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CHEMICALLY - INDUCED RESISTANCE TO *ROTYLENCHULUS RENIFORMIS* BY ETHEPHON GROWTH REGULANT AND RELEVANT PATHOMETABOLITES IN MANGO SEEDLINGS

by

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Plant growth regulators have been reported to induce broad spectrum effects and to modify the physiology of the plant and nematode parasitism (Davide and Triantaphyllou, 1968; Mjuge and Viglierchio, 1976). It was shown in an earlier study that the effects of plant retardants and promotors on the growth of guava and associated *Meloidogyne incognita* (Kofoid *et* White) Chitwood populations were largely dosage dependant (Badra *et al.*, 1980). Roots of plants pretreated with supra-optimal doses of daminozide and chlorocholine chloride retardants or ethephon and GA stimulators were less galled than untreated plants or those receiving sub-optimal doses of the chemicals. Present research attempted to trigger resistance to nematode parasitism in a host plant by the application of supraoptimal rates of an ethylene-generator chemical. Metabolic changes, mainly auxin-phenol interactions, were investigated as a possible underlying mechanism in host resistance (Giebel, 1970).

Materials and Methods

One-year old seedlings of mango (*Mangifera indica* L. cv. Balady) were potted individually in 1 kg autoclaved clay loam soil and then

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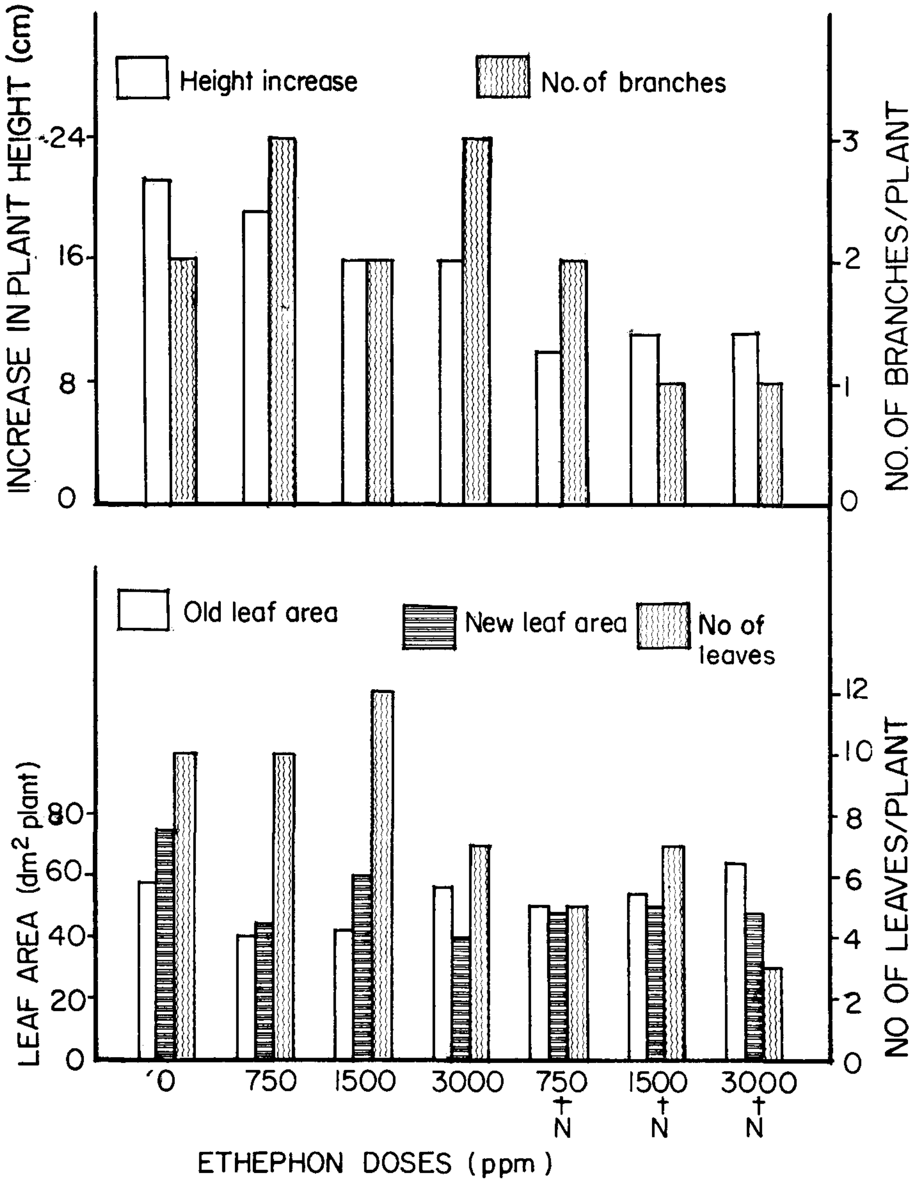

