FIELD VARIATION OF ABIOTIC FACTORS AND THEIR RELATIONSHIP WITH NEMATODE COMMUNITIES IN SUGARCANE

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Abstract

The abundance and distribution of nematodes in the soil is influenced by biotic and abiotic soil factors. A previous study based on soil samples collected over a large part of KwaZulu-Natal showed that numbers of *Pratylenchus*, *Helicotylenchus* and *Paratrichodorus* were inversely related to pH and positively related to iron levels in the soil. Weaker relationships occurred between both aluminium and manganese and the three nematode genera. In contrast, numbers of *Xiphinema* showed no strong association with any of the soil characteristics. To determine whether the same relationships occurred on a much smaller scale, a study was made of the levels of certain abiotic soil factors and the distribution of the plant parasitic nematodes in a single sugarcane field. The data were derived from soil samples collected from five, adjacent, 200m rows across the field. *Xiphinema elongatum* dominated one part of the five transects while *Helicotylenchus dihystera* dominated the other part. The relationship between the soil elements and the nematodes differed from that found in the large scale survey. Co-inertia analysis showed a strong positive association between the numbers of *H. dihystera* and levels of magnesium in the soil whereas the reverse was true for *X. elongatum*. There was also a strong positive association between the numbers *X. elongatum* and levels of phosphorus. *H. dihystera* showed a positive association with most of the soil cations. The opposite was true for *X. elongatum.* The differences between the two studies are thought to be a consequence of the difference in scale.

Keywords: Sugarcane, abiotic soil factors, *Xiphinema elongatum*, *Helicotylenchus dihystera*.

Introduction

Feeding by plant-parasitic nematodes reduces the efficiency of the plant's root system leading to a loss in yield. This can be prevented by controlling the nematodes. In the South African sugar industry the current recommended method of control is the use of carbamate nematicides. These are effective but very poisonous and other, safer methods of control are desirable. Cadet and Spaull (2001) proposed that one way of controlling nematodes was to manipulate their populations in favour of those that are less pathogenic. They suggested that manipulation might be possible if the species respond to changes in soil chemical factors, for example a change in the ion balance of the soil solution. Such a change could affect the nematode's ability to locate plant roots or to find a suitable mate. Cadet and Spaull (2001) found that in a large scale survey of numerous sugarcane fields in KwaZulu-Natal, there was a stong association between some nematodes and certain soil characteristics. The abundance of *Pratylenchus, Helicotylenchus* and *Paratrichodorus* was inversely related to soil pH and positively related to Fe levels. Consistent but weaker relationships occurred between both Al and Mn and these three nematode genera. In contrast numbers of *Xiphinema* showed no strong association with any of the soil characteristics. This study was made on a large scale, extending over several hundred kilometres. To assess whether the same relationships could be detected on a much smaller scale we investigated the association between the levels of certain abiotic factors in the soil and distribution of the plant parasitic nematodes in a single field.

Materials and Methods

At the La Mercy farm on the KwaZulu-Natal North Coast, five adjacent rows of sugarcane, each 200m in length, were selected as five transects across a sugarcane field. The cane was a 13-month old crop of first ratoon NCo376. The soil in the field was a loamy sand. Samples of soil and sugarcane roots were collected to a depth of 30 cm from 40 sampling points, 5m apart, along each of the five rows. Subsamples of 200 cm^3 of soil were processed in the laboratory according to the method of Seinhorst (1962) and the nematodes identified and enumerated. The nematodes were extracted from the roots in a mist chamber (Seinhorst, 1950). Other subsamples of soil were processed in the laboratory of the Experiments Station's Fertilizer Advisory Service to measure pH and levels, (ppm), of various soil elements, viz, phosphorus, potassium, sulphur, calcium, magnesium, aluminium, sodium, zinc, manganese and iron (Barnard *et al.*, 1990).

The relationship between the soil characteristics and the nematode community at each of the sampling points was studied by means of co-inertia analysis using the ADE4 software of Thioulouse *et al*. (1997).

Results and Discussion

The common and abundant plant parasitic nematodes recovered from the soil were *Pratylenchus zeae, Helicotylenchus dihystera, Xiphinema elongatum* and *Paratrichodorus* spp. Species of *Scutellonema, Criconemella* and *Neodolichodorus* were common but less abundant. *Meloidogyne* was not recorded. There was a marked trend in the distribution of two abundant ectoparasitic nematodes, *Helicotylenchus dihystera* and *Xiphinema elongatum,* along the five transects. *X. elongatum* dominated one half of each of the transects while *H. dihystera* dominated the other end (Figures 1 and 2).

