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Assessment of yield losses in groundnut (*Arachis hypogaea* L.) due to arthropod pests and diseases in the Sudan savanna of Ghana

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Abstract
The present study was undertaken to assess the relative abundance and extent of damage caused by the various pests and diseases attacking groundnut in the Sudan savanna zone of the country during the 2015 and 2016 cropping seasons. Selective applications of fungicides and insecticides were deployed in field experiments to assess the damage caused by the key members of the groundnut pest/disease complex namely the soil pests, foliar insects, and foliar diseases. Results showed that most treatments significantly reduced the incidence of the targeted pests and diseases, resulting in lower crop damage and higher yields. Providing full protection to the crop (T6) gave the highest mean kernel yield (mean 930 kg/ha) followed by control of soil pests (T1) and leaf spots (T4) which recorded yields 677 and 640 kg/ha respectively. Totally neglecting pest and disease control (T7) resulted in 57.3% yield reduction, while controlling soil pests (T1), foliar diseases (T4) and foliar insects (T5) reduced yield losses to 27%, 32% and 37% respectively suggesting that these are key pests that need to be controlled to guarantee profitable and sustainable groundnut production in the study area.

Keywords: Groundnut, *Arachis hypogaea*, arthropod pests, diseases, yield losses

1. Introduction

Groundnut (*Arachis hypogaea* L.) is the most important food legume crop in Ghana in terms of area of cultivation and utilization. It contributes significantly towards food and nutrition security, serving as a good source of dietary protein, fats, vitamins, minerals and micronutrients [1]. The crop also contributes to improving soil fertility via biological nitrogen fixation and organic matter returns to the soil while its haulms and provide valuable supplementary feed for livestock especially during the long dry season [2, 3].

The bulk of groundnut production in Ghana takes place in the northern Guinea and Sudan savanna zones of the country which account for up to 85% of national output [2, 3]. Like for most of West Africa, yields are marginally low, usually around 1 t/ha compared with the potential of 2.5t/ha [2, 3]. Both biotic and abiotic factors militate against increased and sustainable production of the crop. The most important biotic constraints include leaf spots, virus diseases, millipedes, aphids, leaf hoppers, termites, and white grubs [4, 5]. Recently, [6] confirmed the relevance pests and diseases as key constraints in Northern Ghana using combinations of farmer perception interviews and direct field sampling but detailed and systematic studies on the levels of damage caused are lacking. Therefore the study was undertaken to assess the relative abundance of, and extent of damage caused by, the various pests and diseases attacking groundnut in the Sudan savanna zone of the country.

2. Materials and Methods

The present study was carried out at Pusu-Namogo in the Sudan savanna zone of Ghana, during the 2015 and 2016 cropping seasons using Randomized Complete Block Designs (RCBD) with 3 replications. Plots consisted of 7 rows, each 4 m long and 60cm apart with interplant spacing of 20cm within rows. The variety Chinese, which is predominantly grown by farmers in the area, was used for the study.

The following treatments were compared.

- **T_1**. Soil treated with *carbofuran 3 G* @ 1 kg a.i. ha to control soil borne pests &diseases
- **T_2**. Seed treated with *chlorpyriphos 20 EC* @ 12.5 mL kg-1seed to control soil insects
- **T3**. Seed treated with *carbendazim* (Goldazim 500 SC) @ 10 ml kg seed to control soil borne fungi

- T_4. Plants sprayed with *mancozeb 50 WP* @ 500 g a.i. ha-1 to control leafspots
- **T_5.** Plants sprayed with *Karate 25 EC* @ 1l/ha to control foliage insect pests
- **T_6**. Plots receive all of 1–5 above to provide total protection from pests and diseases
- **T_7**. Seeds and plants given no protection (control)

The three inner rows of each plot constituted net plot areas from which records were taken on emergence counts, number of dead plants and possible causes of death, total plants, number infested with aphids, leafhoppers, rosette virus and leaf spot at 8, 10 WAE and defoliation due to leaf spot at maturity. Pod, haulm and kernel yields measured at harvest and incidence and damage caused by soil pests assessed from the rhizosphere of damaged plants within net plots.