Fig. 1. - Effect of ethylene-generator ethephon on morphological characters of mangoes.

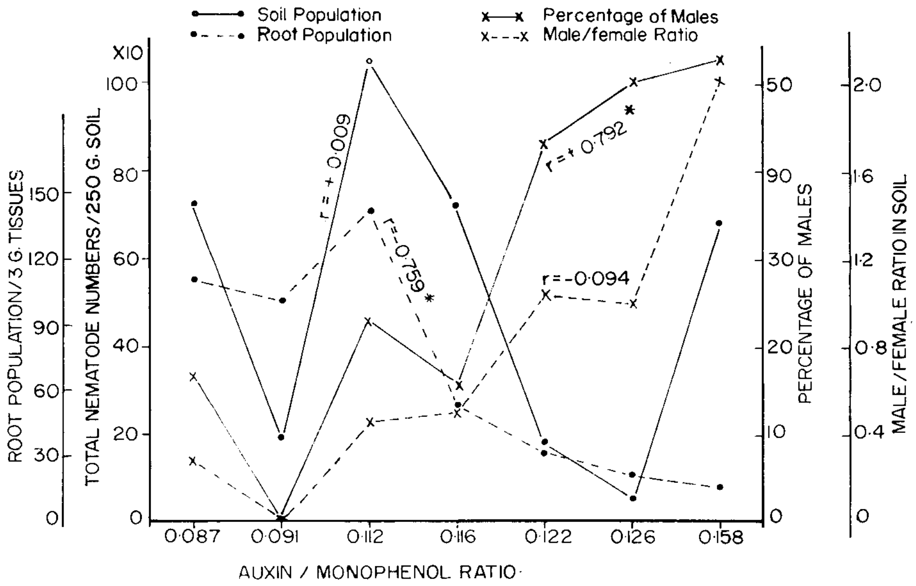

Fig. 2. - Relationship between auxin/monophenol ratio and/or total soil population, root population, percentage of males and male/female ratio in soil.

inoculated with the reniform nematode, *Rotylenchulus reniformis* Linford *et* Oliveira, at 5,000 nematodes/pot. Ethephon (2-chloroethane phosphonic acid; Ethrel 50% aqueous) was applied two weeks later as a foliar spray and then at 3-week intervals. Rates of application were 750, 1500 and 3000 ppm applying 25 ml/plant plus 0.5% Tensofix as a sticker-spreader. In another group, plants received 400 ppm ammoniacal nitrogen as a soil amendment 2 weeks after the last treatment with ethephon. Six replicates/treatment were used. The plants were grown in a glasshouse from May to September then uprooted in late October. Stem height, branching, number and area of leaves as well as fresh weights of tops and roots were recorded. Nematodes in soil (250 g) and on roots (3 g) were recovered from the composite sample for each pot by elutriation and fragmentation, respectively (Oostenbrink, 1960; Taylor and Logering, 1953). Ethanol extracts were prepared by blending 2 g fresh roots/pot in 80 ml ethanol (95%) for 2 minutes and left at 5 °C for two months and then phenols and auxins were determined. Folin reagent (Snell and Snell, 1953) was used to estimate polyphenols and total phenols, and Ehr-

