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Response of Five Cowpea Varieties to Some Phytonematodes under Field Conditions

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Authors' contributions

This work was carried out in close collaboration with all authors. Author JA initiated the study, devised the protocol and drafted the first manuscript. Authors OK and FK perfected the statistical analysis and managed the final manuscript. Author YD collected and managed the field data. Authors AJS and BA extracted, preserved, quantified and identified the plant parasitic nematodes. All authors read and approved the final manuscript.

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ABSTRACT

Five cowpea varieties *viz* Asomdwe, Asetenapa, Hewale, Nhyira and Videza, were evaluated for their reaction to plant parasitic nematodes under natural infestation. *Meloidogyne incognita, Pratylenchus brachyurus*, and *Rotylenchulus reniformis* were isolated from the rhizosphere of the cowpea varieties although each of the varieties reacted differently to these nematode species. The highest number of *M. incognita* was recovered from the rhizosphere of Asomdwe which was 83% higher than Asetenapa which recorded the least number of *M. incognita*. Similarly, there was a significant difference ($P<0.05$) between *R. reniformis* juveniles recovered from the rhizosphere of Hewale and all the other varieties. There was however no significant differences in the number of *P. brachyurus* recovered although Nhyira recorded the highest. Two of the nematode genera- *Meloidogyne incognita* and *Pratylenchus brachyurus* were extracted from the roots of the various varieties with varied population densities. The highest grain yield was recorded in Hewale. It out yielded Nhyira, Videza, Asomdwe and Asetenapa by (58, 49.8, 41.5 and 11.9)% respectively.

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1. INTRODUCTION

Phytoparasitic nematodes represent a major constraint to field crop production, damaging a wide range of crops in both tropical and subtropical climates [1]. As parasites, they damage crops by reducing both yield and quality. Severe infection can lead to damage and death of a large number of plants resulting in financial hardship for farmers [2].

The use of the chemical nematicides has been the major means of managing of these pests. However, the limited availability, health hazards, safety, environmental pollution and storage difficulties of nematicides are limitations in using of this strategy [3].

Several workers have reported the potential efficacy of some leguminous crops in managing nematodes [4,5]. The selection of a nematode suppressive crop must however be of economic justification so that it could be accepted by farmers. Cowpea (*Vigna unguiculata* (L.) Walp.) which is an important plant protein source crop in Africa and some other parts of the developing world, could be of tremendous advantage if found to be effective in reducing nematode population densities. The use of cowpea cultivar 'Iron Clay' as a cover crop according to [6] improved yields of turnip (*Brassica rapa*) and basil (*Ocimum basilicum*) due to a nitrogen benefit and suppression of the root-knot nematode, *Meloidogyne incognita*.

Using cowpea in nematodes management programs has another advantage, related to its nitrogen-fixing ability, to provide nitrogen for itself and other crops. The use of cowpea in nematode management is however varietal dependent. Several commonly cultivated varieties have various degrees of resistance to one or more species of plant parasitic nematodes. The combination of nematode suppressor effect and nitrogen fixing ability, could be especially useful in organic crop production systems where neither nematicides nor synthetic nitrogen fertilizers are used [7]. In the present study, five improved cowpea varieties were evaluated for their reaction and potential of reducing nematode population build up under natural field conditions for future use in an integrated nematode management strategy.

2. MATERIALS AND METHODS

2.1 Study Site

The study was conducted on the plant pathology research field of the Council for Scientific and Industrial Research-Crops Research Institute (CSIR-CRI), Kwadaso Experimental Station, Ghana, during the major and minor cropping seasons of 2013. The soil belongs to the Ferric Acrisol [8] series. The area experiences an average rainfall of 679.4 mm and 411.8 mm during the major and minor seasons respectively [9]. Temperature ranged between 24°C and 28°C.

2.2 Source of Cowpea Varieties

Five cowpea varieties *viz* Asetenapa, Videza, Asomdwe, Nhyira and Hewale (Table 1) were obtained from the Legumes and Oilseed Improvement Division of the CSIR-Crops Research Institute, Ghana, for the evaluation.

2.3 Soil Sampling, Extraction and Identification of Nematodes

Soil was sampled from each plot at the start of the trial and at harvest with a 5 cm diameter soil auger to a depth of 20 cm. Initial soil nematodes were extracted from 200 cm^3 of soil before planting using the modified Baermann tray method [10]. Various nematode species were identified under a compound microscope at a magnification of 100x. Nematode species were identified [11] morphologically.

2.4 Experimental Set up

The experiment was performed in the frame of a RCBD with 4 replications. Plot size for each replication was 3 m × 3 m. Planting was done at a distance of 60 cm × 30 cm with 2 seeds per hole and later thinned to one seedling per hole after germination. The soil was not treated with any nematicide. Weed management was done twice, manually, before harvesting of crop, whilst insect pests of cowpea (thrips, aphids and pod sucking bugs) were monitored and sprayed when needed with Karate 2.5 EC (Lambda-cyhalothrin) at a rate of 800 ml/ha.

