JOURNAL OF PLANT PROTECTION RESEARCH
Vol. 41, No. 1 2001

CHANGES IN CONTENT OF PROTEINS AND FREE AMINO ACIDS IN THE FOLIAGE OF MITE-INFESTED GLASSHOUSE CUCUMBER AND TOMATO TREATED WITH PLANT GROWTH-PROMOTING RHIZOBACTERIA (PGPR)

ANNA TOMCZYK, MAŁGORZATA KIEŁKIEWICZ

WARSAW AGRICULTURAL UNIVERSITY, DEPARTMENT OF APPLIED ENTOMOLOGY, NOWOURSYNOWSKA 166, 02-787 WARSAW, POLAND
e-mail: kielkiewicz@alpha.sggw.waw.pl

Abstract. Experimental cucumber and tomato plants were cultivated under glasshouse conditions with or without PGPR. Young plants were infested with spider mites (*T. urticae* – cucumber and *T. cinnabarinus* – tomato). Leaves were analysed for protein and amino acid concentration.
In infested leaves of the cucumber cultivar, susceptible to spider mites (Corona), an important decrease in protein content occurred in both bacterized and nonbacterized plants. Amino acid content was higher in mite infested leaves and the presence of PGPR did not influence this phenomenon.
The content of proteins was also studied in the leaves of the less susceptible cucumber cultivar (Aramis). Spider mite feeding caused a small decrease in their concentration. The presence of bacteria in the root system caused an increase of soluble proteins in the leaves.
In infested leaves of the highly susceptible tomato cultivar (Romatos), cultivated without bacteria, an evident increase of amino acid content was found opposite to plants with PGPR. The protein concentration was also increased in injured leaves of this cultivar but the presence of bacteria in the root system of mite infested plants caused a decrease of these compounds in their leaves. Injured foliage of the less susceptible tomato cultivar (Slonka) had a lower protein concentration in bacterised plants as compared to those nonbacterised and both controls.

Key words: *Tetranychus urticae*, *Tetranychus cinnabarinus*, cucumber, tomato, plant growth-promoting rhizobacteria (PGPR), soluble protein, free amino acids

I. INTRODUCTION

Leaves infested with spider mites change the content of both primary and secondary plant metabolites (Tomczyk 1989; 1996; Kiełkiewicz 1995; Tomczyk et al. 1998 a;b).

Modified concentration of nitrogen compounds, as a result of mite feeding, may influence host plant metabolism as well as the development of pest population and female fecundity (Tulisalo 1971; Dąbrowski 1974; Wermelinger et al 1985; Tomczyk 1989; Tomczyk 1998 a;b).

The aim of the present study was to determine to what extent spider mites can modify nitrogen metabolism of glasshouse cucumber and tomato, and also whether the presence of plant growth-promoting rhizobacteria (PGPR) may change the content of proteins and amino acids in their foliage.

II. MATERIAL AND METHODS

Cucumber and tomato plants were grown under glasshouse conditions either with or without rhizobacteria. In the first case the seeds were soaked for 20 min. in a suspension of PGPR (Pseudomonas – izolate 112 – derived from cucumber seedling rhizosphere) containing 3 x 10^9 cells in 1 cm^3. Half of the plants were initially infested with 5 mite specimens per leaf, using two species: *Tetranychus urticae* Koch for cucumber and *Tetranychus cinnabarinus* Boisduval for tomato. Finally the plants of each crop were divided into four groups:

Control A: mite-free, nonbacterised,

Control B: mite-free, bacterised,

Mite-infested, nonbacterised,

Mite-infested, bacterised.

Based on the above variants, after 7 weeks of mite feeding the leaves were sampled from Corona cucumber and Romatos tomato (both cultivars highly susceptible to spider mites) and analysed for the content of free amino acids and soluble proteins. The latter compounds were also determined in the foliage of cucumber cv. Aramis and tomato cv. Slonka (both relatively less susceptible).

Soluble proteins were analysed by Bradford's method (Bradford 1976) whereas for free amino acids a T-339 analyser was employed.

III. RESULTS AND DISCUSSION

In infested leaves of Corona cucumber (susceptible cultivar) amino acid content evidently enhanced in both bacterised and nonbacterised plants in relation to control

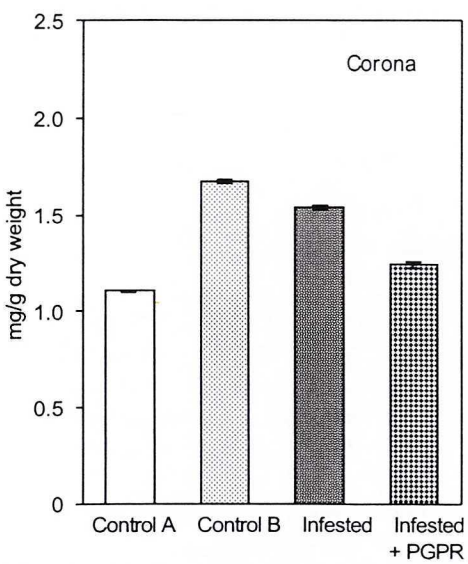

Fig. 1. Content of free amino acids in Corona cucumber leaves from bacterised and mite-infested plants. Standard errors for experimental combinations are presented

