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Effects of NPK Fertilizer Rates and Plant Population on Foliar Diseases, Insect Damage and Yield of Groundnut

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Abstract: Groundnut (*Arachis hypogaeae* L.) is a well know oil-seed crop grown as food for man and feed for animals. It is mostly grown in the savannah region with little cultivation in the forest south. A two season experiments was conducted in 2003 and 2004 respectively, to determine the effects of NPK fertilizer rates and plant population on foliar diseases, insect damage and yield of groundnut. Analysis of variance indicated that NPK fertilizer rates significantly influence foliar disease development with leafspot disease (*Cercospora arachidicola* Hori) (4.618, 4.326) being highest, followed by rust (3.214, 3.013), with seedling blight (2.90; 3.015) being lowest in 2003 and 2004, respectively. 0 kg ha⁻¹ (control) recorded highest in all these foliar diseases investigated, when 130 kg ha⁻¹ recorded lowest development of these foliar diseases. Plant population was significant in these foliar diseases. 1,000,000 plants per hectare, recorded highest foliar diseases development when 250, 000 plants ha⁻¹ had the lowest in all the seasons investigated. Interaction of NPK and plant population was significant on leafspot disease (3.86, 2.70), rust (2.55, 2.00) and seedling blight (1.76, 1.85) in 2003 and 2004 respectively. 0kg ha⁻¹ recorded lowest seed yield, but highest insect damage while 130 kg ha⁻¹ had highest seed yield (tons ha⁻¹) (3.56, 3.23) but lowest insect damage (3.28, 2.96) in 2003 and 2004 respectively. Also foliar diseases development increased with plant age.

Key words: Folior disease, *Arachis hypogaeae* L, leafspot disease, NPK fertilizer

Introduction

Groundnut (*Arachis hypogaeae* L.) is annual legume, belonging to the family *leguminosae*. It is a small erect or trailing herb 16 to 60 cm high and it is one of the most valuable legumes of tropical and sub-tropical countries. They serve as food and cash crop and are exported mainly for their oil FAO (1990). Groundnut otherwise called peanut is a rich source of edible oil (43-55%), protein (25-28%) and its seeds contain vitamin B and C (Hill and Waller, 1988) and Europeans even take it as a substitute for coffee beans. The Nuts are eaten raw, roasted, steamed, crushed and added to soups and stews. By-products from groundnut include fireplace, logs, cat litter, paper, detergent, salve metal polish, bleach, ink, axle grease, shaving cream face cream, soap linoleum, rubber, cosmetics, paints, explosives, shampoo and medicine (Awake, 2003).

There are large prospects of groundnut production in Nigeria but these prospects have not been realized due to some limiting factors in production such as incessant attack by pests and disease especially foliar diseases, improper application of fertilizer and fertilizer rate, as well as improper spacing. The two most important foliar diseases reducing the yield of groundnut wherever they are grown are leafspots caused by *Cercospora arachidicola* and *Cercosporidium personata* and rust caused by *Puccinia arachidis* (ICRISAT, 1987). Some genotypes of *Arachis hypogaeae* are resistance

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to leafspot and rust Subrahmanyam *et al.* (1982). In addition actual production losses due to the diseases are cost of chemicals, application expenses and plant damage incurred during application. Thus, any effort to use non-chemical control on these foliar diseases and improve yield will be highly recommended. Hence the objectives of the study are to determine the effects of NPK fertilizer rates and plant population on the foliar diseases, insect damage and yield of groundnut.

Materials and Methods

The experiment was carried out at the School of Agriculture and Agricultural Technology Research Plot of Federal University of Technology, Owerri in 2003 and 2004 respectively, to determine the effects of NPK fertilizer rate and plant population on the foliar diseases, insect damage and yield of groundnut. The field was located at (5° 29'N, 7° 02'E). The mean annual rainfall was 1800 mm, which span early. March to October and the temperature during the growing season was 24-27°C. The soil type was sandy clay loan, with pH 4.8, 1.5% organic matter, 0.056% total nitrogen and phosphorus 7.84 ppm. The field was previously planted with cowpea, fluted pumpkin and maize and was lying fallow.

