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Relation between concentration of potato virus Y^N and its availability to Myzus persicae

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Abstract

The ability of *Myzus persicae* to transmit PVY^N from potato to tobacco is not influenced by the temperature at which aphids are reared. A positive correlation exists between the relative virus concentration of PVY^N in potato as determined by serology and A6-test, and its availability to *M. persicae* as indicated by transmission tests to tobacco.

Introduction

Temperature is known to influence greatly population density and activity of aphids (Hille Ris Lambers, 1972; Gabriel et al., 1972). Thus temperature may also very much affect the spread of aphid-transmitted viruses, such as potato virus Y^N (PVY^N), in the field. De Bokx and Piron (1977) found that the relative concentration of PVY^N in potato 'Eersteling' is positively correlated with temperature. We have now investigated whether virus concentration in a potato plant affects virus spread from that source. Therefore virus-free green peach aphids, *Myzus persicae*, were allowed to feed on potato plants with varying concentrations of PVY^N and were then transferred to a number of healthy tobacco seedlings. The percentages of infected tobacco seedlings contracting infection were considered a measure of aphid ability to transmit the virus.

Materials and methods

Healthy, pre-germinated tubers, 'Bintje', were planted in plastic pots (8 litres) with steam-sterilized potting soil fertilized with 2 g NPK (12-10-18) and 2 g kieserite each. They were kept for three weeks in a greenhouse at ca. 18 °C. Thereafter, their leaves, dusted with 500 mesh Carborundum, were dry-inoculated with PVY^N, isolated from 'Gineke', and then placed in growth chambers (2 plants per chamber) at the following day/night temperatures: 10/7, 14/9, 18/12, 22/17 and 26/21 °C and with a 15 h photoperiod at 15000 lx. Inoculated plants were also kept in a greenhouse at 22 °C.

Myzus persicae were reared in cages on radish plants at room temperature, as well as on *Capsicum annuum* in growth chambers at the above-mentioned temperatures.

Aphids were starved for 3 h, before they were allowed to feed for 3 to 10 min on a

detached virus-containing potato leaf. Viruliferous aphids were then transferred in groups of three to each of 50 tobacco plants 'White Burley' at the two-to-three-leaf stage, where they remained for 24 h whereafter they were killed with an insecticide. Aphids raised at room temperature were permitted to transmit virus from the plants grown in growth chambers, whereas the aphids raised at different temperatures were used to transmit virus from plants grown at 22 °C.

Transmission of PVY^N was performed 13, 27, 41, 44 and 69 days after inoculation of the potato plants. The first completely expanded top leaf of each plant used for virus transmission was used the next day to determine virus concentration serologically and by the A6-leaf test. Therefore detached leaves were kept in a small water-containing cylinder, closed with a plug (see Fig. 2), to prevent them from wilting. Sap samples were then taken from these leaves, and diluted with water: undiluted, 1/4, 1/16, 1/64, 1/256, 1/1024, 1/4096. The highest dilution still infective or serologically active was taken as a measure of the virus concentration.

The A6-leaf test was according to De Bokx (1972). The serological test was the micro-precipitin test under paraffin oil in plastic Petri dishes.

Results

Table 1 presents the transmission ability of *Myzus persicae* reared at different temperatures.

Aphids raised at low temperatures (10 and 14 °C) usually were much bigger then those kept at 22 °C and 26 °C. However, aphids raised at 10, 14, 18 and 26 °C respectively, transmitted PVY^N from potato to tobacco equally well. Transmission was considerably higher in the second experiment but hardly differed at the different temperatures: between 36 and 41% of the tobacco seedlings became infected with PVY^N. Only aphids reared at 22 °C transmitted virus to a much lower percentage of seedlings, but this may have been due to an unknown experimental error.

The results with aphids reared at room temperature are summarized in Fig. 1.

Virus could be detected in plants grown at 18, 22 and 26 °C with the A6 test 13 days after inoculation and serologically at 26 °C only. At that time no virus could be demonstrated in plants grown at lower temperatures. Virus concentration in potato plants increased with time after inoculation. The maximum (about 256 serologically

Table 1. Ability of *Myzus persicae* reared at different temperatures to transmit PVY^N.