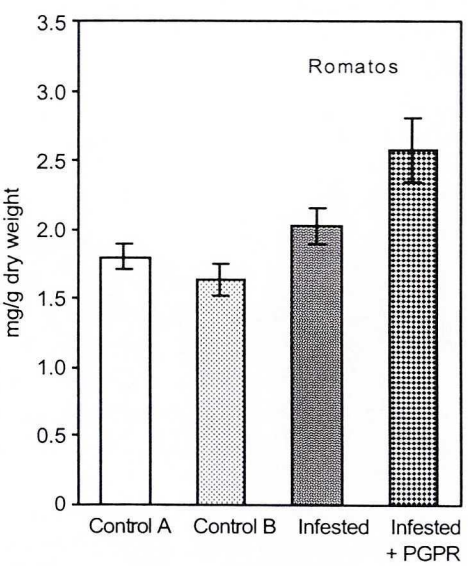

Fig. 2. Content of free amino acids in Romatos tomato leaves from bacterised and mite-infested plants

(Fig. 1). The strongest rise of these compounds (above 52%) was recorded for uninfested and bacterised plants (Control B) while the smallest (11%) for those infested and bacterised.

Likewise cucumber, infested leaves of Romatos tomato (susceptible cultivar) showed a significant increase (by 19%) in the content of free amino acids as compared to control A (Fig. 2). These compounds, instead, declined by 21% when infested plants were grown with rhizobacteria. Such plants, however, were richer in amino acids than those of Control B.

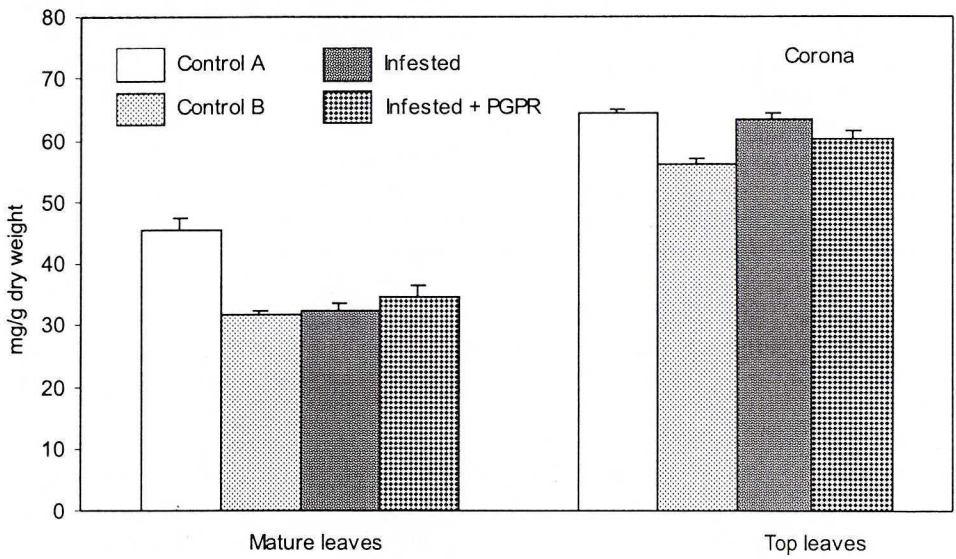

Fig. 3A. Content of soluble proteins in Corona cucumber leaves from bacterised and mite-infested plants

