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Virus Disease Problems on Field Cucumber in Hungary with Some International Aspects

E. KISS[1], G. KAZINCZI[2], J. HORVÁTH[2], S. KOBZA[3], T. BARANYI[4], M. VARGA[5], B. HAVASRÉTI[5] and A. FEHÉR[5]

[1]Plant Health and Soil Conservation Station of County Csongrád, Hódmezővásárhely, Hungary
[2]Dept. Plant Pathology and Virology, University of Veszprém, Georgikon Faculty of Agriculture, Institute for Plant Protection, Keszthely, Hungary
[3]Plant Health and Soil Conservation Station of Ministry Agriculture, Budapest, Hungary
[4]Department of Plant Protection and Agro-Environment Management, Ministry of Agriculture and Rural Development, Budapest, Hungary
[5]Plant Health and Soil Conservation Station of County Győr-Moson-Sopron, Győr, Hungary

Viruses caused severe yield losses of field cucumber in Hungary last years. Field surveys have been carried out on field cucumber to evaluate virus infection in the region of Győr-Moson-Sopron county. Virus infection was determined on the basis of symptoms, biotest and with DAS-ELISA serological method for the presence of 15 viruses. The virus vector aphid flight was monitored by Moericke yellow water pan. On the basis of field surveys 100% virus infection has been observed in cucumber fields. Virus symptoms were various, depending on varieties, environmental factors, viruses and strains. Out of the viruses investigated only three [*Cucumber mosaic cucumovirus* (CMV) (DTL serotype); *Zucchini yellow mosaic potyvirus* (ZYMV) and *Watermelon mosaic 2 potyvirus* (WMV-2)] have been occurred on cucumber samples. Biological tests confirmed the results of DAS-ELISA. There was much difference, regarding the frequency of viruses. ZYMV was dominant in 1998, while CMV was dominant in 1999. The proportion of the complex infection was very high. Till now, besides CMV other viruses cannot be detected from weeds in cucumber ecosystems. The peak of aphid flight was in the middle of June and later a secondary peak was observed at the beginning of July, which coincided with the appearance of the first virus symptoms. Regarding, that cucumber production occurs in fields at the same place year by year, soil borne virus vectors may play important role in virus infection. To reduce virus infection we can suggest using of light summer oils, which prevents virus transmission by aphids. It is concluded that team work of virologists, pathologists, growers, technologists and the breeders is necessary to solve virus problems of field cucumber in Hungary.

Keywords: field cucumber, virus diseases.

Cucumis species originated in tropical and subtropical Africa, which is the primary center of diversity. The secondary centres of diversity are China, Iran and Community of Independent States (Kalloo, 1988). In Hungary the area of field cucumber is about 4200 ha. The most important parts of the country, where the little-sized conserve cucumber production occur are the following: Győr-Moson-Sopron county – it is the most important part regarding conserve cucumber production –, southern part of Zala and Somogy, Nyírség, Békés, Jász-Nagykun-Szolnok, Bács-Kiskun and Heves counties. Conserve cucumber is one of our most important export goods. Hungary exports 8–10,000 tons conserve cucumber a year, mainly to Germany, less to Switzerland, Italy, Benelux States and Austria.

From virological point of view, cucumber belongs to the virophilous plants. Cucumber (*Cucumis sativus* L.) is the best known species, susceptible – to our knowledge – to more than 60 viruses (Lovisolo, 1980; Horváth, 1985). Recent investigations cleared up the behaviour of several *Cucumis* species to 12 viruses and 16 new host-virus relations were described (Horváth, 1985). On the basis of the literature the number of viruses infecting cucurbit plants is nearly forty, belonging to 17 virus genus. Most of them belong to the *potyvirus* genus. Great part of this viruses can be transmitted by different vectors, mainly by aphids. Several of them can be transmitted by other vectors, like beetles, whiteflies and soil borne nematodes *(Table 1).*

