GREEN MANURE EFFECTS ON LEAF SPOT DISEASE, GROWTH AND YIELD OF GROUNDNUT (*Arachis hypogaea* L.) IN LOWLAND DERIVED SAVANNAH BASIN, ISHIAGU, NIGERIA.

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ABSTRACT

Leaf spot disease is one of the major diseases ravaging groundnut. This experiment assessed the effect of different types of green manure on leaf spot disease, growth and yield of groundnut in 2016 and 2017 farming seasons. Fresh leaves of neem, Siam weeds and *Gmelina* were each applied at 10 t/ha. The green manures were fitted into a randomised complete block design replicated three times with no manure as the control. Data collected on the Plant height, leaf number, branches, incidence of leaf spot disease, pod number, pod yield, pod weight and number of seeds/pod were averaged and subjected to analysis of variance and correlation analysis. The results showed that the application of green manure, significantly ($P<0.05$) enhanced fresh pod yield and reduced the menace of leaf spot disease on groundnut grown in lowland derived savannah plains of south-eastern Nigeria. The incorporation of fresh Siam weeds or fresh neem leaves into the soil as green manure gave the highest significant ($P<0.05$) fresh pod yield compared with the other treatments. The high fresh pod yield would guarantee improved protein in-take of the people living in the region.

Keywords: *Fresh green manure, fresh pod yield, Groundnut leaf spot*

INTRODUCTION

Groundnut (*Arachis hypogaea*), which is of the family Fabaceae is one of the major sources of vegetable oil in the world grown as an annual crop principally for its edible oil and as a soil improver because of its ability to fix atmospheric nitrogen in the soil (Gibbon and Pain, 2000; Mukhtar *et al.*, 2010). According to Nabil *et al.* (2015) well-drained soils provide good aeration for the roots of groundnut to grow well, especially if they have optimum pH range of 6.0 - 6.5 and high water retention capacity.

Groundnut requires considerable amount of nutrients for high yields. Previous studies by Subrahmanyam *et al.* (2000) and Atoyebi1*et al.* (2017) indicated that legume crops have the ability to utilize soil nutrients that are relatively unavailable to other crops, hence the crop can make good use of residual fertility in the soil. In the production of groundnut, farmers face a number of challenges such as low soil fertility due to excess nutrient uptake associated with continuous cropping, soil nutrient leaching, nutrient loss due to water runoff, inefficient conservation management practices resulting in acidification of the land, which invariably affects groundnut growth and yield negatively (Lourduraj, 1999).

The oil obtained from the seed of groundnut varies from 44 to 50 per cent, depending on the variety and agronomic conditions of the crop in the field. It is used extensively in the domestic and industrial sectors such as food preparation, soap making, cosmetics, lubricants and animal feed. The groundnut seeds are eaten raw, roasted or cooked and serves as a veritable source of protein, vitamin A, B, and some members of vitamin B_2 group.

Singh (1997) and Muktar *et al*. (2010) in their various studies submitted that it is important to add plant materials into the soil so as to increase the supply of plant nutrients required for appropriate growth and development of the crops. Further studies by Yoyock and Oyami (2004) showed that the application of inorganic fertilizer to the soil degrades its fertility through the process of acidification which necessitates the addition of organic manure for proper improvement of the soil status (Muktar *et al*., 2010). However, in contrast, Ojeniyi (2000) submitted that the use of organic manure, especially animal manure is not really helpful in determining the yield of groundnut under intensive agriculture due to findings that it is often associated with reduced crop yield and solid acidity. Naab *et al*. (2005) and Subrahmanyam *et al*. (2006) in their studies submitted that some environmental conditions required for leaf spot disease of groundnut to manifest are warm temperatures and long periods of high humidity or leaf wetness.

However, in humid derived savannah of Ishiagu, there is inadequate knowledge of the association between the groundnut plant and leaf spot disease incidence. Also, there is inadequate documented information on the use of different types of green manure such as fresh neem leaves, fresh Siam weeds and fresh *Gmelina* leaves on the growth, yield and yield components of groundnut.

The objectives of this study were to determine the effect of different types of green manure sources (fresh neem leaves, fresh Siam weeds, and fresh *Gmelina* leaves) and leaf spot disease incidence on the growth and yield of groundnut in lowland plains of Ishiagu, Nigeria.

