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THE RELATIONSHIP BETWEEN INITIAL POPULATION DENSITIES OF *MELOIDOGYNE ARTIELLIA* AND YIELD OF WINTER AND SPRING CHICKPEA

by
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Summary. Microplots were used to investigate the relationship between population densities of *Meloidogyne artiellia* and yields of winter and spring sown chickpea in Italy. Microplots (30 × 30 × 50 cm) were infested with population densities ranging from 0 to 128 eggs and juveniles/cm^3 soil. Eight seeds of chickpea «Ghab 1» were sown in each microplot on 10 December 1986 for winter and on 4 March 1987 for spring chickpea. Both plant growth and yield were greatly affected by *M. artiellia*. Symptoms of nematode attack were evident at large population densities. Tolerance limits of 0.138 and 0.0155 eggs and juveniles/cm^3 soil and minimum relative yields of chickpea grains of 0.1 at $Pi \geq 8$ for winter chickpea and 0.18 at ≥ 1 eggs and juveniles/cm^3 soil for spring chickpea, were estimated. Maximum reproduction rates of the nematode were 55.5 for winter and 3.38 for spring sown chickpea.

The root-knot nematode, *Meloidogyne artiellia* Franklin, was first reported from England on cabbage (Franklin, 1961). Later the nematode was found on wheat in Greece (Kyrou, 1969) and on chickpea in Spain (Tobar-Jimenez, 1973), Italy (Greco, 1984), and Syria (Mamluk *et al.*, 1983; Greco *et al* ., 1984). The nematode has a wide host range and reproduces well on cereals, cruciferous and legumes (Di Vito *et al.*, 1985a). Among them are several plant species that are widely cultivated in the Mediterranean basin and severe damage must be expected, especially on chickpea (*Cicer arietinum* L.) (Di Vito and Greco, 1988). Therefore investigations were undertaken to ascertain the effect of a range of initial densities of an Italian population of *M. artiellia* on the yield of winter and spring sown chickpea.

Materials and methods

Two hundred seventy two microplots consisting of bottomless square sections of concrete tube (30 × 30 × 50 cm) were buried in the soil to within 5 cm of the upper edge in the field at Bari. The microplots were contiguous along the rows and spaced 30 cm between rows. Each microplot contained 36 dm^3 of a sandy loam soil fumigated with 300 l/ha of 92% 1,3 dichloropropene 6 months before sowing.

Meloidogyne artiellia was reared on durum wheat (*Triticum durum* Desf.) grown in microplots the year before and harvested the previous June. The infested soil was thoroughly mixed in November and 10 soil samples of 500 cm^3 were processed by Coolen's modified method (Coolen, 1979; Di Vito *et al.*, 1985) to estimate the nematode population densities. Appropriate amounts of infested soil, with 20 g of a fertilizer (20% P_2O_5) incorporated, were then mixed with the soil in each microplot, using a concrete mixer, to give a series of nematode population densities ranging from 0 to 128 eggs and juveniles/cm^3 soil. There were 8 replicates of each inoculum level arranged in a randomized block design.

The microplots were sown each with 8 seeds of cv. Ghab 1 on 10 December 1986 for winter and on 4 March 1987 for spring chickpea. They were then inoculated with *Rhizobium* sp. and after emergence the plants were thinned to four per plot.

To obtain information on the decline of the nematode population in the absence of a host, 10 more microplots were inoculated with 15.9 and further 10 with 21.6 eggs and juveniles/cm^3 soil for winter and spring chickpea, respectively, and left without plants.

During the experiments microplots sown with spring chickpea were irrigated once only on 15 April 1987. The leaf miner (*Liriomyza cicerina* Rond.) was controlled with sprays in both crops with methidathion.

