ROLE OF WEEDS IN THE EPIDEMIOLOGY OF VIRUSES

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ABSTRACT

Weeds influence the quality and quantity of crops not only in a direct way (e. g. by competing for nutrients and water) but also indirectly as alternative hosts of various pathogens. Alternative hosts serve as food for the vectors of viruses, while the seeds and vegetative reproductive organs of certain weed species may play important role in the epidemiology and overwintering of viruses. The aim of our investigations was to detect new virus-weed relations and to study biological decline of weeds due to virus infection. Last years some new host-virus relations were determined. Alfalfa mosaic *alfamovirus* (AMV), tobacco mosaic *tobamovirus* (TMV) from *Asclepias syriaca*; sowbane mosaic *sobemovirus* (SoMV), potato Y *potyvirus* (PVY) from *Alisma plantago-aquatica*; cucumber mosaic *cucumovirus* (CMV) from *Ambrosia elatior* were isolated under natural conditions in Hungary. Different examinations were carried out to study the effect of SoMV infection and autecological factors on the germination and seed viability of *Chenopodium* species. It could be shown that autecological factors influenced the germination of *Chenopodium* seeds to a greater extent, than did virus infection. Germination and seed viability of *Chenopodium* species due to virus infection was reduced by 6-21% and 1-23%, respectively, depending on species. CMV significantly reduced the photosynthetic pigment content of *Datura stramonium* leaves, while henbane mosaic *potyvirus* (HMV) caused disturbances in water relation. TMV infection considerably decreased the height, fresh and dry weight, meso- and microelements of *Solanum nigrum*. Opposite effect was observed in case of potassium (K) content which were considerably enhanced in the TMV infected leaves. We conclude that viruses unfavourably influence the physiological processes of the weeds, therefore -in indirect way- viruses may contribute to the reduction of their competitive ability.
Key words: weeds, viruses, virus epidemiology, biological decline

IZVLEČEK

VLOGA PLEVELOV PRI EPIDEMIOLOGIJI VIRUSOV

Pleveli ne vplivajo na kakovost in količino pridelkov gojenih rastlin samo neposredno (n.pr. konkurenčen odnos za hranila in vodo), temveč vplivajo tudi posredno kot alternativni gostitelji za številne škodljive organizme. Alternativni gostitelji predstavljajo vir hrane za prenašalce virusov, medtem ko imajo semena in vegetativni razmnoževalni organi nekaterih plevelnih vrst pomembno vlogo pri prezimitvi virusov. Namen naše raziskave je bil ugotoviti nove odnose virus-plevel ter preučiti biotično propadanje plevelov zaradi infekcije z virusi. V zadnjih letih so bili ugotovljeni nekateri novi odnosi med virusi in pleveli. Lucernin mozaik, *alfamovirus* (AMV), tobakov mozaik, *tobamovirus* (TMV) iz *Asclepias syriaca;* sojin mozaik, *sobemovirus* (SoMV), krompirjev (SoMV), krompirjev Y *potyvirus* (PVY) iz *Alisma plantago-aquatica*; kumarični mozaik, *cucumovirus* (CMV) iz *Ambrosia elatior* so bili virusi, ki so jih

na Madžarskem izolirali v naravnih razmerah. Opravljene so bile različne raziskave, s katerimi so preučevali vpliv infekcije s SoMV ter okoljske dejavnike na kalitev ter vitalnost *Chenopodium* vrst. Iz raziskave je mogoče razbrati, da okoljski dejavniki vplivajo na kalitev semena *Chenopodium* vrst v večjem obsegu kot okužba z virusi. Kalitev ter vitalnost semena *Chenopodium* vrst je bila zaradi okužbe z virusi zmanjšana za 6-21 % in 1-23 %, odvisno od vrste. CMV statistično značilno zmanjša odstotek vsebnosti fotosintetskega pigmenta v listih *Datura stramonium*, medtem ko henbane mosaik *potyvirus* (HeMV) povzroča motnje pri preskrbi z vodo. TMV infekcija občutno vpliva na zmanjšanje višine, sveže in suhe mase, mezo in mikroelementov *Solanum nigrum*. Nasproten učinek smo opazili v primeru kalija (K), katerega vsebnost se je občutno povečala v listih, ki so bili okuženi s TMV. Sklenemo lahko, da virusi neugodno vplivajo na fiziološke procese pri plevelih, zaradi česar lahko na posreden način pripomorejo k zmanjšanju njihove konkurenčne sposobnosti.
Ključne besede: pleveli, virusi, epifitotiologija virusov, biotično propadanje

