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Effect of Neem and False Yam botanicals on Parasitic Nematodes of Yam (*Dioscorea spp*)

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Abstract:
A field experiment was conducted in two locations within the Yendi district of Northern Ghana. The objectives were: to assess the effect of leaves of neem and false yam on yam leaf diseases, dry rot and tuber cracking, and to evaluate the effect of pounded Neem seed and False yam leaves on yam nematodes population in the soil, and tuber yield.The experiment was laid in Randomized Complete Block Design (RCBD) in three replications. Each experimental unit consisted of ten mounds. In all, there were three treatments: False yam leaves, Neem seed and Control. A local yam variety of Dioscorea cayenensis, 'Labreko' setts, were planted on mounds at 100 cm x50 cm planting distance. Data were collected on nematode numbers, the incidence of mottling, mosaic and anthracnose on yam leaves at ten weeks after emergence, dry rot and cracking on the yam tubers at harvest, and tuber yield.The result showed that false yam leaves and Neem seed statistically had the same effect on the control of cracking on yam tubers. However the control was significantly different from the botanicals ($P<0.05$) and recorded higher score of tuber cracking than the botanicals. There were significant difference ($P<0.05$) between Jashee and Pashee locations in the occurrences of yam parasitic nematodes. The botanicals also had significant effect on nematode number, both Neem seed and False yam leaves reduced parasitic nematode population than the untreated mounds. False yam leaves significantly reduced nematode number more than Neem seed. Neem seed reduced nematode number by 29% as compared to 67% by False yam. Tuber yield was not significantly affected by the botanicals.The study showed that Neem seed and False yam leaves had thesame effect on the reduction of cracking on yam tubers. Cracking which affected the quality of yam tubers was more in the control than in the botanicals, this suggests that both Neem seed and False yam leaves could be a better option to farmers in the control of tuber cracking. This study also shows that when one milk tin, in quantity, of the botanicals were used, it emerged that false yam leaves reduced nematode numbers more than Neem seed; suggesting that two milk tins of Neem seed and one milk tin of False yam leaves may be the effective levels to suppress parasitic nematode in yam.

Keywords: *Neem, False yam, Nematodes, Yam*

1. Introduction

Yams (*Dioscorea spp*) are annual or perennial climbing plants with edible underground tubers. The Food and Agriculture Organization (1998) estimated that the world production of yam is around 30.2 million tons per year and over 90% of the world's yam production is derived from West Africa. There are over 600 yam species grown throughout the world, however, Tetteh and Saakwa (1994) observed that six species are cultivated in Ghana. These are *D. rotundata* (white yam), *D. alata* (water yam), *D. Cayenensis* (yellow yam), *D. Bulbifera* (aerial yam), *D. esculenta* (Chinese yam) and *D. dumetorum* (trifoliate yam). The distribution of yam production throughout the country is largely dependent on rainfall patterns. Yams require five months' rainfall out of the Eight months of growth in the field (Orkwo & Asadu, 1997). Yams generally grow better in areas where annual rainfall ranges from 1000 to 1500 mm and is well distributed over six to seven months of the growing season.

Yam is a valuable source of carbohydrate to the people of the tropical and subtropical Africa, Central and Southern America, parts of Asia, the Caribbean and Pacific Islands (Coursey, 1967). Yam is also a source of disogenin, a precursor of progesterone, cortisone and other medically important steroids (Coursey, 1967). A number of Dioscorea species have been commercially grown to provide a source of diosgenin, which is used in the manufacture of oral contraceptives, sex hormones and cortisone. Furthermore, yam contains vitamins such as ascorbic acid and caroteniods, which is the source of yellow colouring of *Dioscorea cayenensis* (Coursey, 1967). Average daily consumption of yam is about 300 kcal per capita (FAO STAT, 2012), and it is the third most important source of energy in the Ghanaian diet, accounting for 20 percent of total calorie intake (FAO STAT, 2012).Considerable amount of ritual traditions and fun fare have developed around yam production, from land clearing to harvesting. The tubers are processed into various types of dishes, including pounded yam, boiled yam (ampesi), roasted yam, yam chips and yam flakes. Boiled yam (ampesi) was

