EFFECT OF SOME SYSTEMIC NEMATICIDES ON PLANT-PARASITIC NEMATODES

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I N T R O D U C T I O N

The sedentary endoparasites, the root-knot nematodes (*Meloidogyne* Goeldi), which have a wide host range and a high reproductive potential, are the most prevalent and destructive plant-parasitic nematodes. They penetrate rootlets as a second-stage larvae, become sedentary before molting, and remain through the rest of the life cycle. Thus penetration of a host by a nematode is a transitional stage between two different environments, viz. soil and plant.

Since the main part of *Meloidogyne* life cycle (parasitic phase) is displayed within root tissues, promising almost non-volatile compounds with systemic properties, have been developed. Some of these compounds are granular materials which are incorporated into the soil and, then, pervade through root tissues to destroy the infectious nematodes. Therefore, mobility of pesticides in soil is an important factor in determining the rate of uptake in plants. Accordingly, some mobility is desirable to assure distribution in the root zone; while faster mobility is unfavorable as it reduces the residual effect of the pesticides in treated soil; consequently, less efficient control measures will ensue.

Factors subserve the speed of mobility are concerned mainly with type and structure of the soil and the properties of the used pesticides. Furthermore, the rate of release of pesticides from the used formulation is considered to be one of the principal factors in this respect.

The purpose of the present experiments is to assess the effect of soil type on root-knot nematode population, to test the efficacy of certain systemic nematicides in controlling the concerned nematodes, and to explore the mobility of the tested nematicides in two types of soil.

REVIEW OF LITERATURE

Knowledge of ecological relationships between plant-parasitic nematodes and their environment is important for understanding some of the principles of nematode control. The microhabitat of soil nematodes is primarily the labyrinth system of the soil and the water films extending over the soil particles and nematodes. The relationship between soil moisture and pore size is so close that, in studies of their influence on nematode movement, it is necessary to consider them together (Wallace, 1956). Nematodes are wholly dependent on water for movement. Wallace (1958 a,b&c) analyzed the importance of the moisture content and geometry of the environment for migration of Heterodera schachtii Schmidt larvae in soil. He found that speed was greatest in pores of 30 - 60 u diameter, which corresponds to a particle size of 150 - 250 u. Conversely, he added, in channels appreciably wider than 100 u (the diameter of the nematode), there was less restriction to lateral movement and a corresponding reduction of forward movement. He also indicated that pore diameters less than 20 u prevented nematode movement. Thus, H. schachtii larvae, migrating downwards through vertical saturated columns of sand, were greatly impeded where the sand particle diameter was less than 150 to 250 u, because the mean pore diameter was about the same as the nematode width (Wallace, 1958a). In the case of *Pratylenchus zeae* Graham and *Pratylenchus brachyurus* (Godfrey) Goodey, they moved further in sandy loam than in clay soil (Wallace, 1963). Movement of *Pratylenchus penetrans* Cobb was greater in Fox sandy loam, a coarse-textured soil, than in Vineland silt or Jeddo loams, both fine-textured soils, because of differences in their respective pore distribution and moisture retention properties (Townshend & Webber, 1971). Townshend (1972) found that penetration of corn roots by *P. penetrans* and *Pratylenchus minyus* Sher and Allen was greater in Fox sandy loam than in Vineland silt loam and Jeddo loam. Kincaid (1964) suggested that porous sandy soils favored movement of root-knot nematodes. Furthermore, Oteifa et al. (1964) studied the infection index of root-knot nematode, *Meloidogyne javanica* (Treub) Chitwood, on cowpeas in desert sand, Nile mud and valley soil. They concluded that soil containing 60-75% sand with ratios of silt/clay in the orders of 1 : 1, 2:1 and 3 : 1 were found the best for nematode infectivity. Rode (1962) found that *Heterodera rostochiensis* Wollenweber migrated further in sandy soils, less in loamy soils and least in clay soils. In some soils, chemical factors may affect nematode activity and movement (Luc, 1961).

Practical control of plant-parasitic nematodes with nematicidal chemicals is a relatively recent development. The most successful and effective nematicides in use today are volatile halogenated hydrocarbons. A trend toward less volatile materials began with the development of DBCP (1,2-dibromo-3-chloropropane). The use of DBCP as a preplant treatment has been practiced successfully against root-knot nematode on sugar-beet (Lear & Raski, 1958), on velvet sweet-potatoes (Thomason & Mckinney, 1961), on tomato (Johnson & Lear, 1966), and on common beans in sandy soils (Yousif, 1972). Lownsbery et al. (1968) attributed the failure of DBCP post-planting treatment in controlling Meloidogyne and Pratylenchus nematodes to their nature of endoparasitic habits.

