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CHANGE IN MINERAL NUTRIENTS CONTENTS OF FIVE RIDGE GOURD (*LUFFA ACUTANGULA* (L.) ROXB.) VARIETIES AFFECTED BY ROOT-KNOT NEMATODE

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Abstract

Mineral nutrient changes in 5 Ridge gourd varieties inoculated with root-knot nematode, *Meloidogyne incognita* were investigated. Five ridge gourd varieties, namely Priya, BSS-1009, Aneeta, Aarti and Harsha were inoculated with root-knot nematode and studied their effects on the changes of mineral nutrients contents of shoots and roots. The contents of Ca, Mg, Fe, Zn, Cu and Mn varied greatly among the varieties in both shoot and root. Some changes in mineral nutrients were observed due to the inoculation of root-knot nematode. The percentage of Ca, Mg, Fe, Zn, Cu and Mn were found lower in inoculated shoot and root samples than the healthy counterpart in most cases. The lowest Ca content was found in Priya in both shoot and root but Mg content was minimum in Aarti variety.

Introduction

The root-knot nematode, *Meloidogyne incognita* is the most important nematode pests worldwide due to their great damage resulted in the very wide host range which include more than 3000 plant species (Abad *et al*. 2003). Nematode pests in general, affect host plants quantitatively and qualitatively. Quantitatively by reducing the total production causing about 20.6% worldwide yield loss and qualitatively by devaluating the produced crops as a result of some malformations as well as decreasing the organic and mineral components of the produced fruits (Sasser 1989). Plant parasitic nematode, *Meloidogyne incognita* alters the metabolic processes of the host plant which are manifested in the form of cellular, physiological and biochemical changes in the infected host. The root-knot nematodes cause measurable changes in the morphology and physiology of the tomato plant (Williamson and Gleason 2003). The changes in the physiological and biochemical processes of infected host because of disturbed metabolism decide whether the host becomes susceptible or resistant to nematode attack (Krusberg 1963). In the recent past some progress has also been made in this direction to understand the basic biochemical mechanism of plant nematode interactions by several workers (Howell and Krusberg 1966, Ganguly and Dasgupta 1983, Mohanty *et al*. 1995, Nayak 2015). Considering the importance of the subject, the present investigation was undertaken to find the changes, if any, in calcium, magnesium, iron, zinc, copper and manganese contents of 5 varieties of ridge gourd inoculated with root-knot nematode.

Materials and Methods

Seedlings of 5 ridge gourd (*Luffa acutangula* (L.) Roxb.), namely Priya, BSS-1009, Aneeta, Aarti and Harsha were grown in earthen pots in the greenhouse. Moreover, 25 pots were arranged i.e. 5 replications were made and 2 - 3 seedlings per pot were maintained. These plants were washed 30 days after nematode inoculation (1000 J_2/seedling/pot) and mineral nutrient contents of shoot and root samples were estimated by Atomic Absorption Spectrophotometer (AAS) methods.

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The estimation of mineral nutrients was done following the procedure of Jackson (1973). For this purpose, powdered plant samples (0.2 g) were taken in a 100 ml conical flask. To each flask 10 ml of concentrated HNO_3 was added. These flasks were kept undisturbed overnight. Then the flask containing samples were heated on a hot plate till brown fumes evolved. Five ml of di-acid mixture ($HNO_3 : HClO_4$) (70%): 3 : 2 by volume) was added to each flask. Again, the flasks were heated till fumes evolved reducing the volume of content to about 2 ml. Therefore, conical flasks were taken out from hot plate and allowed to cool. Then 15 ml warm distilled water was added to each flask. The content of conical flask was transferred to a 50 ml volumetric flask followed by twice rinsing with distilled water. Then the volume was made up to 50 ml with distilled water and the aliquot was filtered through Whatman No. 42 filter paper. The filtered extract was kept for estimation of mineral nutrients like calcium, magnesium, sulphur, copper, zinc and manganese.