1. INTRODUCTION

Weeds influence the quality and quantity of crops not only in a direct way (e.g. competing for nutrient and water uptake), but also as alternative hosts of various pathogens. Alternative hosts serve as food for the vectors of viruses, while the seeds and vegetative reproductive organs of certain weed species may play an important role in the epidemiology and overwintering of viruses (Kazinczi *et al.*, 1999).
Several important weed-virus relations and virological importance of weeds were determined last years (Horváth and Szirmai 1973, Davis and Allen 1975, Schmelzer and Wolf 1977, Salamon 1986, 1989, Horváth *et al.*, 1983, 1993, 1995, Wilson *et al.*, 1981, Daniel and Tsai 1990).
It is known that from the point of integrated weed management we do not kill weeds, but keep the level of the weed population under the economic threshold. Therefore the biological decline of weeds means advantages for the plant production. Competitive ability of the diseased plants reduces due to their reduced growth, nutrient and water uptake. Therefore the aim of our study was: 1. to detect new virus-weed relations and 2. to study biological decline of weeds due to virus infection.

2. MATERIALS AND METHODS

During the last years different weed species, showing virus symptoms were collected from arable land from different crop ecosystems in Hungary. Plant samples were tested for virus infection on the basis of symptoms, biological and serological (DAS ELISA) tests. To determine artificial host-virus relations mechanical inoculations were also made in virological glasshouse.
To study biological decline of weeds, modell species were chosen from the family Solanaceae and Chenopodiaceae. Laboratory germination tests were done with seeds of *Chenopodium album* derived from healthy and diseased plants infected with Chenopodium mosaic *sobemovirus*. In order to determine the seed viability TTC test was carried out after the international standard (Moore 1985). In pot experiments *Datura stramonium* and *Solanum nigrum* plants were inoculated with cucumber mosaic-, henbane mosaic- and tobacco mosaic viruses. Four weeks after inoculation chlorophyll-a, chlorophyll-b and carotinoid content of the leaves were determined. The fresh and dry weight of both the shoots and the roots were measured. In order to compare the drought resistance of the healthy and CMV infected *Solanum nigrum*, the sublethal water saturation deficit was determined after Weinberger *et al.*, (1972).

3. RESULTS AND DISCUSSIONS

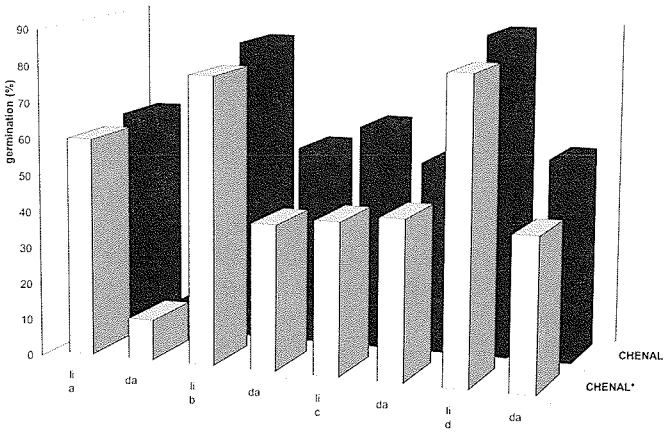
New weed-virus relations were determined, which are also important for weed- and virus ecology (Table 1).