Groundnut variety M554-76 was used for the experiment and NPK 15:15:15: was the compound fertilizer used. 64 plots were mapped out and beds of (1.0×1.0) m made with 0.4 m as main plot gap and 0.2 m as sub-plot gap and 2 seeds were planted at 2cm depth for all the plots. Four levels of NPK 15: 15: 15 fertilizer were used. These include 0, 40, 80 and 130 kg ha⁻¹, respectively and 4 levels of plant population; 1,000,000; 250,000; 111, 111 and 62, 500 plants ha⁻¹, respectively. A 4×4 factorial experiment was laid out in a Randomised complete block design at 4 replications.

Date were collected on the leafspot disease severity, Rust, seeding blight, insect damage and yield in tons ha⁻¹.

Leafspot Disease Severity

The severity of this disease was estimated using visual observation and scoring using the following scale.

Severity estimation spots per/leaf	Scale	Interpretation
0	0	No infection
1-2	1	Slight infection
21-40	2	Moderate infection
41-60	3	Extensive infection
61-80	4	Very extensive infection
81-100	5	Leaves completely infected

Rust Severity

This was determined using the following scale:

- No symptoms
- Pin point whitish/necrotic lesions, no reduction of leaf size
- Rusting leaves, reduction of leaf size especially at shoot tips
- Rusty leaves, severe reduction of leaf size at shoot tip
- Rusty leaves, defoliation of shoot from the apex downwards

Seedling Blight

This was determined using the scale:

- No symptoms
- Mild chlorotic pattern over leaflets or mild distortion at the base of leaflets only with the remainder of the leaflets appearing green and healthy.

- Moderate pattern of different colours throughout the leaf, narrowing and distortion of the lower one-third of leaflets.
- Severe distortion of two-thirds of the leaflets and general reduction of leaf size
- Severe distortion of the entire leaf and severe leaf reduction.

Insect Damage

This was obtained by counting the number of damaged pods at harvest and expressed as percentage of the total pods formed and recorded pre treatment level.

Seed Yield (tons ha⁻¹)

The seed yield from each net plot area were used to calculate the proportional yield obtainable from one hectare and exposed in tons ha⁻¹.

Data were analyzed using the methods of Little and Hills (1972) as well as Steel and Torrie, (1981) as described for the Randomized Split Plot Experimental Design. Treatment effects were separated using Fishers Protected Least Significant Difference (LSD) at 5% probability.

Results

Soil test carried out prior to planting revealed that pH was 4.8, organic matter was 1.5% total nitrogen and phosphorus content were also low. Investigation revealed that plant population was significant on leafspot disease severity 3.664, 3.585, Rust 3.20, 3.11 and seedling blight 2.50, 2.83 at 5% probability level in 2003 and 2004, respectively. Also NPK fertilizer was also significant on leafspot disease severity 4.618, 4.326, Rust 3.214, 3.013 and seedling blight 2.901, 3.015 while fertilizer and plant population interaction was significant on leafspot disease severity 3.850, 2.704, Rust 2.55, 2.00 and seedling blight 1.76, 1.85 in 2003 and 2004, respectively (Table 1).

Mean values of main effects indicate that 130 kg ha⁻¹ recorded lowest leafspot disease severity 0.96, 1.06 when 0 kg ha⁻¹ (control) recorded highest 2.08, 1.92 in 2003 and 2004 respectively. Same trend was observed in rust and seedling blight. 130 kg ha⁻¹ had lowest rust 1.00; 0.92 when 0 kg ha⁻¹ 1.46; 1.38 were highest. Also 130 kg ha⁻¹ had lowest seedling blight 1.10, 1.22 when 0 kg ha⁻¹ 1.32, 1.40 were highest. 250,000 plants/ha recorded lowest leafspot disease severity 0.76, 0.64 when 1,000,000 plants ha⁻¹ had highest 1.86, 1.75. Also 250,000 plant ha⁻¹ recorded lowest Rust 0.51, 0.44 when 1,000,000 plant ha⁻¹ had highest rust 1.50, 1.28. On seedling blight, 250,000 plants ha⁻¹ also recorded the lowest 0.51, 0.66 when 1,000,000 plants ha⁻¹ had highest 1.34, 1.41 in 2003 and 2004, respectively (Table 2).