Table 1

Viruses infecting cucurbit crops, grouped by the vectors

Vector	Virus	Reference	Other modes of transmission*
Aphids	*Bryonia mottle potyvirus* (BryMV)	Lockhart and Fischer (1979)	M
	Clover yellow vein potyvirus (ClYVV)	Hollings (1965)	M
	Cucumber mosaic cucumovirus (CMV)	Price (1934)	M, S
	Melon vein-banding mosaic potyvirus (MVBMV)	Huang et al. (1993)	M
	Muskmelon vein necrosis carlavirus (MuVNV)	Freitag and Milne (1970)	M
	Papaya ringspot potyvirus type W (PRSV) [syn. *Watermelon mosaic 1 potyvirus* (WMV-1)]	Webb (1965)	M
	Telfairia mosaic potyvirus (TeMV)	Nwauzo and Brown (1975)	M, S
	Watermelon mosaic 2 potyvirus (WMV-2)	Webb and Scott (1965)	M
	Watermelon moroccan mosaic potyvirus (MWMV)	Fischer and Lockhart (1974)	M
	Zucchini yellow fleck potyvirus (ZYFV)	Martelli et al. (1981)	M
	Zucchini yellow mosaic potyvirus (ZYMV)	Lisa et al. (1981)	M, S
Beetles	*Melone rugose mosaic tymovirus* (MRMV)	Jones (1981, cit.: Brunt et al., 1996)	M
	Squash mosaic comovirus (SqMV)	Freitag (1956)	M, S
	Wild cucumber mosaic tymovirus (WCMV)	Freitag (1952)	M, S
	Cucumber green mottle mosaic tobamovirus (CGMMV)	Ainsworth (1935)	M, S, W
Fungi	*Cucumber necrosis tombusvirus* (CuNV)	McKeen (1959)	M, W
	Melon necrotic spot carmovirus (MNSV)	Kishi (1966)	M, S
	Tobacco necrosis necrovirus (TNV)	Smith and Bald (1935, cit.: Brunt et al. 1996)	M
	Cucumber leaf spot carmovirus (CLSV)	Weber et al. (1982)	M, S
Nematodes	*Tobacco ringspot nepovirus* (TRSV)	Van Koot and Van Dorst (1955, cit.: Lovisolo, 1980)	M, S, P
	Tomato ringspot nepovirus (ToRSV)	Provvidenti and Schroeder (1970)	M, S, P
	Arabis mosaic nepovirus (ArMV)	Hollings (1963)	M, S
	Tomato black ring nepovirus (TBRV)	Forghani et al. (1965)	M, S, P
	Tobacco rattle tobravirus (TRV)	Böning (1931, cit.: Brunt et al., 1996)	M, S

Table 1 (cont.)

Vector	Virus	Reference	Other modes of transmission*
Thrips	*Tomato spotted wilt tospovirus* (TSWV)	Samuel et al. (1930, cit.: Brunt et al., 1996)	M
Whiteflies	*Beet pseudo-yellows closterovirus* (BPYV)	Duffus (1965)	not known
	Cucurbit yellow stunting disorder virus (CYSDV)	Célix et al. (1996)	not known
	Cucumber vein-yellowing virus (CVYV)	Cohen and Nitzany (1963)	M
	Lettuce infectious yellows closterovirus (LIYV)	Duffus et al. (1986)	not known
	Squash leaf curl bigeminivirus (SLCV)	Cohen et al. (1983)	not known
	Watermelon curly mottle bigeminivirus (WmCMV)	Brown and Nelson (1984, cit. Brunt et al., 1996)	M
	Watermelon chlorotic stunt bigeminivirus (WmCSV)	Jones et al. (1988, cit.: Brunt et al., 1996)	G
Leafhoppers	*Beet curly top hybrigeminivirus* (BCTV)	Freitag and Severin (1936, cit.: Lovisolo, 1980)	G, C
Unknown	*Melon ourmia ourmiavirus* (OuMV)	Lisa et al. (1988)	M
	Tobacco mosaic tobamovirus (TMV)	Foster and Webb (1965)	M
	Tomato bushy stunt tombusvirus (TBSV)	Schmelzer (1958, cit.: Brunt et al., 1996)	M, S, P
	Cucumber soil-borne carmovirus (CuSBV)	Koenig et al. (1982)	M
	Melon variegation cytorhabdovirus (MVV)	Rubio-Huertos and Pena-Iglesias (1973)	not known

