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Cumulative vector intensity and seed potato virus infection in Hungary

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Summary: Aphids were collected by Moericke yellow pan traps placed in the potato fields. The cumulative vector intensity is an index that describes the vector abundance and their propensity to transmit PVY (3). The vector intensity was obtained as the number of known PVY vector species caught and multiplied by their relative vector efficiency value. Cumulative vector intensity for the season was calculated by accumulating species-specific vector intensity values at each trapping date. In those places where the number of PVY vectors caught by yellow pan traps were the highest (1194, 1495 and 663, 570, respectively), the cumulative vector intensity was also the highest (322 and 570, respectively). This high vector intensity resulted in high progeny tuber infection 21 and 31 %, respectively. In those years when the cumulative vector intensity did not reach the value of 10 until the end of June and the beginning of July the proportion of PVY infected progeny tubers met the requirements of the standard, it was less than 5 %. The cumulative vector intensity seems to be a reliable way to forecast virus threat to seed potato. Both seasonal variation and vector abundance is reflected in cumulative vector intensity, above all propensity of different vector species is included in the calculation. As the virus translocation from leaves to tubers takes 12–14 days. Therefore it is imperative that immediately after weekly trap catches cumulative vector intensity values are calculated, as when values reach around ten growers in seed potato growing region will have 12 days to execute killing leaves and stems of seed potatoes.

Key words: *Potato virus Y, seed potato, PVY vector aphid species, cumulative vector intensity*

Introduction

Beside Colorado potato beetle (*Leptinotarsa decemlineata* Say) the other major problem of potato production in Europe is infection by viruses that are transmitted by aphids (Aphididae). The most widespread viruses are potato Y potyvirus (PVY) and potato leaf roll polerovirus (PLRV) (*Wolf* et al, 1998, *Weideman*, 1988). In Hungary, both PVY and PLRV are economically important potato viruses (*Horváth*, 1964, 1967). Both viruses are transmitted by aphids; PVY in non-circulative, PLRV in circulative manner. In Hungary an aggressive PVY strain; the tobacco veinal necrosis strain of PVY (PVYN) was detected from tobacco (*Szirmai*, 1958). This strain became the prevailing potato virus in Europe by the 1980s (*Weidemann*, 1988, *Chrzanowska*, 1991) regularly causing serious epidemics in Hungary (*Horváth*, 1967, *Beczner* et al., 1984, *Horváth & Wolf*, 1999). PVYN severely damaged the highly susceptible traditional Hungarian potato cultivars. Therefore, during the 1970s the Hungarian potato cultivars were replaced with modern Dutch cultivars. The high cost of the imported seed potato resulted in the relocation of seed potato production from the traditional hill areas to lowland areas where the growers had enough capital to pay for the high cost of imported seed potatoes. Under Hungarian circumstances, higher temperature and lower precipitation created unfavourable ecological conditions under which the susceptible Dutch cultivars become virus infected due to the high virus infection pressure. In this study we demonstrate that cumulative vector intensity is suitable to forecast the time of the haulm destruction.

Materials and methods

During a long term survey between 1993 and 2005, the aphid flight activity was monitored in 5 different locations of Hungary by Moericke yellow water pan traps (*Moericke*, 1955).

Aphids were collected with two yellow water pan traps. One of the traps was placed 30 meters from the edge and the other was in the middle of the potato seed producing fields from the time of plant emergence until haulm destruction. The traps were emptied twice weekly. Insects captured were preserved in 70 % ethanol until identification. All aphid species were identified by using the keys of *Blackman & Eastop* (1984) and *Basky* (1993).

The cumulative vector intensity is an index that describes the vector abundance and their propensity to transmit PVY (*Irwin & Ruesnik*, 1986). The vector intensity was obtained as the number of known PVY vector species caught multiplied by their relative vector efficiency value. The relative vector efficiency values of different vector species used in this study were based on *van Hoof*, 1980, *van Harten*, 1983 and *Sigwald*, 1984. The relative efficiency value of *Myzus persicae* Sulzer is 1.0, *Macrosiphum euphorbiae*

Thomas 0.10, *Acyrthosiphum pisum* Harris 0.05, *Aphis nasturtii* Kaltenbach 0.42, *Aphis fabae* Scop.) 0.1, *Phorodon humuli* Schrank 0.15, *Rhopalosiphum padi* L. 0.03, *Metopolophium dirhodum* Walker 0.01.

