Datura GENUS WEEDS AS AN EPIDEMIOLOGICAL FACTOR OF *Alfalfa mosaic virus* (AMV), *Cucumber mosaic virus* (CMV), AND *Potato virus Y* (PVY) ON SOLANACEUS CROPS

Malezas del género *Datura* como factor epidemiológico del *Virus del mosaico de la alfalfa* (AMV), *Virus del mosaico del pepino* (CMV) y *Virus Y de la papa* (PVY) en Solanáceas cultivadas.

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A B S T R A C T

Plant samples of jimsonweed (*Datura stramonium* L.) and thornapple (*D. ferox* L.) were collected to determine the presence of *Cucumber mosaic virus* (CMV), *Alfalfa mosaic virus* (AMV), and *Potato virus Y* (PVY) in Santiago, Chile (33º34' S lat, 70º38' W long, altitude 625 m.o.s.l.), using double stranded RNA (dsRNA) analysis and ELISA. Both weeds were positive to the three types of virus with a percentage of infection ranging from 20-30% except for PVY infection in *D. stramonium* with an incidence of 5%. Under controlled conditions, the aphid *Myzus persicae* (Sulzer) transmitted CMV from *D. ferox* to tomatoes (*Lycopersicon esculentum* Mill.) and sweet peppers (*Capsicum annuum* L.*)*, but did not transfer it to potatoes (*Solanum tuberosum* L.). Seeds of positive *D. stramonium* and *D. ferox* plants did not transmit CMV, AMV or PVY. In the field, the presence of virus-infected *Datura* plants in the vicinity of the test crop plots and flight activity of aphid vectors was not correlated with the levels of infection of tomatoes, peppers and potatoes. Wind direction probably affected the ability of flying vectors to transmit viruses. *Datura* weeds, especially *D. ferox*, ought to be controlled not only because of economic losses produced by weed-crop competition, but also because they are alternative hosts of CMV, AMV and PVY. From an epidemiological perspective, management of weed control ought to include not only *D. ferox* plants within the crop, but also plants surrounding the upwind edges of the field.

Key words: weeds, *Datura* sp., AMV, CMV, PVY, epidemiology, *Myzus*.

R E S U M E N

En Santiago, Chile (33º34' lat. Sur, 70º38' long. Oeste, altitud 625 m.s.n.m.) se colectaron plantas de chamico (*Datura stramonium* y *D. ferox*) para determinar la presencia del *Virus mosaico de la alfalfa* (AMV), *Virus mosaico del pepino* (CMV) y *Virus Y de la papa* (PVY) mediante análisis doble stranded RNA (dsRNA) y ELISA. Ambas malezas fueron positivas a los tres tipos de virus y los porcentajes de infección estuvieron entre 20-30%, excepto para PVY en *D. stramonium* que fue de 5%. Bajo condiciones controladas, el áfido vector *Myzus persicae* Sulzer transmitió CMV desde *D. ferox* a tomates (*Lycopersicon esculentum* Mill.) y pimientos (*Capsicum annuum* L.), sin embargo no lo transfirió a papas (*Solanum tuberosum* L.). Semillas de plantas positivas de *D. stramonium* y *D. ferox* no transmitieron CMV, AMV ni PVY. En campo no se correlacionó la presencia de chamico infectado y vuelo de los áfidos vectores con los niveles de infección de tomates, pimientos y papas. La capacidad de infección de estos insectos pudo afectarse por la dirección de los vientos y su relación con la ubicación de las plantas cultivadas. Las plantas de chamico, especialmente *D. ferox*, deben ser controladas no sólo por las pérdidas económicas producidas por la competencia maleza-cultivo, sino que además por ser hospederos alternativos de CMV, AMV y PVY. Desde un punto de vista epidemiológico, el control no sólo debiera circunscribirse a plantas de chamico del potrero, sino que también aquellas de las inmediaciones, especialmente en la línea de dirección de los vientos.

Palabras clave: malezas, *Datura* sp., AMV, CMV, PVY, epidemiología, *Myzus*.

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INTRODUCTION

Volunteer plants and weeds provide shelter and sources of nutrients for virus vectors. Other vegetative structures and/or contaminated weed seeds may also harbor viruses. Aside from facilitating the spread of disease as alternative source of inoculum, these plants sustain the viability of the virus between crop seasons (Duffus, 1971). Numerous species of weeds that act as reservoirs for a virus and its vectors, and certainly those of the genus *Datura*, have been found to be important in the epidemiology of certain diseases (Johnson *et al*., 1996; Fereres *et al*., 1996; Latham and Jones, 1997; Hobbs *et al*., 2000).

