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Plant parasitic nematodes associated with cabbages in Kenya

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Abstract: A survey was conducted in 22 farms in Kiambu and Kajiado districts to study the nematode associated with cabbage. Roots were rated for galls using a scale of 0 – 10. Roots were stained in Phyloxine B and in NaOCl-acid - fuchsin for egg mass and endoparasite detection. Some roots were macerated for nematodes assays. A 200g soil sample per farm was assayed for nematodes. The study revealed that cabbage is a poor host of root knot nematodes (RKN) with 0 – 40% of the root systems galled and very few egg masses. The roots were predominantly infected by lesion nematodes (*Pratylenchus* spp.), having a 56% frequency of occurrence. The species detected included *Pratylenchus brachyurus, P. zeae, P. scribneri, P. neglectus* and *P. loosi*. The lesion nematodes were also detected in soils with a frequency of occurrence of 64%. *Meloidogyne* spp were detected in both the roots and soil at a frequency of occurrence of 26 and 14%, respectively. *Tylenchorhynchus* and *Belonolaimus* spp, potentially serious nematodes of vegetables were also recovered in significant numbers. The spiral nematodes; *Scutellonema, Helicotylenchus* and *Hoplolaimus* spp. were detected in soil with a frequency of occurrence of up to 77%. The stubby root nematodes (*Trichodorus* and *Paratrichodorus* spp) were present in 65% of the farms. Other nematodes detected
included *Xiphinema, Longidorus, Criconemoides, Hemicriconemoides and Hemicycliophora*, *Tylenchus*, *Coslenchus, quinisulcus*, *Polenchus* and *Paratylenchus* spp. Although *Filenchus* spp. were detected in about 73% of the farms, it has not been reported as a serious pest of cabbage.
Key words: *Belonolaimus* spp., cabbages, Kenya, *Meloidogyne* spp., poor host, *Pratylenchus* spp; *Tylenchorhynchus* spp. survey, *Trichodorus* spp.

Introduction

Cabbage (*Brassica oleracea* var *capitata*) cultivation is an important economic activity in Kenya, coming second to tomato in the vegetable category. Because cabbage has been reported to be a non-host to RKN, it is assumed that it is a poor host to all nematode pests and is therefore a preferred rotation crop in vegetable and cereal production systems (Pattison *et al*., 2006; Bello *et al*., 2004). Because of this, no study has been conducted to assess the nematode pests that are associated with this crop in Kenya. This study was therefore conducted to evaluate the nematode pests that associate with cabbage.

Materials and methods

Soil and root sampling
Rhizopshere soil and root samples were taken from 22 farms in six different divisions. The six areas were Kabete [(KB) 1972 -1997masl)], Lari [(LR) 2678 - 2692 masl)], Limuru [(LM), 2309 - 2350 masl)], Githunguri [(GG) 1935 – 2075 masl)], Gatundu [(GT) 1590 - 1600 masl)] in Kiambu district and Athi River basin [(AR) 1490 - 1510 masl)] in Kajiado district. The areas were in the South Eastern part of Kenya (S 00 - 01^0, E 036 - 037^0). Pluktor and Gloria were the most popular cabbage hybrids cultivated in the areas surveyed.

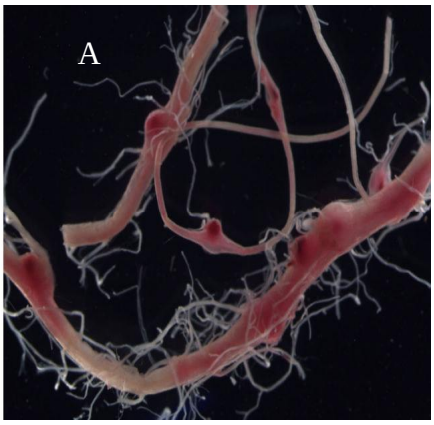
Ten mature stems of cabbage (after harvesting) were randomly selected per farm and gently dug out using a hand trowel before placing them in a polyethylene sample bag and gently shaking the soil off from the roots to minimize root damage and loss. The roots were then placed separately in polyethylene sample bag. The soil samples from each farm were combined and thoroughly but gently mixed before taking a 1kg sub – samples. Both the root and the soil samples were then placed in a cool box and transported to the laboratory for further processing. The root and soil samples were stored at 4^0C before nematode bioassays were conducted.

