EFFECT OF POPULATION DENSITIES OF *MELOIDOGYNE INCOGNITA* ON COMMON BEAN

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Summary. The effect of initial population densities of an Italian population of *Meloidogyne incognita* host race 1 on the growth of common bean was investigated in 800 cm^3 pots. Each pot was inoculated with 0, 0.0625, 0.125, 0.25, 0.5, 1, 2, 4, 8, 16, 32, 64, 128, 256 or 512 eggs and second stage juveniles/cm^3 soil and sown with one pregerminated seed of the dwarf common bean cv. Talento. Data of height, internode length and fresh top and root weight of the plants fitted the Seinhorst model $y = m + (1\text{-}m)z^{P\text{-}T}$. The tolerance limits of fresh top and root weight, height and internode length of plants were 0.25, 2, 0.3 and 0.5 eggs and juveniles/cm^3 soil, respectively. Minimum relative yields of fresh top and root weights, height and internode length of plants were 0, 0, 0.15 and 0.14 at ≥128 eggs and second stage juveniles/cm^3 soil, respectively. The maximum reproduction rate of the nematode was 888-fold at the lowest initial population densities. The root gall index was lowest at low initial populations and highest at ≥16 eggs and second stage juveniles/cm^3 soil.

Common bean is the most widely cultivated legume. In 2002, about 26,837,000 ha were cultivated worldwide, with a dry seed production of 18,334,000 t (FAO, 2002). Several species of nematodes have been reported to damage the crop (Sikora and Greco, 1990) with an annual yield loss of about 11% at world level (Sasser and Freckman, 1987). Among them the root-knot nematodes *Meloidogyne incognita* (Kofoid *et* White) Chitw. and *M. javanica* (Treub) Chitw., are the most common and damaging nematodes of common bean in several countries. In Italy, common bean is one of the most common food legumes and is often damaged by root-knot nematodes under both field and greenhouse conditions. Nevertheless, information on how these nematodes affect the yield of this crop is limited. In Florida (U.S.A.), McSorley *et al.* (1981) observed that the extent of damage to snap bean was correlated with the soil population gradient of *M. incognita*. In Brazil, the tolerance limit of common bean to *M. javanica* was 1 egg/cm^3 soil (Sharma, 1981), while in Venezuela Crozzoli *et al.* (1997) found that the tolerance limits of three common bean cultivars to *M. incognita* were between 0.02 and 0.03 egg/cm^3 soil. In Italy, information on the pathogenicity of *M. incognita* to common bean is lacking. Therefore, an experiment was undertaken in a glasshouse to relate the effect of a range of initial population densities of an Italian population of *M. incognita* with the growth of this crop plant.

MATERIAL AND METHODS

The Italian population of *M. incognita* host race 1, was reared in pots containing tomato (*Lycopersicum esculentum* Mill.) plants of the cv. Rutgers in a glasshouse at 25±3 °C. When large egg masses were formed, the plants were uprooted and the roots were gently washed, finely chopped, thoroughly mixed and numbers of eggs and second stage juveniles/g roots estimated by processing six 5 g root samples with 1% solution of sodium hypochlorite (Hussey and Barker, 1973). Infested roots were thoroughly mixed with 2 kg of steam sterilized sandy soil and this was then used as inoculum. Ninety clay pots were filled with 800 cm^3 of stem sterilized sandy soil (90% sand, 4.9% silt, 5.1% clay and 2.4 % organic matter). Appropriate amounts of inoculum were thoroughly mixed into the soil in each pot to give population densities of 0, 0.0625, 0.125, 0.25, 0.5, 1, 2, 4, 8, 16, 32, 64, 128, 256 and 512 eggs and second stage juveniles/cm^3 soil. The chopped infested roots were used to prepare the inoculum instead of dispersed eggs because they were found more efficient (Di Vito *et al.*, 1986). A single pregerminated seed of dwarf common bean (*Phaseolus vulgaris* L.) cv. Talento was sown per pot. The pots were then arranged on benches in a glasshouse at 25±3 °C in a completely randomized block design with six replications for each inoculum level. During the growth period, pots were irrigated and fertilized as required and data were recorded on the appearance of symptoms of nematode infestation (stunting and yellowing).

