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STUDY OF HOST-PARASITE INTERACTION IN TOMATO PLANTS*

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Abstract

A quantitative comparative study was made of the peroxide metabolism enzyme (SOD, peroxidase and catalase), protein and ascorbic acid contents of homogenates of the roots, stem and lraves of 6 well-defined tomato varieties differing in sensitivity to tobacco mosaic virus (TMV), 15, 30and 50 days after TMV infection and in non-infected plants of the same ages. It was found that the virus infection and the development of the host-virus interaction leaves its impression on the plant metabolism even if the plant exhibits no external sign of the TMV infection.

Introduction

We earlier dealt with the quantitative changes in three plant (or animal) peroxide metabolism enzymes, namely superoxide dismutase (SOD; EC 1.15.1.1), peroxidase (P-ase; EC 1.11.1.7) and catalase (C-ase; EC 1.11.1.1.6), in plant seeds and during development of the bean plant (DO QUY HAI et al., 1975; KOVÁCS et al., 1975). These three enzymes are involved in the generation and decomposition of H_2O_2 (MATKOVICS, 1977).

The aim of the present work was to seek a correlation in the quantitative changes of the peroxide metabolism enzymes (PME) in normal and TMV-infected individuals of 6 well-defined tomato varieties of various ages. Simultaneous protein and ascorbic acid (AA) measurements were also made.

Materials and Methods

The tomato plants were obtained from the Vegetable Production Research Institute in Kecskemét. Money maker (MM) K 363 early and S.A.D. (Subarctic delight) late TMV-sensitive, -Tml homozygote, -Tml/+ heterozygote TMV-tolerant and -$Tm2^2$ TMV-resistant, varieties were examined. The plants were grown in air-controlled and artificially-illuminated green-houses, and were pricked out on the 12th day. Infection with a concentrate of TMV strain O was performed on the 14th day, by means of carborundum rubbing with a spatula (MÉSZÖLY et al., 1963). Samples were taken on the 15th, 30th and 50th days after infection, i.e. when the plants were 29, 44 and 64 days old.

The plants were washed free of dust and soil with tap-water, dried between filter papers, and 1 g wet weight was taken separately from the root, the stem and the leaf. The sample was ground with a minimal amount of quartz sand, washed into a centrifuge tube with 0.01 M phosphate buffer of

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pH 7.0 in a ratio of 1:5, centrifuged, and the enzymatic activity and other quantitative determinations were carried out on the supernatant.

The dry matter contents of the samples were also determined, after the plant parts had been dried to weight constancy at 105 °C.

Protein was determined by the method of LOWRY et al. (1951) with the Folin reagent, and AA by a colorimetric method with dinitrophenylhydrazine (ROE et al., 1943).

P-ase activity was determined spectrophotometrically with the quaiacol method at 470 mn (COLOWICK et al., 1955), and C-ase activity at 240 nm via the H_2O_2 decrease (BEERS et al., 1952). The C-ase activities were expressed in Bergmeyer units (BU). SOD was calculated via its inhibition of the autoxidation of epinephrine to adrenochrome in alkaline medium (MISRA et al., 1972; SIMON et al., 1974; MATKOVICS et al., 1977).

Enzyme activities were calculated with a PL/1 programme on an R 40 computer (Marburg, GDR). The errors in the enzyme activity determinations were ±5—10% (MATKOVICS et al., 1977), and in the protein and AA determinations were ±1—2%. Every result was the mean of at least 10 parallel measurements.

Spektromom 360 ans 201 spectrophotometers (MOM, Budapest) were emploed. The various chemicals used were products of Merck (Darmstadt, FGR), Boehringer (Mannheim, FGR) and Reanal (Budapest, Hungary), of the highest purity.

Results and discussion

The results are presented in 7 Figures and 3 Tables, arranged in chronological sequence. In the Figures the empty columns denote the data for the normal plants, and the shaded columns those for the virus-infected ones. Columns 1, 2 and 3 refer to the root, stem and leaf, respectively. The SOD activities in the 29-day-old plants were so low that it was not considered wortwhile to include them in the comparison.