Table 1: New weed-virus relations

Plant species	Viruses	Type of relations
Alisma plantago-aquatica	Potato Y *potyvirus*, Chenopodium mosaic *sobemovirus*	Natural
Asclepias syriaca	Tobacco mosaic *tobamovirus*, alfalfa mosaic *alfamovrus*	Natural
Ambrosia elatior	Cucumber mosaic *cucumovirus*	Natural
Chenopodium album	Chenopodium mosaic *sobemovirus*	Artificial
Chenopodium murale	Chenopodium mosaic *sobemovirus*	Artificial
Echinocystis lobata	Zucchini yellow mosaic *potyvirus*, potato X *potexvirus*	Artificial
Plantago major	Tobacco mosaic *tobamovirus*, tomato mosaic *tobamovirus*	Natural
Solanum nigrum	Melandrium yellow fleck *bromovirus*, Chenopodium mosaic *sobemovirus*	Artificial
Solidago gigantea	Cucumber mosaic *cucumovirus*	Natural

Germination percentage of *C. album* was significantly influenced not only by autecological factors, but by Chenopodium mosaic *sobemovirus* as well. Virus infection resulted in an average reduction in germination of 15%. Infection did not influence the germination of the freshly harvested seeds. Germination of those seeds -which were previously stored at room temperature, at –18 C and 4 C in wet sand- was reduced due to virus infection (Fig.1.). The viability of seeds derived from virus infected plants was reduced by 23% as compared with healthy control.

Figure 1: The effect of autecological factors and Chenopodium mosaic *sobemovirus* infection on the germination of seeds of *Chenopodium album* (li, light; da, dark; *, virus infected plants; a, fresh seeds; b, stored at paper bag at 25 C; stored at -18 C; d, stored at 4 C in wet sand)



In pot experiments the fresh and dry weight of the shoots and roots significantly reduced due to virus infections (Table 2). Enhanced dry matter content indicates, the HMV caused disturbances in water relations of *D. stramonium*. Chlorophyll-a, chlorophyll-b and carotinoid content of *D. stramonium* leaves significantly reduced due to CMV infection (Fig.2.). CMV infection reduced sublethal water saturation deficit (WSDsubl) of *Solanum nigrum* by 17%, as compared to healthy control. The WSDsubl of the healthy and infected *S. nigrum* leaves was 36% and 30%, respectively. It means that leaves can lose only low percent of their maximum water content without irreversible injuries. In previous experiments high values of WSDsubl (over 70%) was obtained with species *Digitaria sanguinalis* and *Ambrosia artemisiifolia* (Almádi 1976, Kazinczi and Hunyadi 1992). Our preliminary results indicated biological decline of *S. nigrum*, regarding to seed production, nutrient uptake and activity of certain enzymes (Kazinczi *et al.*, 2001).

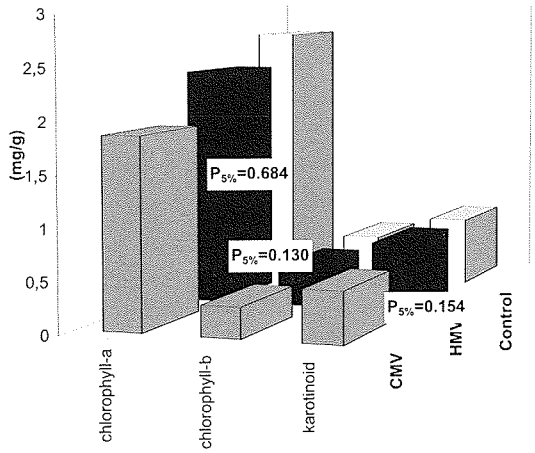
Table 2: The effect of virus infection on the fresh and dry weight of weeds

Plant/virus*	Fresh weight (g/plant)		Dry weight (g/plant)	
	shoot	root	shoot	root
Datura stramonium/HMV	4.4	1.3	0.6	0.2
Datura stramonium/CMV	6.9	4.1	1.0	0.2
Control	11.6	5.8	1.6	0.6
LSDP(5%)	2.0	0.3	0.3	0.2
Solanum nigrum/TMV	9.5	0.98	0.88	0.13
Control	43.2	5.5	4.2	0.58
LSDP(5%)	3.66	0.78	1.44	0.25