The common beans were harvested 45 days after sowing and the numbers of nodes, height and fresh top and root weights per pot were recorded.

Root infestation by the nematode was assessed by estimating the root gall index on a 0-5 scale (Di Vito *et al.*, 1979) and by counting the number of eggs and juveniles in the egg masses present on the roots by processing each root system in a 1% sodium hypochlorite solution (Hussey and Barker, 1973). The final population density of the nematode in the soil of each pot were evaluated by processing 500 cm^3 soil by modified Coolen's method (Coolen, 1979; Di Vito *et al.*, 1985). The number of eggs and juveniles in the soil plus those found on the roots of the same pot was considered as the total final population (*Pf*) per pot.

Data on plant growth parameters were fitted to Seinhorst's models (Seinhorst, 1965; 1979) and Duncan's Multiple Range Test was performed for the data on root gall index.

RESULTS AND DISCUSSION

The Italian population of *M. incognita* negatively affected the growth of common bean plants. Symptoms (stunting and yellowing) of the nematode attack were clearly evident two weeks after sowing in pots infested with ≥32 eggs and second stage juveniles/cm^3 soil. Ten days later all plants in pots infested with more than 64 eggs/cm^3 soil were dead.

Data on fresh top and root weights, height and internode length of plants fitted the model $y = m + (1 - m)z^{P-T}$ proposed by Seinhorst (1965; 1979), where y is the relative yield (the yield at a given $P > T$ divided by the average yield at all $P \leq T$) with $y = 1$ at $P \leq T$, m is the minimum yield (= y at very large population density), P (= Pi) is the nematode population density at sowing expressed as eggs and second stage juveniles/cm^3 soil, T is the tolerance limit of the crop to the nematode (= value of P up to which no crop damage occurs), and z is a constant with $z^{-T} = 1.05$. By fitting the data to this model, values of tolerance limits (T), relative yield (y) at different population densities and minimum yields (m) were derived from the curves in Figg. 1-2.

The tolerance limits (T) of fresh top and root weights, height and internode length of plants were 0.25, 2, 0.3 and 0.5 eggs and second stage juveniles/cm^3 soil, respectively (Figg. 1, 2). Minimum relative yield (m) of fresh top and root weights, height and internode length of plants were 0, 0, 0.15 and 0.14 at Pi ≥128 eggs and second stage juveniles/cm^3 soil soil, respectively (Figg. 1, 2). The maximum reproduction rate of the nematode (Pf/Pi) was 888-fold at the lowest initial population densities (i.e. Pi = 0.0625 eggs and second stage juveniles/cm^3 soil), while the highest final population density (a Pf of 684 eggs and second stage juvenile/cm^3 soil) was found in the pots with an initial population density of 16 eggs and second stage juveniles/cm^3 soil (Fig. 3). The root gall index on the roots of common bean was lowest at low initial population densities and highest at Pi ≥16 eggs and juveniles/cm^3 soil (Table I).

The differences in tolerance limits of common bean to *M. javanica* (1 egg/cm^3 soil) observed by Sharma (1981), to *M. incognita* (0.02-0.03 egg/cm^3 soil) estimated by Crozzoli *et al.* (1997), and that in our experiment