2.1 Statistical analysis
Data were subjected to ANOVA with Least significant difference (LSD) used to compare treatment means at the 5% significance levels. Yield losses were calculated for each treatment using fully protected plots (T6) as the base.

3. Results
All the treatments significantly improved plant establishment and reduced the incidence of dead plants compared with the control in both years, with T4 (insecticide spray) and T5 (fungicide spray) having the least such effects. (Table 1). Leafhopper infestation was also reduced significantly by all treatments over the control in 2015 but in 2016, only T4 (insecticide spray) and T6 (total protection) showed significant reduction in the incidence of the pest. Treatments similarly reduced the incidence of leafspots, though such reductions were not always significant especially in 2015. Incidences of rosette virus and its main vector, *Aphis craccivora*, were generally too low in both years and were therefore omitted in the write-up.

For the soil arthropods, millipede and white grub populations (Fig.1 and 2) were significantly reduced by all treatments in both years. Carbofuran application (T1) and full protection (T6) had the greatest impact while Seed treatment with insecticide (T2) and with fungicide (T3) had the least, especially in 2015 when the incidence of both pests were higher. Pod boring and scarification showed a similar trend, with carbofuran (T1) and full protection (T6) giving the greatest protection in both years of the study (Table 2). Termite incidence was low and sporadic during the study period and could thus not be reliably assessed and analysed.

Yields were generally higher in all treatments than the control (Table 3) though such differences were not significant in the cases of pod yield for Seed treatment alone (T2, T3) in 2015 and kernel yield for insecticide spray (T4) in 2016. For both years, full protection (T6) gave the highest mean kernel yield (930 kg/ha) followed by carbofuran (T1) and fungicide spray (T4) which recorded yields of 677 kg/ha and 640 kg/ha respectively. Yield loss calculations showed that totally neglecting pest and disease control (T7) resulted in about 57.3% reduction in kernel yield, while omitting control of any of the pests targeted in the study reduced yields by 27 – 44%.

Table 1: Incidence of foliar pests and diseases on trial plots

	Total plant		**leafhoppers**		**Leaf sp**ot	
Treatment	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
T1	54.00a	51.67a	6.67b	4.67cd	4.67ab	2.67bc
T2	53.00a	50.33a	3.00cd	6.00bc	4.00ab	4.00ab
T3	50.67a	50.00a	4.00cd	8.00a	4.00ab	2.67bc
T4	53.33a	42.67b	5.00bc	2.67d	4.33ab	4.33a
T5	45.33b	41.67b	7.67b	6.67ab	3.00b	2.00bc
T6	55.33a	50.00a	2.33d	2.67d	3.00b	0.67c
T7	38.00c	42.00b	10.00a	6.33abc	6.33a	5.67a
Mean	49.95	46.91	5.52	5.29	7.00	3.14
LSD(0.05)	4.79	5.00	2.73	1.81	2.48	2.22

Means followed by the same letter(s) are not significantly different

Table 2: Pod load and damage caused by soil arthropods

	Total pods		**% Bored pods**		**%Scarified pods**	
Treatment	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
T1	469.30b	400.00b	4.03c	4.00cd	0.40b	3.60c
T2	434.70b	391.30bc	5.00c	7.43bc	1.07b	9.33ab
T3	462.70b	362.70cd	5.03c	9.70b	1.43b	8.93b
T4	461.70b	323.70e	6.30b	9.50b	1.53b	8.87b
T5	455.30b	330.70de	4.87c	7.77b	1.47b	9.03b
T6	527.30a	481.30a	2.47d	2.53d	0.77b	3.07c
T7	302.00c	277.70f	10.83a	14.30a	3.03a	11.87a
Mean	444.71	366.77	5.50	7.89	1.39	7.81
LSD (0.05)	40.65	35.33	1.23	3.63	1.20	2.62

