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Aphid Transmission of Two Important Potato Viruses, PVY and PLRV by *Myzus persicae* (Sulz.) and *Aphis gossypii* (Glov.) in Hatay Province of Turkey

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Abstract: Transmission assays by using aphid vectors were established to determine the effects of two aphid species (*Myzus persicae* Sulz. and *Aphis gossypii* Glov. on four solanaceae test plant species (*Capsicum annum* L., *Lycopersicon esculentum* L., *Physalis floridana* Rydb. and *Solanum tuberosum* L.). Transmission rates of PVY and PLRV from potato to other test plants were investigated by DAS-ELISA assays. All experiments were carried out at 26:22±2°C (day:night) under a 16:8 h (light:dark) photoperiod conditions. Late 4th instar or early adult *M. persicae* and *A. gossypii* apterae were used in the transmission experiments. The aphids were not subjected to preacquisition starving in the assays. Each aphid species were reared on PVY-infected source potato plants for 5 h as Acquisition Access Period (AAP). Then, aphid group including 10 individuals were taken from donor plants were transplanted on to healthy receptor test plants for 15 h as Inoculation Period (IP). For PLRV transmissions, two aphid species reared on source potato plants for 24 h as AAP were transferred on to each healthy test plants as a group including 10 individuals for 24 h as IP. After IP, the aphids were removed from plants mechanically. PVY and PLRV were transmitted in higher rates by *M. persicae*. PVY and PLRV were more efficiently transmitted from potato to pepper seedlings among the other inoculated solanaceous test plants by both aphid species. The lowest transmission was occurred in tomato (2/15) and *P. floridana* (3/15) by using *A. gossypii*. Seed transmission of viruses were not determined by DAS-ELISA in seedlings re-obtained from experimentally infected test plants.

Key words: Potato, potato viruses, aphid vectors, *Myzus persicae*, *Aphis gossypii*

INTRODUCTION

Potato (*Solanum tuberosum* L.) has been naturally infected by over 30 viruses and virus strains. Many of these viruses are dependent on potato for their survival and spread^[1]. The most important and worldwide virus diseases of potato are caused by potato leafroll poleovirus (PLRV, Genus *Poleovirus*, Family *Luteoviridae*) and potato Y potyvirus (PVY, Genus *Potyvirus*, Family *Potyviridae*), transmitted in a persistent and a non-persistent manner by aphids, respectively. Cucumber mosaic cucumovirus (CMV, Genus *Cucumovirus*, Family *Bromoviridae*) and alfalfa mosaic alfamovirus (AMV, Genus *Alfamovirus*, Family *Bromoviridae*) are the other aphid-transmitted viruses infecting potato in North America^[2,3].

All potato viruses contain single stranded RNA and infection of new hosts depends upon assisted transmission. Aphids are the most important vectors of potato viruses. Thirteen potato viruses are transmitted by aphids and especially by *M. persicae*^[2,4]. Aphids cause direct and indirect damage such as transmission of

viruses to many crops, of which potato is one of the most important^[5,6]. Since diseases caused by these viruses can be spread season by season and from infected plants to healthy plants, control of aphid-borne potato viruses like PVY is difficult^[7]. Mix infection of Potato virus X (PVX, Genus *Potexvirus*, Family *Flexiviridae*), which is a non-vector virus, and PVY in potato depreciate the yield and quality^[8]. Although, PVY infect mainly solanaceous plants, it is spread among a wide range of plants by 73 aphid species. PVY transmission involves interactions between virus particles, virus-encoded non-structural Helper Component (HC) protein and vector aphid stylets^[9-11].

Virus diseases caused by PLRV and PVY constitute a major constraint to potato production in Turkey^[12,13]. Potato is extensively cultivated as early crop in the Eastern Mediterranean Region of Turkey. The plants cultivated by using seed tubers that are usually brought from other provinces. According to results of ELISA tests, PLRV infection rates of 1-17% reported in potatoes growing in the region^[12]. There is no study on the other potato virus diseases in the region.

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This presented study was carried out on the transmission of PVY and PLRV from infected potato plants to healthy test plants belong to Family Solanaceae to determine the vector efficiency by using two important aphid species, *M. persicae* and *A. gossypii*. The effect of the some solanaceous plants as host of PVY and PLRV were also investigated in the transmission experiments.

