# PVY transmission by aphids: implications of the host plant and the virus isolate

Ahmad Al-Mrabeh[1,2] , Brian Fenton[1] , Graham Cowan[1] , and Lesley Torrance[1]

[1]Scottish Crop Research Institute (SCRI), Invergowrie, Dundee, Scotland UK, DD2 5AD
[2]Institute for Research on Environment and Sustainability (IRES), School of Biology, University of Newcastle, Newcastle upon Tyne, UK, NE1 7RU.

## INTRODUCTION

Potato virus Y (PVY) is currently the most important virus affecting potato production worldwide and recently new, more aggressive recombinant isolates have become prevalent in potato growing areas. Indicator plants are used routinely for virus propagation and virus transmission studies by plant virologists, these model plants are usually not the natural virus host. However, the virus disease is usually more easily studied using indicator plants that can be grown readily in glasshouse.

Changes to virus populations in the field occur in response to host genotype, vector pressure and environment. Whereas in laboratory isolates the selection pressures are different and it is known that a virus isolate may lose the capacity to be vector transmitted after successive manual passage on host plants (Atreya et al., 1991)

Selective mutation and adaptation of RNA viruses by continuous passage through their host plants has been reported (Yarwood, 1979; Garcia-Arenal et al., 2001). For example, PVY isolates from potato were shown to be able to infect tobacco but not peppers, and the pepper strains were unable to infect potato (Gebre Selassie et al., 1985). Similarly Marte et al. (1991) found that PVY isolates in central Italy are better adapted to tobacco, whereas isolates from southern regions infected pepper more readily than tobacco.

Aphids are well known to show some level of preference towards some plants compared to others. Potato plants for example, are more favoured by M. persicae compared to tobacco plants. On the other hand, tobacco is extensively used in laboratory for different kind of virus studies including aphid transmission, the effect of the host is often mitigated by using large numbers of individual aphids per plant for aphid transmission studies.

### Research aims

1- Investigate whether acquisition or transmission of field and laboratory isolates of PVY differ.
2- Study the effect of plant host species on aphid transmission efficiency of both virus isolates.

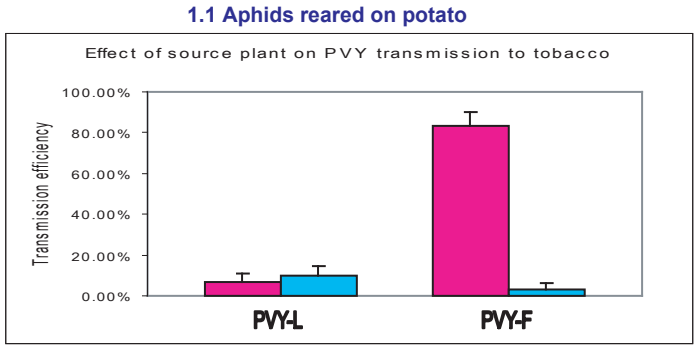
## CONCLUSIONS AND FUTURE WORK

- PVY-F was more readily aphid transmissible from potato when aphid was maintained on potato although the virus reached similar concentration in both hosts. No such effect was observed with the poorly transmissible PVY-L.
- The host plant used for maintaining aphids influenced their capacity for virus acquisition, aphids maintained on potato acquired PVY-F isolate more readily from potato compared to tobacco. In contrast, there was no difference in acquisition of PVY-F or PVY-L by aphids maintained on tobacco or oilseed rape, both viruses were acquired with equal efficiency from tobacco.
- There was an influence of recipient host plant on virus transmission; more tobacco plants became infected than potato with both virus isolates.
- Sequences of PVY-F and PVY-L coat protein and helper component genes implicated in aphid transmission, revealed that no major differences on virus transmission. But, there were some substitutions in some amino acid sequences after the DAG motif in the PVY-L isolate which may suggest an effect on virus adaptation. Further investigations are required to reveal that and to investigate any mutations in the PVY-L genome responsible for such adaptation to tobacco.
- Future work is required to determine whether the host differences are found in other field isolates of PVY or with other aphid species.
- More work is needed to investigate if the host effect on aphid vectoring ability is related to feeding preference only or whether the molecular process of HC-Pro binding to aphid receptors is affected.