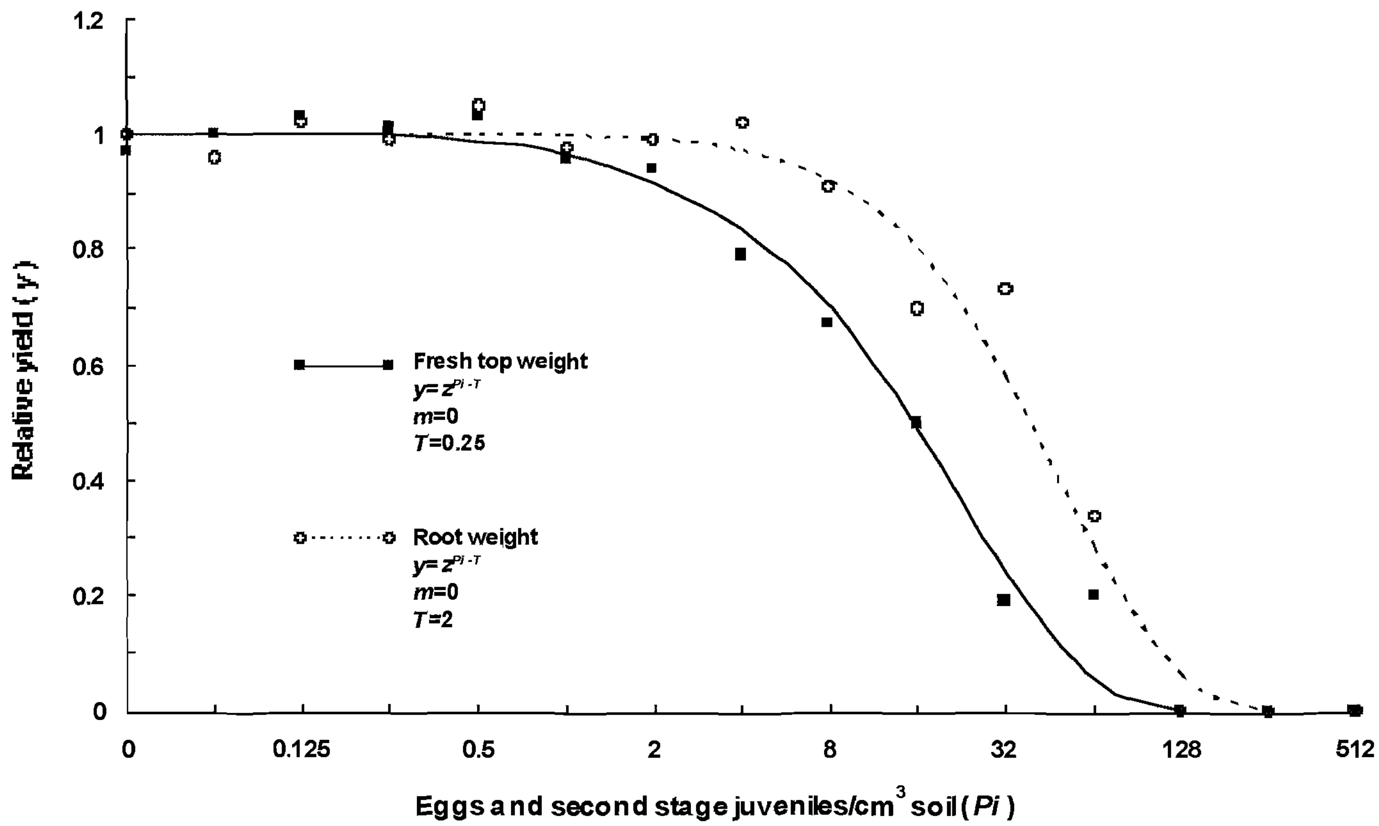

Fig. 1. Effect of population densities of *Meloidogyne incognita* host race 1 at sowing on the fresh top and root weights of common bean cv. Talento.