The result of the investigation revealed that 0 kg ha⁻¹ (control) recorded highest insect damage 4.87, 4.25 but lowest yield 1.96, 1.80 while 130 kg ha⁻¹ had highest yield 3.56, 3.23 but lowest insect damage 3.28, 2.96 in 2003 and 2004 respectively. Also 250,000 plants ha⁻¹ recorded lowest insect damage when insect damage on 1,000,000 plants ha⁻¹ were highest (Table 3). However, 1,000,000 plants ha⁻¹ recorded highest yield followed by 250,000 plants ha⁻¹ while 62,500 plants ha⁻¹ had the

Table 1: Analysis of variance for foliar diseases of groundnut in 2003 and 2004

Sources	df	Mean		Squares			
		Leafspot disease		Rust		Seedling blight	
		2003	2004	2003	2004	2003	2004
Replication	3	1.001	1.005	0.012	0.036	1.010	1.018
Fertilizer rate	3	4.618*	4.326*	3.214*	3.013*	2.901*	3.015*
Error (a)	9	0.105	0.122	0.182	0.321	0.266	0.242
Plant population	3	3.664*	3.585*	3.20	3.11	2.50	2.83
Fertilizer and plant	9	3.859*	2.704*	2.55*	2.00*	1.76*	1.85*
Population Interaction	36	0.034	0.042	0.50	0.043	0.062	0.054
Error (b)							

Key: *Significant at 0.05 probability level

Table 2: Means of main effects of NPK fertilizer rates and plant population on leafspot, rust and seedling blight in 2003 and 2004

NPK fertilizer Rate (kg ha ⁻¹)	Leafspot disease		Rust		Seedling blight	
	2003	2004	2003	2004	2003	2004
0 kg	2.08	1.92	1.46	1.38	1.32	1.40
40 kg	1.17	1.35	1.22	1.26	1.20	1.12
80 kg	0.96	1.14	1.15	1.32	1.16	1.28
130 kg	0.96	1.06	1.00	0.92	1.10	1.22
LSD _{0.05}	0.518	0.215	0.208	0.194	0.204	0.231
Plant population						
1,000,000	1.86	1.75	1.50	1.28	1.34	1.41
250,000	0.76	0.64	0.51	0.44	0.51	0.66
111,111	1.46	1.22	1.10	1.18	1.25	1.32
62,500	1.73	1.64	0.95	1.06	1.13	1.26
LSD _{0.05}	0.263	0.155	0.130	0.122	0.136	0.154

Table 3: Mean values of main effects of NPK fertilizer and plant population on insect damage and yield in tons ha⁻¹ in 2003 and 2004

NPK fertilizer Rate (kg ha ⁻¹)	Insect damage		Yield (tons ha ⁻¹)	
	2003	2004	2003	2004
0 kg	4.87	4.25	1.96	1.80
40 kg	4.45	4.10	3.41	2.86
80 kg	3.77	3.90	3.52	3.10
130 kg	3.28	2.96	3.56	3.23
LSD _{0.05}			2.41	3.06
Plant population				
1,000,000	3.31	2.83	5.72	4.88
250,000	2.44	2.48	3.01	3.25
111,111	3.00	2.77	2.01	2.34
62,500	2.51	2.38	1.70	1.86
LSD _{0.05}	0.475	0.498	1.67	2.140

Table 4: Mean values of interaction effects for leafspot, rust and seedling blight of groundnut in 2003 and 2004 treatment