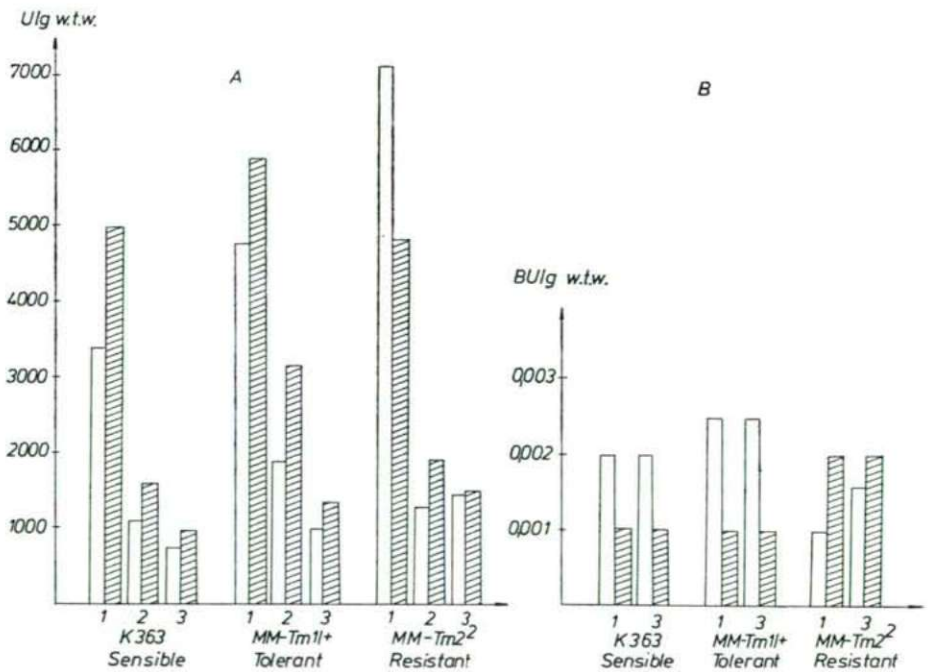

Fig. 1. P-ase (A) and C-ase (B) activities of 29 day old control and virus-infected tomato plants, measured in homogenate supernatants.

Figure 1 shows that in the TMV-sensitive and tolerant varieties the P-ase activities rise as a result of TMV infection. The changes in the root are very striking. In contrast, in the resistant variety the P-sae activity in the root decreases markedly. Hence, the changes in the P-ase, whether positive or negative, are characteristic of the infection.

C-ase can not be detected in the stems of the plants. Otherwise, it exhibits opposite tendencies to those observed for P-ase (cf. columns A and B in Fig. 1).

It may be seen in Fig. 2. that the protein determination method revealed somewhat higher values in the infected plants. The AA results for the infected plants were well in excess of those for the controls.

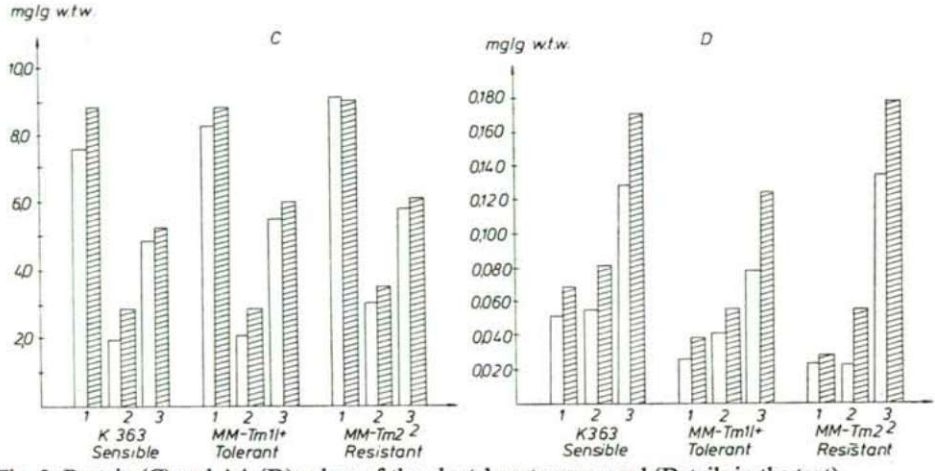

Fig. 2. Protein (C) and AA (D) values of the plants' parts compared (Details in the text).

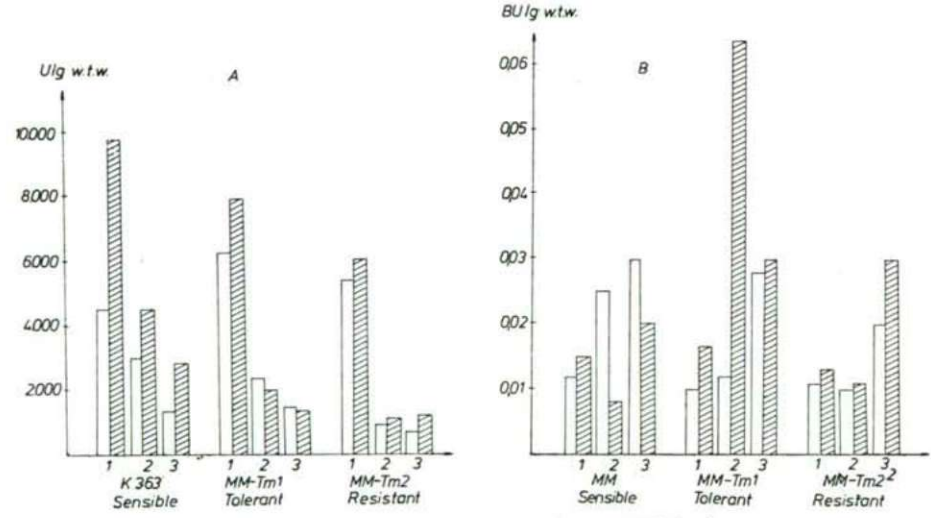

Fig. 3. P-ase (A), C-ase (B) activities compared 30 days after TMV infaction.