* C, Cuscuta spp.; G, grafting; M, mechanically; P, pollen; S, seed; W, water

Until know out of them only three aphid borne viruses [*Cucumber mosaic cucumovirus* (CMV), *Zucchini yellow mosaic potyvirus* (ZYMV) and *Watermelon mosaic potyvirus* (WMV)] are known to have economic importance in Hungary (Szirmai, 1941; Horváth and Szirmai, 1973). ZYMV has been isolated in Hungary in 1995 at the first time, and it seems to have a real threat for cucurbitaceous production (Tóbiás et al., 1996). Since 1996 the biology of ZYMV has been intensively studied in Hungary. Tóbiás et al. (1998) reported, that nucleotid sequence of coat protein region of ZYMV-10 strain showed 86–98.6% homology with other ZYMV strains, while amino acid homology are between 91.7–98.2%. ZYMV-10 strain has the highest nucleotid sequence homology with strain isolated in Israel (98.6%) and amino acid homology with California strain (98.2%). Tóbiás et al. (2001) replaced the coat protein (CP) gene of *Plum pox potyvirus* (PPV) with that of ZYMV and characterized of the hybrid *potyvirus.* They have stated that exchange of CP gene had no effect on the host range. Studies on epidemiology of ZYMV were carried out as well (Basky and Tóbiás, 1998).

Among cucumber varieties parthenocarp ones: Amber, Accordia, Ringo and Harmonie are the most often grown which has high resistance to viruses on the basis of descriptions (Mártonffy, 1999). In spite this fact, severe virus disease has been occurred on field cucumber in Hungary last years, which pay attention to the growers, researchers and breeders (Basky, 1983, 1985; Tóbiás et al., 1996; Basky and Tóbiás, 1998; Kiss and Fehér, 1998; Salamon et al., 1998).

Therefore field surveys have been carried out on field cucumber to evaluate virus infection last two years.

Materials and Methods

Nearly hundred samples of different cucumber varieties (Accordia, Ringo, Amber, Harmonie, NU8105, Etűd), squash and other species from cucumber ecosystem from different places of Győr-Moson-Sopron county (Csorna, Rábatamási, Kapuvár, Farád, Szárföld) were collected in 1998 and 1999 years. First half of the samples was mechanically transmitted to cucumber (*Cucumis sativus* L. cvs Delicatess and Amber) in vector free virological glasshouse. The other half of the samples was investigated by DAS-ELISA serological method after Clark and Adams (1977) for the presence of 15 viruses [CMV (DTL and ToRS serotype), *Watermelon mosaic 1 potyvirus* (WMV-1), WMV-2, *Zucchini yellow fleck potyvirus* (ZYFV), ZYMV, *Arabis mosaic nepovirus* (ArMV), *Tomato black ring nepovirus* (TBRV), *Tomato ringspot nepovirus* (TRSV), *Tomato spotted wilt tospovirus* (TSWV), *Squash mosaic comovirus* (SqMV), *Melon necrotic spot carmovirus* (MNSV), *Tobacco necrosis necrovirus* (TNV), *Tobacco rattle tobravirus* (TRV), *Cucumber green mottle mosaic tobamovirus* (CGMMV), *Tomato bushy stunt tombusvirus* (TBSV)]. Substrate absorbance was measured two hours after adding the substrate at 405 nm wavelength on Labsystems Multiskan RC ELISA Reader. Test samples were considered positive if their absorbance values exceeded twice those of the healthy control samples.

Possibility of seed transmission of viruses was examined in preliminary studies, too. The virus vector aphid flight was monitored by Moericke yellow water pan from the beginning of June to the beginning of August.

Results and Discussion

During field surveys, 100% virus infection was observed in cucumber fields. Symptoms were various; depending on cucumber varieties, environmental factors, viruses and virus strains. The most often symptoms were the following: yellow and green mosaic, malformation, blistering, vein banding, necrotic spots, growth reduction, chlorotic rings, leaf deformation and vein clearing on the leaves; reduced growth of the internodes on the stem; severe deformations on the fruits. On the basis of the symptoms it was impossible to distinguish the different viruses because the same viruses can produce different symptoms and oppositely; different viruses could produce the same symptoms. Due to the complex infections more severe symptoms have been occurred.

We have confirmed the results of earlier surveys on cucumber in Hungary (Kiss and Fehér, 1998). On the basis of serological tests, three viruses (CMV-DTL serotype, WMV-2, ZYMV) have been occurred in cucumber samples. ZYMV was first described in Italy (Lisa et al., 1981) and became widespread all over the world (Lisa and Lecoq, 1984; Sammons et al., 1989; Schrijnwerkers et al., 1991; Perring et al., 1992; Grafton-Cardwell et al., 1996; Alhudaib, 1997). In Hungary ZYMV was isolated by Tóbiás et al. (1996) at first time, and became one of the most serious viruses of cucumber.

Besides CMV, ZYMV and WMV-2, other countries have another viral problems in cucumber, e.g. *Beet pseudo-yellows closterovirus* (BPYV) and Cucurbit yellow stunting disorder virus have been associated with yellowing diseases of cucumber in Spain (Berdiales et al., 1999).

