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COMPARATIVE EFFECTS OF POTASSIUM LEVELS ON GROWTH AND MINERAL COMPOSITION OF INTACT AND NEMATIZED COWPEA AND SOUR ORANGE SEEDLINGS

by

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Potassium (K) is important in the productivity of legumes and citrus. Many workers have demonstrated that the addition of K was associated with an increased reproduction rate of several nematode pathogens, e.g. *Tylenchorhynchus* and *Pratylenchus* (Oteifa and Diab, 1961), *Meloidogyne* (Haque *et al.*, 1973 and Oteifa, 1951 and 1968) and *Rotylenchulus* (Ismail, 1975). However, there has been no comparison of the growth and mineral composition of healthy and infected plants under different K fertility levels. Such a study may help to identify the additional potassium required to compensate for nematode loss.

MATERIALS AND METHODS

Cowpea, *Vigna sinensis* Endl. cv. Azmerely and 6-month old sour orange, *Citrus aurantium* L. seedlings were raised in 15-cm clay pots filled with 1 kg steam-sterilized clay-loam. Cowpeas were thinned to two plants per pot and sour orange to one seedling per pot. After 15 days nematodes were added to half the pots for each experimental host, while the other pots were left uninoculated. The citrus nematode, *Tylenchulus semipenetrans* Cobb, was added to sour orange at 5,000 nematode/pot, while the reniform nematode, *Rotylenchulus reniformis* Linford *et* Oliveira, was inoculated to cowpeas at 2,000 nematode/pot. After 10 days, K_2SO_4 was applied to pots with or without nematodes at the rate of 600, 900 or 1,200 ppm K/pot; other pots were left untreated (−K). There were three repli-

cations of each treatment for sour orange and four for cowpea. Pots were maintained in a greenhouse at 25 ± 4°C for 60 days. The plants were then uprooted and shoot and root weights were recorded. Nematodes were extracted from 250 g soil samples using Oostenbrink's apparatus (1960). Nematode populations in the roots were determined from a 3 g composite root sample per treatment using the Waring blendor tchnique of Fallis (1943) as modified by Taylor and Loegering (1953). Shoot and root samples were oven-dried at 60°C and the nitrogen content was determined according to the A.O.A.C. method (1965). Other elements were measured using an atomic absorption spectrophotometer (Pye Unicam SP 1900).

RESULTS

The effect of the different treatments on the growth of sour orange and cowpea is illustrated in Fig. 1. Both healthy and nematode infested plants responded to the addition of K, the response increasing positively with increased dosage. There were no adverse effects in the 600-1,200 ppm range; the response to K was significant ($P = 0.05$) in both hosts but was greater in sour orange.

In pots without additional K, *T. semipenetrans* retarded the total shoot + root growth of sour orange by 21.5%, and *R. reniformis* checked cowpea by 18.9% (Table I). Supplementation of K improved the growth of both host plants in pots with and without nematodes,

Table I - *Assessment of nematode loss percent in total growth of sour orange and cowpeas as influenced by K levels* *.

Treatment	Sour orange			Cowpea		
	Plant alone (g)	Plant + *T. semi-penetrans* (g)	Nematode loss * %	Plant alone (g)	Plant + *R. reni-formis* (g)	Nematode loss * %
Untreated	4.66	3.66	21.5	19.00	15.41	18.9
+ 600 ppm K	7.33	4.66	36.4	26.08	17.58	32.6
+ 900 ppm K	8.33	6.16	26.1	27.91	22.08	20.9
+ 1,200 ppm K	11.16	6.83	38.8	32.65	26.11	20.0

* Percent difference as calculated between healthy and infested growth at each K level.