The relationship between plants of the genus *Datura* (jimsonweed, *D. stramonium* L., and thornapple, *D. ferox* L.), which are commonly found among irrigated summer crops in central Chile, and the aphid, *Myzus persicae* (Sulzer) is of great interest to farmers. Plants of the genus *Datura* are susceptible to a wide range of viruses. Potentially these weeds constitute a source of viral agents that can be transmitted to neighboring crops by insect vectors and, in particular, *M. persicae* (Hanafi *et al.,* 1995; Apablaza *et al.*, 2003).

In Chile, jimsonweed and thornapple are frequently confused in the field. *D. stramonium* hosts the *Alfalfa mosaic virus* (AMV) and the *Solanaceae* family is the most susceptible group of plants to this virus (Reyes, 1996). Early reports in northern Chile indicated the presence of *Cucumber mosaic virus* (CMV) and *Potato virus Y* (PVY) on *D. stramonium* (Ormeño and Sepulveda, 2005). These viruses have caused severe losses in sweet pepper yields (Sepúlveda *et al.*, 2005). *Datura* weeds have been referred to in different areas as an alternative host of CMV, AMV (Hobbs *et al.*, 2000) and PVY (Bellardi *et al.*, 1999).

Many aphid species, especially *M. persicae* and *Aphis gossypii*, transmit AMV, CMV and PVY non-persistently when the insects feed on an infected plant (Graham *et al.*, 1979; Harris *et al*., 2001). A wide range of spontaneous annual and perennial plant hosts are involved in virus epidemiology and survival, many of them, being asymptomatic carriers (Jones *et al.,* 1991; Latham and Jones, 1997).

Seed transmission is particularly important for viruses with no alternative host plants or with no vectors. Viruses can be perpetuated from seeds, disseminate, and start primary infection in the field reaching other plants through insects and nematodes (Neegaard, 1977). Seed transmission is variable and its efficiency is not indicative of its importance; epidemics may also occur from infected seeds with poor transmission rates using efficient vectors for secondary dissemination. It has been estimated that 18% of viruses are transmitted by seeds. Many viruses, including AMV and CMV have been found to propagate either through true seed transmission or transmission by the embryo as a means of dissemination (Neegaard, 1977).

The aims of this research were to determine the presence of the main viruses that infect tomato, potato and pepper crops (CMV, AMV, and PVY) on *Datura* weeds, and to study the transmission of the pathogens through seeds from infected weeds or by aphid vectors.

MATERIALS AND METHODS

This study was conducted at La Platina Experimental Station, INIA (National Institute of Agricultural Research), in Santiago, Chile (33º34' S lat, 70º38' W long, altitude 625 m.o.s.l.). Whole plants, leaves and seeds samples of *D. stramonium* and *D. ferox* were collected at different locations of the Experimental Station either exhibiting virus-induced symptoms (mosaic, mottled leaves, and stunting) or asymptomatic, in March 2002, and February 2003. A total of 58 plants were collected in the field and these samples were classified by botanical characteristics and for virus symptoms, weighed, and frozen at –20°C. The presence of a virus or viruses in the sample was confirmed through double stranded RNA (dsRNA) analysis (Dodds *et al.*, 1984), and then specific viruses were identified by DAS-ELISA (Clark and Adams, 1977) with BIOREBA (Reinach, Switzerland) for CMV, AMV, and PVY, and AGDIA (Elkhart, Indiana, USA) antibodies for the genus *Potyvirus*.

Double stranded RNA (dsRNA)

Datura weed leaves (3.5 g) were ground with 8 mL extraction buffer STE (61 g Tris base, 58 g NaCl, 3.7 g Na_2EDTA x 2 H_2O, and 800 mL H_2O) and mixed well. The macerate was put into a 250 mL flask, and 1 mL sodium dodecyl sulfate (SDS) at 10% (detergent) and 0.5 mL bentonite at 2% were added. Under a hood, 9 mL phenol was added, and

the flasks were horizontally agitated for 20 min. Then samples were centrifuged in 50 mL tubes at 8000 rpm for 15 min at 4°C. The resulting supernatant was recovered with a pipette and 2.1 mL of ethanol 95% was added to each 10 mL of supernatant. The sample was then placed in a cellulose column 10 ml STE-ethanol (16% ethanol), glass wool and 1 g cellulose (Cellulose fibrous medium, C-6288 Sigma, St. Louis, Missouri, USA), and allowed to flow at a low flux rate (in droplets).

