

EFFECT OF FERTILIZERS ON THE GROWTH OF BITTER GOURD AND THE ROOT KNOT NEMATODE, *Meloidogyne incognita*

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ABSTRACT

Root knot nematodes are serious pests of bitter gourd in Marassana, Kandy where susceptible hosts are cultivated intensively. The pest status of the nematode become very acute in soils deficient in nutrients but gourd plants can withstand heavy population of the nematodes in fertile soils. A pot experiment was done in a heated glass house at International Institute of Parasitology(IIP), England in 1988 using soils infested with a Sri Lankan isolate of *Meloidogyne incognita*. There were five different combinations of N, P and K fertilizer treatments and two nematode densities, five juveniles per 1 cm³ of soil and the control in a factorial experiment with four replicates. Shoot and root growth and the final nematode population densities in roots were determined 1 1/2 months after sowing seeds. Results showed that ammonium sulphate as the source of N has reduced the nematode population in roots and plant growth was not affected by the nematode only when the nitrogen fertilizer was available to the plant. A follow-up study was done in 1998 in a farmer field at Marassana under natural infestation of the same species. There were three fertilizer treatments; NPK, PK and without NPK as the control and two different population densities of the nematode, 10 and two second stage juveniles per 1 cm³. This experiment was replicated five times in a completely-randomized design. Fresh weight of roots, dry weight of shoots and the nematode population were taken one and a half months after sowing. Results showed that the shoot growth has reduced under the heavy population density of the nematode when there was no nitrogen fertilizer but root growth and the nematodes were more in heavily infested soils with nitrogen fertilizers. Results indicate that bitter gourd plants compensate the damage of the nematode by producing more roots under natural conditions if nitrogen fertilizer is available to the plant.

KEY WORDS: Bitter gourd, *Meloidogyne incognita*, Root knot nematode

INTRODUCTION

It was revealed from a survey done in mid 1980 at Marassana (where a root knot problem was reported) that there is no regular application of the recommended amount of fertilizers in fields. Farmers had never used any organic fertilizers and occasionally added some inorganic fertilizers to the fields, mainly at the flowering stage and afterwards. It was well known that continuous intensive cultivation of crops throughout the year depletes soil nutrients very rapidly and fertilizers are essential components for crop growth. Therefore, the plants grown in nutrient deficient soils cannot possibly withstand pests and diseases as well as in nutrient rich soils (Healds and Burton, 1968; Ishibashi, 1970; Riggs et al,1989). Hence the influence of fertilizers on bitter gourds, infested with nematodes was investigated in a glass house study and in farmers fields.

MATERIALS AND METHODS

Experiment 1

This experiment was done in a heated glasshouse at IIP, England in 1988 using root knot nematode infested soil obtained from Sri Lankan isolates of *M. ingognita* cultures. The nematode population in the soil was estimated by the tray technique (Whitehead and Hemming, 1965). Nematode treatments were, five juveniles from 1 cm³ of soil and for control, the infested soil was sterilized in an electric soil sterilizer for an hour at 70°C. Plastic pots (15 cm diameter and 1500 cm³ capacity) were filled with the infested and the sterilized soil. Bitter gourd seeds were germinated on moist filter paper at 25 °C in a culture room for three days. Seedlings with uniform root growth were selected and sown in pots of soil.

The different combination of fertilizers were added to the pots 1 week after planting and every 10 days thereafter. The fertilizer treatments were: NPK, NP, NK, PK, No fertilizer. The source of fertilizers were ammonium sulphate (21% N), superphosphate (14.3% P) and potassium sulphate (K) and N, P and K, were applied at the rate equivalent to 95.8, 117.2 and 97.3 kg/ha (0.48, 0.48 and 0.27 g/pot) respectively.

There were five fertilizer treatments and two nematode densities in a factorial experiment with four replicates. Plants were harvested 1 1/2 months after sowing seeds and fresh and dry weight of shoots, fresh weight of leaves, total length of shoots and number of laterals and the nematode population densities in roots were determined.

Experiment 2

This experiment was done in a farmer's field in Marassana area during the dry season of April 1989. This field had been continuously cultivated with bitter gourd for more than five years and massive root galls were observed on most of the plants of the standing crop. Poor growth and yields of the crop had been observed by the farmers for nearly two years but the same crop had been grown because other vegetables such as tomato and carrots had also failed several times.