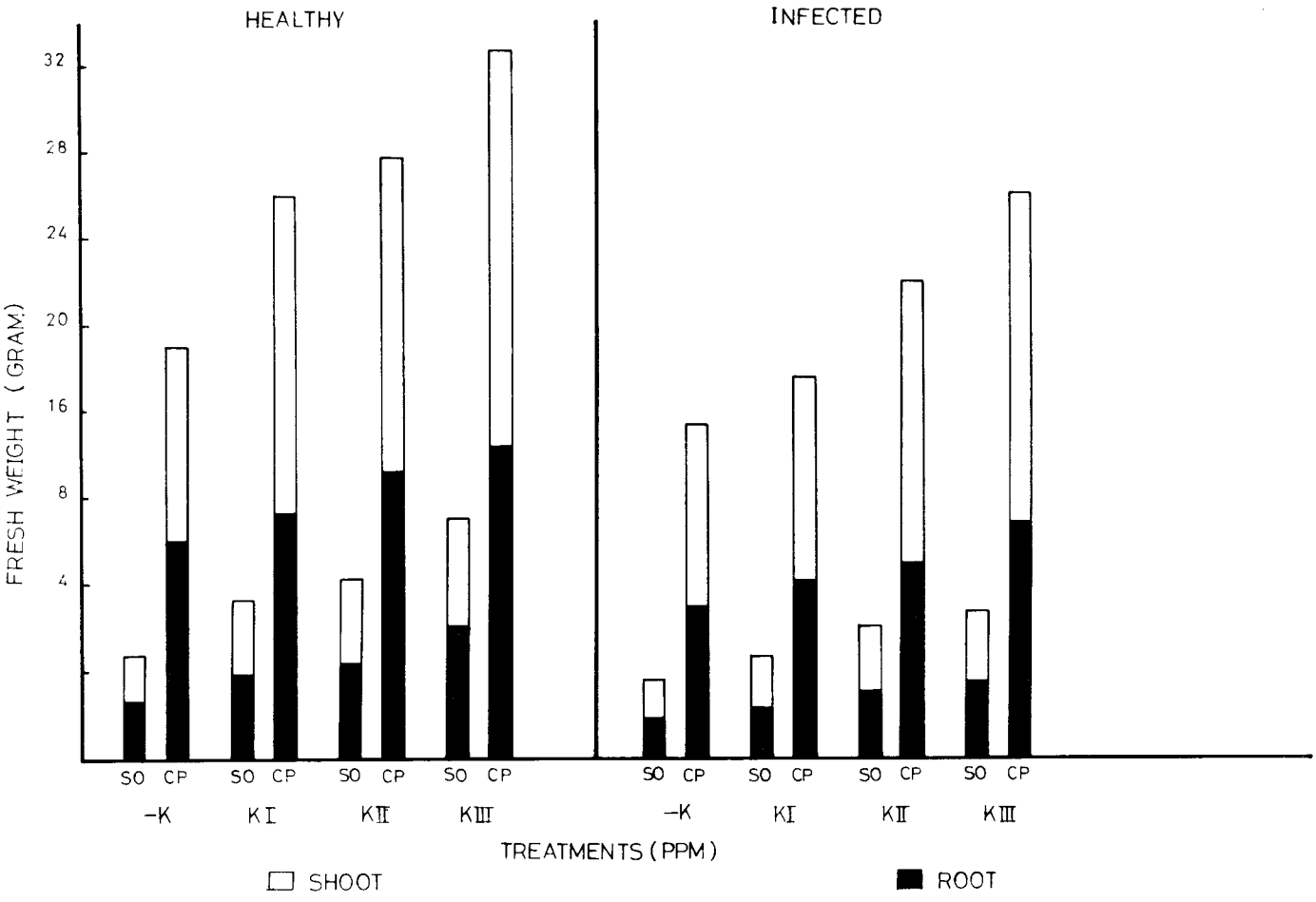

Fig. 1 - Effect of potassium nutrition on total shoot and root growth of healthy and nematized cowpeas and sour orange. (SO = sour orange, CP = cowpea, −K = no potassium, K I, K II and K III = 600, 900 and 1,200 ppm potassium).

although the calculated per cent difference due to the presence of nematodes was greater than in pots without added K (Table I).