Before the column had a chance to dry, it was washed three times with 20 mL STE-ethanol. One milliliter of STE was added and passed through without collecting, and then 6 mL STE without alcohol, let to rest 10 min, and the content with the RNA was collected in a clean tube. Finally, 20 mL absolute alcohol and 500 μL sodium acetate were added and left overnight at –20°C to allow RNA to precipitate.

Samples were centrifuged the following day. The supernatant was eliminated and the tubes were left to dry until the alcohol evaporated. The resulting pellet was resuspended in 100 µL TBE 1X. 50 µL of the resuspended pellet were run on 5% vertical polyacrilamid gels, prepared on an electrophoresis buffer (BE) 1X, and maintained for 3 h at room temperature at 110 V and 60 mA. Gels were stained with $AgNO_3$. Leaves of *Nicotiana glutinosa* L. were artificially inoculated with CMV and used as a molecular weight pattern reference.

Double antibody sandwich ELISA (DAS-ELISA)
The method described by Clark and Adams (1977) was used with minor modifications. 100 µL of the different antibodies diluted in coating buffer (1.59 g CO_3 Na_2, 2.93 g HCO_3Na, 0.2 g N_3Na, pH 9.6, completing to 1 L with distilled water) were placed in each well of the polystyrene plates (Brand, Wertheim, Germany) at the concentration indicated by the manufacturer. The plates were covered to avoid evaporation and incubated at 37°C for 3 h. Subsequent steps were all followed by five washes with PBS-TWEEN buffer (0.2 g H_2PO_4K, 8.0 g NaCl, 2.9 g HPO_4 Na_2 x 12 H_2O, 0.2 g KCl, 0.5 mL Tween-20; pH 7.4, made up to 1 L distilled water).

The leaf samples were macerated in plastic bags adding extraction buffer (220 mL PBS-Tween, 4.4 g PVP 40, 0.44 g egg albumin, 0.27 g SO_3Na_2, completed to 1 L with distilled water) at a 1/10 (w/v) dilution. Then 100 μL of this extract were added in duplicate to each plate and incubated overnight at 5°C. Negative and positive controls were included for each virus analyzed.

Each virus conjugate was diluted with buffer (220 mL PBS-Tween, 4.4 g PVP 40, 0.44 g egg albumin, completing to 1 L with distilled water) in the ratio indicated by the manufacturer. Then 100 μL were added per well and the plate covered to avoid evaporation and incubated 3 h at 37°C.

Finally, 100 mL of the substrate solution was added per well, prepared with 0.75 mg p-nitrophenyl phosphate per mL of buffer substrate (97 mL diethanolamine; pH 9,8; completed to 1 L with distilled water). The absorbance was measured at 405 nm with a plate reader (ASYS Hitech GmbH, Digiscan Microplate Reader V3.0, Eugendorf, Austria). Samples whose absorbance was greater than twice the control were considered positive for the respective virus.

Transmission of virus by *Myzus persicae*
Aphids for the transmission experiments were collected from potato, jimsonweed, thornapple, and bull mallow (*Malva nicaeensis* All.) plants at the Experimental Station. Adult aphids were left on Petri dishes for 24 h, from which nymphs were collected and transferred to feed on non-infected potato (*Solanum tuberosum* L.) plants, to ensure uninfected colonies (no transovarial transmission occurs in *M. persicae*). To secure a source of the three viruses, plants of *D. stramonium* and *D. ferox* were inoculated with CMV, AMV, and PVY. The same weed plants collected in the field were used as virus source and the following procedure was utilized to prepare the inoculum: leaves were macerated with a mortar adding inoculation buffer (9.94 g HPO_4 Na_2 0.1 M; 4.08 g H_2PO_4K 0.1 M; pH 7.0–7.4; completed to 1 L with distilled water) in a ratio of 1 g leaves per 10 mL buffer. The macerate was inoculated by mechanical friction with carborundum (300 mesh) to the two first true leaves of *D. ferox* and *D. stramonium* plants obtained from seeds of virus-free plants. Symptoms were observed at 20 d. At 30 d, with enough foliar area, an ELISA was performed to verify the presence of the virus. All greenhouse experiments were performed on a 16 h photoperiod and a temperature range of 20 to 26ºC. Certified tomato (cv. Cal Ace) and pepper (cv. Resistant) seeds were sown in trays containing