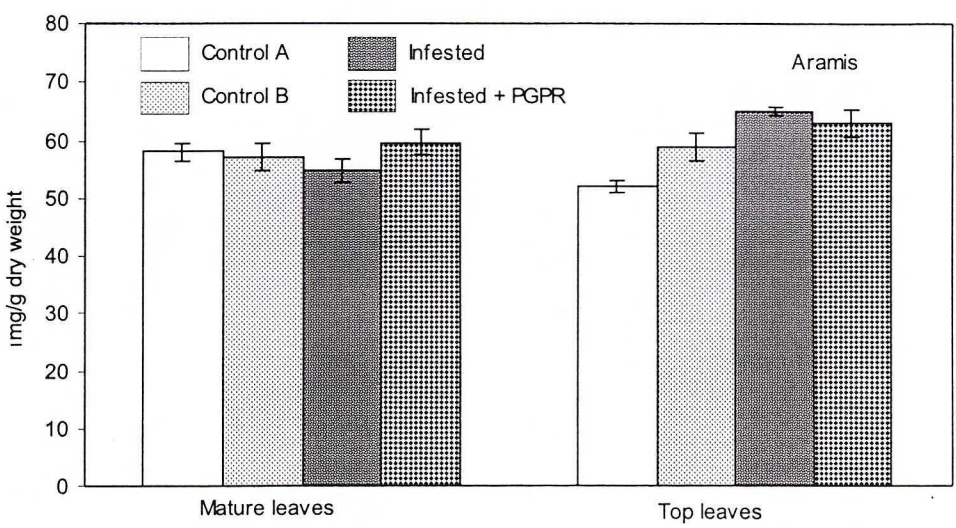

Fig. 3B. Content of soluble proteins in Aramis cucumber leaves from bacterised and mite-infested plants

Summarising: in response to mite infestation, cucumber cv. Corona and tomato cv. Romatos – both highly susceptible to spider mites – significantly raised the content of free amino acids in their leaves. This increase was less pronounced for infested cucumber plants grown with rhizobacteria, while for such tomato amino acids concentration in the foliage was even lower as compared to uninfested and nonbacterised plants. It was found that high amino acids level in plant tissue promote development of mite population (Tulisalo 1971; Wermelinger et al. 1985; Tomczyk 1989). The limitation in amino acids increase as an effect of spider mite feeding, caused by PGPR, can function as possible defence of plant.

Concentration of soluble proteins in directly infested, mature leaves of cucumber cv. Corona significantly decreased (by 29%) as compared to control A and this reduction was not influenced by the presence of rhizobacteria (Fig. 3A). Infestation did not affect the protein concentration in the top leaves (mite-free) of these plants but significant decline in protein content was found in bacterised plants, both infested and mite-free.

Tests with Aramis cucumber (less susceptible cultivar) showed only some reduction of protein content, as compared to control A, in fully mature leaves of infested plants grown without rhizobacteria, while in those bacterised it was similar to the control A and B (Fig. 3B). However, a significant rise of proteins, by about 25% in relation to control A, was recorded in the top leaves of infested plants, regardless of PGPR treatment. The obtained data lead to the conclusion that in young leaves of less susceptible cultivar of cucumber can accumulate more protein in response for spider mite feeding. The presence of PGPR in root system of infested plants does not change their reaction for infestation.

Similar increase in protein concentration was observed in the leaves of the susceptible tomato cultivar Romatos as a results of pest feeding, and even more (by 43%) in response to both combined studied factors: mite infestation and PGPR treatment (Fig 4A). Such a trend was not observed for infested plants cv. Slonka (less susceptible), Fig 4B. Increase in protein concentration in response to pest attack is often observed in the leaves of different host plants (Tomczyk 1989).

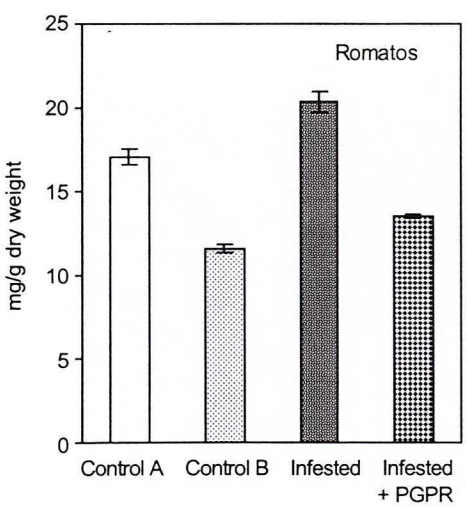

Fig. 4A. Content of soluble proteins in Romatos tomato leaves from bacterised and mite-infested plants

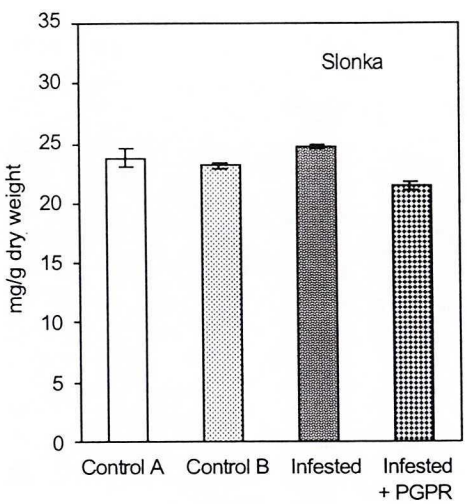

Fig. 4B. Content of soluble proteins in Slonka tomato leaves from bacterised and mite-infested plants

The general conclusion can be made from obtained data: the infested leaves of glasshouse cucumber and tomato, particularly those of mite-susceptible cultivars, show altered nitrogen metabolism. Such changes are influenced and partially modified by the presence of plant growth-promoting rhizobacteria (PGPR).