The population increases of *T. semipenetrans* and *R. reniformis* under the different treatments are presented in Table II. Root populations of both *T. semipenetrans* and *R. reniformis* increased substantially with the addition of K, presumably associated with the improved growth of the plants. Soil populations also showed increases with additional K, except for *R. reniformis* on cowpea which dropped by 42.5 and 86.1% with respect to 600 and 1,200 ppm K, respectively. In general, the results indicate that K had a greater effect on the reproduction of *R. reniformis* than on *T. semipenetrans*.

Table II - *Influence of K levels on multiplication of* T. semipenetrans *and* R. reniformis *infecting sour orange seedlings and cowpeas.*

Treatment	Sour orange + *T. semipenetrans*			Cowpeas + *R. reniformis*		
	Soil population/pot	Root population/root system	Total populations	Soil population/pot	Root population/root system	Total populations
Untreated	4838	2097	6935	40800	7644	48444
+ 600 ppm K	4632	3332	7964	58076	13475	71551
+ 900 ppm K	5138	5586	10724	88729	24525	113254
+ 1,200 ppm K	5563	9800	15363	22709	50503	73212

Table III presents the values of chemical elements in the root and shoot tissues of cowpea and sour orange pertinent to the different treatments. Infection by either nematode species apparently interferred with the translocation and/or absorption of several elements in infected plants. Infection with *R. reniformis* resulted in the accumulation of N, K and Cu, but slight reductions were observed in Ca, Na, Zn, Mg and Mn levels in the roots. Shoots of infected cowpeas showed increases in K and Ca and to a lesser extent in N, Na, Zn, Mn and Cu. Sour orange infected with *T. semipenetrans* contained lower Zn, Mn and Cu but higher N, K, Ca, Na and Mg in the roots and lower K and Zn, but increased Ca, Na, Mg and Cu in the shoots.

Table III - *Effect of K levels on mineral composition of intact and nematized cowpea and sour orange seedlings.* (μg/g dry tissue weight)

Treatment	Shoot								Root							
	N^{+3}	K^{+1}	Ca^{+2}	Na^{+1}	Zn^{+2}	Mg^{+2}	Mn^{+2}	Cu^{+2}	N^{+3}	K^{+1}	Ca^{+2}	Na^{+1}	Zn^{+2}	Mg^{+2}	Mn^{+2}	Cu^{+2}
CP alone	24.08	16.23	7.70	3.38	0.40	12.75	0.13	0.70	12.88	12.88	1.80	6.90	0.23	11.75	0.28	0.50
CP + N	19.74	17.30	8.25	3.30	0	12.75	0.11	0.21	16.24	12.95	1.48	6.23	0.14	11.00	0.21	1.45
CP + K I	28.00	18.93	12.38	3.73	0	13.00	0.21	0.40	12.46	15.95	1.75	5.83	1.62	10.00	0.10	0.30
CP + N + K I	21.84	18.10	5.80	3.55	1.01	12.25	0.09	0.30	12 04	12.65	1.20	5.18	0.29	11.75	0.25	0.33
CP + K II	20.44	19.23	7.10	3.95	0	12.50	0.11	0.97	18.20	16.88	2.73	5.40	0.32	11.00	0.16	1.50
CP + N + K II	21.84	18.63	5.43	3.38	0.04	12.00	0.08	0.33	15.54	16.33	2.23	5.20	0.57	10.75	0.19	1.97
CP + K III	24.64	20.20	6.73	4.05	0	12.25	0.13	0.70	14.50	15.43	2.20	5.00	0.38	11.00	0.14	0.89
CP + N + K III	23.80	19.93	6.53	3.65	0.17	12.25	0.13	0.48	17.08	16.73	2.68	5.68	0.45	11.25	0.20	1.83
SO alone	11.48	13.51	6.75	8.88	0.28	3.15	0	0.15	8.12	7.41	1.60	7.14	0.75	3.38	0.12	2.41
SO + N	11.48	11.33	7.75	8.99	0.13	4.05	0	0.29	8.63	9.28	1.64	7.61	0.57	4.57	0.09	1.66
SO + K I	8.96	12.68	6.98	6.55	0.15	2.88	0	0.06	7.98	9.45	1.98	5.00	0.45	3.88	0.12	1.46
SO + N + K I	10.78	11.75	7.13	7.50	0.23	3.63	0	0.35	8.68	12.21	1.63	4.40	0.35	3.25	0.08	1.44
SO + K II	13.58	11.98	8.28	6.01	0.03	4.25	0	0.08	7.50	9.24	1.79	7.39	0.68	4.38	0.14	1.81
SO + N + K II	13.54	17.93	6.89	7.23	0.23	4.08	0	0.17	6.72	11.62	1.98	5.65	0.75	3.74	0.02	2.48
SO + K III	9.52	14.15	7.04	9.11	0.63	3.50	0	0.15	6.02	7.01	2.46	6.25	0.38	3.15	0.08	1.29
SO + N + K III	11.20	17.75	6.09	6.66	0.20	3.25	0	0.08	13.77	11.20	1.49	4.35	0.43	2.50	0 07	1.61