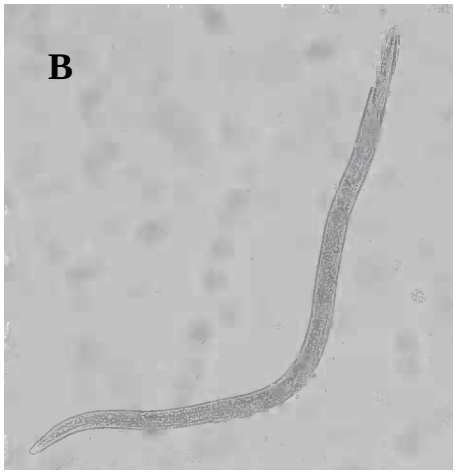
Nematode assays
The roots were gently but thoroughly washed, blotted dry and visually scored for galling index using a 0 – 10 galling scale (Bridge and Page, 1980) where 0 = no galls, 1=10% of root system galled, 2 = 20% of the root system galled; 3 = 30% of root systems galled, 4 = 40% of the root system galled; 5 = 50% of root systems galled and root system reduced and 10 = all roots severely knotted, no root system and plant usually dead. Each root system was then divided into two sub – samples; the first sub sample (10gm) of each root system was immersed in Pyloxine B (Holbrook *et al*., 1983) to stain the egg masses which were then visually counted and scored using a 0 – 5 egg mass rating index; where 0= no egg masses; 1=1- 2; 2= 3 – 10; 3= 11- 30; 4= 31- 100 and 5 > 100 egg masses per root system (Taylor and Sasser, 1978). The remaining root sub- samples from each farm were pooled together and carefully mixed before taking a 200g fresh root weight per farm for nematode extraction using the Maceration and Filtration techniques (Fallis 1943). The nematodes were enumerated and identified to genus level. The remainder of the roots was cleared using sodium hypochlorite and stained in Acid fuchsin (Byrd *et al*., 1983) to detect the presence of endoparasitic nematodes. The roots were scored for the presence or absence of the nematodes.

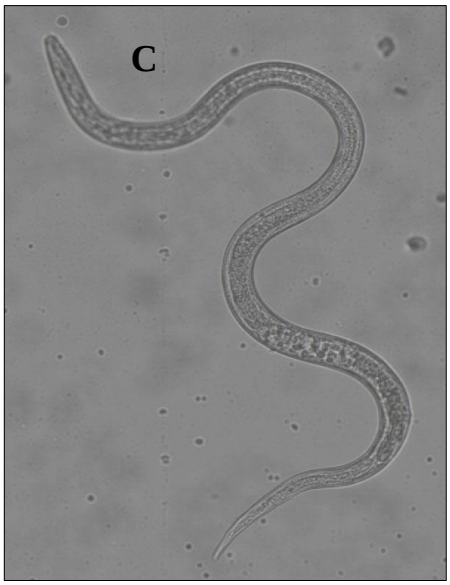
The soil samples were thoroughly but gently mixed and the large lumps were carefully broken down to avoid damaging the nematodes. The samples were divided into 3 sub – samples; the first sample was taken for physicochemical analyses at Kenya Plant Health Inspectorate Service (KEPHIS). The second and third were used for nematode extraction using the Jenkins (1964) Centrifuge-Flotation Method and Thomas (1959) Extraction Tray method, respectively. The nematodes extracted using the two methods were combined before enumerating them and identifying the plant parasitic nematodes to genus level. A photographic record of the nematode genera was obtained using a digital camera (Leica DFC 280) mounted on a compound microscope.