V. REFERENCES

1. Bradford M.M. 1976. A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein dye binding. Ann. Biochem., 72: 248-254.
2. Dąbrowski Z.T. 1974. Zasady wyboru i akceptacji roślin żywicielskich przez przędziorka chmielowca, *Tetranychus urticae* Koch. Rozprawy i monografie, SGGW, Warszawa.
3. Kiełkiewicz M. 1995. Chemistry of Gerbera foliage and its influence on two-spotted mite (*Tetranychus urticae Koch*). pp. 517-526. In "The Acari, Physiological and Ecological Aspects of Acari-Host Relationship" (D. Kropczyńska , J. Boczek, A.Tomczyk A., eds.).
4. Tomczyk A. 1989. Physiological and biochemical responses of different host plants to infestation by spider mites (*Acarina: Tetranychidae).* Treatises and Monographs, Warsaw Agricultural University Press, 112pp.
5. Tomczyk A. 1996. Mechanisms of physiological and biochemical interactions between spider mites (*Tetranychidae*) and their host plants. Acarology IX Proceedings 1996. 25-28.
6. Tomczyk A. 1997. Wpływ przędziorków na zawartość niektórych składników organicznych w liściach i owocach porzeczki czarnej. Ogólnopolska Konferencja Ochrony Roślin Sadowniczych: 106-108.
7. Tomczyk A., Kiełkiewicz M., Czajkowska B. 1997. Chemical composition of linden tree leaves and spider mite populations in polluted urban conditions. Insects. Chemical, physiological and environmental aspects. Wydawnictwo Uniwersytetu Wrocławskiego: 228-233.
8. Tomczyk A. 1998a. Content of some organic compounds in the leaves of cucumber in relation to its susceptibility to spider mites. Zesz. Nauk. 214 – Ochrona Środowiska 2: 115-120.
9. Tomczyk A. 1998b. Changes in free amino acids concentration in the leaves of greenhouse cucumber after its infestation with spider mites. Proceedings of the VIth European Congress of Entomology. Book of Abstracts: 513-514.
10. Tulisalo U. 1971. Free and bound amino acids of three host plants species and various fertilizer treatments affecting the fecundity of two-spotted spider mite, *Tetranychus urticae* Koch. Ann. Entomol. Fenn., 37(3): 155-163.
11. Wermelinger B., Oertli J.J., Delucchi V. 1985. Effect of host plant nitrogen fertilization on the biology of the two-spotted spider mite, *Tetranychus urticae* Koch. Entomol. Exp. Appl., 38: 23-28.

Anna Tomczyk, Małgorzata Kiełkiewicz

ZMIANY W ZAWARTOŚCI BIAŁEK I WOLNYCH AMINOKWASÓW W PORAŻONYCH PRZEZ PRZĘDZIORKI LIŚCIACH OGÓRKÓW I POMIDORÓW SZKLARNIOWYCH UPRAWIANYCH W OBECNOŚCI BAKTERII SFERY KORZENIOWEJ WSPOMAGAJĄCYCH WZROST (PGPR)

STRESZCZENIE

Rośliny ogórka i pomidora uprawiano w warunkach szklarniowych, w obecności bakterii sfery korzeniowej (PGPR) i bez bakterii. Młode rośliny porażano przędziorkami (*Tetranychus urticae* Koch – ogórek i *Tetranychus cinnabarinus* Boisduval – pomidor). Liście porażonych roślin poddano analizie

na zawartość białek rozpuszczalnych i aminokwasów. W porażonych liściach wrażliwej na przędziorki odmiany ogórka (Corona) zaobserwowano znaczny spadek zawartości białek zarówno w przypadku roślin uprawianych bez bakterii jak i w obecności PGPR. W porażonych liściach tej odmiany wzrastała natomiast zawartość wolnych aminokwasów. Badano również zawartość białek rozpuszczalnych w liściach mniej podatnej na przędziorki odmiany ogórka (Aramis). Żerowanie przędziorków powodowało kilkuprocentowe obniżenie zawartości białek, a obecność PGPR w sferze korzeniowej porażonych roślin prawie nie miała wpływu na ich poziom w liściach.

W porażonych liściach wrażliwej na przędziorki odmiany pomidora (Romatos) stwierdzono, podobnie jak w przypadku ogórka, istotny wzrost zawartości wolnych aminokwasów. U porażonych roślin tej odmiany, uprawianych w obecności PGPR, obserwowano natomiast spadek zawartości aminokwasów w porównaniu z roślinami kontrolnymi nie traktowanymi bakteriami.

W porażonych liściach tej odmiany zaobserwowano wzrost zawartości białek rozpuszczalnych zarówno u roślin z PGPR jak i bez bakterii. Nie obserwowano tego zjawiska u mniej podatnej na przędziorki odmiany pomidora Slonka.