

INFLUENCE OF SOIL AMENDMENTS IN THE MANAGEMENT OF STEM ROT (*Sclerotium rolfsii*) OF GROUNDNUT (*Arachis hypogaea*, L.) IN ISHIAGU, EBONYI STATE, NIGERIA.

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SUMMARY

Experiments were conducted to determine the influence of soil amendments in the management of stem rot of groundnut caused by *Sclerotium rolfsii* in Ishiagu, Ebonyi state, Nigeria. The experiment consisted of seven treatments laid out in a randomised complete block design (RCBD) replicated three times. Soil samples were collected from the topsoil at a depth of 0 to 15 cm before application of the treatments to determine the physic-chemical properties of the soil. Potato dextrose agar was used to isolate the organism and the pathogenicity was carried out on a local variety (Ishiagu local). The data collected were subjected to analysis of variance (ANOVA) and the means separated using Tukey at $p < 0.05$. The results of the soil physical and chemical analysis showed that the organic carbon, organic matter, nitrogen and available phosphorus were very low. The result also revealed that the application of treatments gave a non-significant ($p < 0.05$) effect on percentage disease incidence. However, the untreated plot (33.33) had the highest disease incidence while plot treated with palm bunch ash (PBA) (6.25) had the least. Application of palm bunch ash showed significant effects on the disease severity. Moreover, the result of the number of harvested pods showed a significant difference ($p > 0.05$) among the seven treatments, plot treated with goat manure (1335.83 ton/ha) had the highest, followed by the plot treated

with combination of goat manure and palm bunch ash (888.33 ton/ha) while the control (429.17 ton/ha) had the least. The pathogen *S. rolfsii* was isolated from the diseased groundnut tissue and the pathogenicity conducted on the local variety confirmed the organism as the causative agents of stem rot of groundnut. Therefore, the use of soil amendments such as palm bunch ash and goat manure could be an alternative means of managing the stem rot and increase the yield of groundnut by the small-scale farmers.

Keywords: Soil, amendments, stem, rot and groundnut

GROUNDNUT (*Arachis hypogaea* L.) is a major legume and an important oil seed crop in Nigeria, covering nearly half of the area under oilseeds (3). It is grown in over 100 countries of the world with a total estimated area of 21.8 million ha and with production of 28.5 million tons (12). Nigeria is the largest groundnut producing country in West Africa, accounting for 51 % of production in the region. The country contributes 10 % of total global production and 39 % that of Africa (12). Several factors are responsible for low productivity among which diseases like leaf spot, collar rot, stem rot, bud necrosis, etc., are very important. Among the diseases, stem rot is a major problem caused by *Sclerotium rolfsii* Sacc. which is an economically important soil borne pathogen of groundnut. It is known to be pathogenic on nearly 500 plant species. The disease is also referred as *Sclerotium* blight, *Sclerotium* wilt, southern blight, southern stem rot and

white mould which cause 55-95 % mortality of the crop at seedling stage under favourable conditions (10). Manures and by-products derived from the processing of plants and animals have been used for centuries as sources of fertiliser for crop production including palm bunch ash (2; 1) but beneficial or detrimental effects on plant diseases were never thoroughly investigated (13). However, Lazarovits *et al.* (13) found that certain organic amendments released some product which controlled a variety of soil borne diseases of potato, pests and weeds on the field. The formation of these products to concentrations lethal to pathogens is regulated by the soil physical and chemical properties such as pH, organic matter content, and their nitrification rate, sand content and buffering capacity. Teekpeh *et al.* (18) reported a reduction in the percentage disease severity index in anthracnose infected pepper as result of application of poultry manure.

Conn and Lazarovits, (7) further stated that liquid swine manure reduced scab and wilt of potato. Swine manure killed *Verticillium dahliae* within a day after application on acidic soil, but had no effect in neutral or alkaline soils (7). Looking at the versatile nature of the pathogen and cultivation system, stem rot of groundnut cannot be managed successfully by any single method. The only way in the absence of resistant cultivars is to follow integration of different methods to manage the disease at satisfactory level. Hence, the needs to investigate the effects of soil amendments singly and in combination for the management of stem rot in groundnut.

MATERIALS AND METHODS

Field experiment

The experiments were conducted at the Teaching and Research Farm, Plant Pathology Laboratory and Screen house of the Federal College of Agriculture, Ishiagu, Ivo L.G.A. of Ebonyi, State which is located at latitude 05° and 056° North and Longitude 07° and 041° East in the derived Savannah Agro - ecological zone of Nigeria. It is in South-Eastern part of Nigeria, with annual mean temperature of 27°C minimum and 33°C maximum and average relative humidity of 88 %, with annual rainfall of 1350 mm to 2000 mm (14). The experiments were conducted during

the early growing season (May-August) of 2019.

Cured swine and goat manure were sourced from college farm while empty oil palm bunches were obtained from an oil mill at Ishiagu. They were dried and burnt into ash to obtain palm bunch ash. The groundnut seeds (Ishiagu local) were sourced from Ekeh market, Ishiagu.