sterilized soil. Potato (cv. Desiree) plants were obtained from tubers sprouted in 1 L pots with sterile soil. After 15 d, tomato seedlings were ready to use, pepper plants at 20 to 25 d after, and potato plants at 10 d after planting. Because only the *D. ferox* plants resulted positive to inoculation, transmission was done only from this species and not from *D. stramonium*. For the tests, six potato, tomato and pepper plants were used for each virus, and 10 aphids were placed on each one. The insects were left on Petri dishes without food for 4 h and transferred to infected *D. ferox* plants, in groups of 120 aphids. They were allowed to feed for 3 to 4 min and then transferred to the potato, tomato or pepper plants. A *D. ferox* plant free of the three viruses was used as control. The insects were left 24 h and then eliminated with metamidophos (0.6 L ha^{-1}). The plants were subjected to ELISA to verify virus infection 30 to 35 d after transmission.

Seed transmission

Seeds were obtained from seven *D. stramonium* and twelve *D. ferox* mother plants collected at La Platina Experimental Station. ELISA test results indicated that all mother plants carried at least one of the viruses under study. Then these seeds were sown in sterilized soil in 104 speedling tray cups. For each virus and plant species, seeds were collected from three mother plants. Germination tests were carried out before sowing, scarifying the seeds with different strength solutions of sulfuric acid for a range of different times. Seeds of *D. ferox* were submerged for 1 min in 10 mg kg^{-1} giberellic acid to induce germination. For each mother plant a total of 832 seeds were sown in four speedling trays with two seeds per cuplet. A total of 10,212 seedling plants sprouted and were kept in the greenhouse permanently. Forty days after sowing, plants were tested by ELISA of the virus detected previously in the mother plant, in samples composed by 10 plants each.

Virus transmission in the field

Transmission in the field was studied in 10 x 30 m potato, tomato, and pepper plots, in a sector infested with *D. stramonium* and *D. ferox* and other species of weeds at La Platina during the summer 2002-2003. Once the crops were planted, 2.0 m width strips were staked out around the entire lot where weeds were left uncontrolled. Figure 1 shows the location and position of each crop as well as the surrounding vegetation and the prevailing wind direction at Santiago (Southern Hemisphere summer).

Potato tubers cv. Desiree were hand sown at 0.75 x 0.2 m and emerged in the first week of December. Commercial tomato cv. Cal Ace and green pepper

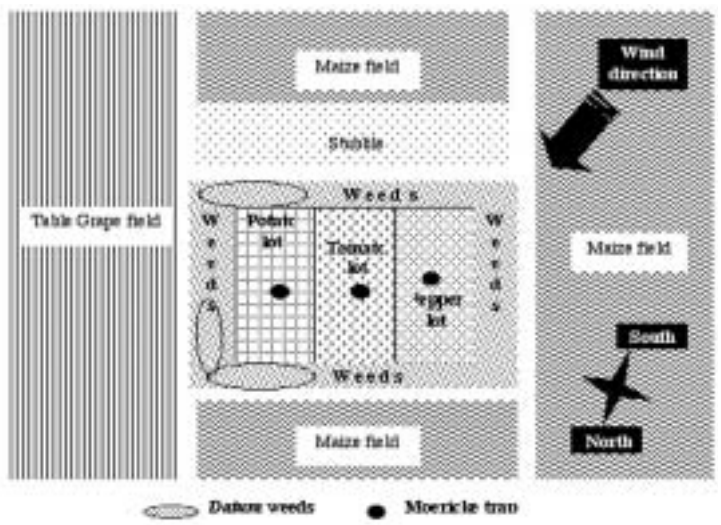

Figure 1. Detail of geography and position of each lot of Solanaceous crop as well as the surrounding vegetation (weeds and crops) and prevailing wind direction at Santiago during the Southern Hemisphere summer.