Materials and Methods

The experiment was conducted at the Federal College of Agriculture, Ishiagu, Nigeria in 2016 and 2017 farming seasons, which lies on, latitude 5^0 56' N and longitude 7^0 32' E with an elevation of 150 m above sea level in the derived Savannah agro-ecological zone of south eastern Nigeria. The location is characterised by a mean annual rainfall and temperature of 1,350 mm and 29 $^{\circ}$C, respectively. The experiment was set up using a randomized complete block design (RCBD) with three replications.

Green manure

Fresh leaves of neem (*Azadirachta indica*), siam weed (*Chromolaena odorata*) and *Gmelina arborea* were collected from the environment of Federal College of Agriculture Ishiagu, Ebonyi State and used as the treatments in the experiment. These were used as green manures.

Experimental design

Randomized complete block design with the treatments replicated three times was used in the experiment.The experimental site was cleared, ploughed and harrowed. Experimental plots were made manually with Indian hoe. The plot sizes were 2 m x 2 m, with inter-block spacing of 100 cm and inter-plot spacing of 50 cm. The green manure materials collected from the environment of Federal College of Agriculture, Ishiagu were chopped into smaller pieces with a sharp knife before they were applied and incorporated into the soil with garden fork to achieve a homogenized mixture. The soil was then left for two weeks for proper decomposition of the green manure before the planting of the groundnut seeds during the early planting season. The treatments were incorporated into the soil as green manure at 10 t/ha and no manure control (0 t/ha). The erect groundnut variety (*SAMNUT* 21) obtained from the Institute for Agricultural Research (IAR), Ahmadu Bello University (ABU) Zaria, Kaduna State was sown at the plant spacing of 30 cm by 50 cm inter- and intra-row spacing, which gave a total plant population of 50 plants/plot at two seeds per hole (133,333 plants/ha).

The experimental plots were weeded at three weeks after planting manually with the aid of a weeding hoe to achieve a clean field prior to pegging of the established crop. A fish net was used to create a barricade round the farm to prevent macro-pests such as squirrels, hares and grass-cutters from entering into the farm.

Data collection and Analyses

Growth data collected at 3, 6, 9 and 12 WAP were plant height, which was done with the aid of a metre rule from the base of the plant to its tip, number of leaves/plant and number of branches/plant by counting the total number of leaves and branches on the plant at the sampled dates. The incidence of leaf spot disease (*Cercospora arachidicola* Hori) on the established groundnut plants was assessed by counting the total number of plants infected at 9 and 12 WAP. Thirty (30) plants were assessed in a plant population of 50 plants/$4m^2$ experimental plot. This implied that incidence was monitored on individual groundnut leaf, individual groundnut plant and by considering the groundnut plant population. The disease incidence recorded was calculated thus: [Incidence (%) = Number of plants infected / Total number of plants on the plot].

The harvesting of fresh ripe groundnut pods was done manually at the end of the vegetative cycle (90 to 110 days after planting). The ripe pods collected after uprooting the plants were properly cleaned to remove soil particles. Yield components such as fresh pod weight/plant, number of pods/plant, number of seeds/pod and fresh pod yield (t/ha) were collected. Data on fresh pod weight/plant and fresh pod yield were determined by weighing with the aid of a standard scale balance.

Data collected were averaged over the two years. The collected growth and yield data were subjected to analysis of variance (ANOVA) for a single factor treatment using Genstat Discovery Edition 3 (Genstat, 2007). The significant treatment means were separated using Fisher's least significant difference (F-LSD) at 5 % level of probability following the procedure outlined in Obi (2002). Correlation of the variables to determine the relationships between them was carried out. Pearson correlation coefficients of the variables were calculated using SPSS statistical package for windows version 17.0 (2010) while the relationship between fresh pod yield leaf spot disease infection at 9 WAP was carried out using simple linear regression method.

Results and Discussion

Analysis of variance (Table 1) indicated that plant height, number of leaves/plant and number of branches/plant at the different ages sampled as well as all the other response variables evaluated [leaf spot disease at 9 and 12 WAP, pod weight/plant, number of pods/plant, number of seeds/pod and fresh pod yield (t/ha)] were significantly ($P<0.05$) affected by the different types of green manure used in the study.