Figure 3 indicates that the P-ase values attain their maxima in the 44-day-old plants, but the differences between the controls and the infected plants are also maximum here. At this stage C-ase activity can be detected in all the plant parts, and increases considerably. With the exception of the stem and leaf homogenate supernatants for the sentivie MM variety, the tendencies are the same as for P-ase, i.e. the controls exhibit higher values.

Fiaure 4 shows that at this time the protein values (C) are lower and the AA results (D) higher for the infected plants than for the controls.

50 days after the virus infection, the P-ase (A) and C-ase (B) activities (Fig. 5)

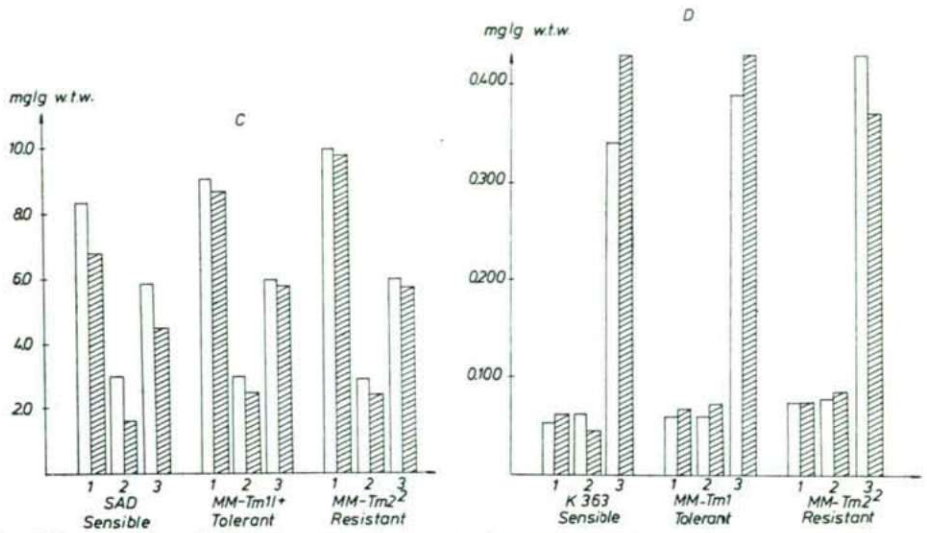

Fig. 4. Protein (C) and AA (D) measured 30 days after TMV infection (see the text).

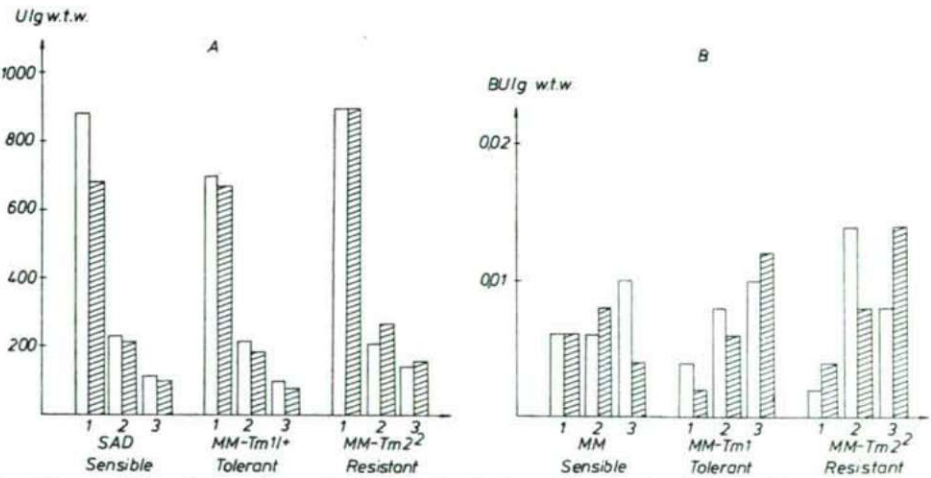

Fig. 5. P-ase (A) and C-ase (B) activities into the 64-days old control and infected tomatoes.