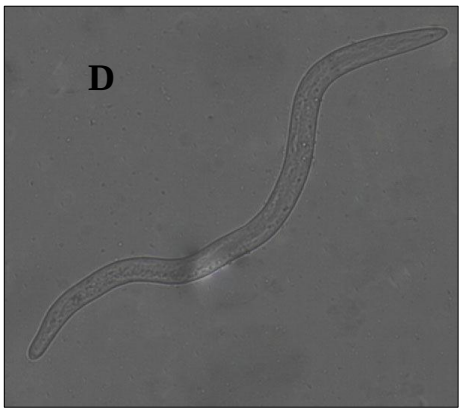
Results and Discussion

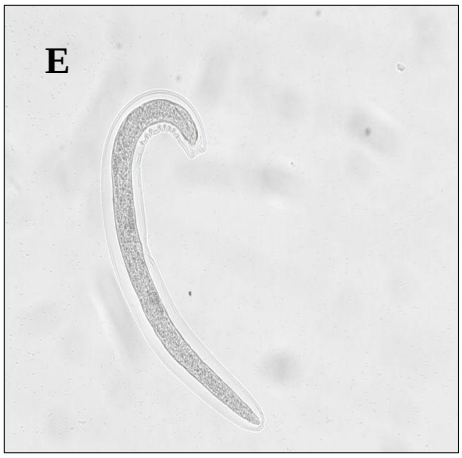
The study showed that cabbage is a very poor host of root –knot nematodes (RKN) as was revealed by the relatively low numbers of RKN in the root systems and, the low galling indices [(0 – 4) (Plate 1A)] and egg mass indices (0- 2) in almost all the farms. Nematode galls were only detected in roots from Githunguri farms probably because of the inclusion in cabbage production systems of a diversity of vegetables which are known to be good hosts of RKN. Similarly the egg mass indices were only detected from farms in Githunguri. Root knot nematodes in cabbage roots and rhizosphere soils had a frequency of occurrence of 26 and 14 %, respectively (Tables 1 and 2). Although











A: Galled cabbage root (as indicated by the arrows) stained in acid fuchsin from one of the farms in Githunguri

B: *Pratylenchus* spp. (x20). (lesion nematode) obtained from roots and rhizosphere soil of cabbage in Limuru farms

C: *Belonolaimus* spp. (x20). One of the most destructive nematode in vegetable production systems in Kabete

D. *Tylenchorhynchus* spp. (x10). One of the most destructive nematode pests of cabbage from farms in Athi – River basin

E. *Paratrichodorus* spp. (x 20). A stubby root nematode from rhizosphere soil of cabbage in one of the farms in Gatundu

Table 1: Mean nematode genera and frequency of their occurrence in roots of cabbage in six areas
KB= Kabete; LR= Lari; LM= Limuru; GG=Githunguri; GT= Gatundu; AR=Athi River

Nematode genera	Areas surveyed							Frequency of occurrence %
	KB	LR	LM	GG	GT	AR	MEAN	
Pratylenchus	8.5	0	12.4	7.8	0	1	5.45	55
Meloidogyne	2	0	0.6	0.2	1.5	0	0.55	26
Xiphinema	11	0	0.4	0	0	0	1.26	14
Hemicycliophora	0	0	0	0.4	0	0	0.086	5
Quinisulcius	0	0	0.2	0	0	0	0.043	5
Tylenchorhynchus	0	0	0.4	0	0	1	0.3	14
Helicotylenchus	0	0	0	0.4	0	0	0.086	9
Hoplolaimus	0	0	0	0	0	0.4	0.086	5
Longidorus	0	0	0	0	0	0.6	0.13	5
Belonolaimus	0	0	0	0.8	0	0	0.17	5
Trichodorus	0	0	0	0.4	0	0	0.086	5

Table 2: Mean nematode genera and frequency of their occurrence in the rhizosphere soil of cabbage roots in six areas

Nematode genera	Areas surveyed							Frequency of occurrence %
	KB	LR	LM	GG	GT	AR	MEAN	
Pratylenchus	9.5	25	18.46	8.6	10	6.8	13.17	64
Meloidogyne	1.5	0	1.6	1	3	0	1.04	14
Tylenchus	9	11.5	4	3.4	10.5	4	5.76	50
Paratylenchus	0	0	1.8	0	0	0	0.39	50
Xiphinema	6.5	10	1.6	17	22	4	8.97	50
Filenchus	26.5	10	7.6	9	13	9.2	10.9	73
Trichodorus	1	23.33	1.2	10	9	0.4	6.9	59
Paratrichodorus	3	12.5	1.2	12.8	8.5	2.6	6.13	46
Longidorus	7	10	0	6.8	6	7.8	5.51	59
Polenchus	0.5	0	0	0	3.5	0	0.43	14
Hemicriconemoides	5	0	1.6	0	0	0.8	1.05	18
Hemicycliophora	18	0	0	0	3	0.8	2.42	73
Scutellonema	4	0	17.2	8.8	10.5	33.2	13.54	77
Helicotylenchus	5	24	18.6	14.2	2	13.2	13.4	18
Hoplolaimus	1	0	5.2	2.6	0	4	2.64	56
Belonolaimus	1	0	3.2	5.8	0	3.2	2.72	50
Coslenchus	1.5	0	0	0	0	0	0.17	5
Trophus	0	0	1.2	0	0	0	0.26	5
Quinisulcius	0	0	2.6	0	0	0	0.56	9
Tylenchorhynchus	0	0	8.6	0	0	14.2	4.54	32

