

Plant parasitic nematodes: A threat to vegetable production in Kenya

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Abstract A survey of plant parasitic nematodes (PPN) associated with cabbage was carried out in selected agro-ecological zones (AEZs) in Kenya to determine PPN density, distribution and farmer's awareness of nematodes associated problem. Sixty cabbage farms were sampled and nematode assays on root and soil samples were carried out. Nematode population density differed significantly ($P < 0.05$) across all the AEZs with Upper highland 1 (UH1a) recording the highest PPN population and UM1 recording the lowest. Nematodes from cabbage roots also differed significantly ($P < 0.05$) across AEZs with Upper highland 1 (UH1b) recording the highest population density of 60 nematode $10g^{-1}$ of dry roots and UM1 having 1.2 nematodes $10g^{-1}$ of dry roots. *Pratylenchus* was the most abundant nematode in all AEZs. Only 3% of sampled farmers were aware of nematodes associated problems and none of them applied any nematode management practice.

Key words: Agro-ecological zones, cabbage, farmer's awareness

Introduction

Cabbage (*Brassica oleracea* L. var *capitata*) constitutes one of the most important vegetables in Kenya (Kungu, 2005). In 2007, cabbage was the leading vegetable in Kenya in terms of production and second to tomato, in term of sales according to the (Ministry of Agriculture 2007). Plant parasitic nematodes remain a major challenge in crop production especially in developing countries. They reduce quality and quantity of crop yield. In Kenya, PPN have been found to constrain the production of different vegetables (Waceke, 2007). According to Chitwood (2003) these pest cause a worldwide loss estimated at \$125 billion. Despite their destructive nature, they are often overlooked or rarely perceived to be important pests by many agricultural scientists (Bridge, 1996). Farmers knowledge on the presence and management of PPN remains very low (Maina *et al.*, 2010). This study was therefore, conducted to determine nematodes associated with cabbage in various AEZs of Embu and Nyandarua Counties and to evaluate farmer's awareness of nematodes associated problem.

Material and methods

Field survey. A survey was carried out in sixty farms in six agro-ecological zones (AEZs) leading in cabbage production in Embu and Nyandarua Counties of Kenya. The six AEZs included five upper highland zones (UH1a, UH1b, UH2, UH3 and UH4) in Nyandarua County and one upper midland zone (UM1) in Embu County (Jaetzold & Schmidt, 1983; 2006). Upper highland zones are found in altitude ranging from 2200 to 2740 m, characterized by low temperature and high rainfall. The zones have potential for crop production and are leading in vegetable production in Nyandarua County. Upper midland zone (UM1) is located in altitude of 1600-1850 m with

temperatures ranging between 17.5-18.9°C. It has a full long cropping season with intermediate rains which favour cabbage production amongst other vegetables (Jaetzold & Schmidt, 2006).

A garden trowel was used to dig soil within the cabbage rhizosphere to a depth of 15-20 cm. Ten samples of rhizosphere soil and roots from mature cabbage were randomly collected in each farm. Soil samples were pooled, thoroughly mixed well before drawing a 1 kg soil representative sub-sample that was packed in a polythene sample bag. Roots were packed separately in a polythene sample bag. The samples were placed in a cool box and transported into the laboratory and stored in the fridge at 4°C before nematode assay.

Additionally, a questionnaire was administered to sixty farmers during a field survey to assess farmer's awareness of nematodes and the associated problems, and to determine various farming practices common among cabbage farmers.

Nematode assay. In the laboratory soil samples were thoroughly but gently mixed from which, 100 g was obtained for nematode extraction using modified Baermann Tray technique (Hooper *et al.*, 2005). Endo-parasitic nematodes were extracted from 10 grams of roots using modified Maceration-Filtration technique as described by Hooper *et al.* (2005). Recovered nematodes from each AEZ were enumerated and their population expressed as the number of PPN in 100 g and 10 g of dry soil and roots, respectively. Extracted nematodes were identified to genera level based on their morphological features as described by Siddiqi (1989; 2000) and Hunt *et al.* (2005). Data collected were normalised using logarithmic transformation ($\text{Log}_{10}[x+1]$) prior to Analysis of Variance. Means considered significantly different at $P \leq 0.05$ were compared by LSD.

Results

The study revealed that cabbage is a host to PPNs in various AEZs in Embu and Nyandarua Kenya. The mean population densities of PPNs associated with cabbage soil were significantly ($P < 0.05$) different among the six AEZs. UH1a was the most heavily infested; with an overall mean number of 225 nematodes per 100g of dry soil followed by UH1b. However, there was no significant ($P > 0.05$) difference between the two zones. The mean nematode population in UH1a was significantly ($P < 0.05$) different from that of UH3 and UM1 but not different from UH1b, UH2 and UH4. The lowest number of nematode

was recorded in UM1 which had 28 nematodes per 100 g of dry soil (Fig. 1).