Table 1: Analysis of variance showing significance of the effects of different types of green manure on the plant response variables examined

Source of variation	Plant response variables	WAP	Mean square	Error mean square
Green manure	Plant height (cm)	3	5.4347*	0.2696
		6	1.03369*	0.0513
		9	17.4909*	0.8675
		12	1741.67*	8.664
	Number of leaves/plant	3	1201.76*	59.61
		6	3797.60*	353.50
		9	1201.76*	59.61
		12	4520.00*	224.2
	Number of branches/plant	3	57.153*	2.835
		6	64.066*	0.3178
		9	333.80*	16.56
		12	797.58*	39.56
	Leaf spot	9	4.2502*	0.7068
		12	28.220*	1.40
	Pod weight/plant		11598.90*	575.30
	No. pods/plant		35557.00*	11741.0
	No. seeds/pod		0.180041**	0.00813
	Fresh pod yield (t/ha)		45.308*	2.247

WAP, Weeks after planting; *, **,significant at 0.05 and 0.01 level of probability, respectively.

The green manure treatments significantly (P<0.05) affected plant height of groundnut at the sampled ages (Table 2). The application of fresh neem leaves induced taller plants at the sampled weeks followed by the application of fresh Siam weeds while the application of fresh *Gmelina* leaves gave the lowest plant height values across the sampled dates. The findings are in agreement with Nwite *et al*. (2009) and Mukhtar *et al.* (2014) who reported from their various studies in two different agro-ecological zones on the effect of organic manure soil amendments that organic manure enables crops grow with vigour through the process of decomposition and release of growth enhancing nutrient elements into the soil for ease of absorption by the growing crops.

Table 2: Effect of different types of green manure on plant height of groundnut at different ages

Types of green manure	3	6	9	12
	Weeks after planting (WAP)			
No manure control	6.29	20.34	32.04	35.46
Fresh neem leaves	8.72	21.42	28.81	44.03
Fresh Siam weeds	6.97	20.35	27.94	35.69
Fresh *Gmelina* leaves	5.68	20.12	26.30	25.38
S.E.D	0.424	0.1849	0.761	2.403
$LSD_{(0.05)}$	1.037	0.4524	1.861	5.881

S.E.D = Standard error of difference between two means LSD = Least significant difference

The results presented in Table 3 showed that the green manure treatments exhibited significant (P<0.05) effect on the number of leaves/plant of at all the sampled dates in the experiment. The application of fresh neem leaves gave the highest number of leaves/plant compared with the other types of green manure used in the study.

Table 3: Effect of different types of green manure on number of leaves/plant at different ages

Types of green manure	3 WAP	6 WAP	9 WAP	12WAP
	Weeks after planting (WAP)			
No manure control	89.86	246.21		565.9
Fresh neem leaves	123.46	272.76		624.50
Fresh Siam weeds	117.15	231.35		566.70

Fresh *Gmelina* leaves	82.76	187.66	530.80
S.E.D	6.30	15.35	12.23
$LSD_{(0.05)}$	15.42	37.57	29.91

The application of green manure (Table 4), especially fresh neem leaves in the soil induced greater number of branches/plant relative to the other treatments. Except at 3 WAP, the application of neem leaves gave the highest number of branches/plant at the other sampled dates closely followed by the application of fresh Siam weeds. These works are in agreement with that of Subrahmaniyan *et al*. (2000) and Nabil *et al*. (2015) who submitted that the application of manure in the form of any substance helps to increase the supply of plant nutrients, which increases crop growth and invariably yield.

Table 4: Effect of different types of green manure on number of branches/plant at different ages

Types of green manure	3	6	9	12
			WAP	
No manure control	30.53	60.90	131.51	106.90
Fresh neem leaves	25.71	63.96	148.78	141.57
Fresh Siam weeds	22.47	62.02	136.75	141.30
Fresh *Gmelina* leaves	20.55	60.83	123.68	132.37
S.E.D	1.375	0.460	3.32	5.14
$LSD_{(0.05)}$	3.364	1.126	8.13	12.57

The application of different types of green manure significantly ($P<0.05$) affected leaf spot disease incidence in groundnut (Table 5) at 9 and 12 WAP. Higher percentage of the disease was recorded at 12 WAP relative to 9 WAP, an indication that increased foliage on the groundnut plant increases the presence of leaf spot disease. The application of fresh neem leaves recorded the lowest incidence of the disease on the plant while fresh *Gmelina* leaves exhibited the highest incidence at the two sampled dates. The findings from the study were similar to Waliyar (1990) and Tshilenge-Lukanda *et al.* (2012) in their different works on leaf spot disease of groundnut in which they reported that the disease manifests more with the age of the growing groundnut plant. Furthermore, Gata-Gonçalvès *et al*. (2003) and Ambang *et al*. (2010) submitted that the use of natural biocides of plant origin such as yellow oleander (*Thevetia peruviana*) in different forms of application could serve as a promising outlet for environmental sustainable control of plant fungi diseases such as leaf spot disease in groundnut, contrary to our study and findings which encouraged the use of different types of green manure as a panacea to the leaf spot disease effect on groundnut.