Temperature (° C)	Numbers of infected plants out of 40 tobacco plants		Total number of infected plants
	1ste exp.	2nd exp.	
10	13	19	32 (40%)
14	7	25	32 (40%)
18	6	23	29 (36%)
22	0	11	11 (14%)
26	12	21	33 (41%)

Tabel 1. Het vermogen van Myzus persicae, gekweekt bij verschillende temperaturen, om PVY^N over te brengen.

Fig. 1. Relation between concentration of PVY^N in potato plants grown at various temperatures and transmission to tobacco by *Myzus persicae* reared at room temperature.

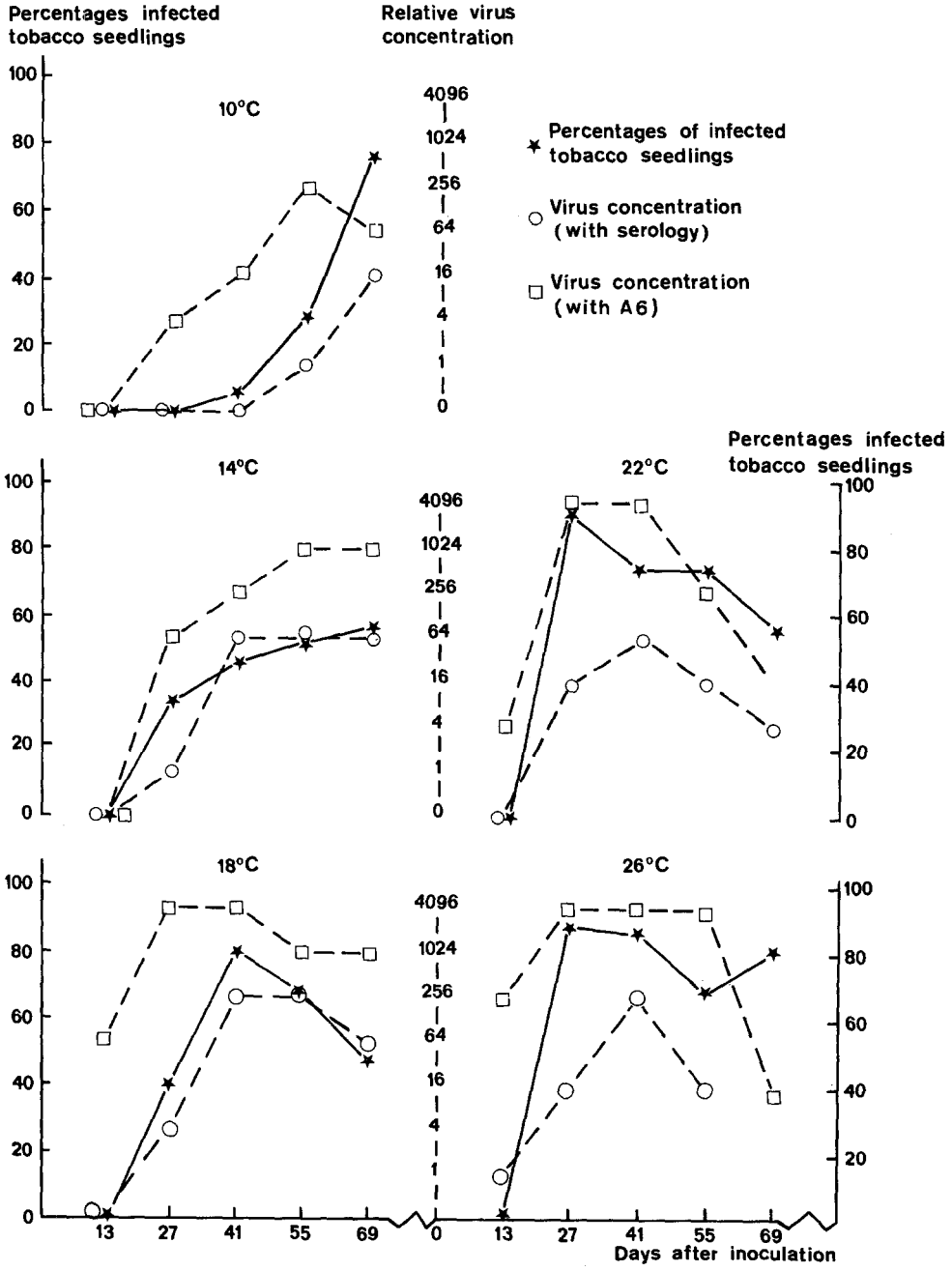

Fig. 1. Relatie tussen de concentratie van PVY^N in aardappelplanten geteeld bij verschillende temperaturen en overdracht naar tabak door Myzus persicae gekweekt bij kamertemperatuur.