All cucumber and squash samples were infected by one or more viruses in 1998. Hundred, 63 and 33% of the cucumber, squash and weed samples were infected with viruses in 1999. In 1998 CMV alone did not occur, while in 1999 WMV-2 alone did not occur on cucumbers. The proportion of the complex infections in both years was very high *(Fig. 1).*

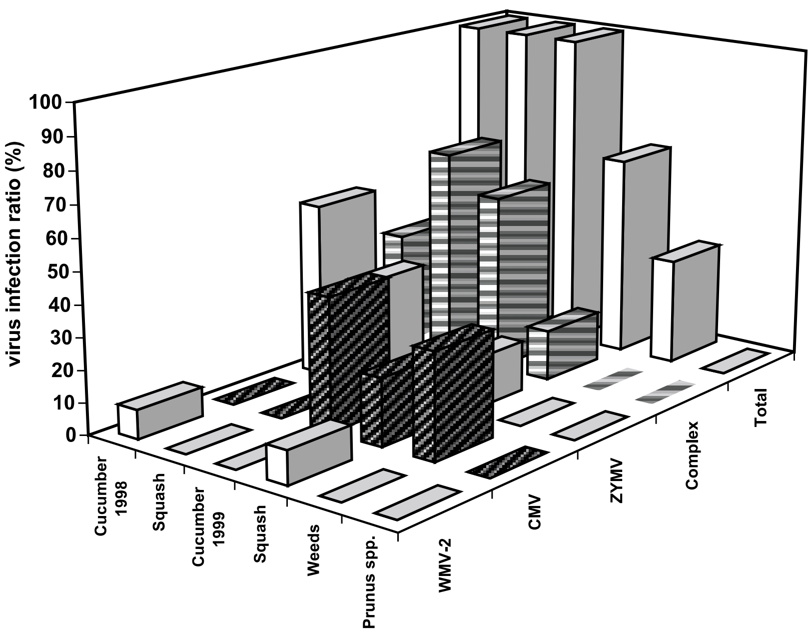

Fig. 1. Virus infection ratio of cucumber and other plants from cucumber ecosystem

On the basis of our surveys among weeds from cucumber ecosystem five species *(Malva neglecta, Ambrosia elatior, Chenopodium album, C. hybridum* and *Solanum nigrum)* were infected with CMV. Besides CMV, other cucurbit viruses cannot be isolated from weeds in cucumber ecosytem. Woody plants (*Prunus* spp.) were not infected by cucurbit viruses. There was much difference between the two years, regarding the frequency of cucurbit viruses. In 1998 the occurrence of ZYMV was dominant, while in 1999 CMV was dominant on cucumber *(Fig. 2).*

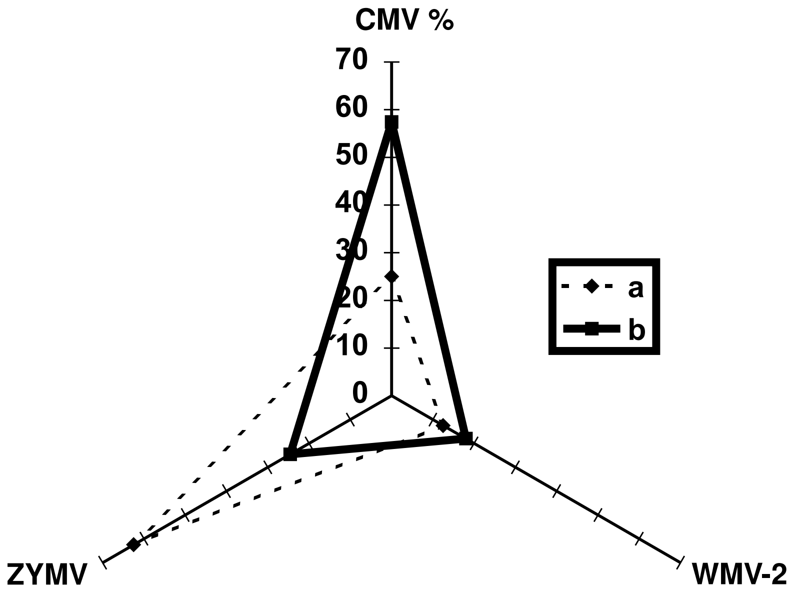

Fig. 2. The frequency of occurrence of viruses (%) on cucumber (a, 1998; b, 1999 years)

The peak of virus vector aphid flight was in the middle of June, and later a secondary peak was observed at the beginning of July, which coincided with the appearance of the first virus symptoms in fields. In spite of the regular spraying with different insecticides, the protection was not effective. Treatments with insecticides are effective only in case, when viruses are transmitted in persistent (circulative) manner. All of the detected cucumber viruses (CMV, ZYMV, WMV-2) can be transmitted by nonpersistant manner. Therefore effective technology need against aphid vectors, including the use of light summer oils.