Table 5: Effect of different types of green manure on leaf spot disease incidence of groundnut at 9 and 12 WAP

Treatment	Leaf spot disease incidence (%)	
	9	12
	WAP	
No manure control	37.72	39.11
Fresh neem leaves	29.38	29.75
Fresh Siam weeds	33.40	34.81
Fresh *Gmelina* leaves	34.01	36.30
S.E.D	0.686	0.966
$LSD_{(0.05)}$	1.680	2.364

The application of different types of green manure (Table 6) significantly affected yield and yield components of groundnut. Except fresh pod weight/plant and fresh pod yield/hectare, the application of fresh neem leaves gave the highest number of pods/plant and number of seeds/pod relative to the other green manure treatments. However, fresh Siam weeds gave the highest fresh pod yield, which was higher by 28.04, 2.29 and 45.15 % relative to no manure control, fresh neem leaves, and fresh *Gmelina* leaves, respectively. The results collaborate Subrahmaniyan *et al.* (2000) who submitted that application of farm yard manure, which is another type of organic manure at 10 to 15 t/ha increased groundnut pod yield and yield components significantly. Also, our findings were similar to previous results obtained by Nabil *et al.* (2015) in their works on integrated use of organic, inorganic and bio-fertilizers on yield of groundnut in which they reported positive effects of the soil amendments, especially organic fertilizer to increased grain yield in groundnut.

Table 6: Effect of different types of green manure on yield and yield components of groundnut

Treatment	Fresh pod weight/plant (g)	No. Pods /plant	No. seeds /pod	Fresh pod yield (t/ha)
No manure control	206.50	229	1.20	12.91
Fresh neem leaves	280.6	353.12	1.67	17.53
Fresh Siam weeds	287.10	331.2	1.39	17.94
Fresh *Gmelina* leaves	157.47	115.3	1.11	9.84
S.E.D	19.58	88.5	0.0772	1.224
$LSD_{(0.05)}$	47.92	216.5	0.1888	2.995

The correlation analysis between all the pairs of variables (Table 7.) indicated that fresh pod yield had positive and highly significant ($P \leq 0.05$) correlation with all the variables tested (plant height, number of leaves/plant, number of branches/plant, leaf spot disease incidence, fresh pod weight/plant, number of pods/plant number of seeds/pod). Except number of pods/plant that showed non-significant ($P \geq 0.05$) but positive relationship with plant height, number of leaves/plant, number of branches/plant and leaf spot disease incidence; all the other variables evaluated exhibited different degrees of significance and positive associations amongst themselves. These results were similar to the findings of Adebisi *et al.* (2004) and Peric *et al.* (2016) on interrelationships in soybean in which they reported that pod weight/plant is one of the main characters that exhibited positive and significant effect on grain yield of the crop.

The regression analysis (Fig. 1) indicated that the relationship between fresh pod yield and leaf spot disease incidence in groundnut was linear with a coefficient of determination (R^2) of 0.5016, an indication that leaf spot disease incidence has the tendency to increase as fresh pod yield in ground nut increases.

Table 7: Correlation matrix of growth, fresh pod yield and yield components of groundnut

Plant characters	Fresh pod yield (t/ha)	Plant height (cm)	Number of leaves /plant	Number of branches /plant	Leaf spot disease incidence	Fresh pods weight /plant (g)	Number of pods /plant	Number of seeds/pod
		(9 WAP)						
Fresh pod yield (t/ha)	1.00	0.788**	0.886**	0.889**	- 0.708**	1.000**	0.771**	0.944**
Plant height (cm) at 9 WAP		1.00	0.965**	0.959**	0.953	0.788**	0.382ns	0.866**
Number of leaves/plant at 9 WAP			1.00	1.000**	- 0.923**	0.886**	0.491 ns	0.961**
Number of branches/plant at 9 WAP				1.00	0.920**	0.889**	0.493 ns	0.964**
Leaf spot disease incidence at 9 WAP					1.00	- 0.708**	- 0.220 ns	0.787**
Fresh pods weight/plant (g)						1.00	0.771**	0.944**
Number of pods/plant							1.00	0.640*
Number of seeds/pod								1.00

ns. non-significant, **. Correlation is significant at the 0.01 level (2-tailed), *. Correlation is significant at the 0.05 level (2-tailed). WAP, weeks after planting.