CP = cowpea, SO = sour orange and N = nematode. K I, K II and K III = 600, 900 and 1,200 ppm potassium.

DISCUSSION

The experimental data indicate that potassium nutrition affects the host-parasite interrelationships. Increased K supplied to nematode-infected plants resulted in increased growth of the plants together with increases in the populations of *R. reniformis* and *T. semipenetrans*. These findings agree with those of other authors (Oteifa and Diab, 1961; Haque *et al.*, 1973; Ismail, 1975). Oteifa (1953) showed that excessive applications of K favoured the rapid development of nematodes by shortening their life cycles. The large increase in nematode populations after the application of K suggests that K is required for multiplication, nutrition and/or egg production. However, increased K improved root growth which thus increased the sites available for the nematodes, as evident in the present study.

Nematode infection apparently affected the mineral content and physiology of the host plants by reducing some elements and increasing others via their translocation and/or their absorption. The variability apparent between the mineral abnormalities caused by *R. reniformis* and by *T. semipenetrans* may relate to variable pathological processes induced by different nematode enzymes. No less important is the specific host response to infection. The variable mineral composition of *T. semipenetrans* infected tissues, the lower P_f/P_i ratio of *T. semipenetrans* and evidence from other investigators (Bijloo, 1968; Kirkpatrick *et al.*, 1962 and Van Gundy and Kirkpatrick, 1964) suggest that a toxic principle in root sap of sour orange might be involved. However, K application to some extent countered these adverse effects as indicated by the good growth of infected plants.

SUMMARY

Healthy and nematode parasitized plants of sour orange, (*Citrus aurantium* L.) and cowpeas (*Vigna sinensis* Endl.) responded positively to treatment with 600, 900 and 1,200 ppm potassium (K). Sour orange seedlings showed greater response to K than cowpeas. Populations of *Tylenchulus semipenetrans* Cobb infecting sour orange and *Rotylenchulus reniformis* Linford *et* Oliveira infecting cowpeas increased due to K application and correlated with increasing K levels. Numbers of *R. reniformis* in soil, however, declined in the presence of 1,200 ppm K but *T. semipenetrans* parasitizing sour orange treated at this K level did not. Nematode damage to cowpeas was greater at the low rate of 600 ppm, but higher doses enabled infested plants to maintain good growth. Addition of K resulted in higher N, K, Cu and Zn in treated plants, but Mg, Ca and Na levels decreased.

RIASSUNTO

Effetto comparativo di diversi livelli di potassio sulla crescita e la composizione minerale di piantine di Vigna e Arancio amaro attaccate e non da nematodi fitoparassiti.

Piantine di Vigna (*Vigna sinensis* Endl.) e di Arancio amaro (*Citrus aurantium* L.), attaccate e non da nematodi fitoparassiti hanno risposto positivamente a somministrazioni di 600, 900 e 1200 ppm/vaso di potassio. Anche le cariche di *Tylenchulus semipenetrans* Cobb, su Arancio amaro, di *Rotylenchulus reniformis* Linford *et* Oliveira, su Vigna, sono aumentate dopo la somministrazione dell'elemento. Le somministrazioni di potassio hanno incrementato nei tessuti delle piante il contenuto di N, K, Cu e Zn e diminuito quello di Mg, Ca e Na.

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