



Control of the Citrus Disease Complex in Iraq

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Authors' contributions

This work was carried out in collaboration between all authors, Author IIA designed the study, wrote the protocol and managed the final manuscript, authors BGA and SAA-R were carried out the field and laboratory studies, wrote the first draft of the manuscript, performed the statistical analysis and managed literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study was conducted in a citrus orchard in Baghdad province, Iraq. Roots were severely infected with citrus-root nematode *Tylenchulus semipenetrans* and the fungus *Phytophthora citrophthora*, die back symptoms were highly observed on the vegetative growth, and the yield of these trees were very poor. The experiment included 16 treatments using three nematicides Rugby (Cadusafos), Mocap and Garland, and three fungicides Previcure, Agrifos and Nando, and the control (untreated) with three replicates/treatments. Each treatment was about 50 m² and consists of ten citrus trees using complete randomized block design (CRBD). Soil and root samples were taken a week before treatment and six months after treatment for nematode extraction (250 g soil and 1 g roots) and for fungus using potato dextrose agar media (PDA) for germination. Results indicated that all the fungicides applied had no effect on citrus root nematode, but when they were applied with nematicides simultaneously there was a sharp decline in nematode population. All the nematicides applied in this experiment were highly effective against the nematode and significantly reduced their number compared to the untreated (control) plot. Rugby (Cadusafos) was significantly effective than the other nematicides, where the number of nematodes

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in 250 g soil and 1 g root reduced from 3833.3 and 1876 juvenile before treatment to 333.3 and 124 juveniles after treatment respectively. Similar effect was found when these nematicides were applied with the fungicides for controlling the disease complex and it was found that Rugby again was highly effective than the other applied nematicides.

Keywords: Citrus disease complex; nematicides; fungicides.

1. INTRODUCTION

Citrus plantation is considered as one of the most important economic crop concentrated in the central and southern regions of Iraq. The average production is about half a million ton/year [1]. Citrus root nematode *Tylenchulus semipenetrans* Cobb was first recorded in Iraq in 1965 as a cause of citrus decline [2]. The nematode has been found in almost every citrus grove and nurseries in the country with high population in many areas [3]. An association between citrus root nematode and some soil fungi such as *Fusarium*, *Pythium*, *Phytophthora* and *Rhizoctonia* has been previously reported [4-7] causing more deterioration in both root and vegetative citrus growth. Similar interaction effect was observed with other plant parasitic nematodes and some soil fungi [8]. Several control measures were applied to control this disease complex such as using mycorrhizal fungus [9], biological control [10,11] and chemical control [12,13,14].

The present study was conducted to determine the efficacy of some nematicides and fungicides in control the pathogens, the nematode *Tylenchulus semipenetrans* and the fungus *Phytophthora citrophthora* (complex disease), to achieve satisfactory control in Iraqi soils.

2. MATERIALS AND METHODS

Citrus orchard was selected at Doura in Baghdad Province/Iraq, because citrus growth was very poor and roots were severely infected with citrus root nematode *Tylenchulus semipenetrans* Cobb and the fungus *Phytophthora citrophthora* (R.B.Sm & E.H.Sm) L. Nematode juveniles and males and the fungus were estimated from composite soil samples at 10-30 cm depth. The experiment was consisted of 16 treatments using 3 nematicides as follows:

- 1- Rugby (Cadusafus) at rate 6 cm³/m² added with irrigation water.
- 2- Mocap 20EC at rate 5cm³/m² added with irrigation water.

- 3- Garland at rate 5 cm³/m² added with the irrigation water.

Also 2 fungicides were used in this experiment as follows:

- 1- Agrifos at rate 1 cm³/m² added with irrigation water.
- 2- Nando at rate 1 cm³/m² added with irrigation water.

Other treatments consist of the mixture of each nematicide with either fungicide at same rate of application when they were applied alone. Therefore, we had 16 treatments including the control (untreated). Each treatment consists 3 replicates. Each treatment was about 50 m² and consists 10 citrus trees using complete randomized block design (CRBD), statistical analysis was done according to according to Duncan's multiple limits at (P=0.005). For counted the nematode soil and root samples were taken (250 g soil and 1 g roots) a week before treatment and 6 months after treatment for nematode extraction, and root samples for the fungus was germinated by potato dextrose agar media (PDA).