The better the ability of the aphid to transmit the virus the higher the relative vector efficiency value. The cumulative vector intensity was calculated by summarising the vector efficiency values of each trapping date.

Virus survey of potato cultivars

Virus infection of progeny tubers was assessed during post-harvest inspections. During each inspection 200 tubers per plot were selected and the apical eye from each was planted in a greenhouse. Plants grown from these eyes were ELISA tested for PVY. In order to detect all PVY strains, polyclonal antisera were used for DAS ELISA (*Clark & Adams*, 1977). During the study between 1993 and 2005, samples of 148 plots with different cultivars originating from 44 fields were examined.

Statistical analyses

Using the following factors cumulative vector intensity as continuous predictor, simple linear regression analysis was used to determine the potential for progeny tuber infection by PVY.

Aphid data were log-transformed, virus infection data proportion of PVY infected progeny tubers were arcsin-transformed to normalise their distribution.

All analyses were made using the Statistica program package (Statsoft Tulsa, OK, USA) (*STAITSTICA STATSOFT*, 1997).

Results

During the survey between 1993 and 2005, the total aphid number and vector number varied between 194-1575 and 30-663, respectively. The value of cumulative vector intensity calculated using the yellow pan trap catches and the vector propensity values varied between 1.8 and 322. The value of cumulative vector intensity was the highest in 1995 in the eastern part of Hungary (322). However, the total aphid number caught by the two Moericke yellow pan traps during the survey was not the highest in this year at this location. The two yellow pan traps between mid May and mid July caught 1194 aphid individuals. The number of PVY vector species was 663. The high proportion of the most effective vector, *Myzus persicae* resulted in the highest cumulative vector intensity of the period tested. The mean proportion of the PVY and PLRV infected progeny tubers was also the highest in this location in 1995: 31.8±17.67, 13.25±9.42, respectively.

The highest total aphid number was caugt in the middle of the country near the Danube in 2001: 8746 individuals were caught between 14 May and 19 July during the vegetative period of the seed potato. The number of PVY vector species was 1099 and the value of cumulative vector intensity was 106.73. Although the aphid flight was very intensive in this location in 2001, the proportion of the PVY vector individuals was low, because high number of *Cavariella aegopodii* (Scopoli) *Cavariella theobaldi* (Gillette & Bragg) and *Capitophorus* species were present in high number in the yellow pan traps.

Simple linear regression analysis revealed a significant positive relationship between cumulative vector intensity and PVY incidence in progeny tubers R^2=0.21 F=20.64 P=0.000. The calculation and interpretation of cumulative vector intensity is shown in *Figure 1*.

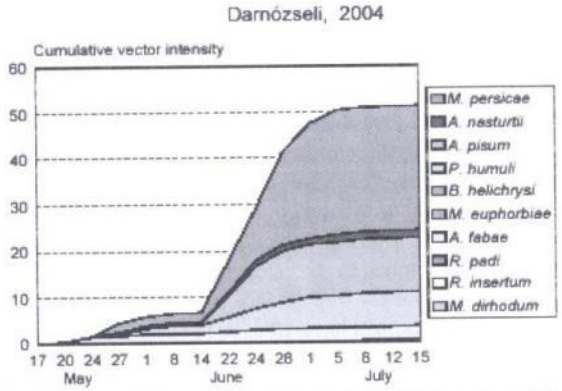

Figure 1. The cumulative vector intensity value of PVY vector aphid species at Darnozseli in 2004

The cumulative vector intensity values and the PVY infection values of the progeny tubers of different potato cultivars were placed of the map of Hungary. The sizes of the circles are proportional with the cumulative vector intensity values, and those of the of the columns are proportional with the PVY infection % of the progeny tubers of different potato cultivars. Figures 3-5 show that both the value of cumulative vector intensity and the proportion of PVY infected progeny tubers are lower in the southern and the eastern part of Hungary.

