

Comparative Effects of Inoculating Tomatoes (*Lycopersicon esculentum mill.*) with Two Strains of VAM Fungi and Nematicides Application on the Control of Root-knot Nematodes (*Meloidogyne incognita*)

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Abstract-Root-knot nematodes, *Meloidogyne incognita* was found to cause the major problems recorded on vegetables in Oman. Their damage, however, was found to be comparatively high on tomatoes. This trial was therefore conducted to compare the use of traditional nematicides recommended for the control with the efficiency of using mycorrhizal fungi as a means of biological control. The treatments used included a noninoculated control and an inoculated control with nematodes in addition to two treatments to which nematicides were added (Mocap3 and Vydate 3), plus two more treatments, where mycorrhizal fungi was added(a and b). Results revealed that the nematicide Mocap3 was superior in controlling nematodes population in tomatoes followed by the addition of mycorrhiza(b) resulting in 98 and 97% reduction in galls/plant, respectively. The nematicide Vydate3 and Mycorrhiza (a), however, reduced the number of galls/plant to 86 and 90%, respectively. Regarding other growth traits, Mocap3 and Mycorrhiza(b) outyielded all other treatments significantly in fruit numbers. 100 and 44% increase in fruit numbers was obtained over the uninoculated control treatment, respectively. The increase in fruit numbers was 600 and 400% when compared with the inoculated treatment. The other growth traits data was rather erratic. Correlation analysis revealed that there was significant positive correlation between growth traits which is an indication that fruit yield depended on the vigor of the plant, shoot and root weights. The results also revealed the efficacy of the use of biocontrol agents as a means of nematodes control as a good substitute for the use of chemical agents if preceded by conducting experiments for the selection of the suitable mycorrhizal strains.

Keywords: *Root-knot nematodes nematicides mycorrhiza Lycopersicon esculentum, AM fungus., Biological control, Meloidogyne incognita.*

Introduction

Tomato is often severely attacked by root-knot nematodes, *Meloidogyne incognita*. A yield loss of 35-39.7% has been reported due to nematode infestation (Reddy, 1985; Jonathan, et. al, 2001). Occurrence and severe infestation of root-knot nematodes, *Meloidogyne incognita* on tomato was also recorded earlier in the Sultanate of Oman (Waller and Bridge, 1978), which were found to cause the major problems recorded on vegetables in Oman. Their damage, however, was found to be comparatively high on tomatoes (Mani & Muzna, 1994). Soil treatment and sanitary practices are seldom found to be effective in controlling them (Southey, 1959). Bindra and Kaushal, 1971; Mani and Muzna, 1994 reported the use of nematicides as bare root dips for the control of root-knot nematodes.

Ecofriendly approaches had been tried by soil amendments (Rajendran & Saritha, 2005), organic soil amendments

(Nagesh & Reddy, 1997), and biocontrol agents (Kantharaju et.al,2005). The role of AM fungi in reducing harmful infestations by parasitic nematodes is well documented by Mahaveer et.al, 1994; Shreenivasa,2007). Efforts were made by Mishra & Shukla, 1997 to use indigenous isolates of AM fungi for the control of nematodes. The use of arbuscular mycorrhiza (AM) to influence soil borne plant diseases was thought to be based on their ability to promote plant health & reduce the damage caused by pathogens.

In an attempt to elucidate the active mechanisms involved in bioprotection cellular & molecular phenomenon, Cordier, et al. (1998) analyzed the interaction between *Glomus mosseae* & *phytophthora parasitica* in roots of tomato plants (*Lycopersicon esculentum*). They showed that the control mechanism involved induction of localized resistance in arbuscule containing cells and a systemic resistance in nonmycorrhizal tissues. Diedhiou & Heinz (1998) investigated the use of AM as a biocontrol agent for nematodes to replace synthetic nematicides. Positive results were reported regarding the influence on sedentary nematodes. The soils in the Sultanate of Oman, are reported to adsorb phosphorus and render it unavailable despite the high total phosphorus content of most of the soils (MAF, 1996). The only available source is chemical fertilization through the addition of superphosphate and no attempts were made to explore the role of biological fertilizers such as mycorrhizal fungi.

This work was therefore aimed at investigating the use of nematicides as compared to the use of VAM in controlling root-knot nematodes in tomatoes, and look into the use of mycorrhizal fungi in improving the nutrient status of tomatoes.

