Nematol. medit. (1999), 27: 119-122

Department of Nematology, Tamil Nadu Agricultural University,
Coimbatore - 641 003, Tamil Nadu, India

CHANGES INDUCED BY *MELOIDOGYNE INCOGNITA* AND *ROTYLENCHULUS RENIFORMIS*, INDIVIDUALLY AND IN COMBINATION, ON PHYSIOLOGY, CHLOROPHYLL AND NUTRIENTS CONTENT OF PAPAYA

by
S. RAMAKRISHNAN and G. RAJENDRAN

Summary. The effect of different inoculum levels (10, 100 and 1000) of *Meloidogyne incognita* and *Rotylenchulus reniformis*, individually and in combination, on physiological functions, leaf chlorophyll and plant nutrients content of papaya was investigated in a pot experiment. An initial inoculum of 1000 J_2 of *M. incognita* per kg of soil resulted in the greatest reduction in 'a', 'b' and total chlorophyll content, increase in leaf temperature, evaporation rate and diffusion resistance; decrease in photosynthesis; accumulation of nutrients N, P, K, Ca and Mg in the roots. Changes induced by *M. incognita* in the physiology of papaya were directly correlated with nematode inoculum density and were greater than the responses to inocula of *Rotylenchulus reniformis* or concomitant inocula of both nematodes.

Information on the effect of nematodes on the physiological functions of their host plants is scarse, particularly with regard to the effect of mixed species populations on a particular crop. Papaya, is an important tropical fruit which is severely affected by both *Meloidogyne incognita* and *Rotylenchulus reniformis*, which commonly occur together in the same field. An investigation was undertaken to asses the individual and concomitant influence of these nematodes on physiological functions, chlorophyll and nutrients content of their host.

Materials and methods

Thirty day old seedlings of papaya (*Carica papaya* L.) cv. Co 6 raised in 22.5 cm diam. clay pots containing 5 kg of steam sterilized pot mixture were thinned to one seedling of equal growth per pot and inoculated with infective juveniles of *Meloidogyne incognita* (Kofoid *et* White) Chitw. and *Rotylenchulus reniformis* Linford *et* Oliveira, collected from stock culture, at 10, 100 and 1000 per kg of pot mixture, singly and in combination (Table I). An uninoculated control was also maintained. Each treatment was replicated three times and the pots were arranged in a randomised block design in a 30±1 °C temperature controlled glasshouse. The experiment was conducted twice and each was terminated at 90 days after inoculation.

The third leaf of each plant was removed at the end of the above experiment and immediately placed in a Leaf Chamber Analyzer-3 (LCA-3) of the carbon dioxide leaf chamber analysis system to read leaf temperature and for the estimation of some physiological functions viz., photosynthesis, evaporation rate and diffusion resistance (Sen *et. al.*, 1989). Immediately afterwards the leaves were weighed individually

and macerated in a homogeniser with 80% acetone. The extract was used to estimate total chlorophyll, chlorophyll 'a' and 'b' using the method of Arnon (1949) (Table II).

Root samples collected from each plant were washed, oven dried at 60 °C for 48 hours, and then cut into small pieces and ground to powder in a Wiley mill, using a 20 cm stainless steel

TABLE I - *Effect of* Meloidogyne incognita *and* Rotylenchulus reniformis *on leaf temperature and physiological functions of papaya.*