The farmer usually removed the old crop just before starting the new crop as he continuously picked the few fruits produced in the declining crop. Fertilizers had not been applied regularly but occasionally nitrogen fertilizers were applied but quantities and the time of application were not recorded. The

experimental site had more than 80% of plants heavily infested with *Meloidogyne incognita*.

The total area of this field, approximately 0.2 hectares consisted of many small terraces of different shapes and sizes. Plots (1 m²) made on one terrace or the nearby terraces, at the same level of the field, were used for one treatment. The minimum distance between plots was one m. The treatments are given in table 1.

Table 1. The treatments.

<i>Fertilizer treatment</i>	<i>Urea(g/plot)</i>	<i>Superphosphate(g/plot)</i>	<i>Muriate of potash (g/Plot)</i>
NPK	20.8	26.0	15.6
PK	0.0	26.0	15.6
Without fertilizer	0.0	0.0	0.0

The source of N, P, K was urea (46.6% N), superphosphate (48.0% P) and muriate of potash (60.0% K) at the rate of N, P and K equivalent to 95.8, 117.0 and 94.0 kg /ha respectively. Fertilizers were applied at sowing and a month later, as recommended by the Department of Agriculture. Seeds were sown at the rate of four per plot and seedlings were thinned out to two per plot, 2 weeks after sowing. This experiment was done at two locations in the same field at a distance of 5m apart but at the same level. The total area of each location used for experiments was approximately 200 m². On site one, the crop was removed two days before starting the experiment while on the other debris was cleared one month before the start of the experiment. The nematode population was reduced by the following methods:

1. All the infested root material was uprooted and removed from the site;
2. The field was flooded for one week (originally it was planned to flood the field for more than a month but this was not possible due to severe drought in March 1987);
3. Soil was turned over several times by deep ploughing and exposed to the hot sun. (maximum day temperature 30⁰ -32⁰C). Soil samples were collected from 10 places at random from each location and the initial population density of *Meloidogyne incognita* was estimated using the tray technique. Population densities were ten and two second stage juveniles per cm² of soil for location 1 and location 2 respectively.

This experiment was terminated one and a half months after sowing because some plants started dying. The plants were uprooted and taken to the laboratory at Horticulture Research and Development Institute, Peradeniya and data on: dry weight of the roots, fresh weight of the roots, female root knot nematode population density in roots and root knot nematode females with egg masses in roots were collected

RESULTS

Experiment 1

The weight of roots of nematode infested plants was less than uninfested plants and the difference was very prominent only when the plants were grown without N fertilizers (figure 1). The growth of shoots was not affected by nematode infestation when the nitrogen fertilizer was available to the plant (figure 2). The plants were stunted, i.e. shoot weight, length, foliage, number of lateral shoots and leaf area was less than in infested plants grown without nitrogen fertilizer. Although root growth was more in plants supplied with nitrogen fertilizers than without nitrogen, the shoot growth did not show a great difference in uninfested conditions. Adult female population of root knot nematodes was low in roots when nitrogen fertilizer was available to the plants (table 2).

Table 2. Influence of different combinations of NPK on the nematode population in roots

<i>Fertilizer treatments</i>	<i>Number of galls/10g roots</i>	<i>Females with and without egg masses/ 10 g roots</i>	<i>Females with egg masses/10 g roots</i>
NPK	36	47	33
NP	36	56	33
NK	59	68	55
PK	111	157	99
No fertilizers	107	160	92

Mean of four replicates; * Data were not statistically analyzed.