found to be the most preferred yam product in Ghanaian urban centres, followed by pounded yam (fufu) (Aidoo, 2009). Yam cultivation is also a major source of employment for many people in the yam zone. During 2005 – 2010 periods, yam production accounted for about 24 percent of total roots and tubers production in Ghana (MoFA, 2010). In addition, Ghana earns significant amount of foreign exchange from exporting yam. Yam production is therefore a significant crop to the people of Ghana. However, notwithstanding its socio-economic and industrial importance, its production is still confronted with so many problems of which, pests and diseases including nematodes are indispensable. According to luc *et al*. (1993) and Caveness, (1992) the nematodes known to cause serious damage are *Scutellonema bradys*, *Pratylenchus coffeae* and *Meloidogyne spp*. which are both field and post-harvest pests. The yam nematode (*Scutellonema bradys*) is found in many yam growing areas of the world having reported from West Africa, the Caribbean, and India (Luc. *et al*., 1993). The nematode invades the young developing tubers through the tissues of the tuber growing points, alongside the emerging roots and shoots and through cracks or damaged areas in the tuber skin (Bridge, 1972). Their infection results in Small yellow necrotic lesions develop under the skin during the early stages. These later turn dark brown, and eventually the suberized lesions coalesce to form a continuous layer beneath the surface, a condition referred to as 'dry rot'. This can also result in cracks of the skin of such infected tubers (Orkwor *et al.,* 2000). Orkwor *et al*. (2000) reported that *Scutellonema bradys* infection causes about 25% post-harvest loss.With the Root-knot nematodes (*Meloidogyne spp*), they are adapted to either cooler or warmer regions of the world. Among the several species of Root-knot nematodes, Addo (1970) reported that the most prevalent species in Ghana are the *M. incognita, M. javanica and M. aranaria*.The root-knot nematodes (*Meloidogyne spp*) adversely affects the marketable value of tubers because of the unappealing and warty appearance associated with rot of stored yam (Luc *et al*., 1993).According to Nwauzor and Fawole, (1981) *Meloidogyne spp,* could cause a reduction of 30 % to 52% in the price of tubers with increased weight loss and rotten tubers of both *D. Allata* and *D. rotundata*. The last reported yam parasite in Ghana, lesion nematode (*Pratylenchus spp*), is a vagrant endo-parasites (PANS, 1978).Its species are distributed throughout the temperate and tropical parts of the world. Eighteen (18) species have been identified as serious pests of many agricultural crops, but only one or two species have been found to be yam parasites (Thompson *et al.,* 1973, PANS 1978). According to Acosta and Ayala, (1976) *Pratylenchus spp* per plant of *D. rotundata* can produce significant tuber damage, and 1000 nematodes per plant can cause complete deterioration and severe reduction in tuber quality.These nematodes are major threat to yam production in Ghana, especially, within Pashee and Jashee in Yendi district of the Northern region of Ghana.

Some recommended control measures that have been found feasible in the control of these nematodes include: planting of carefully selected nematodes-free yam seed and dipping of seed yams in hot water at various time and temperature. PANS, (1978) and Bridge (1975, 1972) found this method to effectively reduce the nematode menace to yam cultivation especially when tubers are dipped in water temperatures within 32^{o}C to 55^{o}C for 30 minutes. Orkwor *et al.*, (2000) and Caveness (1992) also indicated that carefully planned rotation and fallow schemes that include resistant or non-host crops (e.g. Groundnuts, stylo, mucuna) can be effective in reducing nematode population. With respect to the use of resistance yam species, Green and Florini, (1996) stressed the importance of developing standard rapid methods for screening yam germplasm for nematode resistance. In addition, the use of chemical nematicides such as D-D and Carbofuran has been found to be effective against nematode in the field. However, these methods have come with setbacks, especially on the field. Under field conditions, it is difficult for farmers to obtain disease free planting materials since yam setts or seed yam that have already been infected with nematodes serve as a major source of inoculums for the spread and re-infection of new tubers. In addition, most yam species and varieties are susceptible to one nematode or another, for instance, *D. rotundata*and D. *prachensilis* are highly susceptible to many species of nematodes (Caveness 1979, 1992).

