



Short Communication

Environmental Abiotic and Nematode Biotic Factors Affecting Virulence of Corn Cyst Nematode, *Heterodera zae* on Corn in Egypt

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Abstract | Soil texture as abiotic factor alongside three biotic factors respecting with nematode such as inoculation levels, inocula storage conditions and inocula source types affects the virulence of *Heterodera zae*. Lighter soil textures such as sandy clay loam and sandy loam were found to be more conducive to nematode proliferation compared to other soil types. Previous studies have stated that the initial level of *H. zae* increased, the final population also showed a corresponding increase, but a negative correlation existed between the initial level and rate of nematode build-up. Notably, highly final population were detected on inoculated corn plants with fresh stored cysts under greenhouse conditions compared to stored cysts in a refrigerator or under laboratory conditions. When the corn plants were inoculated with juveniles, the nematode attained the lowest rate of build-up while the maximum value was achieved when eggs were used as the inoculum. Additionally, corn growth was significantly reduced in cases where eggs were used for inoculation compared to juveniles or cysts.

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Keywords | *Hererodera zae*, Soil textures, Inoculation levels, Inocula storage conditions, Types of inocula, Virulence, Egypt



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Introduction

In Egypt, the corn cyst nematode, *Heterodera zae* has been identified as a significant nematode affecting maize plants, as highlighted by Aboul-Eid and Ghorab (1981), Ismail (1985, 2009), Abadir (1986), Moussa *et al.* (1988) and Ismail *et al.* (1993). Successful establishment of a plant parasitic nematode species is depending on how much the environmental a biotic factors and nematode biotic conditions are favoring its survival. Some methods are discussed as follows:

An environmental abiotic factor

Behavior of *H. zae* as influenced with soil textures: Movement, development and distribution of the nematode were observed in the best soil textures. Upadhyay *et al.* (1972), Whitney and Doney (1973), Santo and Bolander (1979), Anand and Weather (1985), Walia (1987) and Todd and Pearson (1988) stated that the virulence of related nematode species, including *Heterodera rostochiensis*, *H. schachtii*, *H. cajani* and *H. glycines* were more favourable in the light clay soil than in the heavy clay soil. Lighter soils were observed to be more favorable for *H. zae* build-

up and attributed to good aeration and porosity in these soil types (Srivastava and Sethi, 1984a). Studies conducted by Egyptian researchers, showed that *H. zae* vitality increased in light soil than heavy soil (Ismail, 1985; Abadir, 1986; Ismail and Khair, 2014a) which help free vitality the nematode infection. The same findings are consistent with earlier research by Wallace (1963); Upadhyay *et al.* (1972); Taha and Kassab (1979) and Walia (1987). Specifically, lighter soils i.e., sandy clay loam and sandy loam have been identified as more conducive environments for corn plant damages by the nematode infection compared to other soil types, (Anand and Wrather, 1985; Ismail and Khair, 2014a; Abd- Elgawad, 2024).

Nematode biotic factors

Heterodere zae behavior as influenced with nematode inoculation levels and response of the corn growth: Biotic factors such as nematode inoculation levels are useful in evaluating the virulence potential of a nematode species (Ismail, 2023). The relationship between inoculation levels of other cyst nematode species and host plant growth, nematode build-up was deeply studied (Rao and Peachy, 1965) on *H. rostochiensis*, Gill and Swarup (1973) on *H. avenae*, Sharma and Sethi (1975) on *H. cajani*, Maas and Brinkman (1977) on *H. graminicola* and Griffin (1988) on *H. schachtii*). Specifically, 100 or 500 cysts of *H. zae* plant affected corn height; while levels of 100, 250, 500, or 1000 cysts/plant adversely decreased the fresh and dry weights (Ghorab, 1978). Applying 100 juveniles of *H. zae* kg of soil for the Pusa isolate and 1000 juveniles per kilogram for other isolate significantly decreased corn growth in compared to check plants (Srivastava and Sethi, 1984b). In 1985, Ismail declared that rate of cyst increase for corn cyst nematode was achieved at 200 cysts/plant. Abadir (1986) reported that Tanta isolate of *H. zae* inoculated with 1000 eggs and juveniles/plant was most virulence producing the highest number of cysts but, at using of 2000 eggs and juveniles/plant it was surpassed by the Belbais isolate. Plant growth reduction caused by the nematode could be attributed to the modification of plant physiological function i.e. photosynthesis, transpiration and mineral uptake following infection as reported by Heald and Jenkins (1964), Wallace (1963), Ismail (1985) and Ismail and Khair (2014b).