MATERIALS AND METHODS

Plant and insect materials: Pepper (*Capsicum annum* L. cv. Demre) and melon (*Cucumis melo* cv. Galia) were used as host plants in aphid culture assays. Pepper, Downy ground-cherry (*P. floridana*), potato (*Solanum tuberosum* L. cv. BSS-340) and tomato (*Lycopersicon esculentum* cv. H-2274) seedlings were used as receptor test plants in transmission experiments^[14,15]. Healthy potato plants were obtained by germinating of True Potato Seeds (TPS). All the plants used in the experiments were cultivated in peat:tuff mixture (1:1) in a controlled climated room at 16:8 (light:dark) photoperiod, at a temperature of 26°C day and 22°C night. Test plants at the 2-3 leaves growth stage were used in the inoculation trials by aphids.

Myzus persicae and *Aphis gossypii* derived from a single virginoparous apterae. *A. gossypii* was reared on melon plants, whereas *M. persicae* was reared on pepper plants. Both clones were reared at 16:22°C (night:day), under a 16:8 (light:dark) photoperiod. Late 4th instar or early adult *M. persicae* apterae were used in the transmission experiments.

Virus sources and transmission experiments: The plants infected with PVY and PLRV were obtained by planting of infected seed tubers of Agria, Marabel and Marfona cultivars in the plastic pots under the same conditions in a growth room. Seed tubers were supplied from Potato Research Institute, Nigde-Turkey. Except PVY and PLRV, all potato plants were also tested by DAS-ELISA for presence of AMV, CMV and PVX^[16]. The plants developing the severe characteristic symptoms and also had the highest A₄₀₅ nm absorbance values by ELISA were selected among the potatoes were found to be infected with the viruses.

After DAS-ELISA tests, two potato plants cv. Marfona for each virus (PVY and PLRV) and aphid species (*M. persicae* and *A. gossypii*) were accepted as virus source plants for acquisition of the viruses in the transmission experiments.

Approximately, 1500 young adult aphids were put on the PVY source plants for 5 h as Acquisition Access Period (AAP). Then, the each aphid group of 10 individuals were taken from donor plants were transferred on to healthy receptor test plants for 15 h as Inoculation

Period (IP). For PLRV transmissions, two aphid species including 1500 young adults reared on source potato plants for 24 h as AAP were transferred on to each healthy test plants as a group of 10 individuals for 24 h as IP. After IP, the aphids were removed from plants mechanically.

All plants used in transmission experiments were kept under the controlled conditions in an insect-proof room and checked for presence of PVY and PLRV by DAS-ELISA. In ELISA tests, the leaf samples with the absorbance (A₄₀₅) values twice higher than negative control were accepted as infected with the viruses. Healthy plants coming from seeds were used as negative controls in the assays. ELISA reagents were supplied from Bioreba.

RESULTS AND DISCUSSION

During the growing of the healthy test plants, except *P. floridana*, all plants emerged from seed homogeneously. *P. floridana* seeds were germinated in a high rate (95%), but seedlings were not exhibited a uniform growing. After transplanting of each seedling into plastic pot, 15 seedlings at similar growth stage of each test plant were selected to be used in the transmission assays.

Thirteen seed tubers from each cultivar Agria, Marabel and Marfona were germinated in peat:tuff of mixture (1:1) in plastic pots. Then, all plants were tested by DAS-ELISA for presence of AMV, CMV, PLRV, PVX and PVY. No AMV, CMV and PVX- infected samples were tested among the plants obtained from seed tubers. Potato plants coming from seed tubers of cv. Marfona were used as source of PVY and PLRV isolates due to higher infection rates of the viruses were found in that cultivar than the others (Table 1).

Four out of 11 plants infected with only PLRV and 4 out of 13 plants infected with only PVY were selected as virus source plants in transmission experiments by using two aphid species since they had given overall 3-fold higher mean A₄₀₅ absorbance values ranged between 3.634 to 3.828 than the values of healthy controls (0.118 to 0.176). Two plants infected with each virus were accepted as a group for feeding of each vector species during the virus acquisition. The selected plants exhibited severe symptoms such as shorter internodes, malformation of the leaves with chlorosis, vein necrosis in PVY infection, stunting plant with upward curled leaves in PLRV infection.

Results of the comparative studies on the vector transmission and host range of potato isolates of PVY and PLRV were presented in Table 2 and 3, respectively.