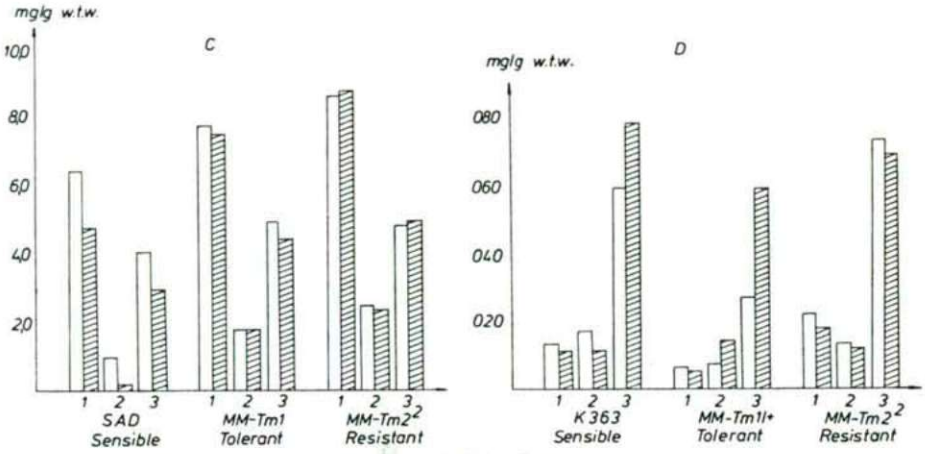

Fig. 6. 64 days old tomatoes protein (C) and AA (D) values.

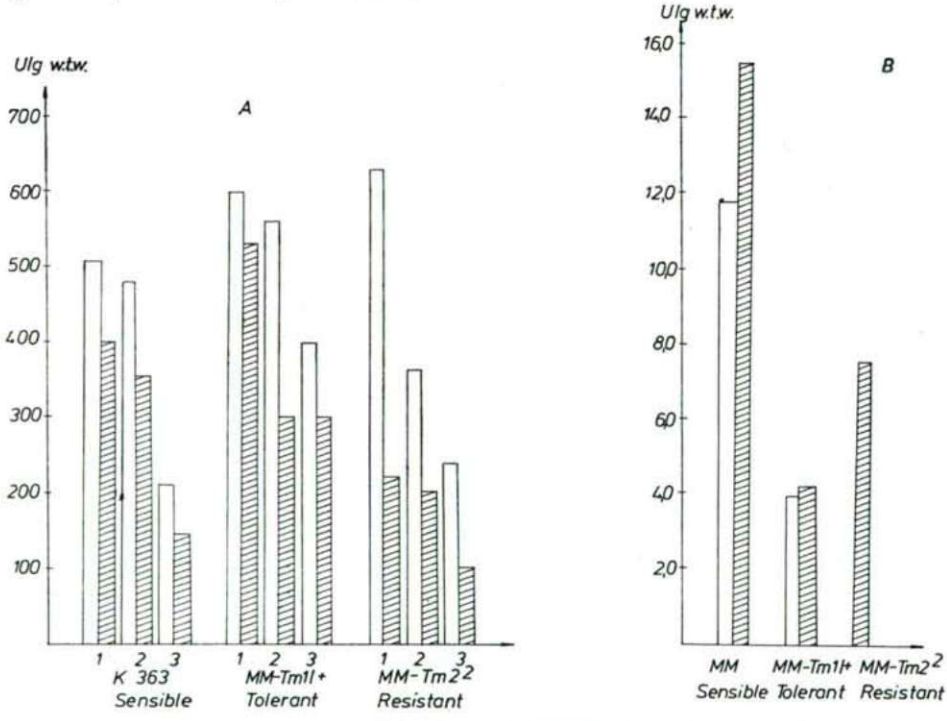

Fig. 7. SOD activities after 30 (A) and 45 (B) days after TMV infection (see the text).

and the protein (C) and AA (D) values (Fig. 6) are still reminiscent of the TMV infection from a metabolic aspect. Mainly the AA data still reveal large differences in the leaves of the sensitive and the tolerant plants.

Figure 7 compares the SOD activities in the various plant parts after 30 and 50 days of infection. In the latter case, only the stem data are of interest. After 30 days, the SOD activities are lower in all parts of the infected plants than in the controls, but after 50 days the stem of the infected plants yields a higher activity.

The measurements clearly demonstrate that, for all of the mechanisms examined, the tomato plant varieties "remember" the TMV infection even after their survival.

Much attention has earlier been paid (FARKAS et al., 1958, 1960; HALLIWELL, 1974) to the biochemical mechanism of the host-parasite interaction in plants. We wished to supplement the many previous part-data with a study of definite tomato varieties infected with TMV and kept under constant conditions. Our data tend to support the mechanism given by HALLIWELL (1974). This considers the primary characteristic of the parasite effect in the host-parasite interaction to be the accumulation of H_2O_2 and radicals formed from oxygen, and our enzyme examinations appear to support this (MATKOVICS et al., 1978).

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