Inoculum level/ kg soil	Leaf temperature* (°C)	Physiological functions*		
		Evaporation rate (mol/m^2/s)	Diffusion resistance (sec cm^{-1})	Photosynthesis (mg Co_2/dm^2 leaf/hr)
10 *M. incognita* (Mi)	25.2 (+3.1)	8.09 (+0.50)	10.03 (+30.09)	24.81 (-2.13)
100 Mi	25.8 (+3.5)	8.31 (+3.23)	10.68 (+38.52)	24.30 (-4.14)
1000 Mi	26.3 (+5.5)	8.96 (+11.30)	15.31 (+98.57)	20.76 (-18.11)
10 *R. reniformis* (Rr)	25.2 (+1.0)	8.07 (+0.25)	8.88 (+15.18)	24.96 (-1.54)
100 Rr	25.8 (+3.5)	8.16 (+1.36)	10.64 (+38.00)	24.73 (-2.45)
1000 Rr	26.2 (+5.2)	8.62 (+7.08)	14.10 (+82.88)	22.53 (-11.12)
5 Mi + 5 Rr	25.0 (+0.5)	8.06 (+0.12)	8.43 (+9.34)	25.01 (-1.34)
50 Mi + 50 Rr	25.7 (+3.2)	8.10 (+0.62)	10.35 (+34.24)	24.88 (-1.85)
500 Mi + 500 Rr	25.8 (+3.6)	8.87 (+10.19)	12.27 (+59.14)	22.70 (-10.45)
Control	24.90	8.05	7.71	25.35
CD (P=0.05)	0.49	0.08	1.97	0.20

* Figures in parentheses are percentage increase or decrease over control.

TABLE II -*Effect of* M. incognita *and* R. reniformis *on chlorophyll content of papaya leaves.*

Inoculum level/ kg soil	Chlorophyll content (mg/g leaf tissue)		
	Chlorophyll 'a'	Chlorophyll 'b'	Total Chlorophyll
10 *M. incognita* (Mi)	0.90	0.70	1.60
100 Mi	0.89	0.65	1.54
1000 Mi	0.80	0.52	1.33
10 *R. reniformis* (Rr)	0.90	0.70	1.60
100 Rr	0.89	0.67	1.56
1000 Rr	0.83	0.53	1.36
5 Mi + 5 Rr	0.90	0.70	1.61
50 Mi + 50 Rr	0.90	0.67	1.58
500 Mi + 500 Rr	0.84	0.54	1.38
Control	0.90	0.70	1.61
CD (P=0.05)	0.046	0.030	0.042

screen with a mesh size of 0.84 mm. These samples were analyzed for nitrogen (Yoshida *et al.*, 1972), phosphorus, potassium, calcium and magnesium content (Jackson, 1973) (Table III).

Results and discussion

Leaf temperature, evaporation rate, diffusion resistance and reduction in photosynthesis increased with an increase in initial inoculum levels of *M. incognita* and *R. reniformis*, individually and concomitantly. Changes in these physiological functions were most pronounced with an individual inoculum of *M. incognita* (Table I).

A single initial inoculum of 1000 J_2 of the root-knot nematode produced the maximum increase in leaf temperature (26.3 °C), evaporation rate (8.96 mol/m^2/S) and diffusion resistance (15.31 sec. cm^{-1}) with significant increases of 5.5, 11.3 and 98.6 per cent, respectively, compared with the uninoculated control (Table I). However, photosynthesis (20.76 mg. CO_2/dm^2 leaf/hr) decreased significantly to 18.1% at this level. Concomitant populations of 1000 nematodes of each species adversely affected the evaporation rate, diffusion resistance and photosynthesis but not as much as a single inoculation of *M. incognita* at 1000 J_2 per kg of soil. Leaf temperatures were similarly affected by all the treatments (Table I).

The leaf chlorophyll content was lowered with an increase in nematode densities independently and concomitantly (Table II) as reported by Ramakrishnan (1995). The 'a', 'b' and total chlorophyll content at 1000 J_2 of *M. incognita* was significantly lower compared to the uninoculated control. The decrease of chlorophyll 'a' and 'b' by 1000 J_2 of *M. incognita* was on par with 1000 *R. reniformis* independently or with concomitant populations of both species. However, an inoculum of 1000 J_2 of *M. incognita* reduced the total chlorophyll and significantly differed from concomitant population of 1000 *M. incognita* and *R. reniformis* per kg of soil (Table II).

In general, per cent nutrient content of the roots significantly increased with increase in the inoculum level of single and concomitant populations of *M. incognita* and *R. reniformis* but decreased as *R. reniformis* increased (Table III).