Digested sample was introduced to AAS for Fe, Mn, Ca, Mg, S and Cu analysis after standardizing the AAS with respective standards and calculated as follows:

$$\text{(Fe, Mn, Ca, Mg, Mn, S, Cu) mg/100 g} = \frac{\text{AAS} \times 50}{\text{Sample wt. (g)} \times 10}$$

Results and Discussion

Many kinds of elements and enzymes are present in the plant system that influences the metabolism of the pests fed upon them. The chemicals may consist of simple nitrogen, phosphorus, potassium, zinc, copper, iron, calcium, magnesium, manganese, carbohydrates and fats to complex proteins, enzymes, phenolic compounds etc., which may nourish, starve or kill the feeding organisms upon them. In the course of feeding some chemicals may be depleted or some others may be *de novo* synthesized, that may be detrimental to the pest. In order to know the chemical and genetic basis of resistance, 5 varieties were chosen for a detailed analysis. One set of each uninoculated (healthy) and inoculated (infected) plants was analysed to test the effects of root-knot nematode infection on the growth and vigour of the plants and their root-system.

The calcium content found to decrease in the shoot system of infected varieties of ridge gourd Priya, BSS-1009, Aneeta, Aarti and Harsha by 36.58, 36.05, 1.70, 16.25 and 23.44% in root system by 40.55, 23.39, 12.05, 5.86 and 29.51%, respectively than their respective healthy counterparts. The lowest calcium content was found in Priya variety in both shoot and root (Table 1). The results of the present investigation revealed that the infected plants had decreased percentage of calcium content in both shoots and roots of susceptible and resistant varieties. The above data are in agreement with findings of Mohanty *et al.* (1999) who indicated that there was reduction of micro nutrients *viz.* Zn, Cu, Fe, Mn, Mo and B on cowpea when inoculated by *Rotylenchulus reniformis*.

It is apparent from Table 2 that the magnesium content decreased in the shoot system of infected varieties of ridge gourd Priya, BSS-1009, Aneeta, Aarti and Harsha by 19.21, 22.05, 15.79, 18.14, 21.72 and in root system by 5.91, 35.69, 32.15, 17.65, and 28.12%, respectively than their healthy counterparts. The lowest manganese content was found in BSS-1009 variety in both shoot and root. The results of the present investigation revealed that the infected plants had decreased percentage of magnesium content in both shoots and roots of susceptible and resistant varieties. The above data are in agreement with findings of Mohanty *et al.* (1999).

The sulphur content was found to decrease in the shoot system of infected varieties of ridge gourd Priya, BSS-1009, Aneeta, Aarti and Harsha by 18.45, 15.49, 91.66, 13.33, 91.78 and in root system by 17.85, 93.58, 91.02, 93.35, and 92.94%, respectively in comparison to their respective healthy counterparts (Table 3). It was depicted that the decrease of sulphur content was recorded highest as 91.78% in infected shoot of variety Harsha and that of root by 93.58% in BSS-1009 over healthy counterparts on dry weight basis. The results of present investigation revealed that the infected plants had decreased percentage of sulphur content in both shoots and roots of susceptible and resistant varieties.

Table 1. Changes of calcium contents in five ridge gourd varieties as infected by root-knot nematode, *M. incognita.*

Varieties	Calcium content ppm on dry weight basis							
	Shoot				Root			
	Infected (I)	Healthy (H)	Mean	Increase/decrease over healthy (%)	Infected (I)	Healthy (H)	Mean	increase/decrease over healthy (%)
Priya	17.33	27.33	22.33	–36.58	14.66	24.66	19.66	–40.55
BSS-1009	26	40.66	33.33	–36.05	24	31.33	27.66	–23.39
Aneeta	38	38.66	38.33	–1.70	34	38.66	36.33	–12.05
Aarti	24	28.66	26.33	–16.25	21.33	22.66	21.99	–5.86
Harsha	32.66	42.66	37.66	–23.44	28.66	40.66	34.66	–29.51
SE(m)±	1.42	1.9			1.59	0.72		
CD(0.05)	4.62	6.19			5.18	2.34		

Table 2. Changes of magnesium contents in five ridge gourd varieties as infected by root-knot nematode.

