyan P, Palaniappan SP (2001). Principles and Practices of Agronomy: Integrated Farming System. Agrobios publishers. pp. 486-489.

Behera UK, Sharma AR, Pandey HN (2007). Sustaining productivity of wheat–soybean cropping system through integrated nutrient management practices on the Vertisols of central India. J. Plant Soil. 297:185-199.

Bruresh MK, Khan MJ, Mughal AQ, Bukhari SB, Jan MT (1994). Influence of various Tillage practices on yield of wheat-maize under clay loam soil condition. Sarhad J. Agric. 20:429-435.

Chikowo R, Mapfumo P, Leffelaar PA, Ken, Giller E (2006). Integrating legumes to improve N cycling on smallholder farms in sub-humid Zimbabwe: resource quality, biophysical and environmental limitations. J. Nutr. cycle Agrosyst. 76:219-231.

Drinkwater LE, Janke RR, Rossoni-Longnecker L (2000). Effects of tillage intensity on nitrogen dynamics and productivity in legume-based grain systems. J. Plant Soil. 227:93-113.

Gadgil S, Seshagiri Rao PR, Rao NK (2002). Use of climate information for farm-level decision making: rainfed groundnut in southern India. J. Agric. Syst. 74:431-457.

Giller KE, Cadisch G, Ehaliotis C, Adams E, Sakala WD, Mafongoya PL (1997). Building soil nitrogen capital in Africa, American Society of Agronomy and Soil Science of America, USA, Replenishing soil fertility in Africa, SSSA Special 51:151-157.

Kumar K, Goh KM (2000). Crop residues and management practices: effects on soil quality, soil nitrogen dynamics, crop yield, and nitrogen recovery. Adv. Agron. 68:197-319.

Malik MR, Malik BA, Haqqani AM (1991). Economics of intercropping legumes with cereal and soil seed crops. Sarhad Journal of Agriculture 6:717-223.

Muhammad JA, Khan Saeed K (2005). Grain legume effect soil nitrogen, grain yield and nitrogen nutrition of wheat. crop. J. Crop Sci. 37:734-739.

Niringye CS, Ssekabembe CS, Kayamanywa S (2005). Effect of plant nodulation on yield of maize and climbing beans grown in an intercropping system. Afr. crop Sci. J. 13:83-93.

Nazifi MI (2004). Principles and Practices of Agronomy: Integrated Farming System. Agrobios publishers. 486-489.

Ogah JBO, Wheeler TR, Haris PM (2019). Effect of nitrogen and irrigation on water use of maize crops. Field Crops Res. 78:105-117.

Ojiem JO, de Ridder N, Vanlauwe B, Giller KE (2006). Socio ecological niche: a conceptual framework for integration of legumes in small holder farming systems. Int. J. of Sustain. Agric. 4, 79-93.

Shah A, Shah SH, Peoples MB, Schwenke GD, Herridge DF (2003). Crop residue and fertilizer N effects on nitrogen fixation and yields of legume-cereal rotations and organic fertility. Field crop Res. 83:1-11.

Stefan H, Christian N (2002). Biomass production and N Fixation of five Mucuna Pruriens varieties and their effect on maize yields in the forest zone of Cameroun. J. Soil Sci. Plant Nutr. 165:101-109.

Zilic SM, Milasinovic D, Terzic M, Barac, Ignjatovic MD (2011). Grain characteristics and composition of maize specially hybrids. Spanish J. Agric. Res. 9:230-241.

Appendix 1. Physicochemical properties of the experimental site at Gombe and Makurdi in the Rainy Season of 2020.

Soil property	Gombe		Makurdi	
	Before	After	Before	After
% Sand	14.3	15.06	14.4	15.08
% Silt	58.3	57.54	60.2	61.52
% Clay	27.4	27.4	25.4	25.4
Texture	Loam sandy	Loam sandy	Loam sandy	Loam sandy
Ph	5.11	5.13	4.10	4.12
Organic carbon (%)	0.76	0.79	0.78	0.80
Organic matter (%)	1.53	2.00	2.61	3.02
Total nitrogen (%)	1.20	1.29	2.23	2.31
P(Bray)ppm	11.02	12.98	11.01	13.79
CEC ($CmolKg^{-1}$)	4.81	6.56	4.91	6.57
EC ($CmolKg^{-1}$)				
Ca^{2+}	3.32	4.41	3.41	4.35
Na^{2+}	0.57	0.58	1.56	1.59
K+	0.24	0.28	0.25	0.27
Mg^{2+}	0.93	0.98	0.94	0.99
Base saturation	74.74	78.95	75.11	79.89

Key: ppm = part per million, CEC = cation exchange capacity, EC = exchangeable cation