3. RESULTS AND DISCUSSION

The effect of complex of citrus root-nematode and the fungus caused severe damage to the root growth which reflected on citrus growth and yield production. The number of nematodes in control (untreated) was higher in the soil (5166) and roots (2333) juvenile per 250 g soil and 1 g root. Similar results have been reported previously about the interaction between citrus root nematode and some soil fungi in Iraqi citrus orchards [15,10,14], and around the world [16,17].

Other results showed that all the fungicides applied alone had no effect on citrus root nematode, but when they were applied as a mixture with either nematicide simultaneously there was a sharp decline in nematode population (Table 1).

Table 1. Average numbers of citrus root nematodes in 250 g soil and 1 g root of citrus trees, before and after treatment

Treatments	Number of nematodes/1g. root		Number of nematodes/250g. soil	
	Before treatment	After treatment	Before treatment	After treatment
Control	2333.3 ⁿ	2125 ^o	*5166.7	4583.3 ^m
Garland	1250 ^b	166.7 ^b	2750	333.3 ^a
Rugby	1875 ^f	125 ^a	3833.3	333.3 ^a
Mocap	1833.3 ^f	458.3 ^h	4666.7	1000 ^g
Previcure	1166.7 ^a	1666.7 ^m	3000	2416.7 ^j
Agrifos	1541.6 ^d	1875 ⁿ	4000	4166.7 ^l
Nando	2458.3 ⁱ	1416.7 ¹	3166.7	4000 ^k
Previcure + Garland	1708.3 ^e	375 ^f	3666.7	833.3 ^f
Previcure + Rugby	1333.3 ^c	416.7 ^g	4583.3	833.3 ^f
Previcure + Mocap	1541.6 ^d	719.7 ^j	2666.7	750 ^e
Agrifos + Garland	1541.6 ^d	291.7 ^d	3416.7	583.3 ^c
Agrifos + Rugby	1541.6 ^d	250 ^c	3750	833.3 ^f
Agrifos + Mocap	1875 ^f	250 ^c	6500	500 ^b
Nando + Garland	1583.3 ^d	333.3 ^e	4500	666.7 ^d
Nando + Rugby	1250 ^b	875 ^k	3083.3	2083.3 ⁱ
Nando + Mocap	2208 ^g	541.7 ⁱ	4500	1250 ^h
			n.s.	

* Numbers represents average of 3 replicates/treatment.

Values with similar letters within same column are not significantly different between them according to Duncan's Multiple limits.

The fungicides sharply reduced the fungi population including the fungus *Phytophthora citrophthora* between 80-90% when spores numbers were counted under the microscope from soil or citrus roots after the soil was treated with these 2 fungicides (Agrifos or Nando). These results reflects positively by reducing the effect of fungi on citrus root growth and their interaction with the nematodes. These results agrees with previous results that Agrifos highly effective against fungi mortality and improve the growth of both citrus roots and vegetative growth [11]. All the nematicides applied in this experiment were highly effective against the nematode and significantly reduced their number compared to the untreated (control) plot (Table 1). But Rugby (Cadusafos) was significantly effective than the other nematicide. Number of nematodes in 250 g soil and 1 g root reduced from 3833.3 and 1876 juvenile before treatment to 333.3 and 124 juvenile after treatment respectively.

Similar effect was found when these nematicides were applied with the fungicides for controlling the disease complex and it was found again that Rugby was significantly highly effective than the other applied nematicides (Table 1). Similar

results were found when Rugby used as alone or as a mixture with fungicide was highly effective against citrus root nematode or root-knot nematode [11,14]. Results showed that both Garland and Mocap were also alone or with combination with either fungicide were significantly effective in controlling citrus nematode. Therefore, both nematicide can be applied against nematodes if rugby is not available.

