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THE EFFECT OF *TAGETES* SPP. EXTRACTS ON THE HATCHING OF AN ITALIAN POPULATION OF *GLOBODERA ROSTOCHIENSIS*

by
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Summary. Leaf and root extracts, separately or in combination, and root leachates, from *Tagetes erecta* and *T. signata*, showed no nematocidal effects when tested on the hatching of an Italian population of *Globodera rostochiensis*. Aqueous extracts showed only inhibiting effects. Antagonist effects between leaf and root extracts of *T. erecta* were very evident on inhibition of egg hatching.

The golden nematode, *Globodera rostochiensis* (Woll.) Berhens causes severe yield losses of potato (*Solanum tuberosum* L.) in many regions of Italy (Greco *et al.*, 1982; Lamberti and Greco, 1989).

Several kinds of plants possess natural products with nematocidal or nematostatic properties (Gommers, 1981). Hills (1960) and Omidvar (1962) reported reduction of populations of *G. rostochiensis* in the presence of *Tagetes* spp., while Uhlenbroek and Bijloo (1958) demonstrated their nematocidal activity on second stage juveniles. However, Omidvar (1961) also showed that root diffusates of *T. minuta* L., *T. florida* Sweet or *T. signata* Bartl., at different concentrations, had no effect on hatch.

Information on the effect of some *Tagetes* species on Italian populations of *G. rostochiensis* and on a possible synergistic or antagonist effect of root and leaf extracts are lacking. An investigation has been undertaken to study the effect of aqueous extracts of leaves and roots and root leachates, from two species of *Tagetes*, on the hatch of an Italian population of *G. rostochiensis*. The possibility of synergism and antagonism between root and leaf extracts was also investigated.

Materials and methods

The population of *G. rostochiensis* was obtained from an infested field at Avezzano (L'Aquila). Cysts were collected by the Fenwick can from dried soil. Four batches of 50 cysts of similar size (about 85 eggs and juveniles/cyst) were placed in 2 cm diam sieves (215 µm aperture) arranged in a 3.5 cm diam Petri dish (Greco, 1981).

Aqueous extracts of *T. erecta* L. (cv. «A fiore doppio») and *T. signata* (cv. «Pumilla nana compatta») were prepared by soaking 50 g of green leaves or roots in 150 ml distilled

water for 24 hrs. Leaves and roots were then comminuted in a blender and the suspension filtered through filter paper. To estimate a possible synergistic or antagonist effect between root and leaf extracts, aqueous extracts for each *Tagetes* species, were prepared as before but using 25 g of leaves or roots in 150 ml distilled water, as described previously.

Root leachates of each *Tagetes* sp. were collected from three-month old actively growing plants, cultivated in fifteen 2,500 cm³ clay pots, by drenching the soil with excess tap water. The leachates were then centrifuged at 1,300 g for 30 min, stored in plastic bottles, and kept in a freezer until required; only small quantities were kept in a refrigerator at 5°C for immediate use. Before using, each plant extract or root diffusate was adjusted to 0.6 mM of sodium metavanadate by adding an equal volume of 1.2 mM of this solution. An aqueous solution of 0.6 mM sodium metavanadate was used as a control (Clarke and Shepherd, 1966; Greet, 1974). Three ml of each test solution was then added to four batches of cysts. Hatching tests were carried out in a growth cabinet at 21°C constant temperature.

Emerged juveniles were removed and counted every week over an eight week period. The solutions were renewed weekly. After three weeks the cysts were removed from the extracts or root diffusates and the incubation continued for five more weeks in the sodium metavanadate solution.

At the end of the experiment, cysts were crushed, according to Seinhorst and Den Ouden (1966) and unhatched eggs and juveniles were counted to ascertain their total numbers at the beginning of the test. Numbers of second stage juveniles emerging weekly were expressed as cumulative percentages of the total egg content of the

cysts. Data were compared by analysis of variance and Duncan's multiple range test.

Results

During the first week no difference was observed in the emergence of juveniles from cysts in aqueous extracts of the two species of *Tagetes* (Table I), but these treatments significantly suppressed egg hatch compared to that of cysts incubated in root diffusates or in sodium metavanadate. Egg hatch in sodium metavanadate greatly increased from the second week onwards. After three weeks the emergence of juveniles was negligible in leaf extract (0.9-2%) and in the combined leaf and root extract of *T. signata*. Hatching in root extracts was intermediate and significantly more than in leaf extract and less than in sodium metavanadate or in root leachates. However, only the root leachate of *T. signata* gave less emergence than the control. Although hatch of cysts incubated in the combined leaf and root extract of *T. erecta* was less (15.7%) than the control (30.7%), nevertheless it was significantly larger than those in leaf or root extracts of the same *Tagetes* species.