The top of plants and seeds were harvested and weighed on 26 June for winter and 7 July 1987 for spring chickpea. The protein content (N × 6.25) of winter chickpea grain was determined with a NEOTEC food quality analyser 51A, which uses the principle of near-infrared re-

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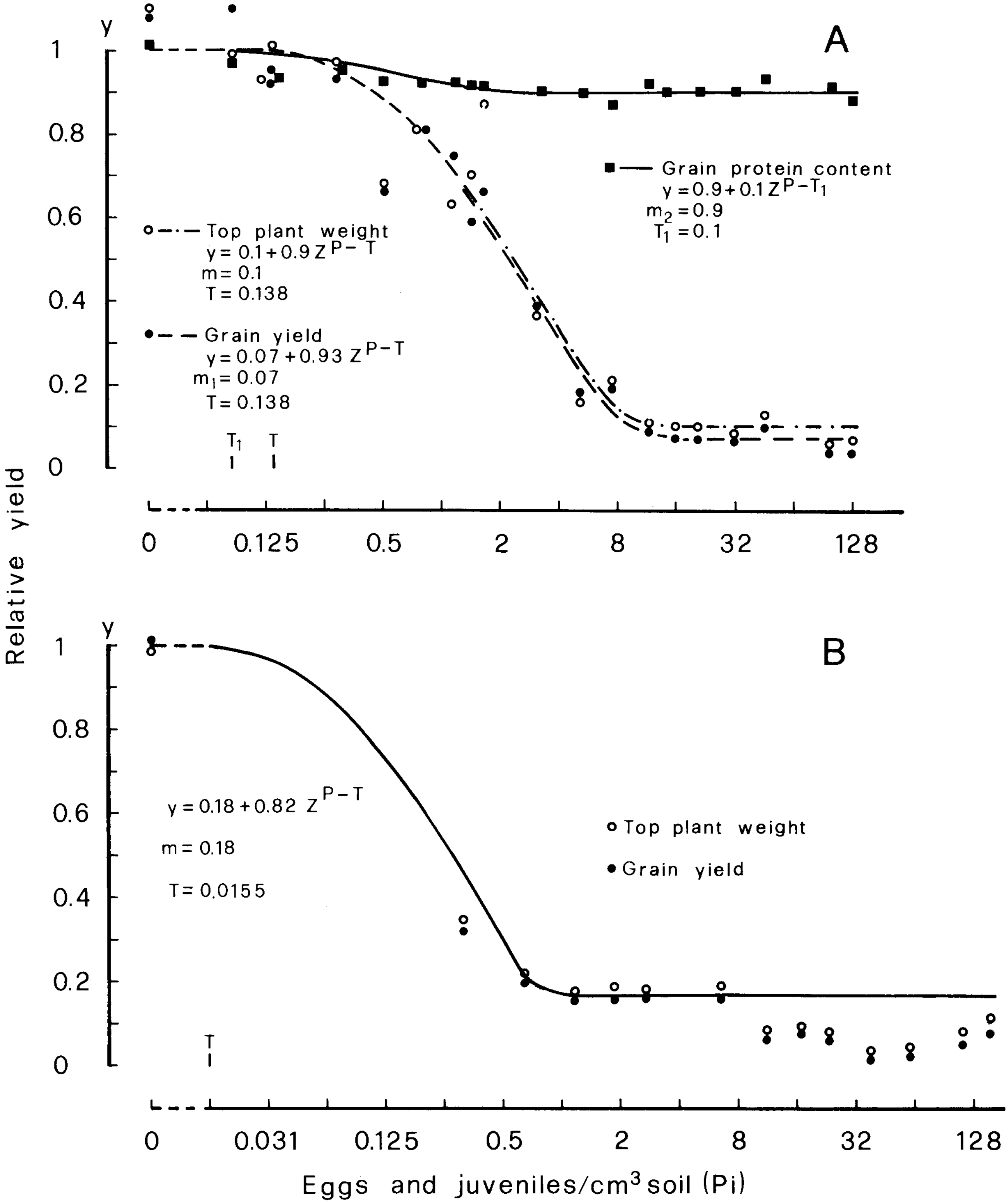

Fig. 1 - Relationship between population densities of *Meloidogyne artiellia* at sowing (*Pi*) and relative top plant weight, grain yield and grain protein content (*y*) of winter sown chickpea (A); and relative top plant weight and grain yield (*y*) of spring sown chickpea (B).

flectance spectroscopy (NIRS). Calibration was done by determining nitrogen content by macro-Kjeldahl procedure (AOAC,1965).