2.5 Data Collection and Analysis

Second stage juveniles (J2) of the nematodes were extracted and assessed from 200 cm^3 of soil and 5 g roots of the various cowpea varieties using the modified Baermann tray method (10). Three plants per plot were uprooted and rated for galls according to Zeck's 0-10 ratings [12]. Yield, being continuous data, was not transformed, but nematode count data were $\log_{10}(x+1)$ transformed to improve homogeneity of variance. Statistical analysis was performed using Genstat 8.1 software (Lawes Agricultural Trust, VSN International). Means were separated using Fisher's Least significance test at $\alpha = 0.05$

3. RESULTS

Three parasitic nematodes; *M. incognita, P. brachyurus* and *R. reniformis* were identified in the current study. The varieties reacted differently to the different nematodes on the field. The highest *Meloidogyne incognita* population recovered from the soil at harvest was recorded for Asomdwe and the level was 83% higher than that recorded for Asetenapa which supported the least population (Table 2). Asomdwe was 10%, 48% and 20% higher than Nhyira, Videza and Hewale respectively (Table 2). The highest number of *R. reniformis* juveniles was recovered from the variety, Hewale. Similarly, *R. reniformis* recovered from Asetenapa, Asomdwe and Videza were 77, 58 and 35 times more than Nhyira respectively which recorded the lowest (Table 2). The lowest number of *P. brachyurus* population was isolated from Videza. It was 72% less than that recorded for Nhyira which recorded the highest (Table 2). Compared to Asetenapa, Asomdwe and Hewale, Nhyira recorded 62%, 31% and 49% more *P. brachyurus* respectively (Table 2). Two of the nematodes; *M. incognita* and *P. brachyurus* were recovered from the roots of all the varieties at harvest (Table 3). There was a significant difference ($P<0.05$) in the number of *Meloidogyne incognita* juveniles recovered from the roots of Videza and Asetenapa (Table 3). Similarly, there was a significant difference between Nhyira and Asetenapa (Table 3). There was also a significant difference between ($P<0.05$) Nhyira and Asetenapa with respect to *P. brachyurus* juveniles recovered from the roots of the varieties at harvest (Table 3). The highest yield of 886 kg/ha was recorded in Hewale. It out yielded Nhyira, Videza, Asomdwe and Asetenapa by (58, 49.8, 41.5 and 11.9)% respectively.

Table 1. Characteristics of cowpea varieties used in the study

Cowpea variety	Maturity period (Days)	Growth habit
Asetenapa	63-70	Erect
Videza	65-72	Semi-erect
Asomdwe	65-72	Semi-erect
Nhyira	65-72	Erect
Hewale	64-72	Semi-erect

CSIR-CRI Annual Report (2010)

Table 2. Second stage juvenile populations per 200 cm^3 of soil sample after harvest

Cowpea variety	*M. incognita*	*P. brachyurus*	*R. reniformis*
Asetenapa	110 (2.0)b	217 (2.3)a	77 (1.9)a
Asomdwe	655 (2.8)a	400 (2.6)a	58 (1.8)a
Nhyira	588 (2.8)a	582 (2.7)a	0b
Videza	335 (2.4)ab	162 (2.2)a	35 (1.6)a
Hewale	522 (2.7)a	297 (2.3)a	170 (2.2)a
LSD ($P < 0.05$)	(0.4)	(0.5)	(1.2)
CV (%)	(3.1)	(2.5)	(45.6)

$\sqrt{(x+0.5)}$ transformed data used in ANOVA in parenthesis. Figures in a column followed by different letters are significantly different ($P < 0.05$)

Table 3. Second stage juvenile nematodes population per 5g cowpea roots and subsequent yield of cowpea

Cowpea variety	*Meloidogyne* spp	*P. brachyurus*	Grain yield (kg/ha)
Asetenapa	61 (1.8)b	3 (0.6)b	780a
Asomdwe	131 (2.1)ab	33 (1.5)ab	518b
Nhyira	240 (2.4)a	173 (2.2)a	372b
Videza	259 (2.4)a	96 (1.9)a	444b
Hewale	77 (1.9)ab	33 (1.5)ab	886a
LSD($P < 0.05$)	(0.5)	(1.2)	266
CV (%)	48.9	45.0	33.4

$\sqrt{(x+0.5)}$ transformed data used in ANOVA in parenthesis. Figures in a column followed by different letters are significantly different ($P < 0.05$)

4. DISCUSSION

Cultivation of nematode-resistant varieties has a dual purpose, to avoid crop damage by nematodes and to reduce nematode population levels [13]. The identification of the three nematodes pest associated with cowpea corroborates the findings of several other studies [14,15,16]. The differently reaction of each variety on nematode population densities corroborates with the findings of [7], confirming that the effect of cowpea in nematode management programs is variety dependent as none of the varieties suppressed the population densities of all the encountered nematode species. This is because resistance is highly specific, being effective against only a single species or even only one race of a species, and would not control other potential pests in fields with poly-specific community [17]. According to [4], leguminous plants contain numerous chemicals, some of which are potentially nematotoxic or influence nematode behaviour. Apart from the nematotoxic potential, they fix nitrogen in the soil and can aid in soil conservation practices. The absence of galls on the roots of cowpea varieties may indicate their ability to inhibit the formation of feeding sites to support the reproduction of females after penetration [18]. Despite the high nematode population recorded for Hewale, the variety had the highest grain yield. However, the high build-up of nematodes in its rhizosphere could predispose subsequent crops to attack.

5. CONCLUSION

The potential of incorporating cowpea varieties in an integrated nematode management approach looks promising. The varied reactions of the various varieties to the nematode pest provides an opportunity for screening for more resistant cowpea varieties and accessions for use in nematode management programs. However the selection and use of any cowpea variety should take into consideration the most economic nematode species in the field.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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