Materials and Methods

A tomato cultivar (Tattoo), obtained from the Plant Production Center at ARC based on its performance as a high yielder (ARC annual Report, 1999) was sown in a mixture of peat and perlite for 21 days. The seedlings were transplanted in pots (0.7m area) containing 8 kgs of a sandy soil chosen with low E.C (Table 1). The treatments used included a noninoculated control and an inoculated

control with nematodes in addition to two treatments to which nematicides were added, and two more treatments, where mycorrhizal fungi was added as detailed below.

Mycorrhiza and fertilizer addition

For mycorrhizal additions, Ten grams of the introduced mycorrhiza; *Glomus moseae* and *Glomus agrogigatal* (obtained from Japan) were added per pot. A basal dose of N and K fertilizers were calculated and added to all the pots as per the Research Center recommendations under Omani conditions i.e. 500 kg of urea and 50 kg of potassium sulfate/ ha. Nitrogen was added as urea and split into three doses (1.4 g/pot for each split). Potassium was added as potassium sulfate at the rate of 0.4g /pot. A hundred mls of sweet water (0.8 DS/m) was added to each pot to evenly distribute the added water inoculum.

Nematodes and nematicides additions

The nematodes (*Meloidogyne incognita*) known to infect tomatoes were isolated from the rhizosphere of tomato plants grown in the open field in Omani soils. The plants were inoculated with the nematodes @ 5,000 freshly hatched second stage juveniles per seedling. The procedures followed what had been reported earlier (MAF,1994). Two recommended nematicides (Mani and Muzna, 1996), namely Mocap and oxamyl (Vydate) were added as aqueous emulsions at the recommended rates of 1000 ppm to the designated treatments.

Each treatment was replicated six times in a completely randomized design. The pots were weekly re-randomized. Pots were kept in a shade. The plants were irrigated every three days with sweet water (EC=0.8 DS/m). The plants were covered with argyl for protection against white flies. The growth continued for two and a half-month starting from transplanting. Observations were recorded on dry weight of shoots and roots, number of fruits, N, P, K content of shoots. Counts were made on the number of galls/plant and the total nematode population in the rhizosphere of the growing plants. MSTATC was used for statistical analysis.

Results and Discussions

The obtained data are presented in table 2 below.

Results revealed that the nematicide Mocap3 was superior in controlling nematodes population in tomatoes followed by the addition of mycorrhiza(b) resulting in 98 and 97% reduction in galls/plant, respectively. The total nematode population was similarly reduced significantly. The nematicide Vydate3 and Mycorrhiza (a), however, reduced the number of galls/plant to 86 and 90%, respectively. The present findings are in agreement with earlier reports of Mani and Muzna (1994) when they applied Carbosulfan, Mocap3 and Vydate3 to tomato plants and concluded that Mocap3 was superior in giving a high degree of protection being only preceded by Carbosulfan. Regarding other growth traits, Mocap3 and Mycorrhiza b outyielded all other treatments significantly in fruit numbers. 100 and 44% increase in fruit numbers was obtained over the

uninoculated control treatment, respectively. The increase in fruit numbers was 600 and 400% when compared with the inoculated treatment.

The other growth traits data was rather erratic. Unexpectedly, Mycorrhiza(a) treatment gave the lowest fruit number, tissue P, and tissue K. Alternatively, the uninoculated control showed the highest tissue mineral content including P,K, and N. although no chemical phytotoxic effects were observed with the growing plants. The positive result obtained with mycorrhiza could be attributed to natural resistance mechanisms reported by Cordier, et al. (1998).

Correlation analysis revealed that there was significant positive correlation between root weight ($r=0.6954$), shoot weight and fruit yield ($r=0.7572$), and root weight and fruit yield ($r=0.6220$). This is an indication that fruit yield depended on the vigor of the plant, shoot and root weights.