After harvest, 20 soil cores were taken to a depth of 30 cm in each microplot to provide a 2 kg composite sample. The samples were processed by Coolen's modified method (Coolen, 1979; Di Vito *et al.*, 1985) and numbers of eggs and juveniles counted. Curves were then fitted to the data according to Seinhorst's equation (Seinhorst, 1965; 1970).

Results

Environmental conditions during the investigation were favourable for both chickpea growth and *M. artiellia* reproduction. Symptoms of nematode attack, yellowing and stunting, were evident by 1 March 1987 in winter chickpea plots with initial population densities $Pi \geq 32$ eggs/cm^3 soil and by mid April at $Pi \geq 4$ eggs/cm^3 soil. At $Pi \geq 16$ eggs/cm^3 soil some plants had died by mid May. Similar symptoms of nematode damage appeared on spring sown chickpea on mid May and also at nematode initial population densities of 0.5 eggs/cm^3 soil. The time scale for emergence, flowering and podding of both crops was not noticeably affected by the nematode infestation. However, plants growing in heavily infested microplots flowered poorly and pods were empty or contained small seeds. Data of the top plant and seed weights, and seed protein content fitted the equation (i) $y = m + (1 - m)\, z^{P-T}$ (Seinhorst, 1965), where y is the ratio between the yield at Pi and that at $P \leq T$, m the minimum relative yield (y at very large Pi), z a constant with $z^{-T} = 1.05$, and T the tolerance limit (Pi above which damage occurs). Fitting the data to equation (i) (Fig.1) gives tolerance limits (T) for chickpea of 0.138 and 0.0155 eggs and juveniles/cm^3 soil for winter and spring chickpea, respectively, and the minimum relative yields (m) of 0.1 at $Pi \geq 8$ for top weight and 0.07 at $Pi \geq 16$ for seed yield of winter sown chickpea. Minimum relative yield of top and seed weights of spring chickpea was 0.18 at $Pi \geq 2$ eggs/cm^3 soil, and for seed protein content of winter chickpea 0.9 at the same nematode density (Fig.1).

Since *M. artiellia* completed only one generation per year (Di Vito and Greco, 1988) the relationship between