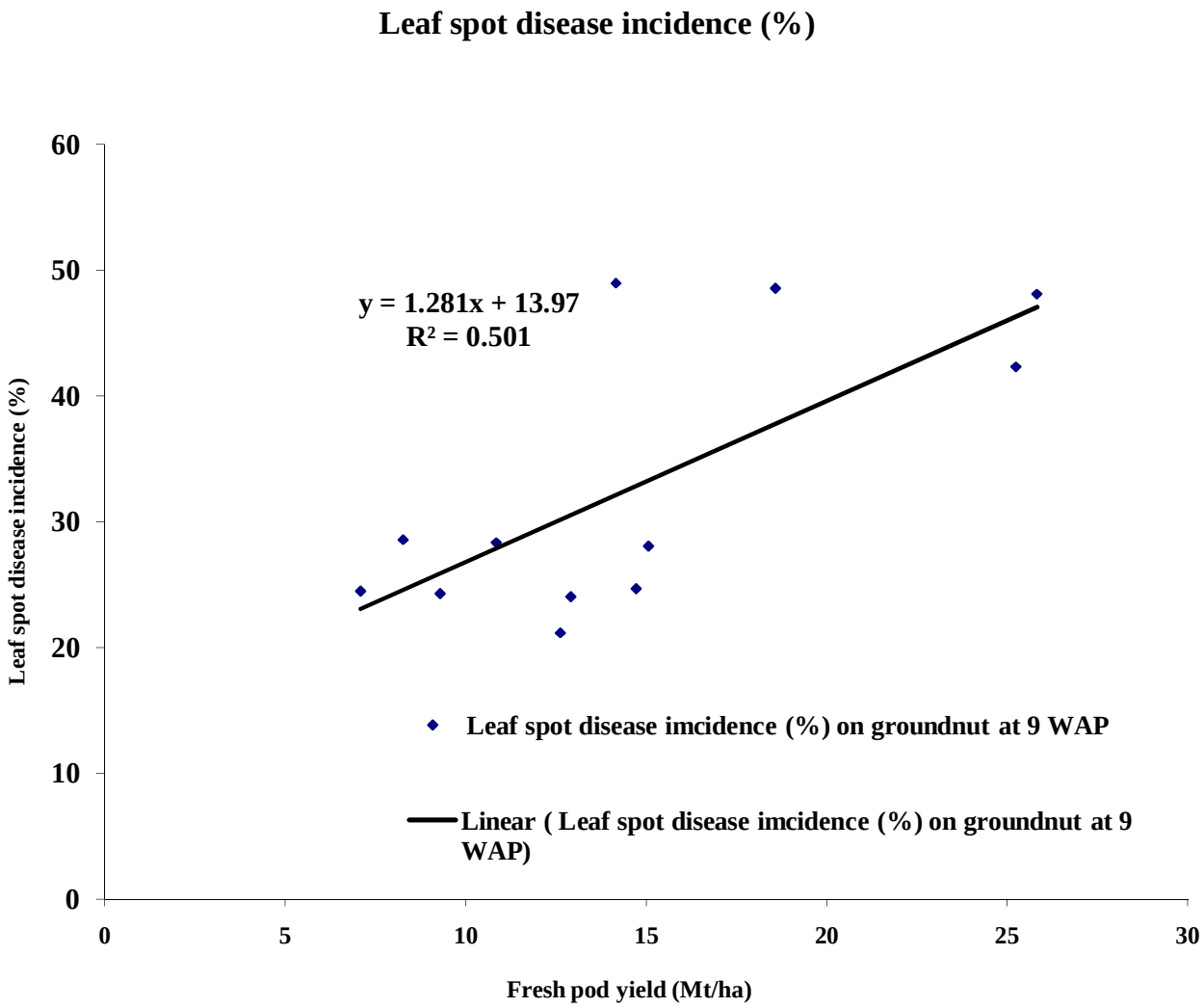

Figure 1: Relationship between fresh pod yield and leaf spot disease incidence (%) of groundnut with coefficient of determination (R^2) of 0.5016.

Conclusion

The results obtained revealed that the use of soil amendments in groundnut production is important because enhances both crop yield, soil fertility and structure of the soil as well as reduces the negative effect of leaf spot disease on the growing groundnut plant. The application of fresh Siam weeds or fresh neem leaves as green manure in the cultivation of ground nut is encouraging for decreased leaf spot severity, increased fresh pod yield and to guarantee improved protein in-take of the farmers living in the agro-ecological zone.

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