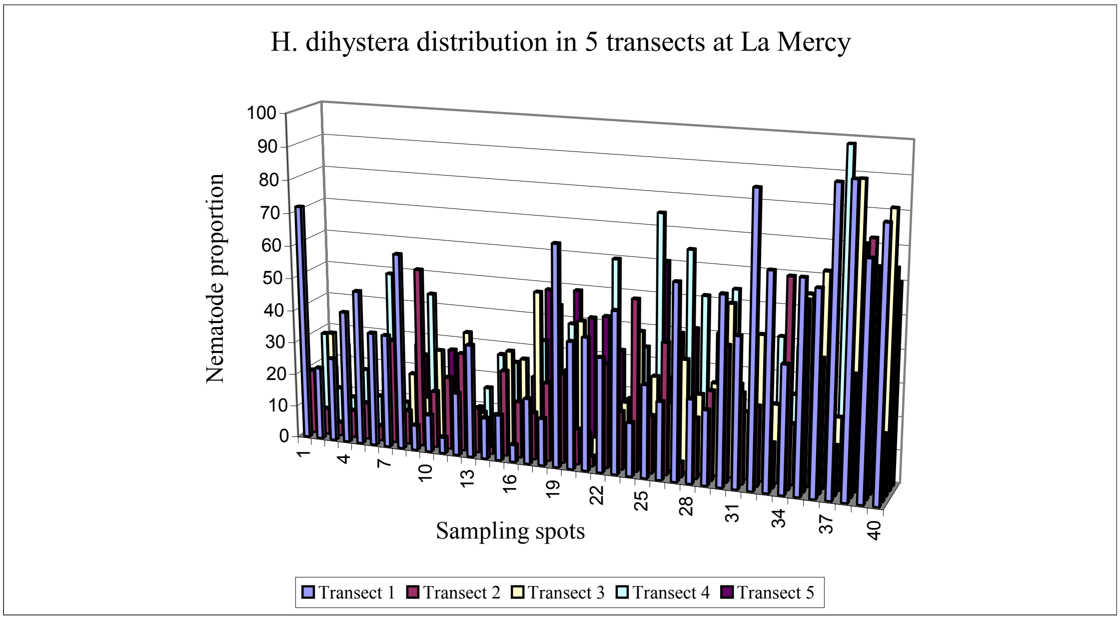

Figure 1: Distribution of *H. dihystera* along the 5 transects at La Mercy

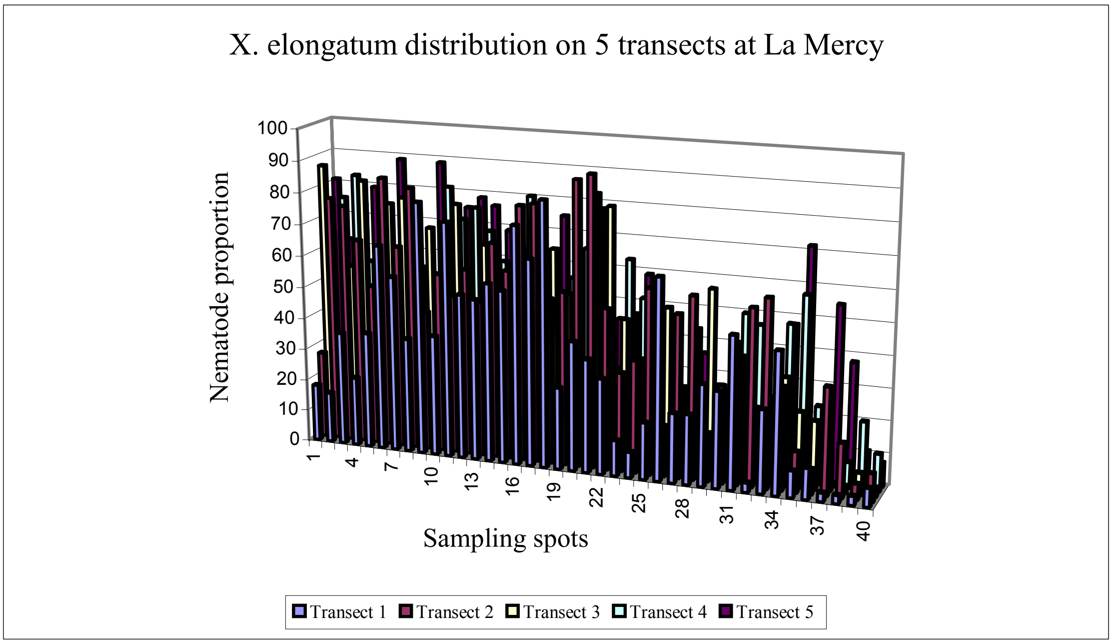

Figure 2: Distribution of *X. elongatum* along the 5 transects at La Mercy

The co-inertia analysis showed that there was a strong positive association between the numbers of *H. dihystera* and levels of magnesium in the soil whereas the reverse was true for *X. elongatum* (Figure 3). There was also a strong positive association between the numbers *X. elongatum* and levels of phosphorus. *H. dihystera* showed a positive association with most of the soil cations. The opposite was true for *X. elongatum.* The association between the soil elements and the two genera does not imply a cause and effect relationship as other biotic or abiotic factors may be responsible for the observed result.

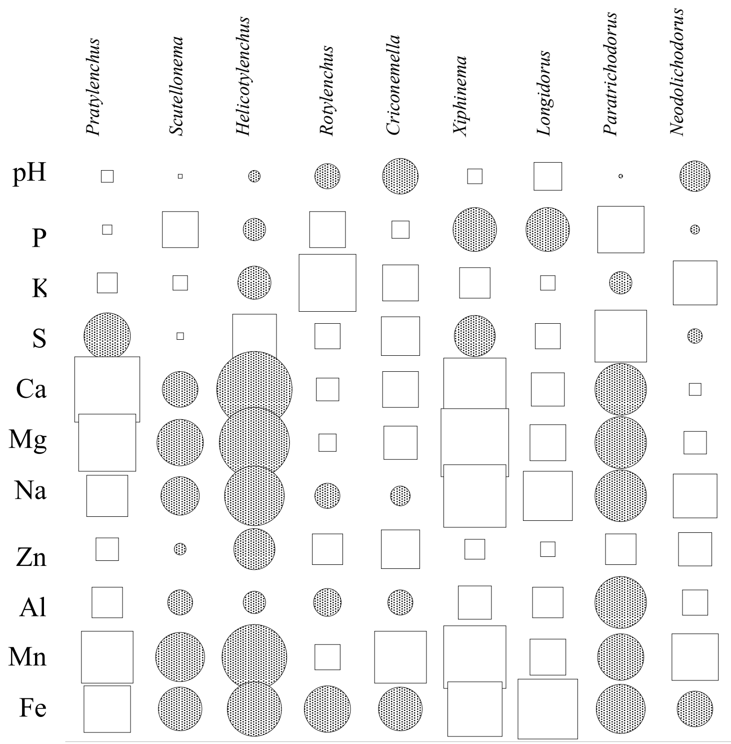

Figure 3: Crossed table for the 5 transects showing correlation between soil elements and nematodes. Circles correspond to positive factorial values and squares to negative values. The size of the symbol is proportional to the absolute value

A previous study based on soil samples collected over a large part of KwaZulu Natal indicated somewhat different relationships. Numbers of *Pratylenchus*, *Helicotylenchus* and *Paratrichodorus* were inversely related to soil pH and positively related to iron levels (Cadet and Spaull, 2001). Weaker, positive relationships occurred between both aluminium and manganese and the three nematode genera. In the present study there was some evidence that *H. dihystera* was positively associated with iron and manganese but far less so with pH and aluminium. Whereas *X. elongatum* showed no association with any of the soil characteristics in the large widespread survey, data from the transects show some evidence of a negative relationship with several factors (Figure3). The differences between the two studies may be a consequence of the difference in scale. Working at a wide scale offers the advantage of identifying interrelationships which could be generalised for the entire sugarcane industry. However, such an approach is complicated by differences in soil type. Some nematodes, such as species of *Meloidogyne*, are rarely associated with sugarcane in clay soils. The clay content has a marked effect on the level of ions in the soil. Consequently, mathematical analysis could simply extract the trivial relationship between the absence of one species in the soil with a low or high level of a chemical element where the species is absent. Working at a smaller scale seems more useful, but carries the risk that the extracted relationships will not be relevant and not applicable to other areas. This dilemma is currently being investigated through analysis at different scales.

Observations in a number of sugarcane fields in South Africa show that, on a within field scale, numbers and/or proportions of *H. dihystera* tend to be higher, and *X. elongatum* lower, in situations where sugarcane growth is above the average (Cadet, unpublished). Identifying the chemical environment that favours this scenario can be expected to lead to improved cane yields. Further work is required to identify the relationship between soil elements and the numbers of *X. elongatum* and *H. dihystera*.

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