References

1. Bindra, O.S. and Kaushal, K.K. 1971. Chemical root dips for control of root-knot nematodes attacking tomatoes. PANS.17:453-457.
2. Bolan, N.S. 1991. A critical Review of the role of mycorrhizal fungi in the uptake of phosphorus by plants. Plant Soil 134:189-207.)
3. Cordier, C., N.Ferrol, J.Barea, S.Gianinazzi, & V.Pearson.1998. Cellular and molecular events underlying the induction of resistance against *Phytophthora parasitica* in mycorrhizal tomato. 2nd Int. Conf. on Mycorrhiza 5-10 July.1998
4. Diedhiou, Papa M. & Heinz-W. Dehne. 1998. Biocontrol of *Meloidogyne incognita* on tomato using *Glomus spp.* and *Fusarium oxysporum*, a mutualistic fungal endophyte. 2nd Int. Conf. on Mycorrhiza 5-10 July/1998
5. Mahaveer, P., Sharma, S., Bhargava Verma, M.K. and Alokadholeya, A. (1994). Interaction between the endomycorrhizal fungus, *Glomus fasciculatum* and root-knot nematode, *Meloidogyne incognita* on tomato. Indian Journal of Nematology 24: 133-139.
6. Mishra, A. and Shukla, B.N. (1997). Interactions between *Glomus fasciculatum* and *Meloidogyne incognita* on tomato. Journal of Mycology and Plant Pathology 27(2): 199-202.
7. Nagesh, M. and Reddy, P.P. (1997). Management of *Meloidogyne incognita* on *Crossandra undulaefolia* using vesicular arbuscular mycorrhiza (*Glomus mosseae*) and oil cakes. Mycorrhiza News 9: 12-14.
8. Kantharaju, V., Krishnappa, K., Ravichandra, N.G. and Karuna, K. (2005). Management of root-knot- nematode *Meloidogyne incognita* on tomato by using indigenous isolates of AM fungus, *Glomus fasciculatum*. Indian Journal of Nematology 35(1): 32-36.
9. Reddy, D.D.R. (1985). Analysis of crop losses in tomato due to *Meloidogyne incognita*. Indian Journal of Nematology 15: 55-59.
10. Reddy, P.P., Rao, M.S., Mohandas, S. and Nagesh, M. (1995). Integrated management of the Citrus nematode, *Tylenchulus semipenetrans* Cobb using VA- mycorrhiza, *Glomus fasciculatum* and oil cakes. Pest Management and Horticulture Ecosystem 1: 37-41.
11. Reddy, B.M.R., Krishnappa, K. and Kasura, K. (1996). Management of root-knot nematode on tomato by seedlings base- root dips in chemicals. Journal of soil Biology and Ecology 16: 145-147. Sasser, J.N. (1990). Economic importance of *Meloidogyne* in tropical countries. In: Root-knot News (*Meloidogyne spp.*)- Systematics, Biology and control (Eds. F. Lamberti and C.E.Taylor). Academic Press, New York pp 477.

Table 1: Chemical and Physical properties of the soils used in the study

EC(Ds/m)	2.6	Soluble K (ppm)	25.3
pH	7.3	Exchangeable K (ppm)	4.6
CaCO ₃	28	Soluble Ca (meq/l)	12.6
Gravel	3.4	Soluble Mg (meq/L)	7.0
Coarse Sand	1.2	Soluble Na (meq/L)	6.3
Fine Sand	32.7	Exchangeable Na (meq/Kg)	3.7
Silt	58.5	Organic Carbon (%)	0.51
Clay	7.2	Organic Matter (%)	0.9
Soil Texture	Silt Loam	SAR	2
N(%)	0.03	Available P (ppm)	36.0

Table 2: The measured plant traits as affected by the different treatments¹ of the trial

Treatment	Branches (No.)	Fruits (No.)	Tissue D.Wt. (g)	Tissue P (ppm)	Tissue K (%)	Tissue N (%)	Galls /plant*	Total nematode population**
Uninoculated Control	12.0 ab	3.0 c	22.8 a	0.378a	59.6a	3.508a	0	0
Nematode Control²	11.0 ab	1.0 d	22.7 a	0.030a	46.5cd	3.459a	525.3 (22.2)	31220 (4.49)
Mocap³	13.0 a	6.0 a	22.7 a	0.795a	52.4bc	3.449a	3(1.73)	595.4 (2.77)
Vydate³	9.0 b	4.0 b	22.6 a	0.239a	57.0ab	2.769c	26.3 (5.12)	4290.6 (3.63)
Mycorrhiza A⁴	9.0 b	2.0 cd	11.4 b	0.099a	44.3d	3.397ab	18.5 (4.3)	3145 (3.49)
Mycorrhiza B⁴	13.0 a	4.0 b	21.2 a	0.216a	48.2cd	3.048bc	4(2)	728.8 (2.86)

¹ Treatment means within columns having common letters are not significantly different by the Duncan Multiple Range test at the 0.05 level of probability.

2. For inoculated treatments, 5000 juveniles were added per plant

3. Mocap & Vydate represents the added nematicides as recommended by the ARC.

4. Mycorrhiza A & B represented by *Glomus moseae* & *G. agrogigatal*, respectively.

* Figures in parenthesis are square root values

** Figures in parenthesis are the arc sine values