Means followed by the same letter(s) are not significantly different

Table 3: Yield and yield losses caused by various pests and diseases

	Pod yield		**Kernel yield**		**% yield loss**		**Mean Loss**
Treatment	2015	2016	2015	2016	2015	2016	
T1	1013b	919b	710b	643b	31.9	21.3	26.6
T2	763cd	733c	547c	520c	47.6	36.4	42.0
T3	783cd	717c	550c	487c	47.3	40.4	43.9

T4	867c	733c	740b	540c	29.7	33.9	31.8
T5	910bc	778c	710b	470cd	31.9	42.5	37.2
T6	1320a	1053a	1043	817a	-	-	
T7	620d	510d	410d	377d	60.7	53.9	57.3
Mean	897	778	673	551	41.52	38.07	39.8
LSD (0.05)	168	89			130	98	

Means followed by the same letter(s) are not significantly different

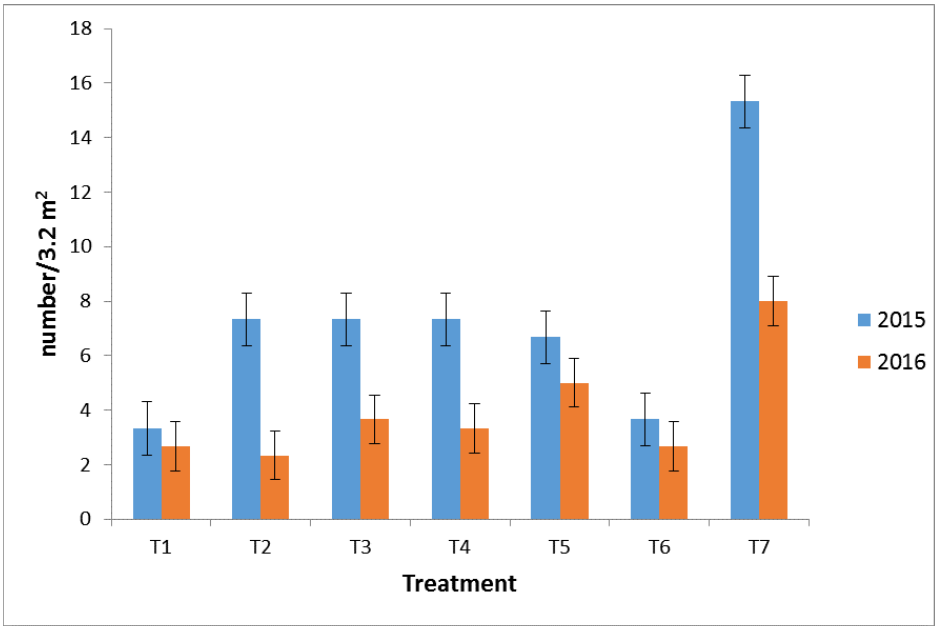

Fig 1: White grub population levels in the present study. Bars represent SEM

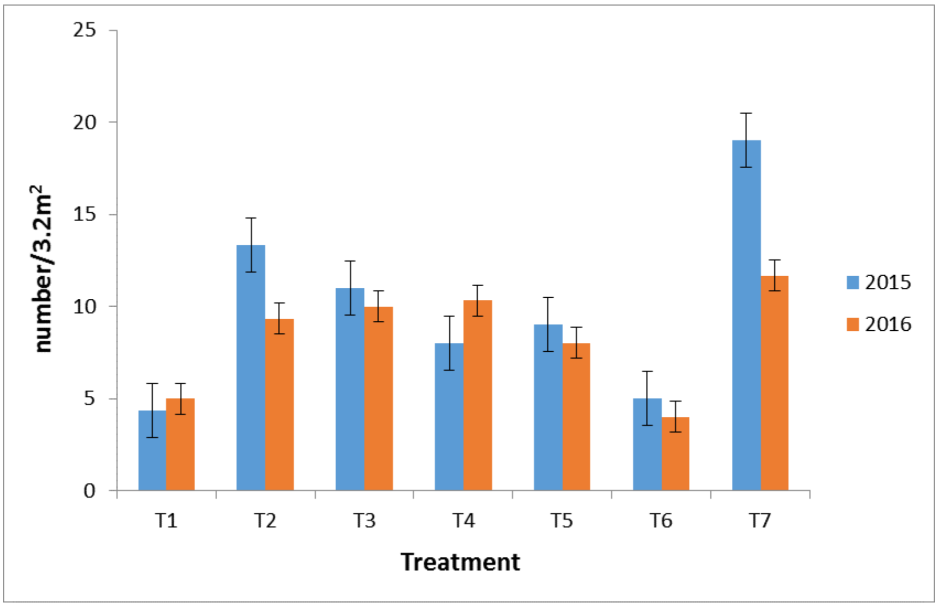

Fig 2: Millipede population levels in the study. Bars represent SEM

4. Discussion

The present study clearly confirm our preliminary observations that soil-borne arthropod pests and foliar diseases are the key biotic constraints to groundnut production in Ghana [6]. In fact, [4,5] also reported termites, white grubs, millipedes and leaf spots as most potentially damaging pests and diseases of groundnut in Ghana. Results from the current study also agree broadly with [7] who conducted extensive surveys in Mali, Burkina Faso, Niger, Nigeria, and Benin and identified termites, white grubs and millipedes as the most important soil arthropods in groundnuts.

White grubs, termites and wireworms destroy the roots and pods while termites also cause pod scarification [8, 9]. The damage caused by these pests lead to losses in grain yield and quality. In our studies, white grub and millipede populations per net plot area varied from 2 - 4 in fully-protected to 15 - 19 in unprotected plots. Though apparently low, these levels inflicted noticeable damage to the groundnut crop, even in the treated plots. Pod damage and yield losses in unprotected plots were 10-14% and 57%, respectively but controlling soil pests with carbofuran application to the soil reduced these to 4% and 26%, confirming their status as the key pests. Yield losses due to soil arthropods in West Africa have been reported by various authors to be in the range of 10 – 40% [8, 7, 10] and the present results indicate that the situation may be similar for Ghana.