Table 1: Infection rates of AMV, CMV, PLRV, PVX and PVY in potato plants germinated from seed tubers of Agria, Marabel and Marfona cultivars under controlled conditions

| Potato cultivars | No. of infected samples/ tested plants | | | | | | | Total |
|------------------|--|------|-------|------|-------|----------|---------|-------|
| | AMV | CMV | PLRV | PVX | PVY | PLRV+PVY | PVY+PVX | |
| Agria | 0/30 | 0/30 | 3 /30 | 0/30 | 7/30 | 2/30 | 0/30 | 12/30 |
| Marabel | 0/30 | 0/30 | 5/30 | 0/30 | 9/30 | 4/30 | 0/30 | 18/30 |
| Marfona | 0/30 | 0/30 | 11/30 | 0/30 | 13/30 | 3/30 | 0/30 | 27/30 |
| Total | 0/90 | 0/90 | 19/90 | 0/90 | 29/90 | 9/90 | 0/90 | 57/90 |

Table 2: Transmission rates of PVY from potato to some solanaceous test plants by two aphid species, *Myzus persicae* and *Aphis gossypii*

| Source plant | Test plants | No. of plants infected/total No. of plants tested | |
|--------------|--|---|-----------------------|
| | | <i>Myzus persicae</i> | <i>Aphis gossypii</i> |
| Potato | Potato (<i>Solanum tuberosum</i> L. cv. BSS-340) | 10/15 | 7/15 |
| | Pepper (<i>Capsicum annuum</i> L. cv. Demre) | 12/15 | 8/15 |
| | Tomato (<i>Lycopersicon esculentum</i> cv. H-2274) | 9/15 | 4/15 |
| | Downy ground-cherry (<i>Physalis floridana</i> Rydb.) | 11/15 | 5/15 |

Table 3: Transmission rates of PLRV from potato to some solanaceous test plants by two aphid species, *Myzus persicae* and *Aphis gossypii*

| Source plant | Test plants | No. of plants infected/total No. of plants tested | |
|--------------|--|---|-----------------------|
| | | <i>Myzus persicae</i> | <i>Aphis gossypii</i> |
| Potato | Potato (<i>Solanum tuberosum</i> L. cv. BSS-340) | 8/15 | 4/15 |
| | Pepper (<i>Capsicum annuum</i> L. cv. Demre) | 9/15 | 4/15 |
| | Tomato (<i>Lycopersicon esculentum</i> cv. H-2274) | 5 /15 | 2/15 |
| | Downy ground-cherry (<i>Physalis floridana</i> Rydb.) | 9/15 | 3/15 |

PVY and PLRV were transmitted in higher rates by *M. persicae* which is the most important vector of both PVY^[2,4,17] and PLRV^[18-22]. Although, higher transmission rates of the viruses by using *M. persicae* were reported in some studies objected for different aspects^[23,24], this might have been due to different acquisition and inoculation times and feeding of the aphids prior to experiments. The aphids used in the present experiments were not subjected to preacquisition starving in our assays. It was reported that pepper PVY isolates were more efficiently transmitted from pepper to potato and to pepper by pepper aphids than potato isolates and some potato isolates were also found to infect pepper when inoculated with *M. persicae*, although, in a lower and more unstable way than the pepper isolates^[24,25]. In the present study, pepper plants could be infected more easily by both aphids than the other solanaceous test plants including potato seedlings cv. BSS-340 germinated from TPS. Both viruses were more efficiently transmitted from potato to pepper seedlings among the inoculated test plants by both aphid species. The lowest transmission was occurred on tomato (2/15) and *P. floridana* (3/15) by using *A. gossypii* that colonize potato and tomato and is a potential vector of PLRV^[26,27]. *A. gossypii* was found to be less efficient vector than *M. persicae* for transmission of both viruses from potato to other test plants including potato.

Inoculated plants developed the symptoms 3 to 4 weeks after inoculation. During the symptomatological assays, mosaic and vein banding on pepper, mild leaf mottling on potato, stunting, mottling, roughness and crinkling of the new leaves on tomato, stunting, small

leaves with purple border, systemic chlorosis on *P. floridana* plants were also observed at the laboratory conditions. Severe symptoms of PVY were also observed on pepper, potato, *P. floridana* and tomato test plants. *P. floridana* is the best indicator plant for PLRV^[28] and is used as a test plant for PLRV transmission by *M. persicae*^[14]. *P. floridana* was also reported to be one of the best host to differentiate among necrotic strain of PVY^[29].

No characteristic symptoms severely occurred on pepper and tomato plants infected with PLRV. *P. floridana* plants developed stunted growth, interveinal yellowing with purplish leaf edges or severe systemic chlorosis in PLRV infection.

Virus transmission did not occurred through pepper and tomato seedlings germinated from seeds obtained from fruits of infected test plants by transmission assays. Potato and *P. floridana* plants could not be investigated due to the fact that, even though these plants flowered, they did not form seeds. Although, DAS-ELISA can readily be applied to investigate both insect vector and host plant of potato viruses^[27], further studies by using more sensitive techniques are needed to estimate the real potential of the transmission efficiency of the vector aphid species for different virus strains and potato varieties.

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