With the development of systemic nematicides a new tool in the control of endoparasitic nematodes was approached. The organophosphorus compounds, e.g. Nemacur P, Nemafos , Thimet + Nemafos mixture and Terracur P, performed satisfactory control measure against the reniform nematode, Rotylenchulus reniformis Olievera and Linford on cotton (Oteifa, 1970; El-Eraki, 1970) and on root-knot nematodes, Meloidogyne spp. on common beans (Yousif, 1972). Temik, a carbamate compound, exercised excellent results against R. reniformis on cotton (Oteifa, 1967 & 1970; Birchfield, 1968;

El-Eraki, 1970), and on sweet-potatoes (Birchfield & Martin, 1968). The action of Temik on nematodes was reported as reduction of *R. reniformis* reproduction rate (Oteifa et al., 1969), decrease in number of *H. rostochiensis* larvae penetrating the roots (den Ouden, 1968; Hague & Paine, 1970) or suppressing hatching of *Meloidogyne incognita* (Kofoid & White) Chitwood (Nelmes & Keerweewan, 1970). Thimet & Nemafos also reduced the rate of reproduction of *R. reniformis* on cotton (Oteifa et al., 1969). El-Eraki (1970) considered Lannate and Temik the leading pesticides in respect to *R. reniformis* control on cotton. Miller and Taylor (1970), however, found in green-house trials that Lannate gave good control of the tobacco cyst nematode, *Heterodera tabacum* Lowns. and Lowns., 3 weeks after addition to soil, but not 8 weeks after addition. Root-knot nematodes were successfully controlled by using Temik on cowpea, okra and Mungo beans (Pagusberon, 1972) and on common beans (Yousif, 1972).

Systemic nematicides are taken up by plant roots and move to the site of action in the roots or in the aboveground parts of the plants. The sorptive ability of soil for cations is well-known. Johnson and Lear (1968) detected DBCP, a contact nematicide, deeper in soil composed of 67% sand, 26% silt and 5% clay than in soil of 65% sand, 26% silt and 9% clay. The soil itself restricts diffusion of the nematicides.

depending on various physical and chemical factors such as the amount of clay and organic matter, soil temperature and the amount of moisture present.

As for systemic nematicides, their mobility is an important factor in controlling nematodes. Temik showed increasing rate of mobility in clay soil (Zidan, 1969). He found that the rate of binding within the top layer was 5.55% of the applied dose, while about of 64.1% was distributed in the next successive 4 layers in the following order, 9.6, 11.6, 10.4 and 32.5% respectively. He also found that the presence of organic matter sources caused increasing rates of binding within the top layer, and the rates of increments varied according to the type of organic matter and were proportional to the levels of application. He concluded that the rate of mobility of each insecticide examined, viz. Heptachlor, Di-syston, Thiocron, Temik and Sevin, was variously influenced according to the type and nature of the used pesticides and the type and level of the added organic matter.

Biddulph et al. (1958) stated that the capacity of plant to take up and transport systemic nematoxicant from leaves, shoots or roots would be affected by the presence of other chemicals either in the formulation or in soil water, climate conditions and physiological gradient in the plant.

Jenson and Konicek (1960) stated that the organophosphorus compounds probably moved upwards in the xylem but downward translocation to the root was slow, and, as detoxification may occur, organophosphates were seldom effective against root pathogens when applied to the leaves. They added that many organophosphorus compounds applied close to the plant roots decreased the number of nematodes in roots, shoots and leaves of the host plant.

Reynolds and Metcalf (1962) studied the effect of soil moisture and water solubility of the systemic insecticides upon adsorption and translocation in insecticidal quantities. They found that materials of very low water solubility took more than 2 weeks to attain aphid mortality ; while moderately water soluble insecticides achieved the same purpose within few days.

Lichtenstein (1959) reported that insecticides were absorbed to the soil organic matter to such an extent that in a muck soil no phytotoxicity was noticeable and the breakdown of insecticides slowed down. It was also possible, he added, that the insecticides dissolved in the organic matter of a muck soil, and; therefore, were less available for metabolism or picked up by plants. Bailey and White (1964) showed that the bioactivity of herbicides and insecticides were lowest in soils higher in organic matter or clay content; while it was highest in the light-textured soils.

Lichtenstein and Schulz (1965) studied the movement of insecticides in soils under leaching and non-leaching conditions. They found that 17 months after soil treatment, 84 to 96% of the insecticides were detected in the upper 3-inch level of the loam soil, 4 to 12% in the 3 to 6-inch layer and 0.0 to 5% in the 6 to 9-inch layer. In muck soil; however, 62 to 74% was found in the top layer.

MATERIALS AND METHODS

1. Nematode inoculum :

The original root-knot nematode inoculum was obtained from infested tomato field at the Faculty of Agriculture, Shubra El-Khaima. Cultures of root-knot nematodes were maintained at outdoors temperature in the Faculty of Agriculture, Shebin El-Kom, on tomato plants (*Lycopersicon esculentum* L. var. Commune) grown in 30-cm pots filled with sterile sand. They were watered daily with tap water and with nutrient solution (Hewitt, 1951) once a week. The mixed species of *Meloidogyne* maintained in the stock cultures were identified by the posterior cuticular pattern (Taylor, Dropkin & Martin, 1955) as *M. javanica* and *M. incognita*.

2. Nematode assay :

At the end of each experiment, tomato plants were gently removed from the pots and roots were washed and weighed. Nematode-galls were separated from each infected plant root, counted, and, then, 5 galls were randomly selected as a represented sample, which, immediately stained with acid fuchsin in lactophenol and stored in it for not less than 24 hours. The represented samples were rinsed in water, macerated and