Viability, infectivity and virulence of H. zae as influenced with cysts storage conditions

Inocula storage conditions are important as biotic

factors influencing on the nematode's behavior. The potato cyst nematode, *H. rostochiensis* cysts and juveniles were viable after 5 years under dry storage conditions (Ellenby, 1955, 1968) in compared to *H. schachtii* because the juveniles of the sugarbeet cyst nematode lose water more than *H. rostochiensis* juveniles, while these conditions are not favorable to *H. avenae* cysts (Winslow, 1955). Active juveniles and cysts of *H. glycines* were extracted from soil balls which taken from soybean seed sources after 5-8 months from collecting time (Epps, 1969). Soybean cyst nematode juveniles survived 7-19 months under irrigation conditions and up to 38 months in dry soil (Slack *et al.*, 1972). Low-temperature (5 or 10°C) was more favourable for the vitality of *H. avenae* juveniles (Davis and Fisher, 1976). Respecting to *H. zae*, there is a scarcity of literature on this particular factor. Krusberg and Sardanelli (1989) observed that eggs or active second stage juveniles inside cysts of *H. zae* still vital under field conditions. Recovered after fifty-one months from naturally infested field soil stored moist under laboratory conditions some good cysts were extracted but after over two hundred days of storage, active larvae emerged from the recovered cysts and many white females developed in bioassays of these cysts. Ismail and Khair (2014c) observed that *H. zae* had higher reproduction rates on inoculated maize plants with fresh cysts followed by which stayed for twelve months under low temperature 5°C. Also, the lowest final population and build-up was found when using *H. zae* cysts stored under laboratory conditions. Consequently, the reduction in plant growth was more significant when fresh cysts were used compared to other storage conditions. Cooling conditions was better for *H. zae* cysts than drying state (Krusberg and Sardanelli, 1989).

Influence of various inocula kinds on virulence of corn cyst nematode

Also, various types of inocula have been studied by some researchers. Gill and Swarup (1973) observed that freshly hatched second-stage juveniles of *H. avenae* was very virulence than cysts done. *H. rostochiensis* populations were significantly increased in case the plants which inoculated with cysts than the eggs and this regarding to the variation in the cyst contents of eggs and juveniles (Den Ouden, 1963). Contrarily, Ismail and Khair (2014d) found that the further development of *H. zae* was high at using eggs as inocula compared with cysts or juveniles. This method was found to be more virulent on

corn growth and this respecting to the presence of eggshell which protect the juveniles from the adverse external conditions during the inoculation process. On the other hand, using juveniles as the inoculum might expose them to harmful conditions during this process. When cysts were used as the inoculum, the variability in their content and delaying of juveniles' emergence may decrease their virulence (Ismail and Khair, 2014d).

Conclusions and Recommendations

Soil textures as an environmental abiotic factor along with certain nematode biotic factors i.e. inoculation levels, inoculum storage conditions and inoculum source types are directly affecting on virulence of corn cyst nematode. Some methods were discussed to manage the nematode.

Novelty Statement

The work declares the important environmental abiotic and nematode biotic factors affecting the population behavior of corn cyst nematode.

Conflict of interest

The author has declared no conflict of interest.

Generative AI or AI-assisted Technology Statement

The author declares that no Genrative AI was used in the creation of this manuscript.

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