KB= Kabete; LR= Lari; LM= Limuru; GG=Githunguri; GT= Gatundu; AR=Athi River

root galling and egg mass indices were only detected in samples from farms in Githunguri, the nematodes extracted from the roots and soil were lower than those from farms in Limuru, Gatundu and Kabete. There were no RKN detected in roots and soil from farms in Lari and Athi River basin (Tables 1 and 2). The suitability of cabbage varieties/hybrids grown in the different areas as hosts to RKN pest, however, need to be tested because the host genotypes play an important role in the level of root infection and soil infestation by the nematode pests. The findings that cabbage is a poor host of RKN corroborates findings by several authors and for many years it has been used as a rotation crop or a biofumigant in RKN management systems (Bello *et al*., 2004; Sikora and Fernandez; 2005). In spite of the low numbers of RKN, they were among those that were predominantly isolated from cabbage roots, being second to lesion nematodes (Table 1). This implies that RKN can be potential pests of cabbage and therefore there is need to determine the host status of the cabbage varieties/ hybrids cultivated locally to local populations of RKN under different soil conditions. For example, RKN are a major pest in cabbage production in Virginia as reported in Virginia Agricultural Statistics Bulletin and Resource Directory (2001) and severely affected plants have nematode galls as large as 1 inch in diameter. A wild cabbage (*Moricandia moricandioides*) was also reported to be susceptible to *Meloidogyne arenaria* race 2, *M. incognita* race 1 and *M. javanica* (Pattison *et al.*, 2006).

Pratylenchus spp. [(lesion nematodes) (Plate 1B)] revealed the highest frequency of occurrence (55%) in cabbage roots in all the farms surveyed as depicted in table 1. *Pratylenchus* in roots was highest in Limuru, followed by Kabete, Githunguri and Athi River and non in Lari and Gatundu areas (Table 1). The nematodes were present in soils of all the farms with Lari farms having the highest (Table 2). The predominant cultivation of maize which is a good host of lesion nematodes and is cropped in rotation with cabbage might explain the high numbers of lesion nematodes in Lari. The species detected in this study were *Pratylenchus brachyurus, P. zeae, P. scribneri, P. neglectus* and *P. loosi*. Lesion nematodes have been reported to be important pests of cabbage and being polyphagus, are capable of infecting several crops

that are grown in cabbage production systems. Predominant species differ with the host genotype, the soil type and the presence of weed and other crop hosts. For example, a survey conducted in the Samsun (Middle Black Sea Region) of Turkey to study the occurrence of plant-parasitic nematodes associated with cabbages (*Brassica* spp.) revealed that *Pratylenchus thornei* was present in roots and soil in relatively high numbers (Mennan and Handoo, 2006).

Other nematode pests detected in roots were *Tylenchorhynchus* (Plate 1D) and *Xiphinema* spp (14% frequency of occurrence), *Helicotylenchus* (9%), *Belonolaimus* (Plate 1C), *Hoplolaimus* and *Hemicycliophora* spp. (5% frequency of occurrence) (Table 1). Some of the most destructive nematodes to cabbages that were also isolated from the rhizosphere soil included *Tylenchorhynchus*, *Belonolaimus*, *Paratrichodorus* (Plate 1E) and *Hemicycliophora* spp. and were predominantly isolated from Athi River, Githunguri and Kabete, respectively. These nematodes were, however, not isolated from farms in Lari and Gatundu farms. This could be due to competition from the lesion nematodes which were predominant in Lari farms, and the fact that most of the farms in Gatundu were previously fallow and the cabbage sampled were the second season crop. Other soil factors may have influenced soil infestation by the nematodes.

Conclusion

Although cabbage has been generally regarded as a non – host of RKN, this study has shown that it's a poor host of root knot nematode, it has a potential of being a good host especially if a susceptible variety/hybrid is planted. It is therefore important to screen new and existing varieties to minimize chances of increasing RKN in vegetable production systems. In addition, continuous cultivation of cabbage should be avoided as they are good hosts of lesion nematodes which are polyphagus nematodes and causes severe damage to other crops in cabbage production systems.The presence of highly destructive *Belonolaimus* and *Tylenchorhynchus* species in association with cabbage production systems should be taken seriously as even very low densities of these nematodes could cause significant damage and yield losses.

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