MINERAL NUTRITION OF PLUM TREES AS AN IMPORTANT FACTOR OF PROTECTION AGAINST PLUM POX VIRUS DISEASE

J. KRÁĽOVIČ, V. KRÁLOVÁ

Institute of Experimental Phytopathology and Entomology, Slovak Academy of Siences, Nádražná 52, 900 28 Ivanka pri Dunaji, Slovak Republic

Summary. – The experimental results obtained from a fruit garden at Krajné pointed out a different content of macrobiogenic elements in the leaves of plum trees infected with plum pox virus (PPV) as compared to healthy ones. Mineral nutrition of diseased trees was characteristic by lower relational values of topical levels of macrobiogenic elements especially those of N/P, N/K, (Ca + Mg)/K, and (N/P)/(N/K).

Key words: plum tree; plum pox virus disease; nitrogen; phosphorus; potassium; calcium; magnesium

Introduction

Fruit growing is an important part of plant production providing a good quality of fruits for direct consumption besides fruit processing. From the standpoint of fruit grower, a realization of yield potential of fruit crops is conditioned by many controllable and uncontrollable factors. Among controllable factors, the plant protection plays a significant role. Besides sound knowledge on the reasons of gradation and epidemic spread of pathogens, an effective protection also presumes the knowledge on criteria for their harmfulness as well as on the mechanism of action of bioactive substances in question on the metabolism of plants. This knowledge is particularly important in the case of PPV causing plum pox disease, sharka.

In Slovakia, many virologists as Kraliková (1964), Paulechová (1980), and Baumgartnerová (1987, 1991) have aimed their attention at the research of PPV that causes a great damage to plum orchards. It seems that from the standpoint of protection against plum pox as well as other virus diseases, a less attention has been paid to the questions of host mineral nutrition. Many papers in phytopathological literature report on the rate of fertilization, supply of inorganic elements from the soil and other aspects (Reichard, 1964; Quelhas dos Santos, 1979; Narasimhan and Alagianagalingam, 1986; Chant *et al.*, 1984), but a little information is available on the content of inorganic elements in plants which through the metabolic processes are known to influence the pathogenesis (Schlösser, 1983; Perrenoud, 1990). With regard to internal concentration of inorganic nutrients, interesting results were obtained on the rhizomania incidence in sugar beet and its harmful effects on mineral nutrition (Kráľovič and Králová, 1996).

The present study was aimed at the analysis of the plum pox disease incidence in relation to the mineral nutrition of plum crops.

Materials and Methods

During August 1997, the status of mineral nutrients in healthy plum trees and those infected with PPV from a fruit garden at Krajné has been examined. The selection of leaves of infected trees was made on the basis of visible disease symptoms.

The content of macrobiogenic elements viz. nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg) was determined by means of chemical analysis of the leaves. For each set (healthy and infected leaves), the analysis of pooled samples from 100 leaves was carried out in quadruplicate. The preparation of plant material and the determination of inorganic elements were performed as described by Kráľovič *et al.* (1995).

The differences between the contents of individual elements were statistically analysed using the Student's t-test.

The mean contents of N, P, K, Ca and Mg were used partly to calculate relational values of topical concentrations of elements in the healthy and infected leaves by means of the formulae (N/P)/(N/K) and (Ca + Mg)/K, partly to compare the differences between them.

Table 1. Content of macrobiogenic elements in the leaves of healthy and PPV-infected plum trees

Element	Content (%)							
	Healthy				Infected			
	1*	2*	3*	4*	1*	2*	3*	4*
N	2.63	2.50	2.80	2.71	2.32	2.10	2.15	2.05
P	0.180	0.210	0.230	0.220	0.195	0.340	0.260	0.260
K	2.18	2.05	2.22	2.19	2.40	2.45	2.59	2.35
Ca	1.66	1.55	1.71	1.65	1.63	1.50	1.62	1.58
Mg	0.295	0.285	0.300	0.290	0.281	0.260	0.270	0.250

*Repeated experiments.