Where yam varieties such as *D. Alata* is resistance to nematodes infection, they are not widely accepted by consumers (Orkwor *at al.,* 2000). Conventionally, the use of chemicals could serve as an effective method in controlling nematodes, unfortunately, most of the nematicides on the Ghanaian market are not only beyond the reach of resource poor farmers but have high mammalian toxicity. There is therefore the need to research into alternative methods, which are not only effective but also environmentally friendly and affordable to resource poor farmers. Mensah *et al*. (2002) suggested that the use of leaves of Neem and False yam as well as fruits of Neem could be an effective method in controlling nematodes. These botanicals, according to Mensah *et al*. (2002) performed better, in most locations, than the untreated mounds and were not significantly different from the chemical nematicides, Furadan and Marshal. Per our literature review, there is a dearth of information on the use of Neem and False yam leaves as bio-chemicals in the control of nematodes on the field. This study was triggered by the fact that these botanicals are cheap, available and can be easily prepared and used by resources poor farmers. The research therefore has the following objectives

i. To assess the effect of Neem and False yam leaves on yam leaf diseases, dry rot and tuber cracking of yam grown in Pashee and Jashee in Yendi district of Northern Ghana
ii. To evaluate the effect of pounded Neem seed and False yam leaves on yam nematodes population in the soil, and the tuber yield of yam.

2. Materials and Methods

2.1. Experimental Site and Design

The study was conducted at Parshee and Jashee in the Yendi district of Northern Ghana. The district is located within the savannah vegetation with temperature between 21 -35 ^{o}C and annual rainfall of 750-1050mm.The experiment was laid in a Randomized Complete Block Design (RCBD). Each experimental unit consisted of ten mounds. In all, there were three treatments, false yam leaves, Neem seed and control with three replications. A local yam variety, 'Labreko' setts, was planted on mounds at 100 cm x 50 cm planting distance.

2.2. Treatment preparation and Data Collection

Matured fruits of Neem (*Azadirachta indica*) and the leaves of False yam (*Icacinia senegalensis*), which are available locally, were collected. Required quantity of the collected fruits and leaves were pounded separately in a mortar with a pestle into powder form. The pounded materials were applied at the time of planting of the yam setts at the rate of one ideal milk tin (small size) per mound. At Twelve (12) weeks after planting soil sample were taken from the five tagged mounds and parasitic nematodes populations were assessed by the modified Baermann's funnel method; where the soil sample was mixed with water, the soil water mixture was stirred and then allowed to stand for 30 seconds. The supernatant was poured through 3 sieves with different mesh sizes. The top sieve was 20-mesh sieve (20 holes per square inch), followed by 60 mesh sieve and the last sieve in the vertical arrangement of sieves was 200 mesh sieves. The first sieve holds large debris but allows the nematodes to pass through to the second and third sieves. Soil in the 60 and the 200 mesh sieves were washed two or three times to remove as much of the debris as possible and the nematodes were then washed into shallow dishes covered with tissue paper at the base of the sieves. The collected water was examined under microscope and the nematode numbers were recorded for each treatment. The incidence of mottling, mosaic and anthracnose on yam leaves were scored on a scale of 0 – 5 (Table 1) at ten weeks after emergence. At harvest, dry rot and cracking on the yam tubers were scored on a scale of 0 – 5 (Table 1). Records were also taken on mottling, mosaic and anthracnose on leaves. Tuber yield of five yam plants of each treatment were also recorded.

Score	Degree of dry rot and tuber cracking	Degree of mottling, mosaic and anthracnose on yam leaf canopy
0	No rot and cracking on tubers	Absence of diseases
1	1/5 of the tubers skin affected	1 – 10% of leaf canopy affected
2	2/5 of the tuber skin affected	11 – 30% of leaf canopy affected
3	3/5 of the tubers skin affected	32 – 60% of leaf canopy affected
4	4/5 of the tuber skin affected	61 – 80% of leaf canopy affected
5	Total dry rot and cracking on the tubers	More than 80% of the leaf canopy affected

Table 1: Scale used for scoring yam diseases

3. Results

3.1. Effects of Neem Seed and False Yam Leaves on the Occurrence of Anthracnose and Leaf Mosaic on Yam Leaves

There was no significant difference (P > 0.05) between Jashee and Pashee in the occurrence of anthracnose disease (Table 2a). The occurrence of mosaic on yam leaf was not significantly different between Jashee and Pashee (Table 2b). Neem seed and False yam leaves were not also significantly different from the control (Table 2b).