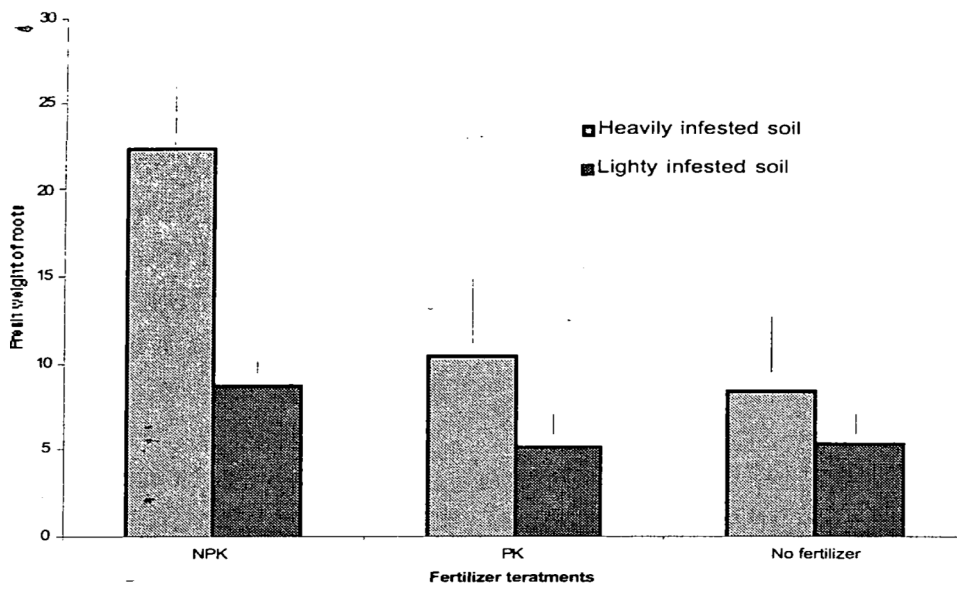


Figure 1. Influence of nematodes on the growth of roots (as a weight) of bitter gourd plants treated with different combinations of NPK fertilizers.

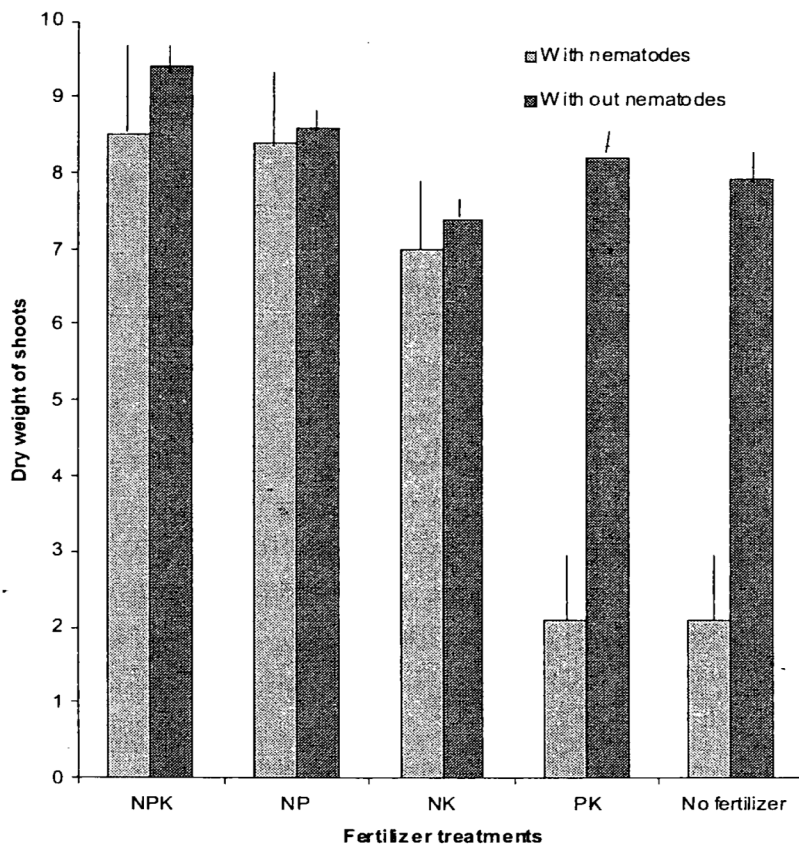


Figure 2. Influence of nematodes on the growth of shoots (as weight) of bitter gourd plants treated with different combinations of NPK fertilizers

Experiment 2

The shoot dry weight was significantly lower where the plants were grown in fields infested with 10 second stage juveniles of *M. incognita* per 1 cm³ soil where nitrogen fertilizer had not been applied (figure.3). The effect of nitrogen fertilizer was not so marked in the lightly infested fields. The effect of nitrogen fertilizer on the weight of roots was also significant at the high level of infestations (figure 4). The plants grown in the highly infested soils with NPK fertilizers had given the best root growth.

The adult nematodes and nematodes with egg masses recovered from plants grown in heavily infested soil was significantly higher than from those with a low infestation (table 3). More nematodes were recovered from the plants grown in highly infested soils with NPK fertilizers than from those with no fertilizers.