Fig. 2. Size and shape of leaves from potato plants, infected with PVY^N, grown at 10, 14, 18, 22 and 26 °C (from right to left).

Fig. 2. Vorm en grootte van aardappelblad van planten geïnfecteerd met PVY^N, geteeld bij 10, 14, 18, 22 en 26 °C (van rechts naar links).

measured) was reached earlier the higher the temperature. Growth of potato plants and development of foliage (Fig. 2) at various temperatures were as described by De Bokx and Piron (1977).

The tuber production was 75 (508 g), 50 (413.5 g), 39 (403.8 g), 23 (480 g) and 14 (98.5 g) at 10, 14, 18, 22 and 26 °C, respectively. This was in agreement with Marinus and Bodlaender (1975), who found that a high temperature always had an adverse effect on tuber yield.

In general the ability of aphids to transmit PVY^N from potato plants grown at various temperatures to tobacco, expressed in percentages of infected tobacco plants, was correlated with the virus concentration of potato leaves on which the aphids had probed. The precipitin test indicated always lower concentrations than the A6 test (Fig. 1).

Discussion

The data presented in Table 1 demonstrate that the ability of *Myzus persicae* to transmit PVY^N was not affected by the temperature at which the aphids were raised. Whether the temperature during starving and probing of the aphids would affect the transmission of PVY^N, was not investigated. Fig. 1 shows that there was a positive correlation between relative concentration of PVY^N and the temperature at which infected potato source plants had been grown. This is in agreement with the findings of De Bokx and Piron (1977).

Plants grown at 10 ° and 14 °C developed large-sized leaves, but short internodes, whereas plants grown at higher temperatures produced small leaves and long internodes. At the end of the experiment (69 days after inoculation), when plants at 10 ° and 14 °C still grew, plants kept at higher temperatures were mature. It is not yet clear, whether the low virus concentration in tip leaves at 10 ° and 14 °C was due to a

slow multiplication in and translocation from inoculated leaves or to a low virus multiplication in the latter. However, since tuber production at 10 °C is highest one may assume that the first supposition is true.

The positive correlation between virus concentration in potato plants and percentages of infected tobacco leads to the conclusion that transmission of PVY^N by *M. persicae* from infected potato to tobacco is highly correlated with the virus concentration in source plants. Determining the transmission ability of *M. persicae* for PVY^N might even be considered as a biological test for determining the relative concentration of PVY^N in potato, although more time-consuming, than a serological or A6 test.

Our findings are in agreement with those of Bagnall and Bradley (1958), who found, that potato cultivars with mosaic symptoms induced by PVY had a higher virus content than did cultivars with necrosis; the former were the better source of virus to *M. persicae*.

Also Zettler (1969) suggested, although no quantitative experiments were conducted, that the availability of bean common mosaic virus to *Aphis craccivora* that probed systemically infected leaflets of bean was related to the virus titer.

Samenvatting

Relatie tussen concentratie van aardappelvirus Y^N en overdracht door Myzus persicae

De Bokx en Piron (1977) vonden, dat de virusconcentratie van aardappelvirus Y^N (PVY^N) in 'Eersteling' positief was gecorreleerd met de temperatuur, waarbij aardappelplanten werden geteeld. De vraag is nu of er een verband bestaat tussen de virusconcentratie in de waardplant en de verspreiding van PVY^N-virus door bladluizen (*Myzus persicae*).

Myzus persicae gekweekt bij verschillende temperaturen (Tabel 1) werd gebruikt voor virusoverdracht uit aardappelplanten geteeld bij 22 °C (= gelijke virusconcentratie), terwijl bladluizen gekweekt bij kamertemperatuur werden gebruikt voor overbrengen van PVY^N uit planten geteeld bij verschillende temperaturen (= verschillende virusconcentraties).

De overdracht van PVY^N door *M. persicae*, werd niet beïnvloed door de temperatuur waarbij de bladluizen werden gekweekt. Er was echter een positieve correlatie tussen de relatieve concentraties van PVY^N in aardappel, bepaald volgens de microprecipitatietoets en de A6-bladtoets, en de overdracht door bladluizen naar tabak (Fig. 1).

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