Experimental design and field operation

The experiment consist of seven treatments includes: Swine manure 10t/ha, Goat manure 10t/ha, Palm bunch ash 10t/ha, Swine manure 5t/ha + Palm bunch ash 5t/ha, Goat manure 5t/ha + Palm bunch ash 5t/ha, Palm bunch ash 3.33t/ha + Swine manure 3.33t/ha + Goat manure 3.33t/ha and Control laid out in a randomised complete block design (RCBD) replicated three times. The land was cleared, ploughed, harrowed manually and made into beds. The total land areas for the experiment were 17 m x 13 m (221 m^2). Each bed size was 2 m x 2 m with spacing of 0.5 m between plots and 1 m between replicates. The groundnut (Ishiagu local) sown 2 seeds at 50 cm x 50 cm spacing gave total of 16 plants per plot and 240 plant population in the entire field. The cured swine and goat manure were incorporated into the soil on designated plots ten days before sowing (DBS). Palm bunch

ash was incorporated into the designated plots at 3DBS. The weeds were controlled using hand pulling and hoe at two and six weeks after sowing.

Soil analysis

At experimental site, surface (0 to 15cm) soil samples were randomly taken 14 DBS. The samples were bulked and analysed for their physico-chemical properties.

Disease Assessment and data collection

The following data were collected on disease incidence (DI) using the following formula

$$\text{Incidence} = \frac{NDP}{TNPP} \times 100\%$$

Where NDP = Number of diseased plants, TNPP = Total number of plants per plot (Diseased and healthy plants) and 100 = percentage.

Disease severity (DS) was rated according to Filion *et al.*, (9) as follows; 1= healthy, 2= Lesion symptoms on the stem only, 3 = Up to 25 % of the plant parts symptomatic (wilt, dead or dying), 4= 26 % - 50 % of the symptomatic plants and 5= above 50 % of the symptomatic plants

$$\text{Severity} = \frac{\text{Sum of scores}}{\text{Number of observations}} \times 100\%$$

The agronomic data collected were plant height (cm), number of leaves, and number of harvested pods and

weight of harvested fruits (kg) from five randomly tagged plants within the plot.

Isolation of the fungus

Diseased groundnut plant tissue from the field were cut into pieces with a sterile knife and were surface sterilize in (1% NaOCl for 3 mins), rinsed in three changes of sterile distilled water and six segments were placed on each 9 cm diameter petri-dish containing Potato Dextrose Agar culture media amended with chlororamphenicol (PDAc) before incubating for 7 days at room temperature (24 -30 °C) and observed daily. The pure culture was obtained sub-culturing unto fresh PDA media were examined under the microscope and the fungus identified using appropriate taxonomic and morphological evidence or criteria guided by Barnett and Hunter (6).

Screenhouse experiment

One groundnut variety (Ishiagu local) was used for the pathogenicity test. Sandy loamy soil was sterilized locally and 5 kg of the soil was filled into each perforated plastic bucket and these arranged in a Completely Randomized Design (CRD). Inoculation of the isolated *S. rolfsii* was conducted on groundnut seeds. Groundnut seeds were inoculated by dipping for 10 minutes in conidia suspension of 7day old culture adjusted to 10⁶ spores/ml using haemocytometer. Five seeds were then sown immediately into locally

sterilized soils in pot (10 cm diameter) and kept in the screen house (4). Sown un inoculated seeds served as control. The sown seeds were watered and seedlings monitored for symptoms manifestations. The fungus was re-isolated from the symptomatic plants and re-identified as *Sclerotium rolfsii* for confirmation.

Statistical analysis

The data collected were subjected to analysis of variance (ANOVA) using Minitab software version 17 and the

mean separated using Tukey at $p < 0.05$.

RESULTS

Physical and chemical properties of soil at experimental site

The results of physical and chemical properties of the soil samples from the experimental field are presented in Table 1. The result shows that the soil was acidic in water (5.4), sandy loamy textured with high proportion of coarse sand and contained 0.519 and 0.070 g/kg of organic matter and total nitrogen respectively as well as 5.60 mg/kg available phosphorus.

Table 1: Physical and chemical properties of soil at experimental site

Soil properties	Values
Clay (%)	9.40
Silt (%)	14.00
Sand (%)	76.60
Organic carbon (g/kg)	0.519
Total nitrogen (g/kg)	0.070
pH (H ₂ O)	5.4
Exchangeable bases (Cmol/kg)	
Mg ²⁺	1.40
Ca ²⁺	1.80
K ⁺	0.091
Na ⁺	0.04
Catio exchange capacity (Cmol/kg)	15.20
Base saturation (%)	21.91
Available phosphorus (mg/kg)	5.60
Soil texture	Sandy loam

Effects of the soil amendments on the disease incidence, severity and agronomic performance of groundnut

Table 2 shows the effects of soil amendments on the disease incidence, severity and yield of the groundnut during 2019 cropping season in Ishiagu. There was no significant difference ($p < 0.05$) among the seven treatments in respect to disease incidence. However, the untreated plot (33.33) had the highest disease incidence while plot treated with palm bunch ash (PBA) (6.25) had the least. Similar patterns were recorded in disease severity which ranged from 1.37 to 4.17. Also, the plot treated with the combination swine manure

and palm bunch ash positively influenced the plant height, leave number and stem girth parameters which were 21.17 cm, 425.10 and 2.48 cm respectively compared to other treatments. However, the result of the number of harvested pods showed a significant difference ($p > 0.05$) among the five treatments, plot treated with goat manure (1335.83 ton/ha) had the highest, followed by the plot treated with combination of goat manure and palm bunch ash (888.33 ton/ha) although it was not different from other treated plots while the control (429.17 ton/ha) had the least. The result of the weight of harvested pods did not also vary among the treatments.