Table I - *Effect of ethephon treatments on the growth of mango seedlings.*

TREATMENT (ppm)	Shoot wt. (g)	Root wt. (g)	Total plant wt. (g)	Shoot/root ratio
Ethephon alone:				
750	23.7 a	8.4 a	32.1 a	2.8 a
1500	20.0 a	7.2 a	27.2 a	2.8 a
3000	23.5 a	6.1 a	29.6 a	3.9 a
Ethephon + Nitrogen:				
750	22.0 a	8.3 a	30.3 a	2.7 a
1500	20.8 a	7.5 a	28.3 a	2.8 a
3000	21.0 a	7.8 a	28.8 a	2.7 a
Untreated control	26.9 b	8.4 a	35.3 a	3.2 a

Means followed by the same letter are not significantly different according to Duncan's multiple range test (P = 0.05).

lich's reagent (as modified by Selim *et. al.*, 1978) was used for the determination of auxins.

Results

The ethephon treatments had a significant effect on shoot weights but not on root weights (P = 0.05) in comparison with controls (Table I). Plant height but not branching was significantly inhibited by 1500 and 3000 ppm (Fig. 1). A smaller number of leaves was observed only in the nitrogen treated group, where newly developed leaves were smaller than on untreated plants. Old leaf area was unaffected at most rates (Fig. 1).

Ethephon led to significant reductions in combined soil and root populations of *R. reniformis* as compared with controls (Table II). This depression generally increased with dosage and was most evident with the addition of nitrogen. The male-female ratio in the soil significantly increased by treatments, and similarly the proportion of the non-parasitic males recording 23% in the controls, 53% with ethephon and 67% with ethephon plus nitrogen.

Table II - *Influence of ethephon treatments on populations of* R. reniformis.

TREATMENT (ppm)	SOIL POPULATION / 250 g					Root infecting population / 3 g tissues (No.)
	Larvae	Males	Females	Total	Male/female ratio	
Ethephon alone:						
750	203 b	115 c	408 d	725 c	0.28 b	112 c
1500	392 d	112 c	224 c	728 c	0.50 c	55 b
3000	25 a	78 b	75 a	178 b	1.04 d	34 a
Ethephon + Nitrogen:						
750	150 b	363 e	177 b	690 c	2.05 e	17 a
1500	0 a	0 a	192 b	192 b	0 a	115 c
3000	0 a	25 a	25 a	50 a	1.00 d	23 a
Untreated control	280 c	248 d	528 e	1056 d	0.47 c	144 d

Means followed by the same letter are not significantly different according to Duncan's multiple range test ($P = 0.05$).

Table III - *Effect of ethephon treatments on phenol-auxin interaction in mango roots* (μg/g *fresh wt.*).

TREATMENT (ppm)	PHENOL CONTENT			Auxin content	Auxin/monophenol ratio
	Mono-[a]	Poly-	Total-		
Ethephon alone:					
750	489.5 b	115.5 b	605.0 b	42.6 a	0.087 a
1500	491.3 b	176.0 e	667.3 c	56.8 c	0.116 b
3000	718.7 f	183.8 e	902.5 e	88.0 e	0.122 c
Ethephon + Nitrogen:					
750	300.7 a	88.0 a	388.7 a	47.6 b	0.158 d
1500	528.0 c	154.0 d	682.0 c	48.0 b	0.091 a
3000	696.7 e	183.3 e	880.0 e	87.4 e	0.126 c
Untreated control	649.0 d	143.0 c	792.0 d	72.9 d	0.112 b

[a] Monophenols were calculated by subtracting polyphenols from totalphenols.
Means followed by the same letter are not significantly different according to Ducan's multiple range test (P=0.05).

Ethephon was antagonistic to phenol and auxin concentrations in roots at 750 and 1500 ppm but synergistic at 3000 ppm (Table III).

R. reniformis population density correlations were significantly negatvie to the auxin/monophenol ratio in host tissues (r= —0.759 *) as shown in Fig. 2. Percentage of males and the male/female ratio in soil were also correlated with this ratio (r= +0.792 * and —0.094, respectively).