TABLE III -*Effect of* M. incognita *and* R. reniformis *on nutrients of papaya roots.*

Inoculum level/kg soil	Nutrient percentage*/g root				
	Nitrogen	Phosphorous	Potassium	Calcium	Magnesium
10 *M. incognita* (Mi)	0.257 (+0.8)	0.216 (+1.4)	0.351 (+0.6)	0.506 (+0.4)	0.256 (-)
100 Mi	0.278 (+9.0)	0.227 (+6.6)	0.418 (+19.8)	0.517 (+2.6)	0.257 (+2.8)
1000 Mi	0.288 (+12.9)	0.231 (+8.5)	0.440 (+26.1)	0.520 (+3.2)	0.260 (+4.0)
10 *R. reniformis* (Rr)	0.256 (+0.4)	0.210 (-1.4)	0.347 (-0.6)	0.505 (+0.2)	0.250 (-)
100 Rr	0.259 (+1.6)	0.208 (-2.4)	0.323 (-7.5)	0.494 (-2.0)	0.248 (-0.8)
1000 Rr	0.225 (-11.8)	0.108 (-15.5)	0.310 (-11.2)	0.491 (-2.6)	0.245 (-2.0)
5 Mi + 5 Rr	0.260 (+2.0)	0.217 (+1.9)	0.347 (-0.6)	0.502 (-0.4)	0.250 (-)
50 Mi + 50 Rr	0.263 (+3.1)	0.221 (+3.8)	0.375 (+7.5)	0.506 (+0.4)	0.248 (-0.8)
500 Mi + 500 Rr	0.284 (+1.4)	0.228 (+7.0)	0.437 (+25.2)	0.517 (+2.6)	0.258 (+3.2)
Control	0.255	0.213	0.349	0.504	0.250
CD (P=0.05)	0.018	0.010	0.028	0.006	0.008

* Figures in parentheses are percentage increase or decrease over control.

There were significant increases in per cent nutrient content of N (12.9), P (8.4), K (26.1), Ca (3.2) and Mg (4) over the uninoculated control at an initial inoculum of 1000 J_2 of *M. incognita*. With concomitant densities of 1000 individuals of *M. incongnita* and *R. reniformis* there were similar per cent increases. However, in plants inoculated with *R. reniformis* only the per cent decrease was 11.8, 15.5, 11.2, 2.6 and 2 in the nutrients content of N, P, K, Ca and Mg, respectively. Variations in the per cent content of Mg in root was minimal between inoculated and uninoculated plants (Table III).

The results of the present study revealed that the adverse changes induced by *M. incognita* were more severe than those caused by *R. reniformis* individually and in combination with *M. incognita* with reference to leaf chlorophyll content, plant functional system and nutrients assimilation in papaya.

Literature cited

ARNON D. I., 1949. Copper enzymes in isolated chloroplasts, polyphenol oxidase in *Beta vulgaris*. *Plant Physiol., 24*: 1-15.

JACKSON M. L., 1973. *Soil chemical analysis*, Prentice Hall of India Pvt. Ltd., New Delhi, India, pp. 273.

RAMAKRISHNAN S., 1995. Studies on root-knot nematode *Meloidogyne incognita* (Kofoid and White, 1919) Chitwood, 1949 in papaya (*Carica papaya* L.). Ph. D. thesis, Tamil Nadu Agric. Univ., Coimbatore, Tamil Nadu, India, 152 pp.

SEN K., CHOUDURI M. M. and ADWARD G., 1989. Physiological studies of stomatal conductance, photosynthetic rate and leaf temperature in paddy grown under upland condition. *Plant Physiol., 83*: 334-338.

YOSHIDA S., FORNO D. A., COCK J. H. and GOMEZ K. A., 1972. *Laboratory manual for physiological studies of rice*. Int. Rice Res. Ins., Phillippines, 178 pp.

Accepted for publication on 4 February 1999.