Table 2. Relational values of the content of macrobiogenic elements in the leaves of healthy and PPV-infected plum trees

Ratio	Relational values										
	Heathy				Mean	Infected				Mean	Significance of difference in means
	1*	2*	3*	4*		1*	2*	3*	4*		
N/P	14.61	11.90	12.17	12.32	12.750±0.626	11.90	6.18	8.27	7.88	8.560±1.203	+
N/K	1.21	1.22	1.26	1.24	1.230±0.011	0.97	0.86	0.83	0.87	0.880±0.030	++
(Ca+Mg)/K	0.90	0.90	0.91	0.89	0.896±0.004	0.80	0.72	0.73	0.78	0.896±0.019	++
(N/P)/(N/K)					15.680±0.685					7.640±1.329	++

*Repeated experiments.
(+): $0.01 < p \leq 0.05$; (++): $p \leq 0.01$.

Results and Discussion

Chemical analysis of the leaves (Table 1) showed certain differences in the content of macrobiogenic elements between healthy and PPV-infected trees. Increased levels of nitrogen, calcium and magnesium were recorded in the healthy trees, while higher levels of phosphorus and potassium were observed in the infected trees.

On the basis of absolute contents the relations between the macrobiogenic elements in healthy and PPV-infected trees were calculated (Table 2). In the healthy leaves,the relational value for N/P of 12.75 was recorded, while in the infected ones it was only 8.56, i.e. 67.14% of the healthy control. A similar trend was observed in other relational values. The N/K value was 1.23 for the healthy leaves but only 0.88 (71.54% of the control) for the infected ones. As for the relational value for (Ca + Mg)/K, this was also higher for the healthy leaves (0.896, i.e. 84.38% of the control) than for the infected ones (0.756). The relational value for (N/P)/(N/K) for the healthy leaves was 15.68, while for the infected ones it was only 7.64 (48.72% of the control). All the abovementioned differences were statistically significant.

These results indicate causative relations between the content of macrobiogenic elements and the spread of plum pox disease in plum trees. These results are in contrast to those obtained by others invariably indicating the role of the mineral nutrition in relation to the resistance of plants against pathogens (Király, 1976, 1980; Schlösser, 1983; Perrenoud, 1990; Reuveni *et al.*, 1996).

The knowledge of plant physiology indicates a genetical basis of mineral nutrition (Gerloff and Gabelman, 1983) and emphasizes the necessity to know an internal concentration of mineral nutrients (Moorby and Besford, 1983). Some macrobiogenic elements, especially nitrogen, phosphorus and potassium, are intimately involved in all general metabolic processes where nutritive disorders are responsible for metabolic and structural modifications limiting plant growth (Greenway and Munns, 1980; Moorby and Besford, 1983).

Studies on physiology of diseased plants suggest that many metabolic changes are in causative relations with nutritive disorders (Király, 1976, 1980; Perrenoud, 1990). According to Schlösser (1983), a slight deviation from optimum supply of nutrients may influence the pathogenesis because both their excess but also deficiency affect the metabolic processes consequently supporting or suppressing a disease. All nutrients affect the healthy status of plants, but nitrogen and potassium appear to be particularly important (Perrenoud, 1990). In phytopathological literature, changes in the behaviour of diseased plants owing to application of nitrogen, phosphorus or potassium are often described (Király, 1976, 1980; Schlösser, 1983; Mucharromah and Kuc', 1991; Reuveni *et al.*, 1996).

Viral pathogens seem to be an exception because they are doing better in the plants with optimal nutrition (Schlösser, 1983). However, many authors have observed the changes in the viral disease intensity in relation to mineral nutrition (Reichard, 1964; Quelhas dos Santos, 1979; Mucharromah and Kuc', 1991). In these reports, there appears also information on the increase in crop yield of infected plants, but the reasons are unknown. Also we have observed this phenomenon in sugar beet infected with rhizomania (Kráľovič and Králová, 1996). A correlation analysis showed complicate relations among the concentration of inorganic elements, degree of infection with rhizomania and yield of sugar beet. In comparison of two variants (non-infected and medium infected) that contained equal levels of nutrients, an increase in refined sugar production (about 1.67 t/ha) was recorded in infected sugar beet. In variants with a similar degree of infection, a decrease in refined sugar production (about 1.58 t/ha) was found in sugar beet containing a lower level of nutrients.