Table 3. Effect of nitrogen fertilizer on *M. incognita* nematode population.

Treatments	Nematode population density (10 g roots)			
	Adult females		Females with eggs	
	N1	N2	N1	N2
NPK	264.0	39.0	129.7	28.5
PK	183.5	21.3	78.3	20.3
No fertilizer	163.0	29.8	53.5	25.6

Mean of five replicates; N1 - Heavily infested soil; N2 - lightly infested soil. * Data were not statistically analyzed.

DISCUSSION

The use of nitrogen fertilizers leads to an increase in the growth of roots of bitter gourd, which may lead to compensation for damage by the nematodes. There are many reports to support this compensatory growth of plants with the application of nitrogen fertilizers (Gair *et al.*, 1969; Mathur and Prasad, 1971; Sivapalan, 1967).

The results of the field experiment showed that nitrogen fertilizer is not only beneficial for the plant but also for the nematode. The number of adult females in roots were affected by the application of nitrogen fertilizers. In fields increased root growth of bitter gourds provided more sites for nematode invasion and therefore the nematode population in roots increased with the application of nitrogen fertilizer.

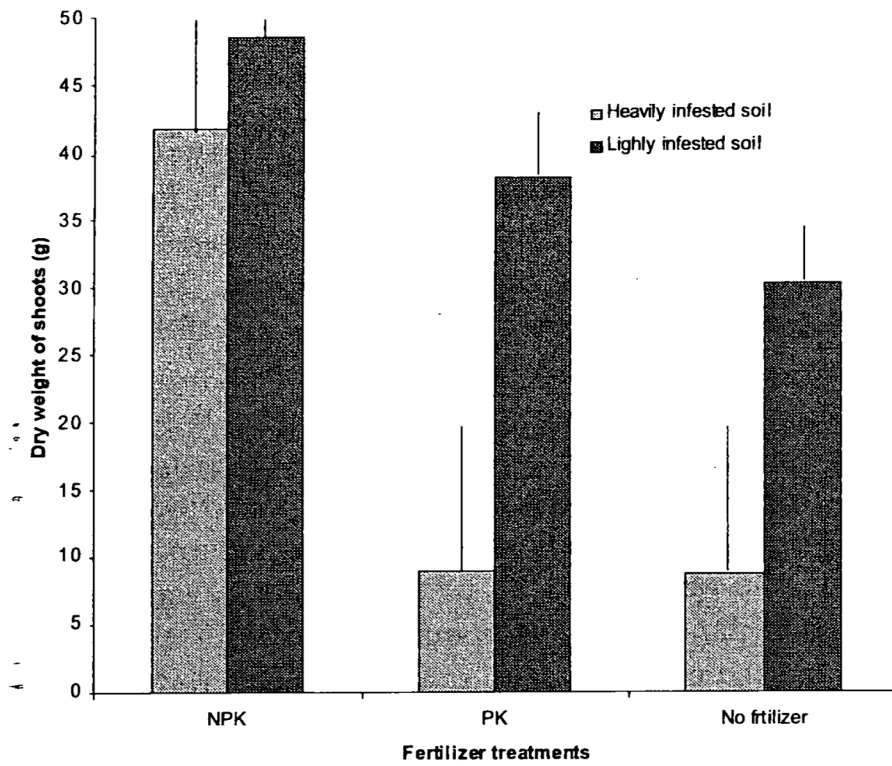


Figure 3. Influence of nematodes on the growth of shoots (as weight) of bitter gourd plants treated with different fertilizers.