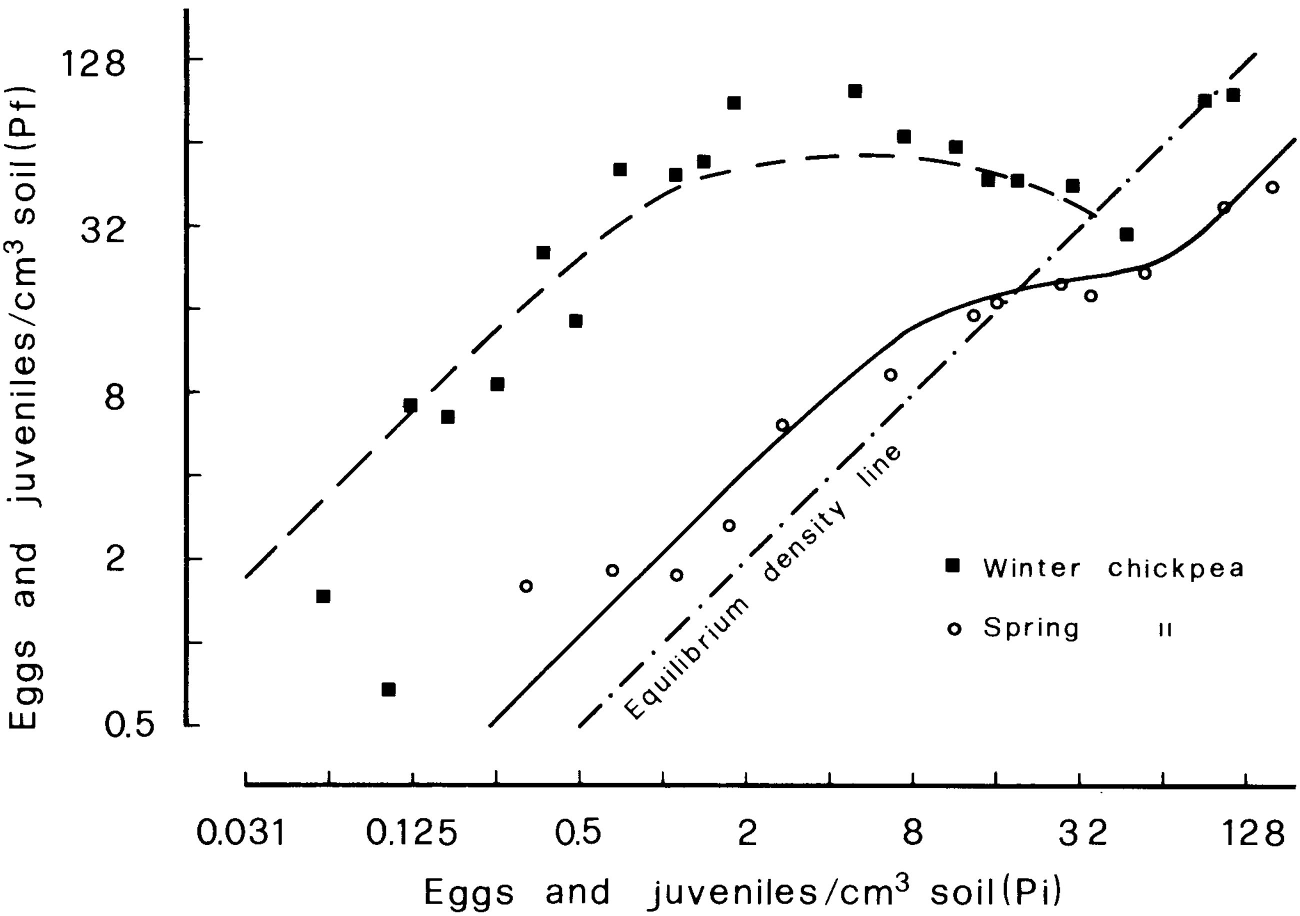

Fig.2 - Relationship between population densities of *Meloidogyne artiellia* at sowing (*Pi*) and at harvest (*Pf*) on winter and spring chickpea.

its initial (*Pi*) and final (*Pf*) population densities can be described by the equation (ii): $Pf = rfa(^{e}\text{-}\log q)^{-1}(1\text{-}q^{Pi}) + rb(1\text{-}y)Pi + b(1\text{-}r)\,Pi$ (Seinhorst, 1970; 1986) in which a = the maximum rate of multiplication, r = the proportion of the egg population (*Pi*) that is induced to hatch when plant size is not reduced by nematode attack (small population densities), f = the relative size of the food source, b = the proportion of the nematode eggs that hatch spontaneously in the absence of host roots and y = the relative size of the root system according to eq. (i). As shown in Fig. 2, reproduction rates of *M. artiellia* on winter chickpea were larger than on spring chickpea and maximum reproduction rates were 55.5 at smallest *Pi* for the first and only 3.38 for spring chickpea. Equilibrium densities of 35.8 and 20.27 eggs/cm^3 soil also were derived for winter and spring chickpea, respectively.

Discussion and conclusion

These investigations confirm the destructive effect of *M. artiellia* on chickpea in the Mediterranean area. In winter the mean soil temperature is 10°C at 20 cm depth. At this temperature the nematode invades chickpea but its development is very slow and the adult stage is not reached until 66 days after plant emergence (Di Vito and Greco, 1988) and thus there is likely to be little damage caused. Spring chickpea emerges about mid March when the soil temperature begins to rise, thus favouring nematode invasion and development with consequent more severe damage to chickpea. Probably the longer growing season and larger root size achieved by the plant in winter, and the lesser amount of damage compared with spring chickpea, may account for the larger reproduction rate of *M. artiellia* on winter chickpea. According to our results the damage caused by *M. artiellia* on chickpea is more severe than that caused by *Heterodera ciceri* Vovlas, Greco *et* Di Vito (Greco *et al.*, 1988), but its tolerance limits are close to those reported for other root-knot nematodes on different crops in the same area (Di Vito *et al.*, 1983; 1985; 1986). Reduction of the grain protein content of chickpea and therefore of its nutritional quality has also been reported previously for *H. ciceri* (Greco *et al.*, 1988) and most probably is a common reaction of the plant to nematode infestation.

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