Similarly the mean population of PPN in cabbage roots were found to differ significantly ($P < 0.05$) with AEZs. The highest number of nematodes in roots (60.2 per 10 g of dry roots), was recorded in UH1b followed by UH3. The number of PPNs from UH1b differed significantly ($P < 0.05$) from that of UH1a, UH2, UH4 and UM1. However there was no significant ($P > 0.05$) difference between UH1b and UH3. The lowest number of nematodes in roots was recorded in UM1 with 1.2 nematodes per 10 g of dry roots (Fig. 2). The population density of specific nematode genera from cabbage roots ranged from 0.1 to 16.4 per 10g

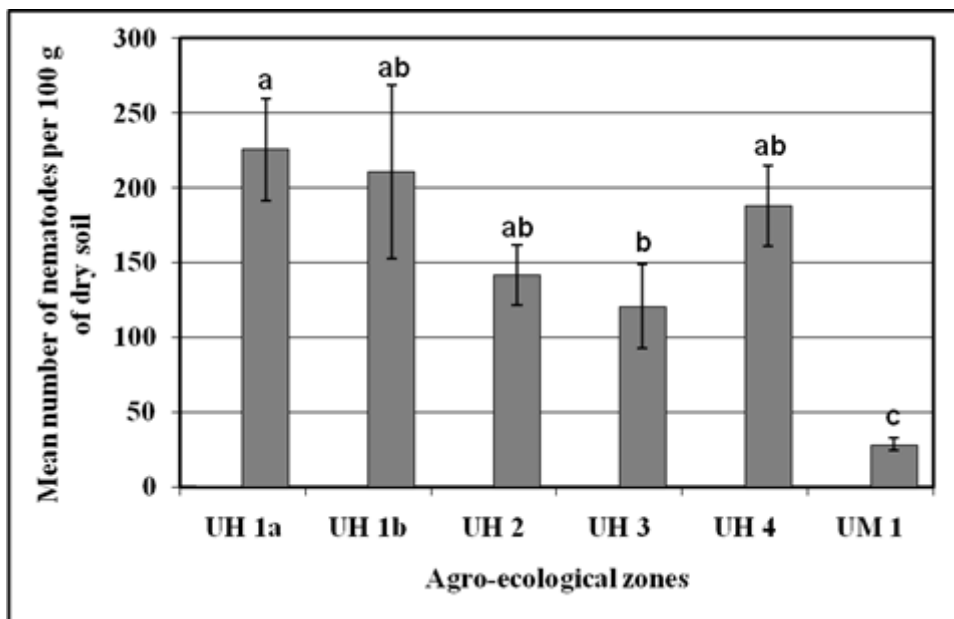


Figure 1. Population of PPN associated with nematodes in various AEZs. † Bars showing the same letters are not significantly different.

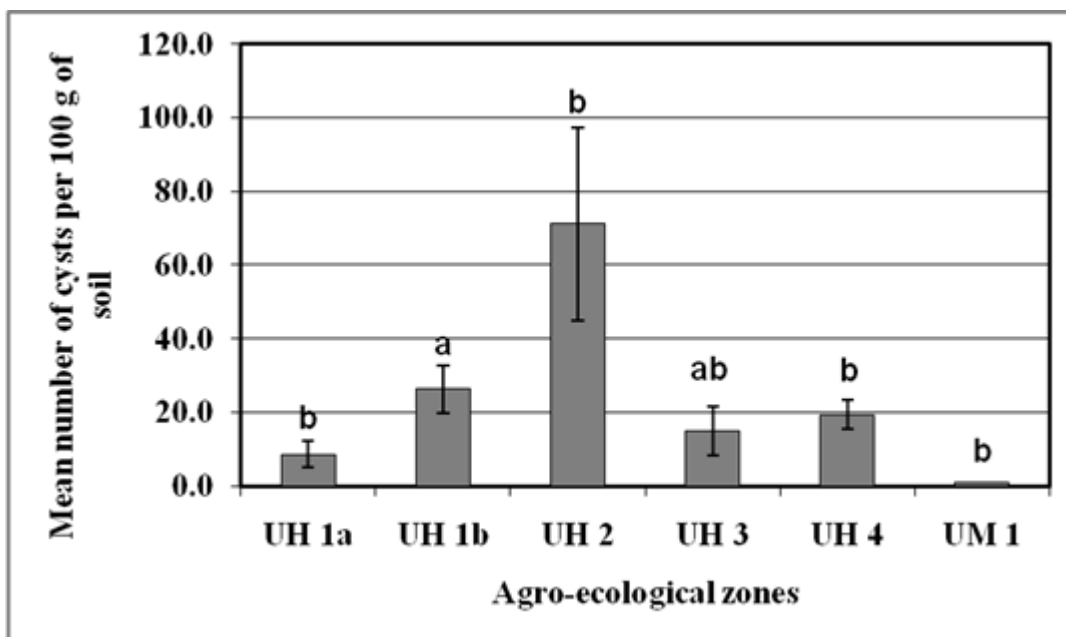


Figure 2. Population of PPN in cabbage roots in various AEZs. † Bars showing the same letters are not significantly different.