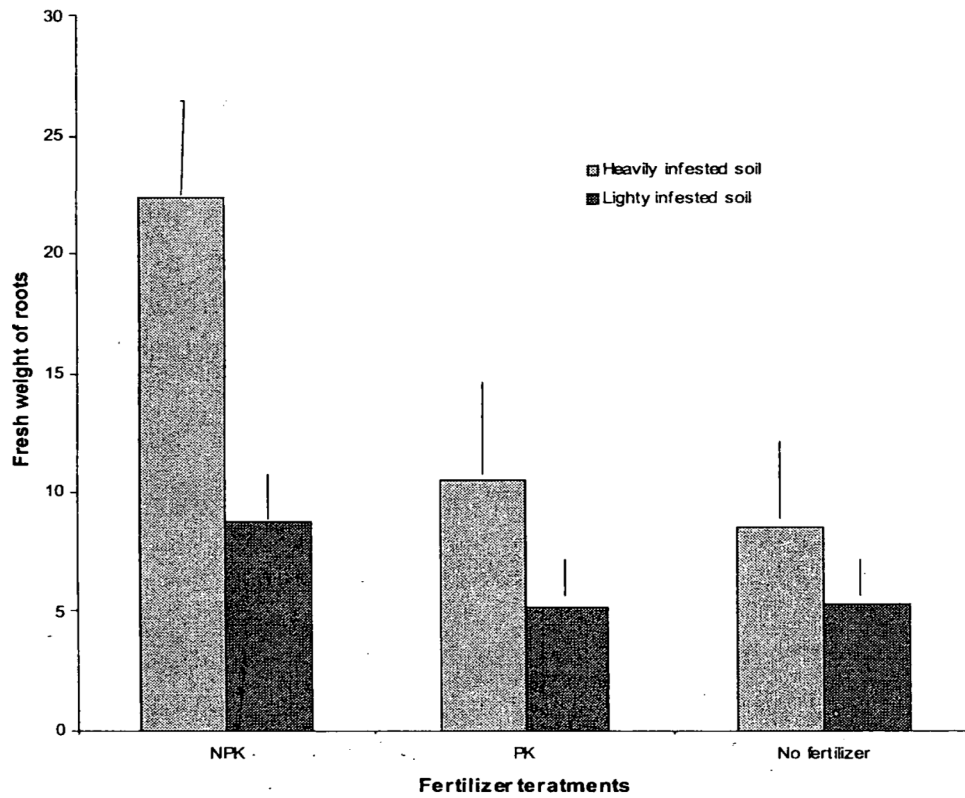


Figure 4. Influence of nematodes on the growth of roots (as a weight) of bitter gourd plants treated with different fertilizers.

There were more nematodes found in bigger root systems than in smaller root systems because of the availability of more sites for invasion of nematodes. This is in agreement with the findings of Rawsthorn (1982). Field experiments suggested that the total nematode population per plant root system is increased with increased root growth in nitrogen rich soils. Similar results were observed on rice infested with *H.oryzae* (Mathur and Prasad, 1971), on cereal with cereal cyst nematodes (Gair *et al.*, 1969) and on tea with *Pratylenchus loosi* (Sivapalan, 1967). Nitrogen fertilizer was beneficial for the root growth and in consequence, increased the root sites for nematode invasion and also enabled more nematodes to developed in such roots. Bird (1970) reported that nitrogen deficiency has no significant effect on the rate of growth of *M. javanica* in tomatoes at initial inoculum densities of 4,000 juveniles per plant. The rate of growth of the nematode was significantly less in nitrogen deficient plants than in plants grown with full nutrients. Bird (1970) explained that the rate of growth of nematodes in roots is influenced by the degree of stress to which the plant is subjected to little stress leads to an acceleration in the rate of growth of nematodes and further stress leads to a slowing down of the overall rate of growth of nematodes. However, in pots the nematode population was found to be suppressed with nitrogen fertilizers.

Suppression of nematodes with the applicaton of nitrogen fertilizers ' NH_4NO_3 ' have been reported on beans and cucumber infested with root knot nematodes due to nematostatic action of NH_3 released from NH_4NO_3 which was toxic to nematodes (Oteifa, 1955; Turlygina,1970). The reason for the lower number of nematodes with $(\text{NH}_4)_2\text{SO}_4$ in pots and higher population with urea in fields needs to be investigated. The use of fertilizers as a chemotherapeutant against yam nematodes *Scutellonema bradys* has been reported from Nigeria (Badra and Caveness, 1979). It has been reported that yam (*Dioscorea spp*) yielded better when nematicides were used combined with calcium nitrate or ammonium nitrate in the control of root knot nematodes (Badra *et al.*, 1980).

CONCLUSION

Bittergourd plant can withstand heavy infestations of the root knot nematode in nitrogen rich soils by compensatory root development. The nature of this plant is similar to the undomesticated plants. The condition in woods (where the top soil layers are rich in nutrients from the decaying plant materials) is ideal for this crop to expand by rapidly, producing a mat of roots, which develop soon after germination to absorb nutrients effectively and

efficiently to support the growing plant. Application of fertilizers, specially nitrogen and organic matter are recommended at the time of sowing for withstanding the nematode damage in bitter gourd.

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