Varieties	Magnesium content ppm on dry weight basis							
	Shoot				Root			
	Infected (I)	Healthy (H)	Mean	Increase/decrease over healthy (%)	Infected (I)	Healthy (H)	Mean	increase/decrease over healthy (%)
Priya	14	17.33	15.66	–19.21	10.66	11.33	10.99	–5.91
BSS-1009	16	20.66	18.33	–22.55	12	18.66	15.33	–35.69
Aneeta	21.33	25.33	23.33	–15.79	12.66	18.66	15.66	–32.15
Aarti	12	14.66	13.33	–18.14	9.33	11.33	10.33	–17.65
Harsha	24	30.66	27.33	–21.72	15.33	21.33	18.33	–28.12
SE(m) ±	1.51	2.02			1.27	1.85		
CD (0.05)	4.92	6.58			4.15	6.03		

As revealed in Table 4 the copper content decreased in shoot system of infected varieties of ridge gourd Priya, BSS-1009, Aneeta, Aarti and Harsha by 20.29, 35.82, 30.5, 20.93, 40% and in root system by 10.55, 44.66, 61.46, 20.29, and 29.49%, respectively in compare to their healthy counterparts. Maximum decrease of copper content was found in shoots of Harsha variety but in root in Aneeta variety. The results of present investigation revealed that the infected plants had decreased percentage of copper content in both shoots and roots of susceptible and resistant varieties.

It is clearly depicted from Table 5 that the iron content of shoot was found higher in infected Priya variety than the healthy counterpart but decreased in the BSS-1009, Aneeta, Aarti and Harsha by 19.29, 15.32, 14.71, 7.72 and 25.41%, respectively and in root system decreased in all the varieties. The lowest values were found in Aarti and Priya in infected shoot and root respectively. The results of present investigation revealed that the infected plants had decreased percentage of iron content in both shoots and roots of susceptible and resistant varieties except Priya variety in shoots. The above data are in agreement with the research findings of Mohanty *et al.* (1999).

Table 3. Changes of sulphur contents in five ridge gourd varieties as infected by root -knot nematode.

Varieties	Sulphur content % on dry weight basis							
	Shoot				Root			
	Infected (I)	Healthy (H)	Mean	Increase/decrease over healthy (%)	Infected (I)	Healthy (H)	Mean	increase/decrease over healthy (%)
Priya	0.29	0.36	0.32	–18.45	0.02	0.03	0.02	–17.85
BSS-1009	0.36	0.42	0.39	–15.49	0.03	0.48	0.25	–93.58
Aneeta	0.02	0.33	0.18	–91.66	0.03	0.32	0.17	–91.02
Aarti	0.02	0.03	0.02	–13.33	0.02	0.34	0.18	–93.35
Harsha	0.02	0.35	0.191	–91.78	0.02	0.34	0.18	–92.94
SE (m) ±	0.02	0.01			0.72	0.38		
CD (0.05)	0.05	0.06			2.37	0.12		

Table 4. Changes of copper contents in five ridge gourd varieties as infected by root-knot nematode.

Varieties	Copper content ppm on dry weight basis							
	Shoot				Root			
	Infected (I)	Healthy (H)	Mean	Increase/decrease over healthy (%)	Infected (I)	Healthy (H)	Mean	Increase/decrease over healthy (%)
Priya	6.56	8.23	7.39	–20.29	5.93	6.63	6.28	–10.55
BSS-1009	4.3	6.7	5.5	–35.82	3.06	5.53	4.29	–44.66
Aneeta	5.56	8	6.78	–30.5	1.63	4.23	2.93	–61.46
Aarti	5.93	7.5	6.71	–20.93	6.56	8.23	7.39	–20.29
Harsha	3.6	6	6.6	–40	2.63	3.73	3.18	–29.49
SE(m) ±	0.70	0.87			0.49	0.38		
CD (0.05)	2.30	2.85			1.60	1.26		

It is revealed from Table 6 that the zinc content decreased in the shoot system of infected varieties of ridge gourd Priya, BSS-1009, Aneeta, Aarti and Harsha by 43.63, 62.58, 4.22, 16.32, 0.83% and in root system by 31.39, 16.98, 39.09%, 3.63 and 47.91%. respectively than their healthy counterparts. The results of the present investigation showed that the infected plants had decreased percentage of zinc content in both shoots and roots of susceptible and resistant varieties. The lowest Zinc content was found in BSS-1009 and Aneeta in shoots and roots, respectively of the infected plants. The above data are in more or less similar to the research findings of Mohanty *et al.* (1999).

