Nematol. medit. (1987), *15*: 259-263.

Department of Plant Pathology, College of Agriculture,
Alexandria University, Alexandria, Egypt

EFFECT OF ROOT-KNOT NEMATODES ON THE PHENOLIC CONTENTS OF BARLEY AND WHEAT

by
M.A. Rezk, I.K.A. Ibrahim and A.A.M. Ibrahim

Several studies have shown that there is a distinct correlation between the degree of plant resistance to nematode pathogens and the amounts of phenolic compounds present in plant tissues (Giebel, 1970, 1974; Kosuge, 1969; Pitcher *et al.* 1960; Troll and Rohde, 1966). Giebel (1974) stated that phenolic compounds are the best known factors involved in the susceptible-resistance response of the host plant. Keoboorueng (1971) reported that infection of rice seedlings with *Hirschmanniella oryzae* caused an increase in phenolic compounds in the roots. Rezk (1976) found that phenolic contents of either healthy or *Meloidogyne javanica* infected corn and rice roots consistently increased with plant age and that such increases were much greater in resistant plants than in susceptible ones. Goel *et al.* (1982) showed that infection with *M. javanica* stunted the growth of *Carica papaya* and enhanced the levels of O-dihydric phenols, total phenols and I.A.A. in infected plants.

The objective of the present study was to determine the effects of *Meloidogyne incognita* (Kofoid *et* White) Chitw. and *M. javanica* (Treub) Chitw. on the phenolic content of barley (*Hordeum vulgare* L.) and wheat (*Triticum aestivum* L.) cultivars, respectively.

Materials and Methods

To determine the effect of *M. incognita* race 1 (MI-1) and race 3 (MI-3) on the phenolic content of the roots of barley cvs. Bonus (resistant to MI-3

and susceptible to MI-1) and CC 163 (resistant to MI-1 and susceptible to MI-3), seeds of each cultivar were sown in 20 cm diam. clay pots containing steam sterilized sandy loam soil. Seven days after emergence, the seedlings were thinned to six per pot. Pots of each cultivar were divided into three sets, each of 16 pots. Pots of the first and second sets were each infested with 10,000 eggs of MI-1 and MI-3 respectively. Pots of the third set were left uninfested to serve as control. Roots of infected and control plants, four pots each were harvested and assayed for phenolic contents at 0,4,11 and 18 days after nematode infestation.

In a second experiment, the effect of *M. javanica* on the phenolic content of roots of the wheat cvs. Giza 155 (susceptible) and Stork (resistant) was determined at 0,4,11 and 18 days after nematode infestation. Seeds of each cultivar were planted in 20 cm diam. clay pots filled with steam sterilized sandy loam soil and this experiment was conducted in similar manner to that described above.

Total phenolic compounds were determined by using 5g of fresh root materials per treatment. Roots were chopped into small bits, plunged into 25 ml of 80% ethanol and boiled for 15 min. (Balasubramanian and Purushothaman, 1972). Total phenols were then extracted following the method of Biehn *et al.* (1968). Quantitative estimation of phenols was carried out by using Folin-Denis reagent (Swain and Hillis, 1959). The amount of total phenolics was calculated against a standard curve of caffeic acid and expressed in μg caffeic acid equivalents per gram fresh weight.

Results

The effects of MI-1 and MI-3 on the total phenolic content of the roots of barley cvs. Bonus and CC 163 are presented in Table I. The initial phenolic content in healthy roots of CC 163 was higher than that of Bonus. On the fourth day, the phenolic content of Bonus roots in uninoculated pots showed a marked increase and then was sharply decreased at 11 and 18 days from the start of the experiment. On the other hand, the phenolic content of healthy CC 163 roots was slightly decreased 4 days after nematode infestation, and then remained stable until the end of the experiment.

The phenolic content in Bonus roots infected with MI-3 increased in comparison with uninfected roots at 4,11 and 18 days after infestation but MI-1 infected roots showed a marked decrease of the phenolic content at 4 and 11 days following infestation. However, no differences in phenolic contents were detected between healthy and MI-1 infected roots, 18 days after nematode infestation. The total phenolic content of CC 163 roots

showed an increase with MI-1 infection and a decrease with MI-3 infection at all stages after nematode infestation.

Generally, the results indicated that in case of the susceptible reaction of Bonus to MI-1 and CC 163 to MI-3, the phenolic content of infected roots had lower levels than those of healthy ones. In the resistant reaction of Bonus to MI-3 and CC 163 to MI-1, the phenolic content of infected roots showed higher levels than those of healthy ones.

The effect of *M. javanica* infection on the total phenolic content in the roots of wheat cvs. Giza 155 (susceptible) and Stork (resistant) is shown in Table II. The phenolic levels in healthy roots of Giza 155 were higher than those of Stork during the period of this experiment. Nematode infestation decreased the total phenolic content of the roots of Giza 155. Infection with *M. javanica* produced a notable increase in the phenolic content of Stork roots (resistant). Generally, the levels of total phenolic contents of nematode infested Stork roots were higher than those of both healthy and nematode infested Giza 155 roots at all stages of the experiment.