Location	Diseases score	Botanicals	Diseases score
Jashee	1.27	Neem seed	1.13
Pashee	1.24	Fasle yam leaves	1.33
Mean	**1.25**	Control	1.33
$LSD_{0.05}$	**0.47**	**Mean**	**1.26**
		$LSD_{0.05}$	**0.58**

Table 2a: Effect of some botanicals on anthracnose diseases at two locations in Yendi district

Location	Diseases score	Botanical	Diseases score
Jashee	2.09	Neem seed	2.00
Pashee	2.04	False yam	2.13
Mean	**2.07**	Control	2.07
$LSD_{0.05}$	0.49	**Mean**	**2.06**
		$LSD_{0.05}$	0.60

Table 2b: Effect of some botanicals on yam leaf mosaic disease at two locations in yendi district.

3.2. Effect of Neem seed and False yam leaves on the occurrence of mottling and dry rot on yam leaves at Jashee and Pashee

There were significant differences (P<0.05) in the occurrence of leaf mottling at the two locations (Table 3a). Pashee recorded higher mottling diseases than Jashee. The botanicals did not show significant difference (P>0.05) in the control of leaf mottling (Table 3a). In addition, the botanicals were not significantly different from the untreated/control mounds. The prevalence of dry rot on the yam tubers was significantly different (P<0.05) in the two locations (Table 3b). Tubers grown at Pashee suffered less dry rot than those of Jashee. The Neem seed and False yam leaves did not show significant differences in control of dry rot on the tuber (Table 3b). The control recorded significantly higher dry rot (P<0.05) than the botanicals.

Location	Diseases score	Botanical	Diseases score
		Neem seed	1.33
Jashee	0.98		
		False yam leaves	1.43
Pashee	2.09		
		Control	1.88
Mean	**1.54**		
$LSD_{0.05}$	0.54	**Mean**	**1.55**
		$LSD_{0.05}$	0.66

Table 3a: Effects of some botanicals on yam mottling diseases at two locatios in Yendi

Location	Diseases score	Botanical	Diseases score
		Neem seed	0.83
Jashee	1. 89		
		False yam leaves	0.67
Pashee	0.67		
		Control	2.33
Mean	**1.28**		
$LSD_{0.05}$	0.68	**Mean**	**1.27**
		$LSD_{0.05}$	0.84

Table 3b: Effects of some botanicals on dry rot diseases at two locations in Yendi district

3.3. Effects of Neem seed and False yam leaves on the control of cracking on yam tuber at Jashee and Pashee

The occurrences of cracking on the yam tubers were not significantly different at the two locations. False yam leaves and Neem seed statistically had the same effect on the control of cracking on yam tubers (Table 4). However, the control was significantly different (P<0.05) from the botanicals. The control recorded higher score of tuber cracking than the botanicals.

Location	Diseases score	Botanical	Diseases score
		Neem seed	1.33
Jashee	1.78		
		False yam leaves	1.00
Pashee	1.68		
		Control	2.83
Mean	**1.73**		
$LSD_{0.05}$	0.41	**Mean**	**1.72**
		$LSD_{0.05}$	0.51

Table 4: Effects of some botanicals on cracking at two locations in Yendi

3.4. Effects of Neem seed and False yam leaves on the occurrence of yam parasitic nematodes in yam mounds at Jashee and Pashee

There was significant difference (P<0.05) between Jashee and Pashee in the occurrences of yam parasitic nematodes (Table 5). Pashee recorded significantly higher numbers than Jashee. The botanicals also had significant effect on nematode number (Table 5). Both Neem seed and False yam leaves reduced parasitic nematode population than the untreated mounds. False yam leaves significantly reduced nematode number more than Neem seed. Neem seed reduced nematode number by 29% as compared to 67% by False yam.