Figura 1. Detalle de la ubicación geográfica y localización de cada uno de los lotes de solanáceas cultivadas, y de la vegetación alrededor (malezas y cultivos) y la dirección de los vientos prevalentes en Santiago durante el verano del Hemisferio Sur.

cv. Resistant seeds were germinated in trays, and seedlings were transplanted to the field by hand on 1.0 m preformed beds in mid December. Seedlings were spaced at 40 cm and 25 cm for tomato and pepper, respectively. Weeds within the crops were controlled chemically with metribuzine (0.38 kg ha^{-1}) sprayed as an early post-transplanting treatment. Subsequently, all crop lots were hand weeded to eliminate plant competition. No other pesticide was used until the end of the growing season in April 2003.

To establish the relationship between the virus in the *Datura* weed plants around the plots with flight activity of *M. persicae*, 10 plants were randomly collected from each of the three crop plots. Plant sampling started on January 10th, 2003, and followed every 15 d, producing a total of seven sampling dates. In addition, on each of these sampling dates, another 10 *Datura* plants were randomly collected from the borders of the plots. *Datura* plants were not separated; neither with or without symptoms nor by species. The collected crop and weed plants were then divided into two samples of five plants each to facilitate ELISA. These samples were marked and frozen at –80ºC until the ELISA tests were performed for the three green pepper viruses under study.

Aphid flight activity was evaluated using Moericke traps (Van Endem, 1972), which were revised twice a week from crop planting in mid December 2002 up to the end of April 2003.

RESULTS AND DISCUSSION

Presence of viruses in *D. stramonium* and *D. ferox*

Results of the RNA and ELISA tests for *D. stramonium* and *D. ferox* revealed differences in the extent of infections with CMV, AMV, and PVY (Table 1). High incidences of the three viruses were detected in *Datura*. CMV was the most prevalent virus with an incidence of 35.7%. All CMV infected *D. stramonium* and *D. ferox* plants showed some symptoms such as mosaics, interveinal chlorosis, mottling, and, in many instances, markedly stunted growth (Figure 2). Plants exhibiting viral symptoms, carrying either AMV or PVY, showed only varying degrees of mosaics, although in many cases, infected weeds did not show any symptoms. *D. stramonium* and *D. ferox* were asymptomatic carriers of AMV and in a lesser proportion of PVY. Most plants showing signs of viral attack were positive in ELISA tests for at least one of the three viruses analyzed.

The presence of CMV and AMV in collected plants clustered by *Datura* species exhibited similar levels of CMV and AMV. PVY was less prevalent in *D. stramonium*. CMV was the most common of the three viruses in *D. stramonium,* while PVY was found more frequently in *D. ferox.* As is shown in Table 1, 30% of the *D. stramonium* plants collected carried CMV, while just 5% harbored PVY. On the other hand, 25% of the plants were infected with AMV. In a preliminary study conducted 400 km north of Santiago, half of the *D. stramonium* plants

Table 1. Number of plant samples with and without virus positive symptoms (PN) for CMV, AMV, and PVY and percent of disease incidence (DI) on *Datura stramonium* and *D. ferox*.

Cuadro 1. Número de muestras de plantas con y sin síntomas de virosis (PN) de CMV, AMV y PVY y porcentaje de incidencia (DI) sobre *Datura stramonium* y *D. ferox*.

Datura plants collected	CMV [1]		AMV [2]		PVY [3]		Total samples
	PN	DI	PN	DI	PN	DI	
With symptoms	15	35.7	13	31.0	10	23.8	42
Asymptomatic	0	0.0	4	25.0	1	6.3	16
D. ferox	8	22.2	10	27.8	10	32.3	36
D. stramonium	7	30.0	7	25.0	1	5.0	22
Total	15	25.9	17	29.3	11	19.0	58

Virus positive samples according to ELISA tests for each virus

[1] CMV: *Cucumber mosaic virus*; [2] AMV: *Alfalfa mosaic virus*; [3] PVY: *Potato virus Y.*

Disease incidence (DI) is the number of at least one positive test reaction as percent of the total number of samples analyzed.

Figure 2. Left: *Datura stramonium* plants showing symptoms of *Cucumber Mosaic Virus*; Right: a healthy plant.
Figura 2. Izquierda: Planta de *Datura stramonium* con síntomas de *Cucumber Mosaic Virus*; Derecha: una planta sana.

collected were positive for either CMV or PVY, but ELISA tests for AMV were all negative (Ormeño and Sepulveda, 2005).