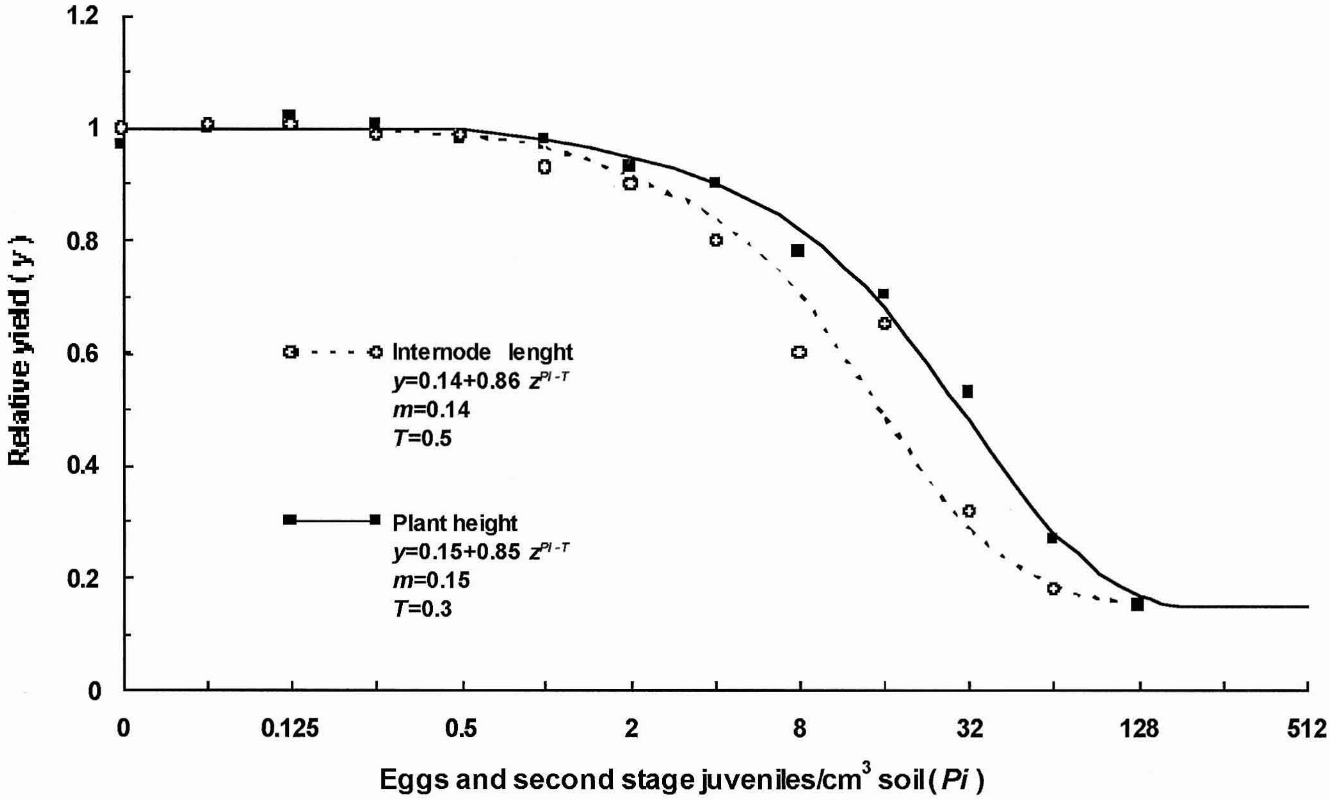

Fig. 2. Effect of population densities of *M. incognita* host race 1 at sowing on the plant height and internode length of common bean cv. Talento.