NPK Fertilizer rate (kg ha ⁻¹)	Plant population	Leafspot disease		Rust		Seedling blight	
		2003	2004	2003	2004	2003	2004
0 kg (control)	1,000,000	3.67	4.63	2.87	2.95	2.67	2.44
	250,000	2.40	2.80	2.00	2.73	2.00	2.33
	111,111	3.38	3.05	1.90	2.20	1.67	2.00
	62,500	3.02	3.16	1.50	1.87	1.33	1.20
40 kg	1,000,000	2.00	2.13	1.67	1.33	1.67	1.33
	250,000	1.00	1.00	1.33	1.00	1.33	1.00
	111,111	0.88	1.10	1.00	0.87	1.00	0.67
	62,500	0.67	1.30	0.67	0.48	0.67	0.33
80 kg	1,000,000	2.00	1.87	1.00	1.00	1.00	0.52
	250,000	2.00	1.07	0.67	1.10	0.67	1.00
	111,111	1.33	1.67	0.62	1.00	0.60	1.08
	62,500	0.67	1.00	0.67	0.33	0.70	0.38
130 kg	1,000,000	2.00	1.67	1.62	1.33	1.33	1.33
	250,000	1.67	1.00	0.33	0.38	0.37	0.30
	111,111	1.33	0.67	0.67	0.67	0.44	0.67
	62,500	0.67	0.33	0.30	0.30	0.22	0.19
LSD 0.05 NPK fertilizer		0.518	0.466	0.310	0.350	0.278	0.250
LSD 0.05 plant population		0.263	0.289	0.251	0.232	0.206	0.210

lowest yield in 2003 and 2004, respectively. Interaction of 0 kg ha⁻¹ and 1,000,000 plants ha⁻¹ produced the highest severity of leafspot disease, rust and seedling blight while 130 kg ha⁻¹ NPK fertilizer and 250,000 plants ha⁻¹ interaction recorded the lowest leafspot disease severity, rust and seedling blight in 2003 and 2004, respectively (Table 4).

Discussion

The low fertility status of the soil observed by low levels of nitrogen, phosphorus and potassium are typical of the fragile tropical soils associated with intense leaching and volatilization. A low level of phosphorus could be as a result of fixation. NPK fertilizer rate was inversely related to leafspot disease severity, rust and seedling blight. This supports the fact that nutrient availability to plants induces resistance to diseases. This is in agreement with Ajari *et al.* (2001) and Nnoke *et al.* (1986). Nutrient absorption by plants facilitates normal physiological function and photosynthetic processes, which made the plants of this treatment to possess the ability to suppress symptom manifestation and disease attack, thereby increase yield. This also justifies the reason for 0 kg ha⁻¹ NPK fertilizer treatment, which was mostly affected by leafspot disease, rust, seedling blight and insect damage. The normal physiological processes were hampered by unavailability of nutrients to the plants, making the plants to be susceptible to these foliar diseases. Interaction of pathogens and host plants result to rapid penetration and spread, which is also subject to environmental influences including soil fertility status. The high severity of leafspot, rust and seedling blight with leafspot occurring highest in 1,000,000 plants ha⁻¹ plots, may be as result of dense foliage canopy which provided hide out for insects and pathogens and provides conducive environment which favors the disease development as proposed by Subrahmayan *et al.* (1980). This is also in line with Hill *et al.* (1988) who proposed that plant diseases such as leafspot is favored by warm-humid conditions, caused by very close spacing as well as FAO (1990) who suggested that closer spacing favours many air borne diseases because of high humidity of crop canopy and that leafspot disease of groundnut is more in dense canopy. Also the significant increase in yield with increase in NPK fertilizer, may be as a result of increase in nutrient supply of phosphorus which is basically needed for seed production hence high seed yield, as proposed by Akintokun and Akanbi (2002). 0 kg ha⁻¹ and 1,000,000 plants ha⁻¹ interaction's record of lowest seed yield, may be due to exhaustion of available nutrients through competition for insufficient nutrient in the soil hence low yield. High grain yield by highest NPK fertilizer rate, may be attributed to adequate availability of nutrient for normal biochemical and physiological activities of plants of this treatment which favors yield, in agreement with FAO (1994) Ojieniyi and Adejobie (2005) who proposed that the NPK fertilizer was more effective in increasing in supply of phosphorus which is basically needed for seed production, hence high seed yield as well as Akintokun and Adewolu (2002). 1,000 000 plants ha⁻¹ record of lowest seed yield may be due to exhaustion of available nutrients through competition for insufficient nutrient in the soil.

In conclusion, N. P. K. fertilizer significantly reduce severity of leafspot disease, rust, seedling blight as well as insect damage and improve yield of groundnut. Planting density significantly influenced these foliar diseases and improves yield but 0 kg ha⁻¹ and 1000,000 plants ha⁻¹ recorded highest severity of leafspot disease, rust, seedling blight and insect damage but produced low yield in 2003 and 2004, respectively.

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