Our findings for CMV in *D. stramonium* agree with previous reports (Bala *et al.*, 1980; Dikova, 1989; Zitter, 2001) on jimsonweed. As for PVY, the results coincide with Büchen-Osmond (1995), who stated that both *D. stramonium* and *D. ferox* are host plants.

Detection of AMV in *D. stramonium* corroborates the findings of Reyes (1996), who obtained similar ELISA results in symptom-showing jimsonweed plants in the Metropolitan Region of Chile. Our results also coincide with Zitter (2001) and Apablaza *et al*. (2003), who stated that *D. stramonium* acts as a reservoir for AMV.

Transmission of the viruses by *Myzus persicae*

CMV-infected tomato and pepper plants began to develop symptoms 30 days after inoculation. Tomato leaves became elongated, narrowed, chlorotic and the growth rate decreased. In peppers, however, only interveinal necrosis developed. No symptoms were evident in the other plants or in the controls. *M. persicae* transmitted CMV from *D. ferox* to tomato and pepper plants, but failed to pass the virus on to potato plants since these are not affected by CMV (Perry, 2003). Three out of five pepper plants and two out of five tomato plants had ELISA positive reactions for aphid-transmitted CMV, which clearly stunted tomato and sweet pepper plants, and even the 20% of cases that resulted in plant death would cause a significant decline in commercial crop yields. Our results indicating that *M. persicae* is a vector of CMV, corroborate the fact that this *Cucumovirus* is transmitted by aphids with extraordinary efficiency (Banik and Zitter, 1990; Perry, 2003).

M. persicae aphids did not transmit either AMV or PVY from infected thornapple plants. Our AMV transmission results differed from those of Gooding et al., 1979 and De la Torre *et al.* (2003), who stated *M. persicae* to be one of the main vectors of this virus. These authors, however, studied the transfer of AMV from tobacco (*Nicotiana tabacum* L.*)* and husk tomato (*Physalis ixocarpa* Brot. ex Hornem.) infested crop plants, respectively.

In previous studies, Avilla *et al.* (1997) found 51.3% PVY transmission with *M. persicae* among pepper plants. Gibson *et al.* (1983, 1988) encountered similar transmission rates from potato plants to commercial tobacco plants pointing out their different vectoring abilities. These transmission results, however, were obtained by using cultivated plants as the source of inoculum for the aphids; none of them used wild plants or weeds. In this regard, transmission abilities of aphids differ according to the nature of the source plant as well as the target host (Harris *et al.*, 2001).

It has long been accepted that a nonpersistent *Potyvirus* such as PVY has low specificity for vector species, but there have been indications that specificity for aphid transmission depends on the host (and target) from which the virus is acquired (Raccah *et al*., 2001). Attraction or repellence between aphid and host may affect transmissibility of the virus due to specific reactions between the virus source plant and the aphids. The role of a helper component (HC) in vector-specific transmission (Sako and Ogata, 1981; Wang *et al.*, 1998), as well as the role of the HC-virion complex from aphid stylets has been suggested (Wang *et al.*, 1996) to explain this different viral transmission and infection. Inability of the aphid to transmit AMV and PVY may be due to specific botanical characteristics of *D. ferox,* that may have interfered with aphid acquisition and/or final transmission of the virus to crop plants.

Virus transmission through *Datura* seeds

ELISA results for viruses in the mother plant indicated that none of the three viruses was transmitted through the seeds of either *D. stramonium* or *D. ferox*.

Seed transmission of CMV has been described for Solanaceous crops such as pepper, tomato as well as for weed species such as *Cerastium*, *Spergula*, *Stellaria* and *Echinocystis* (Neegaard, 1977). Published information on CMV or PVY transmission from seeds in *Datura* species or other nightshade weed species is scarce or nonexistent. Seed transmission of AMV, however, has been previously reported on *D. stramonium*, as well as other nightshade weeds such as black nightshade (*Solanum nigrum* L.), and apple-of-Peru (*Nicandra physalodes* (L.) Gaertn.) (Pesic and Tosic, 1975; Ciampor and Gallo, 1977).

Transmission of virus in the field

Within the crop plots, CMV was found in just one tomato sample collected on February 9, 2003. CMV infection was found in *Datura* weeds bordering the plots from the onset up until last sampling date. Neither AMV nor PVY were detected on bordering weeds or in crop plants.