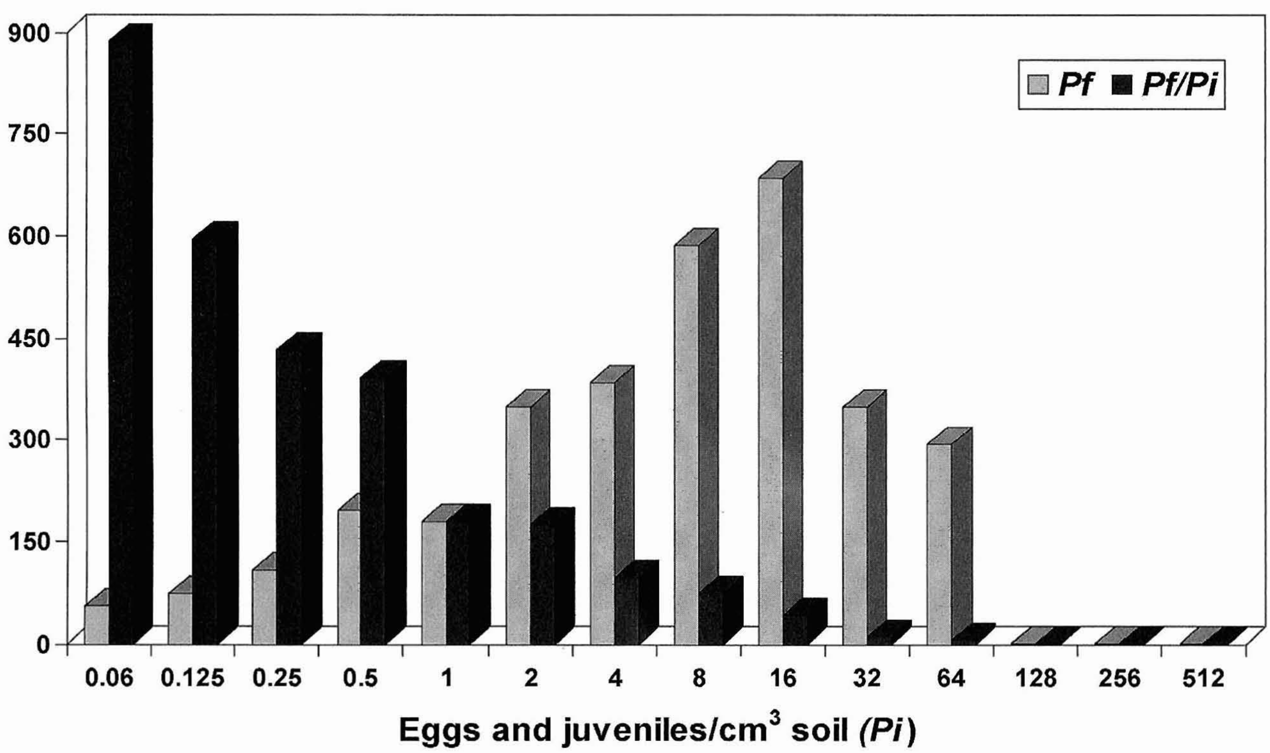

Fig. 3. Relationships between population densities of *M. incognita* host race 1 at sowing (*Pi*) and at harvest (*Pf*) and effect on the reproduction rate (*Pf/Pi*) of the nematode in pots sown to common bean cv. Talento.

Table I. Effect of initial population densities (*Pi*) of *Meloidogyne incognita* host race 1 on the root gall index of common bean.

Eggs and juveniles/cm^3 soil (*Pi*)	Root gall index (0-5)
0.0625	1.2 Aa
0.125	2.6 Bb
0.25	2.7 Bb
0.5	3.3 BCb
1	3.2 BCbc
2	4.5 Dde
4	4.0 CDcd
8	4.5 Dde
16	5.0 De
32	5.0 De
64	5.0 De
128	=
256	=
512	=

Means sharing a common letter are not significantly different according to Duncan's Multiple Range Test. Capital letters for P = 0.01 and small letters for P = 0.05.

(0.25-2 eggs/cm^3 soil) most probably reflect differences in nematode species and origin, growth parameters considered and methods of data interpolation used by the investigators.

Our results demonstrated that the Italian population of *M. incognita* host race 1 is highly pathogenic to common bean; top plant growth reduction would start at soil population densities as low as 0.25 egg of the nematode/cm^3 soil, would reach 50% in soil infested with 16 eggs/cm^3 soil, and growth would be negligible at more than 32 eggs/cm^3 soil. Therefore, to avoid yield losses of common bean, the nematode soil population densities must be reduced to non-damaging levels before establishing a new crop, especially if growing the crop in sandy field soil. Nematicides and soil solarization (Sikora and Greco, 1990; Greco *et al.*, 1998) would effectively control root-knot nematodes but they may not always be feasible. Although several cultivars of common bean that are tolerant (McSorley and Phoronezny, 1981) or resistant (Omwega *et al.*, 1989; Mullin *et al.*, 1991; Sydenham *et al.*, 1996) are available, they are unfortunately not suitable for the Italian market and, therefore, a breeding programme is necessary to make available cultivars of common bean that are both resistant to Italian populations of *Meloidogyne* spp. and suitable for the local market.

In order to tackle this problem, a research programme, partially funded by the Italian Agricultural Ministry, was recently started in Italy. Among the various aims of the project is the introgression of resistance to *Meloidogyne* spp. (Del Bianco *et al.*, 2003) in Italian common bean cultivars, with either dwarf or climbing growth-habits.

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