When the cysts were removed from the test solution, the emergence of juveniles increased in all treatments during the first three weeks and remained at the same level during the rest of the experiment. The ultimate hatch percentages were the same in control, leaf extracts, root extract of *T. erecta*, and in the combined leaf and root extract of *T. signata*. Some hatching stimulation was observed, instead, in root extract of *T. signata*, combined leaf and root extract of *T. erecta*, and in root leachates.

Discussion

The experiment confirmed (Omidvar, 1961 and 1962) that aqueous extracts and root leachates of the two *Tagetes* species have no nematocidal effect on eggs of *G. rostochiensis*. In fact the emergence of juveniles which was suppressed or reduced in the presence of plant extracts or root diffusates resumed when these were removed.

The nematocidal or nematostatic effect of *Tagetes* is associated with the high content (about 0.1% of dry root weight) of α -terthienyl (2,2'-5', 2''-terthienyl) (Uhlenbroek and Bijloo, 1958). Our data show a possible antag-

TABLE I - The effect of root and leaf extracts and root diffusates of *Tagetes erecta* and *T. signata* on the hatching of an Italian population of *Globodera rostochiensis*.

Treatment (aqueous extract)	Cumulative percentages of juveniles emerging weekly								
	Incubation periods (weeks)								
	In test solutions			In sodium metavanadate solution					
Weeks (see text)	1	2	3	4	5	6	7	8	
Leaves									
<i>T. erecta</i>	0.2 aA	1.4 abAB	2.0 aA	24.3 bB	35.3 aAB	39.8 aA	41.7 abA	42.4 aA	
<i>T. signata</i>	0.1 aA	0.6 aA	0.9 aA	18.2 aAB	36.5 abABC	44.9 aAB	47.6 bcAB	48.3 abABC	
Roots									
<i>T. erecta</i>	0.4 aA	1.5 abAB	6.2 bB	14.0 aA	31.3 aA	40.3 aA	41.6 abA	42.3 aA	
<i>T. signata</i>	1.1 abABC	3.7 bB	12.1 cC	24.3 bB	45.9 cdD	54.3 bC	54.8 dBC	55.0 bcCD	
Roots and leaves									
<i>T. erecta</i>	1.0 aAB	12.0 cC	15.7 cCD	25.5 bB	45.4 cdCD	52.2 bBC	53.9 cdBC	54.7 bcCD	
<i>T. signata</i>	0.2 aA	1.9 abAB	2.9 aAB	13.7 aA	34.1 aAB	39.8 aA	41.1 aA	41.4 aA	
Root leachates									
<i>T. erecta</i>	2.8 bcBCD	14.4 cCD	27.1 eEF	48.0 dC	58.0 eE	58.7 bC	58.9 bC	58.9 cD	
<i>T. signata</i>	3.8 cD	13.8 cCD	20.4 dDE	40.2 cC	51.8 dDE	52.3 bBC	52.4 cdBC	52.4 bcBCD	
Control (0.6 mM sodium metavanadate)									
	3.8 cCD	20.3 dD	30.7 eF	40.9 cC	42.7 bcBCD	43.4 aAB	43.5 abA	43.5 aAB	

Data flanked in any column by the same letter are not statistically different according to Duncan's multiple range test (small letters for P = 0.05; capital letters for P = 0.01).

onistic effect of aqueous extract from leaves and roots of *T. erecta*, since egg hatch in the combined extracts was larger (15.7%) compared to that in leaf (2%) or root (6.2%) extracts separately. It is thought, therefore, that there is a different concentration(s) of the chemical(s) involved in the inhibitory effect, not only in different parts of the plant but also between the two species of *Tagetes*.

The results of the experiment have shown that the cultivation of *Tagetes* plants in infested soil for a short period

and or their use as a green manure would have a negligible effect on the control of *G. rostochiensis*. However, the effect of exposure to these extracts for long periods, as would occur when growing *Tagetes* spp., in the soil and climatic conditions prevailing in Italy is not known. It would be useful to investigate this before recommending the cultivation of these plant species for control of nematodes.

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