Discussion

The doses of ethephon used to induce higher levels of endogenous ethylene in tissues did not affect mango growth significantly after most treatments, but modified host biochemistry sufficiently to induce resistance to *R. reniformis*. Ethylene is known to display dual functions causing many of the formative effects of auxin on the one hand, and on the other activating synthesis of phenol enzymes such as PAL and peroxidase (Bidwell, 1974; Dickinson and Lucas, 1977). Present data suggest that this duality of ethylene action mediated subtile biochemical changes which were correlated with a decline in *R. reniformis* multiplication. With increasing ethephon concentration there appeared a threshold level in the auxin/monophenol ratio (0.112), after which additional ethephon resulted in steadily diminishing numbers of the root-infecting females (r = — 0.759 *) along with a marked increase in the percentage of the non-feeding males (r= +0.792 *). It is likely that this ratio was induced by ethephon that eventually led to the decline of *R. reniformis* parasitism. Therefore, it appears that the multiple effects of plant growth regulators can possibly be utilized as beneficial nematostatic agents in nematode population management.

SUMMARY

Foliar sprays of 750, 1500 and 3000 ppm ethephon applied to mango (*Mangifera indica* L.) infested with *Rotylenchulus reniformis* Linford *et* Oliveira influenced growth weights slightly without significant differences between treated and untreated plants. Most morphological characters of treated plants were not altered except some in the nitrogen-ethephon combinations. Treated plants were significantly resistant to *R. reniformis* infestation, soil populations declining by 31, 31 and 83 %, and root numbers by 22, 62 and 76 % with 750,

1500 and 3000 ppm, respectively. Nematode male/female ratio was 0.47 in the control and 1.04 in treated soil. The addition of nitrogen in another treatment with ethephon antagonized nematode propagation and increased the sex ratio to 2.05 in favour of the non-feeding males. Amounts of both phenols and auxins in roots were significantly lower with 750 and 1500 ppm but were significantly greater than in untreated tissues with 3000 ppm. Induction of resistance to *R. reniformis* appeared mediated by critical alterations in the auxin/monophenol ratio. Nematode parasitism decreased steadily as this ratio increased beyond 0.122 and sex differentiation was shifted markedly in favor of males.

LITERATURE CITED

BADRA T., KHATTAB M.M. and STINO G., 1980, Influence of sub- and supra-optimal concentrations of some growth regulators on growth of guava, phenol statuts, nitrogen concentration and numbers of *Meloidogyne incognita*. *Nematologica*, 26: 157-162.

BIDWELL R.G.S., 1974, Action of hormones and growth substances. *In* « Plant Physiology » ed. R.G.S. Bidwell. MacMillan Publishing Co., New York, 494-516.

DAVIDE R.G. and TRIANTAPHYLLOU A.C., 1968, Influence of the environment on development and sex differentiation of root-knot nematodes. III. Effect of foliar application of maleic hydrazide. *Nematologica*, *14*: 37-46.

DICKINSON C.H. and LUCAS J.A., 1977, Host-pathogen interaction at the molecular level. *In* « Plant Pathology and Plant Pathogens » eds. C.H. Dickinson and J.A. Lucas. Blackwell Scientific Publications, Oxford, 105-131.

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

MJUGE G. and VIGLIERCHIO D.R., 1976, Influence of growth promotors and inhibitors on tomato plants infected with *Meloidogyne incognita* and *M. hapla*. *Nematologica*, *21*: 476-477.

OOSTENBRINK M., 1960, Estimating nematode populations by some selected methods. *In* « Nematology » eds. J.N. Sasser and W.R. Jenkins. Univ. North Carolina Press, Chapel Hill, 85-102.

SELIM H.H.A., FAYEK M.A. and SWEDAN A.M., 1978, Reproduction of Bricher apple cultivar by layering. *Ann. Agric. Sci.*, *9*: 157-166.

SNELL F.D. and SNELL C.T., 1953, Colorimetric methods of analysis including some turbimetric and nephalometric methods. D. van Nostrand Inc., Princeton, New York, vol. III, pp. 606.

TAYLOR A.L. and LOEGERING W.Q., 1953, Nematodes associated with lesions in abaca. *Turrialba*, *31*: 8-13.

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