Location	Diseases score	Botanical	Diseases score
		Neem seed	218.0
Jashee	235.0		
		False yam leaves	147.0
Pashee	308.0		
		Control	450.0
Mean	**271.5**		
$LSD_{0.05}$	56.7	**Mean**	**271.7**
		$LSD_{0.05}$	69.5

Table 5: Effects of some botanicals on parasitic nematodes population at two locations in Yendi

3.5. Effects of Neem seed and False yam leaves on yam tuber yield at Jashee and Pashee

Yam tuber yield was significantly different ($P<0.05$) at the two locations. Pashee recorded higher yield than Jashee. Yield was not significantly affected by the botanicals. The untreated mounds recorded higher yield than those treated with the botanical though the differences were not statistically significant (Table 6).

Location	Yield (kg)	Botanicals	Yield (kg)
		Neem seed	10.23
Jashee	7.92		
		False yam	10.43
Pashee	13.28		
		Control	11.13
Mean	**10.6**		
$LSD_{0.05}$	2.59	**Mean**	**10.59**
		$LSD_{0.05}$	13.17

Table 6: Effect of some botanicals on yam tuber yield at two locations in Yendi

5. Discussion

5.1. Effect of Neem Seed and False Leaves on Anthracnose, Mosaic, Mottling and Dry Rot of Yam Tubers

There are instances where parasitic nematodes have, through their feeding activities, transmitted virus into plant cells. Therefore, the study had hoped to find out if these botanicals could reduce these diseases (anthracnose, mosaic, mottling). In this study, the botanicals did not have significant effect on these diseases. This however does not show the impuissance of the botanicals since they could have had a different effect of the prevalence of the above diseases, though was not noticed on the field in this study. Also, since these are organic materials, their efficacy could be noticed when they are allowed on the field for longer period. According to Stoll (2000), one important attribute of insecticides of plant origin is that unlike their synthetic counterpart, they do not reduce the incidence of diseases instantly but adversely affect them in other ways, which may not be possible to evaluate on the field. The result of the effect of the botanicals on dry rot of yam tubers shows that both botanicals were able to reduce dry rot more than the control. These botanicals may contain nematicidal properties that are able to reduce the population of *Pratylenchus coffeae*, the principal causative organism of dry rot in yam tubers. Mensah *et al.* (2002) found that the Neem seed and False yam leaves were not significantly different in their chemical nematicide in the control of dry rot in yam tubers.

5.2. Influences of the Botanicals on Cracking, Parasitic Nematodes and Tuber Yield of Yam Grown in the Yendi District of Northern Ghana

Neem seed and False yam leaves had the same effect on the reduction of cracking on yam tubers. Cracking which affected the quality of yam tubers was more in the control than in the botanicals, this suggests that both Neem leaves and False yam leaves could be a better option to farmers in the control of tuber cracking. The efficacy of the use of botanicals to control parasitic nematode in root and tuber crops is supported by Tabil (1997), who used Neem seed and leaves of Siam weed (*Chromolaena odorata*) to control cracking and root knot in carrots. In addition, research findings by Mensah *et al*. (2002) corroborate the results that Neem seed and False yam can control cracking in yam tubers. The occurrences of parasitic nematode that affect quality of yam tubers were higher at Pashee than Jashee. Parasitic nematodes population in mound treated with the botanicals was also lower than the control mounds. This is because the application of botanicals is known to cause significant reduction of nematode numbers. This is in agreement with Caveness (1992) who reported the potentials of botanicals in the control of yam parasitic nematodes. Tabil (1995) also reported that the nematicidal attributes of substances used in organic amendments have been ascribed to increase population of predators and parasites of nematodes, production of fatty acids, phenols, ammonium and other organic acids imparting tolerance to plants due to their improved growth. Likewise, Akhtar *et al.* (1990) also observed that application of *Azadirachta indica* on the field is reported to be effective in

suppressing nematodes population. When two milk tins of the botanicals were used in the study by Mensah *et al.* (2002), it was realized that Neem seed reduced nematode population more than false yam leaves. However, in this study when one milk tin of the botanicals was used it emerged that False yam leaves reduced nematode numbers more than Neem seed. This suggests that two milk tins of Neem seed and one milk tin of False yam leaves may be the effective levels to suppress parasitic nematode in yam. The result on tuber yield shows that the botanicals used did not have any effect on yield of yam tuber though the prevalence of nematodes populations in the experimental area was significant among the different treatments. The levels of nematodes in the soil of the study area were not very high to reduce yield, however, quality yield could reduce where nematodes were prevalent and were not controlled before yam cultivation.

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