Table 2: Effects of the soil amendments on the disease incidence, severity and agronomic performance of groundnut

Treatment	Disease incidence (%)	Disease severity	Plant height (cm)	Leaf number	Stem girth (cm)	Number of harvested pods (ton/ha)	Weight of harvested pods (ton/ha)
SM	25.00 ^a	3.23 ^{ab}	19.82 ^a	397.11 ^a	2.33 ^a	795.00 ^b	1.92 ^a
GM	14.58 ^a	1.67 ^{ab}	20.64 ^a	380.22 ^a	2.31 ^a	1335.83 ^a	2.83 ^a
PBA	6.25 ^a	1.37 ^b	19.41 ^a	380.22 ^a	2.22 ^a	759.17 ^b	2.00 ^a
SM+PBA	20.83 ^a	2.87 ^{ab}	21.17 ^a	425.10 ^a	2.48 ^a	864.17 ^b	2.25 ^a
GM+PBA	16.67 ^a	3.23 ^{ab}	19.38 ^a	369.33 ^a	2.32 ^a	888.33 ^b	2.33 ^a
SM+GM+PBA	12.50 ^a	3.83 ^{ab}	19.79 ^a	391.11 ^a	2.43 ^a	775.00 ^b	1.92 ^a
Control	33.33 ^a	4.17 ^a	19.05 ^a	334.10 ^a	2.44 ^a	429.17 ^c	1.75 ^a
Means	18.45	2.910	19.893	382.7	2.3627	835.2	2.143
SE	3.09	0.276	0.447	13.0	0.0408	58.8	0.35
CV	76.85	43.46	10.30	15.54	7.92	32.26	28.95

Means in the same column with different superscripts are significantly different using Tukey at ($P < 0.05$). SM = Swine manure; GM = Goat manure; PBA = Palm bunch ash; SE = Standard error; CV = Coefficient of variation

Isolation and pathogenicity of the isolate

The fungus *S. rolfsii* was isolated from the diseased groundnut plant tissues with a whitish colour in colony, later it becomes light brown to dark brown at maturity and they are sub spherical, the surface finely wrinkled and sometimes flattened on potato dextrose agar. The result of the pathogenicity conducted on the local variety (Ishiagu local) confirmed *S. rolfsii* as the causative agent of stem rot of groundnut. The local variety inoculated with the conidia suspension of *S. rolfsii* showed the yellowing and wilting of leaves followed by rotting of stems which appeared as dark brown, water-soaked lesions on the stem at the collar region just above the soil surface.

DISCUSSION

The results of the soil physical and chemical analysis showed that the organic carbon, organic matter, nitrogen and available phosphorus were very low beyond the benchmark for tropical soils (8). The results represent a soil that is poor, degraded and of low fertility status. Onwuka *et al.* (15) reported that eastern Nigeria soils are highly acidic with poor nutrients content due to high rainfall, leaching, soil and air temperature and continuous cropping with inorganic fertilizers and requires soil amendment. Udo *et al.* (19); Ibia and

Udo (11) reported low soil pH, organic matter content and exchangeable bases in South eastern, Nigeria. All the treatments suppressed symptoms of groundnut stem rot relative to the control, and there were differences in the disease severity among the amendments. Palm bunch ash significantly reduced the severity of stem rot of groundnut compared with control. These findings agree with Tai (17) that the use of 15 – 20 t ha⁻¹ compost as a soil amendment is useful in the management of leafy and fruit vegetable diseases in the tropics. Soil application and culture filtrate formulation from farm yard manure was found effective in managing *S. rolfsii* and enhance the seed germination (16). Also, Vinod (20) stated that, farm yard manure was found to be most effective against the root rot of chilli caused by *S. rolfsii* and recorded the least disease (19.34%) incidence. The culture isolate on potato dextrose agar showed that the organism is whitish in colour and later becomes light brown to dark brown at maturity. This corroborates the report of Balubhai, (5) that *S. rolfsii* are initially whitish in colour but later they become dark-brown to chocolate-brown in colour.

CONCLUSION

Palm bunch ash, swine and goat manure are generally considered as a waste product from plant and animals. However, this study has established the potentials of this by-product as a soil amendment for the control of groundnut stem rot diseases caused by *S. rofsii* and also revealed its ability in promoting the yield of

groundnut grown in a degraded soil. This study also revealed that palm bunch ash has a significant effect on the severity stem rot of groundnut. Moreover, goat manure gave the highest yield in terms of number of harvested pods. Pathogenicity conducted on the local varieties confirmed that *S. rofsii* is the causal organism of the disease.

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