Table 1. Population densities of plant parasitic nematodes (PPN) in cabbage roots in Nyandarua and Embu AEZs.

Nematode genera	Number of nematodes/ 10g of dry roots \pm SE†
<i>Helicotylenchus</i>	0.70 \pm 0.35 ^b
<i>Longidorus</i>	0.05 \pm 0.03 ^b
<i>Meloidogyne</i>	1.10 \pm 0.76 ^b
<i>Pratylenchus</i>	16.38 \pm 8.38 ^a
<i>Quinisulcius</i>	0.13 \pm 0.08 ^b
<i>Trichodorus</i>	0.08 \pm 0.07 ^b
<i>Tylenchorynchus</i>	0.38 \pm 0.20 ^b
<i>Xiphinema</i>	0.42 \pm 0.38 ^b

Data are the mean \pm standard error (SE) of nematodes per 10g of dry roots in sixty root samples collected in six AEZs.

†Means followed by the same letter are not significantly different

of dry roots. A population density of *Pratylenchus* spp. was significantly ($P < 0.05$) high compared to other PPN genera isolated from cabbage roots. Root knot nematode (RKN) was present at a low density of 1.1 nematodes per 10g of dry roots (Table 1).

The study reported very low awareness on PPN by the farmers despite the high presence of these pests. Only 3% of interviewed farmers had information about plant nematodes. 1. This was as opposed to 23% and 25% who knew about fungi and bacteria respectively. Although 85% of the interviewed farmers applies chemical in management of other cabbage pests none of them applied any management practice against PPN.

Discussion

The findings of PPN associated with cabbage, support the previous work done with cabbage in Kenya (Waceke, 2007) and other parts of the world (Mennan & handoo, 2006; Pattison *et al.*, 2006). Indeed, nematodes are major pests of vegetable crops (Bridge, 1996), mainly under intensive production systems (Machado & Inomoto, 2001). High numbers of plant nematodes were found to associate with cabbage rhizosphere soil and roots in UH1a and UH1b, respectively. This could be attributed to among other factors intercropping or crop rotation of cabbage with other preferred host resulting in nematode build up in the soil.

It was observed that most farmers used crops that are host to lesion nematodes in their crop rotation cycles. Thirty seven percent (37%) of farmers intercropped cabbage with potatoes (*Solanum tuberosum*). *Pratylenchus* spp. has been found to associate with *S. tuberosum* (Brown *et al.*, 1980) and it was recorded as a major pest in the study area. Therefore, intercropping and/or crop rotation involving potato and cabbage could have resulted in a high frequency of the lesion nematodes as noted in the study. Others (15%) intercropped cabbage with maize which is a good host of lesion nematodes. It has been found that continuous growing of a highly susceptible host plant as a mono-crop or crop rotation greatly increases populations of PPN pests and cause damage to the crop (Bridge, 1996), in the same study, it

was reported that growing a poor host will significantly suppress the nematode populations.

Root knot nematode, a well known pest of vegetables, was reported in low density in both soil and roots. This support early finding that cabbage is a poor host to RKN (Waceke, 2007). On the other hand, low number of nematodes identified in UM1 and UH3 AEZs may have been as a result of high use of organic amendment in these areas. Nearly 70% of the farmers reported application of cattle manure. As reported by Dackman *et al.* (1987) and Wachira *et al.* (2009), addition of organic carbon to the soils in form of manure leads to an increase in the number of free-living and predatory nematodes thus a decrease in PPNs. High organic matter in the soil reduces PPNs by generating toxic compounds in the soil which suppress nematodes or by changing the soil's microfauna and microflora, and increasing the population and activities of antagonistic microorganisms (Oka, 2010).

Upper highland zone, (UH1a & UH1b) receives high precipitation coupled with low temperature hence the soil is able to retain moisture for a longer duration (Jaetzold & Schmidt, 1983) as opposed to the lower AEZs. These factors enhance intensive agriculture and nematode population in the soil. According to Norton (1979), soil moisture is the most important abiotic parameter governing nematode populations. This argument might explain presence of more nematodes in upper AEZs compared to low AEZs. Soil moisture allows nematode mobility to infest crop rhizosphere.

Additionally, lack of knowledge by the farmers as reported in the study coupled with continuous monocropping in most cases may have lead to build up of these pests in vegetable farms (Maina *et al.*, 2010).

Conclusion

Cabbage is a host to important PPN. *Pratylenchus* was the most abundant nematode across the study area. Upper highland zones recorded more PPN than lower zones. Various factors were found to be important in promotion or suppression of nematodes infestations. Among them being intensive vegetable production such as monocultures, lack of nematode control interventions and most importantly, lack of technical knowledge and advice by the vegetable farmers. There is need therefore for extensive farmer education on the types and the available PPN management option to boost their crop production.

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