Greater *M. persicae* flight activity occurred in the pepper plots than in either the potato or tomato sections (Figure 3). The fact that the pepper plot was located facing the actual direction of prevailing summer breezes may explain the higher aphid flight activity among pepper plants than either the tomatoes or potatoes. Unfortunately for these field experiments, *Datura* plants were mainly concentrated at the corner of the lot downwind from the crop plants in exactly the most unfavorable position to benefit from wind assistance (Figure 1).

Flight activity was greatest from mid February through mid March, and this seems to coincide with onset of lower maximum temperatures in late summer, as the aphid adapts better to mild weather (Figure 3).

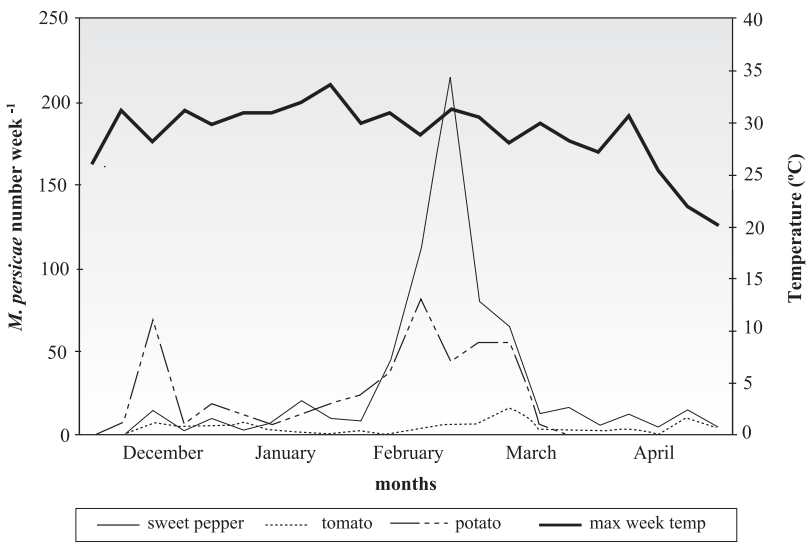

Figure 3. Summer flight activity of *Myzus persicae* in the sweet pepper, tomato and potato plots.
Figura 3. Curvas de vuelo estival de *Myzus persicae* en los lotes plantados con pimiento, tomate y papa.

In spite of the ten-fold increase in flight activity within the pepper plot, only one plant tested positive for CMV using ELISA. Hence, no correlation was found between the presence of the virus in the *Datura* plants in the vicinity of crop plots with flight activity of *M. persicae*, or the presence of viruses in the crops. From an epidemiological viewpoint, this is interesting since neither the presence of the vector nor the presence of alternative host weeds were enough to ensure transmission of CMV to crop plants. Prevailing wind direction (South West) and its relation to the geographical location of virus infected *Datura* weed plants (north east corner in Figure 1) may have played a significant role on the efficiency of transmission of these gliding vectors in the field, as other epidemiological virus studies have suggested (Wilson, 1998).

CONCLUSIONS

Both *Datura* species collected in the field hosted CMV, AMV, and PVY, with incidence of 30.0, 25.0, and 5.0% for *D. stramonium*, and 22.2, 27.8, and 32.3%, for *D. ferox*, respectively. Unlike AMV and PVY, CMV was transmissible from *D. ferox* to tomato and pepper plants through the aphid *M. persicae*.

Under greenhouse conditions, no transmission of CMV, AMV or PVY through the seeds of either *D. stramonium* or *D. ferox* was found.

No correlation between the presence of virus in the *Datura* plants present on the vicinity of crop plots, flight activity of *M. persicae* and the presence of viruses in the crops was found. Wind direction and its relation to the location of virus infected *Datura* weed plants are epidemiological factors that could well affect the transmission efficiency of these flying vectors.

Consistently high levels of infection from CMV, AMV and PVY were found in many field samples of *Datura* weeds. Vectors are, therefore, assured significant reservoirs of inoculum, and may spread diseases to *Solanaceous* crops, which could result in severe economic losses. As aphid transmission of CMV was extremely efficient, resulting lethal in 20% of tested plants, unless environmental conditions and vector activity are not conducive to disease spread, a significant decline of commercial yields of tomatoes and sweet peppers could be expected.

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