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Effect of Magnesium Nutrition on Plant Growth and Multiplication of Potato Virus X

By

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Introduction

Potato virus X multiplication as influenced by mineral nutritions of host has been studied by some workers (HELMS & POUND 1955, BAWDEN & KASSANIS 1950, GANGULI & al. 1963). They have mostly studied the effect of nitrogen, phosphorus and potassium nutrition on the host growth and virus multiplication. Host nutrition with magnesium in relation to PVX multiplication has not been much studied. The present study deals with the effect of magnesium nutrition on the host growth and multiplication of PVX in tomato.

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Materials and Methods

Tomato (*Lycopersicum esculentum* Mill. 'Best of all') was used as host plant. Potato virus X, maintained on *Nicotiana tabacum* L. 'White-Burley' in insect proof chamber, was used as virus.

Sand culture methods were used and the procedure followed was that of HEWITT 1952 and ELLIS & SWANEY 1953. Nutrient solutions containing various levels of magnesium (0,50, 125, 250 and 500 p. p. m.) were prepared using HOAGLAND's and SYNDER's four salt solution (see McLEAN & COOK 1958). One ml of the concentrated micronutrient solution (CHESTER & STREET 1948) was also added to each litre of the solution. The nutrient solutions were adjusted to pH 7 before use. The methods for raising the plants, inoculation procedures and determination of growth data were the

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same as followed by SINGH & BHARGAVA 1966. The virus inoculum was prepared as described by SINGH 1969 and the active virus concentration in the juice of inoculated plants was assayed by counting of local lesions produced on opposite leaves of *Chenopodium amaranticolor* COSTE & REYN.

Tomato seedlings having four leaves of uniform size were taken and transplanted. Transplanted seedlings were divided into five batches having 20 plants in each batch. Each batch was supplied with nutrient solution having different levels of magnesium twice a week. Distilled water was given during intervening period, whenever it was necessary. After five days of transplantation ten plants in each batch were inoculated with the PVX and rest of the plants were left as control. The growth data, virus multiplication and chlorophyll concentration in inoculated tomato plants were taken after 60 days of inoculation.

For chlorophyll extraction 2 gm of leaf samples were collected from each treatment and macerated with 15 ml of acetone. The maceration was done in a mortar with pestle. The macerate was filtered through a Whatman no. 42 filter paper and repeatedly washed until no more green colour remained in the residue. The filtrate was concentrated by evaporating the acetone till the volume was reduced to 5 ml. It was then spotted (0.05 ml) on Whatman filter paper no. 44 for chromatography. Petroleum ether and Benzen in 3:1 ratio was used as solvent. The chlorophyll a and b were separated by pa paper chromatography and were estimated by Densitometer. The substitute standards were prepared and calculations of concentration of chlorophyll a and b were done according to methods described by PEACH & TRACEY 1955 and expressed in μgm/2gm on fresh weight.

Experimental Results

Tomato plants were grown separately in nutrient solutions containing 0,50, 125, 250 and 500 p. p. m. of magnesium. Growth data of tomato plants at various levels showed a gradual increase in height and fresh and dry weight from 0 p. p. m. to 125 p. p. m. (Table 1) beyond which the growth showed a decline. At 0 p. p. m. the characteristic chlorosis of magnesium deficiency was first observed on the tips of older oeaves. This loss of colour advanced along the margins and inwardly between the veins of the leaves. The larger veins of the leaves retained green colour. The inoculated plants became stunted and the symptoms were mild mosaic. Plants at 50 p. p. m. level showed mild chlorosis associated with good vegetative growth while the infected plants at this level had reduced growth with bright mosaic symptoms. Maximum vegetative growth with normal green foliage was noted in healthy plants grown at 125 p. p. m. level while reduced in vegetative growth with mosaic mottling symptoms was noted in inoculated plants. Healthy tomato plants grown at 250 and 500 p. p. m. had dark green foliage in comparison to tomatoes grown at 125 p. p. m. Inoculated plants

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on the other hand showed mosaic symptoms associated with reduced leaflets. The diseased plants, however, were more chlorotic at 500 p. p. m.

Results of the Table 2 indicate that the PVX concentration was maximum in inoculated plants grown at 125 p. p. m. and lowest at 0 p. p. m. The chlorophyll a and b concentrations were highest in healthy tomatoes grown at 500 p. p. m. level and lowest in diseased plants grown at 0 p. p. m.