*HMV, henbane mosaic *potyvirus*; CMV, cucumber mosaic *cucumovirus*; TMV, tobacco mosaic *tobamovirus*

We conclude that viruses unfavourably influence the physiological processes not only of crops but also of weeds. In an indirect way they can therefore contribute to a reduction of the weed's competitve ability. Regarding the fact, that economically important viruses occurs also on weeds, we plan future investigations in order to get new results about the role of weeds in the virus epidemiology, with special regard to seed-transmitted viruses.

Figure 2: The effect of virus infection on the photosynthetic pigment content of *Datura stramonium*



4. REFERENCES

Almádi, L. 1976. Data to the water relation of *Ambrosia elatior*. Bot. Közlem. 163, 199-204.
Daniel, L.L., Tsai, J.H. 1990. Partial characterization and serological analysis of pseudo curly top virus. Plant Dis. 74, 17-21.
Davis, J.R., Allen, T.G. 1975. Weed hosts of the tobacco rattle virus in Idaho. Am. Pot. J. 52, 1-8.
Horváth J., Mamula, D., Salamon P. 1983. Susceptibility of *Asclepias syriaca* L. (Asclepiadaceae) to cucumber mosaic virus and its role in the virusepidemiology. Növényvédelem 19, 352-353.
Horváth, J., Juretic, N., Wolf, I., Pintér, Cs. 1993. Natural occurrence of sowbane mosaic virus on *Chenopodium hybridum* L. in Hungary. Acta Phytopath. et Entomol. Hung. 28, 379-389.
Horváth, J., Salamon, P., Lesemann, D.-E. 1995. Natural occurrence of cucumber mosaic *Cucumovirus* on *Malva sylvestris* plant in Hungary. Acta Phytopath. et Entomol. 30, 145-151.
Horváth, J., Szirmai, J. 1973. Untersuchungen über eine Virose der Wildgurke (*Echinocystis lobata* ŠMichx.Ć Torr. et Gray.) Acta Phytopath. Acad. Sci. Hung. 8, 329-346.
Kazinczi, G., Horváth J., Lukács, D., Hunyadi, K. 1999. Decline of weeds due to virus infection. 11th EWRS Symp. Basel, 1999. p.91.
Kazinczi, G., Horváth, J., Takács, A., Pribék, D. 2001. Alternative hosts of viruses: weeds. Plant Prot. Days Budapest, 2001. p.90.
Kazinczi, G., Hunyadi, K. 1992. Water relations of some annual weeds. Z. PflKrankh. PflSchutz, Sonderh., XII- 111-117.
Moore, R.P. 1985. Handbook on Tetrazolium Testing. Internat. Seed Testing Assoc.Zurich, 1985.
Salamon, P. 1986. *Asclepias syriaca* L., a reservoir host of cucumber mosaic virus in Hungary. Kertgazdaság 18, 45-59.
Salamon, P. 1989. Viruses and virus diseases of cultivated and wild Solanaceae in Hungary. Natural hosts of cucumber mosaic virus (CMV). Növényvédelem 25, 97-109.
Schmelzer, K., Wolf, P. 1977. Wirtspflanzen und ihre Viren, Virosen und Mykoplasmosen. *In*: Klinkowski, M., Pflanzliche Virologie. Registerband Verzeichnisse und Übersichten zu den Virosen in Europa. Akademie Verlag, Berlin 1977. pp. 53-189.
Weinberger,P., Romero, M., Oliva, M. 1972. Ein methodischer Beitrag zur Bestimmung des subletalen (kritischen) Wassersättigungsdefizites. Flora 161, 55-561.
Wilson, K.I., Al-Beldawi, A.S., Amin, M.., Nema, H.A. 1981. *Solanum nigrum*, a new host of tomato yellow leaf curl virus. Plant Dis. 65,979.