Bradley et al. (1962) first reported that mineral oil has an inhibitory effect on transmission of a virus transmitted aphids in a nonpersistent manner. Since then, there have been many reports of mineral oil use in laboratory and field applications, alone and in combination with insecticides, on a wide variety of crops (Bell, 1980; Basky, 1983, 1985; Gibson and Rice, 1986; Webb, 1993). The mechanism by which mineral oil prevents aphid transmission of viruses is still not understood (Peters and Lebbink, 1973; Simons et al., 1977; Qiu and Pirone, 1989; Powell, 1991; Powell et al., 1992; Wang et al., 1996). Wang and Pirone (1996) support the hypothesis that mineral oil interferes with the retention of virions in aphid stylets.

Our preliminary studies did not prove seed transmission. Tóbiás and Kovács (2001) experienced the transmission of ZYMV by seeds of *Cucurbita pepo* var. styriaca.

The extent of seed transmission was low (0.003%), but it had been proved that the whole stand may become infected in case of low infection sources due to intensive aphid invasion (Basky and Tóbiás, 1998). In spite this fact and confusing data available in literature (Lecoq et al., 1981; Wang et al., 1984; Nameth et al., 1986; Gleason and Provvidenti, 1990; Schrijnwerkers et al., 1991) we cannot exclude the possibility of transmission of cucurbit viruses by seeds of cucumber varieties.

On the basis of our surveys virus resistant varieties (Harmonie, Ringo, etc.) were susceptible to viruses so it is presumed that these varieties have low level of resistance (or tolerance). On the other hand, it can be presumed that new, resistance-breaking strain of CMV appeared. Remarkable are the investigations concerned with the virus resistance of various *Cucumis* species (Webb, 1979; Bohn et al., 1980; Pitrat and Lecoq, 1984; Weber et al., 1985; Lebeda et al., 1996; Lebeda and Kristková, 1996). In an earlier experiments *C. myriocarpus* have been found to be resistant to CMV (Horváth, 1975, 1983). Horváth (1993) studied the reactions of 67 accessions of 12 *Cucumis* species to seven viruses. From the point of view of resistance to viruses examined *C. africanus* G1. 2302 proved the best, being immune to five viruses [*Cucumber leaf spot carmovirus* (CLSV), CGMMV, CMV, WMV-2, ZYMV]. Good resistance qualities were shown by *Cucumis melo* PI 217974, which was immune to four viruses (CLSV, CMV, WMV-2, ZYMV) and hypersensitive resistant to two viruses [*Melandrium yellow fleck bromovirus* (MYFV), MNSV]. Due to resistance research, today a number of *Cucumis* cultivars possess resistance to CMV, WMV-1, WMV-2 and ZYMV (Cohen et al., 1971; Provvidenti et al., 1983; Wang et al., 1984). It is possible for cucumber breeders to combine genes for resistance to four viruses. No doubt, however, that investigations on resistance to some important viruses (e.g. CGMMV, CLSV, MNSV) are still very deficient (Horváth, 1993).

Regarding, that severe, unsolved viral problems are on field cucumber growing in Hungary, we have to continue investigations to the following directions: (i) from the point of virus epidemiology it is very important to find primary infection sources and virus reservoirs from cucumber ecosystem, with special regard to perennial plants, (ii) regarding that field cucumber production occurs in field year by year at the same place, we cannot exclude the presence of other, soil borne nematode and fungi transmitted viruses, (iii) natural waters used for irrigation may contain plant viruses and play a vector role in the epidemiology of viruses, (iv) effective technology against aphid vectors is necessary, including light summer oils, (v) future studies are necessary about transmission of viruses by seeds of cucumber varieties, (vi) until know there are no exact surveys regarding the susceptibility or resistance of cucumber varieties to viruses, (vii) identification of sources of resistance is of great importance that could be used for cucumber breeding programs.

We should hope that team work of virologists, pathologists, entomologists, growers, technologists and breeders help us to solve virus problems of field cucumber in Hungary.

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