Incidence and damage by foliar insect pests were low in both years, attacking not more than 10% of plants even in unprotected plots and controlling them alone with pesticides still resulted in nearly 40% yield losses, making them less damaging than the soil arthropods.

Many foliar diseases infect groundnut leaves of which early leaf spot (*Cercospora arachidicola* (Hori) and late leaf spot, *Cercosporidium personatum* (Berk. & Curt) are the most important in Ghana [4, 5]. Apart from damaging the leaves, these fungi also cause lesions on petioles, pegs, and main shoots [11] leading to substantial defoliation and yield losses. In our studies, leaf spot incidence was relatively low and controlling them resulted in yield loss of 32% compared to 57% in totally unprotected plots. The drier and less humid conditions experienced during the crop growth period in both years probably accounts for the lower incidence of the diseases and the associated losses observed, as leaf spots typically cause yield reductions of up to 70% [11]. In fact, [4] reported leaf defoliation of greater than 80% and yield losses of up to 78% caused by *Cercospora* leaf spots on-farm in the Guinea savannah of Ghana.

5. Conclusion

The present study confirms earlier reports that soil arthropod pests and foliar diseases are key constraints to profitable groundnut production in Northern Ghana. Totally neglecting pest and disease control can result in up to 57% yield loss, while omitting control of soil pests, foliar diseases and foliar insects can lower yield by 27%, 32% and 37% respectively suggesting that these are key pests that need to be controlled in order to guarantee profitable and sustainable groundnut production in the study area.

6. Acknowledgements

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