Table 5. Changes of iron contents in five ridge gourd varieties as infected by root-knot nematode.

Varieties	Iron content ppm on dry weight basis							
	Shoot				Root			
	Infected (I)	Healthy (H)	Mean	increase/decrease over healthy (%)	Infected (I)	Healthy (H)	Mean	Increase/decrease over healthy (%)
Priya	18.30	15.34	16.82	19.29	11.22	18.29	14.75	–38.65
BSS-1009	22.10	26.10	24.1	–15.32	22.07	25.40	23.73	–13.11
Aneeta	17.74	20.80	19.27	–14.71	22.11	26.07	24.09	–15.18
Aarti	14.33	15.53	14.93	–7.72	14.32	20.8	17.56	–31.15
Harsha	18.25	24.47	21.36	–25.41	24.15	24.73	24.44	–2.34
SE(m) (±)	3.05	1.51			1.92	1.83		
CD (0.05)	9.95	4.92			6.25	5.99		

Table 6. Changes of zinc contents in five ridge gourd varieties as infected by root-knot nematode.

Varieties	Zinc content ppm on dry weight basis							
	Shoot				Root			
	Infected (I)	Healthy (H)	Mean	Increase/decrease over healthy (%)	Infected (I)	Healthy (H)	Mean	Increase/decrease over healthy (%)
Priya	20.76	36.83	28.79	–43.63	18.73	27.3	23.01	–31.39
BSS-1009	16.66	44.53	30.59	–62.58	9.43	11.36	10.39	–16.98
Aneeta	35.56	37.13	36.34	–4.22	5.36	8.80	7.08	–39.09
Aarti	22.56	26.96	24.76	–16.32	19.33	20.06	19.69	–3.63
Harsha	20.13	20.32	20.21	–0.83	4.13	7.93	6.03	–47.91
SE(m)±	2.37	5.92			2.57	1.35		
CD (0.05)	7.72	19.29			8.37	4.40		

Table 7 shows that the manganese content decreased in the shoot and root system of all the infected varieties of ridge gourd. The decrease was maximum in Aarti (22.09%) in shoots and in root the highest decrease was found in Harsha (31.38%). The results of present investigation revealed that the infected plants had decreased percentage of magnesium content in both shoots and roots of susceptible and resistant varieties.

The single generation of *M. incognita* caused the changes in both concentration and total content of different elements in the ridge gourd varieties to establish relationship between nutrients status and physiological processes. The data indicated that a change in the concentration of the nutrient elements in plant is probably one of the first effects of the nematode on host physiology.

Table 7. Changes of manganese contents in five ridge gourd varieties as infected by root-knot nematode

Varieties	Manganese content ppm on dry weight basis							
	Shoot				Root			
	Infected (I)	Healthy (H)	Mean	Increase/decr-ease over healthy (%)	Infected (I)	Healthy (H)	Mean	Increase/decrease over healthy (%)
Priya	42.5	46.7	44.6	–8.99	111.6	129.2	120.4	–13.62
BSS-1009	47	52.8	49.9	–10.98	85.6	101.5	93.55	–15.66
Aneeta	32.7	36.9	34.8	–11.38	184.4	212.9	198.65	–13.38
Aarti	56.4	72.4	64.4	–22.09	149.6	153.8	151.7	–2.73
Harsha	69.9	77	73.45	–9.22	38.7	56.4	47.55	–31.38
SE (m) ±	2.78	2.70			2.93	1.44		
CD (0.05)	9.06	8.80			9.55	4.69		

The present investigation clearly indicated that root-knot played key role in altering the nutrient contents of the tested host plant. Further, it is of opinion that the basic information provided in this investigation will certainly be helpful to understand the complicated areas of the chemical mechanisms of plant nematode-interaction in relating to root-knot and other plant parasitic nematodes. Root-knot nematode infection often reduces plant growth and yield and decreases nutrient uptake in the infested plants showing the deficiencies of zinc, Iron, copper, sulphur, calcium, magnesium and manganese due to root damage and subsequent prevention of water and nutrient uptake by the roots.

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