Table I - *Effect of* Meloidogyne incognita *race 1 (MI - 1) and race 3 (MI-3) on the phenolic contents of roots of barley cvs. Bonus and CC 163.*

Cultivar and treatment	Total phenolics (μg/g root fresh wt.) (days after nematode infestation)			
	0	4	11	18 days
Bonus:				
MI-1	74.2	74.2**	68.2	60.6
MI-3	74.2	98.5	103.0**	83.3**
Control	74.2	90.9	75.8	60.6
CC163:				
MI-1	98.5	109.1**	113.6**	113.6**
MI-3	98.5	48.5**	65.2**	72.7**
Control	98.5	90.9	90.9	90.9

** Significant at P=0.01 from comparable control.

Table II - *Effect of* Meloidogyne javanica *on the phenolic contents of roots of wheat cultivars Giza 155 (susceptible) and Stork (resistant).*

Cultivar and treatment	Total phenolics (μg/g root fresh wt.) (days after nematode infestation)			
	0	4	11	18 days
Giza 155:				
Infected	75.8	72.7**	78.2**	85.5**
Control	75.8	83.0	89.7	98.2
Stork:				
Infected	62.4	89.7**	92.1**	103.0**
Control	62.4	67.9	72.7	87.3

** Significant at P=0.01 from comparable control.

Discussion

The initial phenolic contents were higher in healthy roots of barley cv. CC 163 (resistant to MI-1) than those of cv. Bonus (susceptible to MI-1). This finding seems to substantiate the contention made by Rezk (1976), that there is a distinct correlation between the degree of plant resistance and the phenolic levels present in root tissues of corn and rice plants. Also, it was evident that the levels of phenolic compounds were increased more in MI-1 infected roots of CC 163 than those of cv. Bonus. This is in line with previous reports of El-Sherif *et al.* (1973), who indicated that nematode infection caused an increase in the phenolic content of infected tissues of resistant plants.

It was evident that the phenolic contents were higher in nematode-infected roots of resistant barley and wheat cultivars than those of susceptible cultivars and the control. Generally, in resistant cultivars the concentration of phenolics progressively increased with time after nematode inoculation. Similar results were obtained by Mahmood and Saxena (1986) who showed that inoculation with *Rotylenchulus reniformis* caused a marked increase in the concentration of phenolics in tomato plants and as the time intervals after inoculation were increased so the phenolics increased.

SUMMARY

The effects of *Meloidogyne incognita* races 1 (MI-1) and 3 (MI-3) and *M. javanica* on the phenolic content of barley and wheat roots were determined. The initial phenolic content in healthy roots of barley cv. Bonus was lower than that of cv. CC 163. The concentration of phenolic content in Bonus roots infected with MI-3 was increased, while decreased in case of MI-1 infection. Conversely, the phenolic content of CC 163 roots infected with MI-1 was increased, while decreased with MI-3 infection. Amounts of total phenol, in healthy roots of wheat cv. Stork were less than those of cv. Giza 155. On the other hand, the total phenols were decreased in roots of cv. Giza 155 infected with *M. javanica* while increased in Stork infected roots. However, amounts of phenols in Stork (resistant) infected roots were higher than those of Giza 155 (susceptible) healthy and infected roots.

LITERATURE CITED

BALASUBRAMANIAN M., and PURUSHOTHAMAN D., 1972 - Phenolic contents of root-knot affected tissues. *Indian J. Nematol., 2:* 77-79.

BIEHN W.L., KUC J. and WILLIAMS E.B., 1968 - Accumulation of phenols in resistant plant fungi interactions. *Phytopathology, 58:* 1255-1260.

EL-SHERIF M.A., HAFIZ, S.L., and OTEIFA B.A., 1973 - Effect of *Rotylenchulus reniformis* infection on the phenolic contents of cotton, *Gossypium barbadense. Nematol. medit., 1:* 111-114.

GIEBEL J., 1970 - Phenolic content in roots of some Solanaceae and its influence on I.A.A. oxidase activity as an indicator of resistance to *Heterodera rostochiensis. Nematologica, 16:* 22-32.

GIEBEL J., 1974 - Biochemical mechanisms of plant resistance to nematodes. A review. *J. Nematol., 6:* 175-184.

GOEL A.K., KUMAR S. and TAYAL M.S., 1982 - Morphophysiological and biochemical alterations induced in *Carica papaya* by *Meloidogyne javanica. J. Nematol., 14:* 422 (Abstr.).

KEOBOORUENG S., 1971 - Effect of rice root nematode, *Hirschmanniella oryzae* (Van Breda de Haan, 1902) Luc and Goodey, 1964 on rice seedlings. Ph. D. Thesis, Agric. and Mechanical College Louisiana State Univ. U.S.A. 73 pp.

KOSUGE T., 1969 - The role of phenolics in host response to infection. *Ann. Rev. Phytopath., 9:* 211-241.

MAHMOOD I. and SAXENA S.K., 1986 - Effect of age of tomato seedlings at time of inoculation with *Rotylenchulus reniformis* on growth and changes in phenolics in plants and reproduction of the nematode. *Pak. J. Nematol., 4:* 27-33.

PITCHER R.S., PATRICK Z.A. and MOUNTAIN W.B., 1960 - Studies on the host-parasite relations of *Pratylenchus penetrans* (Cobb) to apple seedlings. *Nematologica, 5:* 309-314.

REZK M.A., 1976 - Studies on plant-parasitic nematodes attacking Graminae. Ph.D. Thesis, Fac. of Agric. Alex. Univ., Egypt. 159 pp.

SWAIN T. and HILLIS W.E., 1959 - The phenolic constituents of *Prunus domestica* 1. The quantitative analysis of phenolic constituents. *J. Sci. Food Agric., 10:* 63-68.

TROLL J. and ROHDE R.A., 1966 - Pathogenicity of *Pratylenchus penetrans* and *Tylenchorhynchus claytoni* on turfgrass. *Phytopathology, 56:* 995-998.

Accepted for publication on 29 May 1987.