4. CONCLUSION AND RECOMMENDATION

Citrus orchards in the middle of Iraq highly infested with the nematode *Tylenchulus semipenetrans* and the fungus *Phytophthora citrophthora*, farmers may be need to implementation of the control program for the purpose of avoiding damage and losses to their orchards, which requires to the use of nematicides and fungicides to reduce the density of pathogens. Studies must conduct for the selection of resistance varieties of citrus, especially there are many peasant families live on these orchards in many provinces. As well as highly productive varieties must be choose, and get rid of the bad varieties that are still grown in most orchards.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. FAO; 2003. Production Year Book, No.57.
2. Natour RM, El-Haidari HS, Mohammad J. Citrus-root nematode in Iraq in 1965. Plant Disease Reporter. 1965;49:792.
3. Stephan ZA, Alwan AH, Bandar AH. Effect of seasons of the year on the number of citrus root nematode and the resistance of the citrus root stocks to this nematode. Year Book of Plant Protection Research. 1975;1:305-319.
4. Al-Hakim A. Occurrence, rootstocks reaction and control of the citrus nematode, *Tylenchulus semipenetrans* Cobb, in Iraq. M.Sc. thesis, College of Agriculture, University of Baghdad. 1975; 71.
5. Ghali FS. Citrus decline disease caused by *Phytophthora citrophthora* (R.B.Sm. & E.H.Sm.) L. and its relationship with soil water level. M.Sc. thesis. College of Agriculture, Baghdad University. 1980;85.
6. Hassan MS. Studies on citrus replanting problem in Iraq. Ph.D. thesis, College of Agriculture, University of Baghdad. 1987; 88.
7. Stephan ZA, Hassan MS, Antoon BG. Seasonal population changes of the citrus nematode and some fungi of different citrus trees in Iraq. Basrah J. Agriculture Science. 1990;3(1&2):47-64.
8. Powel NT. Interaction between nematode and fungi in disease complex. Annals Review of Phytopathology. 1971;9:255-274.
9. Stephan ZA, El-Behadli AH, Antoon BG, Al-Zahroon HH. Effect of *Glomus mossae* on citrus root stocks growth and its interaction with *Tylenchulus semipenetrans* and *Phytophthora citrophthora* infecting citrus roots. Iraqi J. Agriculture Science. 1989;20(1):191-200.
10. Stephan ZA, Abd Al-Hadi AK, Al-Ani HA. Role of the bio-control fungi *Trichoderma harzianum* and *Paecilomyces lilacinus* in controlling citrus-root nematode and some pathogenic soil fungi attacking sour orange roots. Iraqi J. of Agriculture (Special Issue). 2000;5(3):1-7.
11. Stephan ZA, Saleh HM, Jbara IM, Dawood HB. Influence of biological and chemical pesticides and foliar fertilization in controlling the appearance of citrus trees deterioration at Rashidiya. Iraqi J. of Agriculture. 2005;10(2):113-120.
12. Natour RM, Allow JM, Katcho ZA. The effect of DBCP on citrus root nematode and citrus growth and yield in Iraq. Journal of Nematology. 1975;7(3):270-274.
13. Stephan ZA, Alwan AH, Bandar AH, Anton BG, Ismail AK. Controlling citrus-root nematode on citrus seedlings by chemicals. Year Book of Plant Protection Research. 1981;2(2):205-216.
14. Stephan ZA, Al-Samerai IK, Antoon BG, Dawood HB, Salman ND. Effect of mycorrhizal fungi on disease complex of root-knot nematode and *Rhizoctonia solani* on eggplant roots under lath-house conditions. Arab Journal of Plant Protection. 2009;27:145-151.
15. Stephan ZA, Abd-Al-Hadi AK, Hassaan MS. Disease complex between citrus-root *Tylenchulus semipenetrans* and the fungus *Rhizoctonia solani* on some citrus root-stocks. Iraqi J. of Agriculture (Special Issue). 1999;4(1):200-207.
16. O'Bannon JH, Leathers CR, Reynolds HW. Interactions of *Tylenchulus semipenetrans* and *Fusarium* species on rough lemon (*Citrus lemon*). Phytopathology. 1966;57: 414-417.
17. Van Gundy SD, Tsao PH. Growth reduction of citrus seedlings by *Fusarium solani* as influenced by the citrus nematode and other soil factors. Phytopathology. 1963;53:488-489.

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