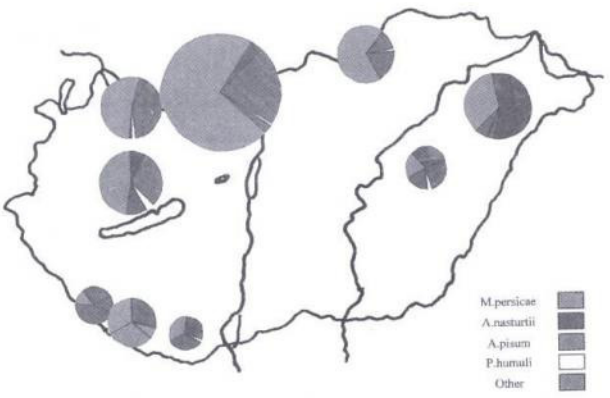

Figure 2. The cumulative vector efficiency values of different locations in Hungary 2003

Discussion and conclusions

Results from this study showed that from healthy propagation material, quality seed potatoes could be produced in Hungary when the cumulative vector intensity

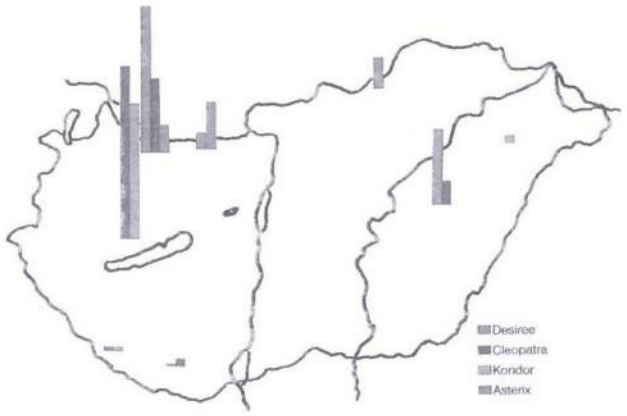

Figure 3. The proportion of PVY infected progeny tubers grown in differnt locations in Hungary in 2003

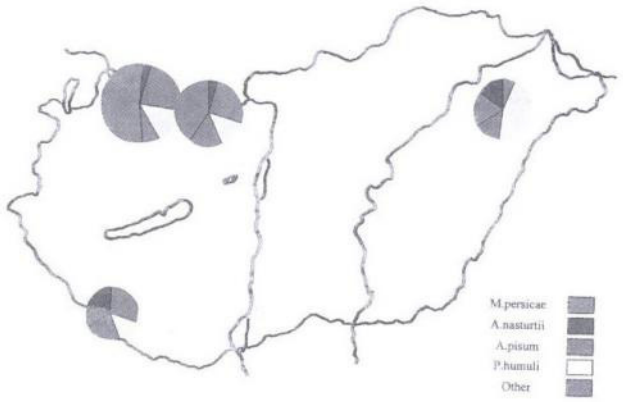

Figure 4. The cumulative vector efficiency values of different locations in Hungary in 2004

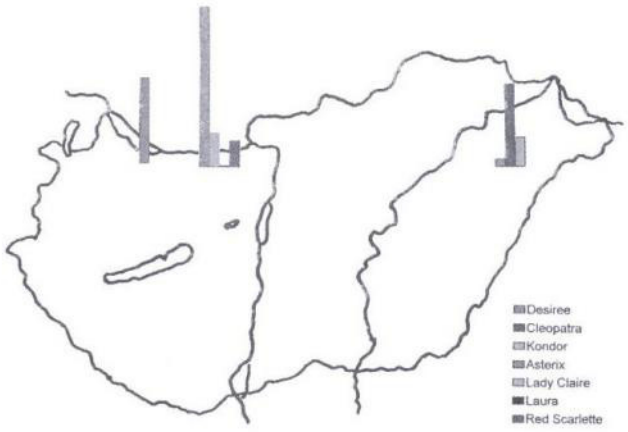

Figure 5. The proportion of PVY infected progeny tubers grown in differnt locations in Hungary in 2004.

was not higher than 10–15 at end of June-early July. Virus translocation from leaves to tubers takes 12–14 days (*Basky & Almási*, 2005). The leaves and stems of seed potatoes have to be destroyed within 12 days when the value of cumulative vector intensity reaches the critical value of 10. The traditional seed potato producers were situated in those regions where the value of the cumulative vector intensity was generally low (Southern and Eastern parts of Hungary). In these places not only the total aphid number was low, but the proportion of PVY vector species was even lower. The most important is the low number of *Myzus persicae,* which is the most important PVY all over the world. In Hungary seed potato producers collect aphids by Moericke yellow water pans. The insect material is shipped to the Plant Protection Research Institute of Hungarian Academy of Sciences to the author. Cumulative vector intensity is calculated immediately after weekly trap catches are identified. The graphs showing the cumulative vector intensity value of certain area are sent to the producer by e-mail. When cumulative vector intensity reaches the value of 10, potato seed producers are warned to destroy the stems and leaves of seed potatoes.

Acknowledgement

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