Discussion

Results (Table 1 and 2) indicate that maximum growth of the tomato plants was obtained at 125 p. p. m. of magnesium and the relative concentration of the PVX in inoculated tomato plants was also found to be maximum at this level. These results show that the concentration of the virus is directly correlated with the growth of the host plants. Excess of the magnesium caused lower vegetative growth of the plants associated with decrease in multiplication of PVX. The lowest PVX concentration was observed in infected tomato plants grown at 0 p. p. m. Low concentration of the tobacco

Table 1

Effect of magnesium nutrition on growth of tomato

Magnesuim Conc. (p. p. m.)	Height of stem (cm)	Fresh weight of shoot (gm)	Dry weight of shoot (gm)
0			
Healthy	20.0	6.3	0.71
Diseased	14.7	3.4	0.332
50			
Healthy	30.3	11.7	1.135
Diseased	17.8	4.08	0.355
125			
Healthy	32.6	12.3	1.214
Diseased	23.2	5.8	0.47
250			
Healthy	23.4	10.4	0.827
Diseased	19.6	4.6	0.451
500			
Healthy	20.4	8,0	0.718
Diseased	18.4	4.15	0.432

Height, Fresh weight and Dry weight values of shoot are the average of 20 plants.

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mosaic virus was also reported in magnesium deficient plant (SHEPHERED & POUND 1960).

Magnesium plays a vital role in the adsorption of other nutrients specially potassium and calcium (HOAGLAND 1944, BROYER & STOUT 1959), acts as a catalyst, activators and co-factors in several enzymatic activities (INGRAHAM & GREEN 1958) and participates in active protein and carbohydrate metabolism (McELROY & NASON 1954). Mg has been also shown to be present in the viral RNA (LORING & WARITZ 1957).

As Mg is also known to be component of the chlorophyll molecule, its various nutrient levels effected the concentration of the chlorophyll, as is evident in Table 2. The lower concentration of the chlorophyll in diseased plants seems to be the effect of virus infection which probably, somehow, retards the activity of the enzymes associated with the biosynthesis of the chlorophyll.

Table 2

The concentration of chlorophyll a and b as express μmg on fresh weight basis in PVX inoculated and healthy tomato plants. PVX concentration in the shoot of infected plants after 60 days of inoculation.

Magnesium Conc. (p. p. m.)	Chlorophyll a	Chlorophyll b	Local lesions*)
0			
Healthy	2.97	3.52	85
Diseased	2.16	2.08	85
50			
Healthy	5.54	3.46	
Diseased	2.97	3.08	268
125			
Healthy	5.94	3.97	
Diseased	3.59	4.44	315
250			
Healthy	6.18	3.86	
Diseased	3.87	3.86	200
500			
Healthy	6.48	3.98	
Diseased	2.26	2.29	112

*) Average number of local lesions produced on 20 leaves of *C. amaranticolor*.

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Summary

The effect of several concentrations of magnesium (0,50, 125, 250 and 500 p. p. m.) on growth and multiplication of Potato virus X in tomato (*Lycopersicum esculentum* Mill. 'Best of all') grown in sand culture were studied. The growth of healthy and diseased plant was reduced at 0 p. p. m. and the maximum vegetative growth was at 125p. p. m. Above 125 p. p. m. level a reduction in plant growth has occured. The PVX concentration coincided closely with the growth. Chlorophyll a and b concentration was lowest in inoculated tomato plants grown in magnesium deficient solution and highest in healthy plant grown at 500 p. p. m. level.

Zusammenfassung

Wie sich verschiedene Konzentrationen von Magnesium (0, 50, 125, 250 und 500 p. p. m.) auf das Wachstum und die Vermehrung des Potato Virus X auswirken, wurde an der Tomatensorte *Lycopersicum esculentum* Mill. 'Best of all' untersucht, die in Sandkultur herangezogen wurde. Das Wachstum der gesunden und der kranken Pflanze war eingeschränkt bei 0 p. p. m., erreichte bei 125 p. p. m. den Höchstwert und ging über 125 p. p. m. zurück. Die PVX-Konzentration stimmte mit den Wachstumswerten genau überein. Die Chlorophyll a und b Konzentration war am niedrigsten in geimpften Tomatenpflanzen, die in magnesiumfreier Lösung kultiviert wurden und am höchsten in gesunden Pflanzen, die bei einem Wert von 500 p. p. m. wuchsen.

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