Highly significant differences in special indicators of mineral nutrition found between healthy and infected plum trees indicate that the epidemic spread of the virus disease may be conditioned by a non-adequate mineral nutrition. It can be expected that a preplanting optimization of the soil supplies of inorganic elements will aid the advancement of natural immunity against viral pathogen resulting into better realization of yield potential of plum crops.

Acknowledgements. The authors are grateful to RNDr. I. Thomka, Select a.s., Bučany, for offering the laboratory facilities and conducting the chemical analysis. This work has been supported by the grants Nos. 2/1101/97 and 2/5055/98 of the Grant Agency for Science.

References

Baumgartnerová H (1987): Study of properties of some viruses of stone fruit trees. *Poľnohospodárska veda, Ser A* **2/87**, 17-97.

Baumgartnerová H (1991): Sharka disease of plums and protection. *Veda a prax* **2/2**, 24.

Gerloff GC, Gabelman WH (1983): Genetic basis of inorganic plant nutrition. In Lauchli A, Bieleski RL (Eds): *Inorganic Plant Nutrition. Encyclopedia of Plant Physiology.* Vol. 15 B, Springer Verlag, Berlin-Heidelberg-New York, pp. 453-476.

Greenway H, Munns R (1980): Mechanism of salt tolerance in non-halophytes. *Ann. Rev. Plant Physiol.* **31**, 149-190.

Chant SR, Gbaja JS, Kang AS (1984): Effect of nutrition on the interaction of Fusarium oxysporum and Sunn-hemp mosaic virus in cowpea seedlings. *Trop. Agric.* (Trinidad) **61** (2), 87-91.

Király Z (1976): Plant disease resistance as influenced by biochemical effects of nutrients in fertilizer. *Proc. 12th IPI Colloq. Fertil. Use Plant Health*, Izmir, pp. 33-46.

Király Z (1980): New trends in plant pathological research – a pathophysiological approach. The Royal Vet. Agric. University, Copenhagen, DSR Forlag, pp. 1-19.

Králiková K (1964): Survey on the investigation of plum virus diseases in Slovakia. *Proc 5th Conf. Czechoslovak Plant Virol.*, Prague, 1962, pp. 346-351.

Kráľovič J, Králová V (1996): Relations among Rhizomania disease, root content of potassium, sodium, α-amino nitrogen and crop yield of sugar beet. *Z Pflanzenk. Pflanzenschutz* **103**, 561-570.

Kráľovič J, Smutný J, Thomka I (1995): Chlorosis of grape vine and protection. *Veda a prax* **1/1**, 36.

Moorby J, Besford RT (1983): Mineral nutrition and growth. In Läuchli A, Bieleski RL (Eds). *Inorganic Plant Nutrition. Encyclopedia of Plant Physiology.* Vol. 15 B, Springer Verlag, Berlin-Heidelberg-New York, pp. 87-521.

Mucharromah E, Kuc' J (1991): Oxalates and phosphates induce systematic resistance against diseases caused by fungi, bacteria and viruses in cucumber. *Crop Prot.* **10**, 265-270.

Narasimhan V, Alagianagalingam MN (1986): Potassium in the management of chilli mosaic disease. *J. Potassium Res.* **2**, 59-64.

Paulechová K (1980): Study of virus diseases of stone fruit trees. I. Plums. *Poľnohospodárska veda*, Ser. A **2/80**, 174.

Perrenoud S (1990): Potassium and Plant Health. *IPI Res. Topics* **3**, 1-365.

Quelhas dos Santos J (1979): Potassium and the potato roll virus. *Potash Rev.*, Subj. 23, pp. 1-59.

Reichard TH (1964): Der Einfluss der Stickstoff und Chlorkaliumdüngung auf den Pflanzgutwert von Kartoffeln. *Die Bodenkultur.* Ausgabe A, Biol. Tech. Teil 14, Vol. 4, pp. 303-312.

Reuveni R, Reuveni M, Agapov V (1996): Foliar sprays of NPK fertilizers induce systemic protection against *Puccinia sorghi* and *Exserohilum turcicum* and growth response in maize. *Eur. J. Plant Pathol.* **102**, 339-348.

Schlösser E (1983): *Allgemeine Phytopathology*. Thieme Verlag, Stuttgart-New York, pp. 1-280.