## RESULTS AND DISCUSSION

### 1- Aphid transmission efficiency to tobacco is influenced by virus source and host used to maintain aphid culture

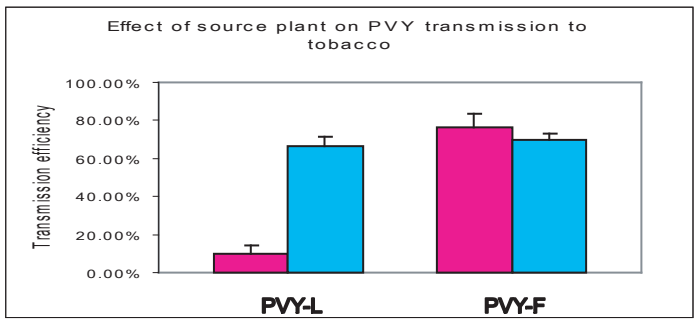
#### 1.1 Aphids reared on potato




PVY-F was efficiently transmitted by aphids when potato ( ) was used as a source of virus. However, transmission efficiency was low when PVY-F was acquired from tobacco source ( ) .

PVY-L was poorly transmissible by aphids whether virus was acquired from the potato or tobacco source.

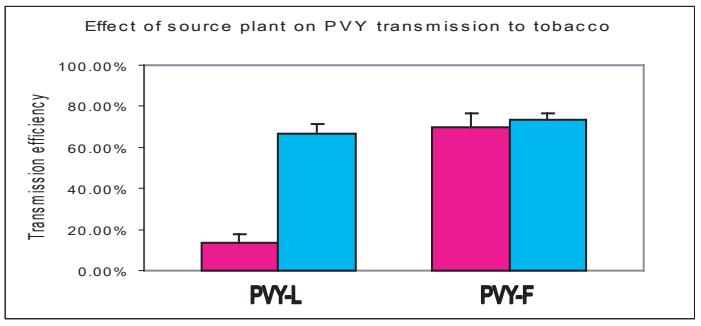
#### 1.2 Aphids reared on tobacco




PVY-F was readily transmitted by aphids when potato ( ) or tobacco ( ) were used as a source of virus.

PVY-L was efficiently transmitted when tobacco was used as a virus source. However, aphid transmissibility was poor from tobacco.

#### 1.3 Aphids reared on oilseed rape

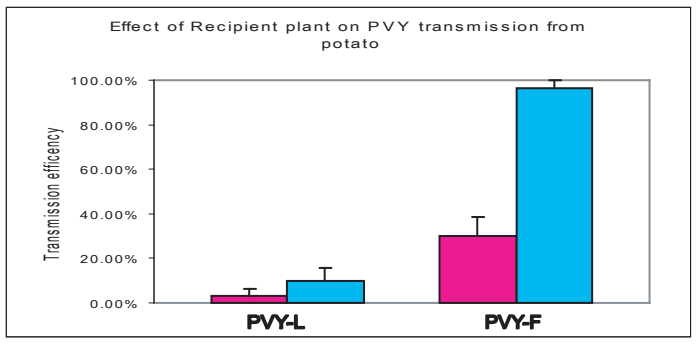



Similar results to those found on tobacco were obtained when a non-virus host plant (oilseed rape) was used to maintain the aphid culture.

Potato virus source  tobacco virus source

### 2-Transmission efficiency is affected by recipient plant

#### 2.1 Aphids reared on potato and virus acquired from potato



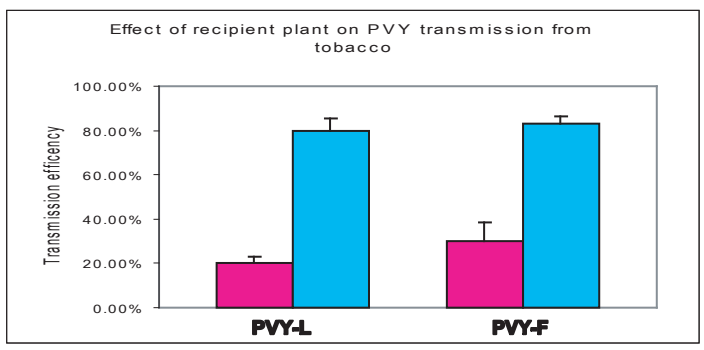

Potato recipient plant  Tobacco recipient plant

Experiments were repeated three times, for each sub-experiment 40 tobacco plants were used (20 for each test plant)

2.1 Aphids maintained on potato transmitted PVY-F to more tobacco plants than potato. In this experiment, PVY-L was not readily transmitted.

2.2 Aphids maintained on tobacco transmitted PVY-F to more tobacco plants than potato.

#### 2.2 Aphids reared on tobacco and virus acquired from tobacco




### 3- Do the isolates differ in concentration and in sequences?

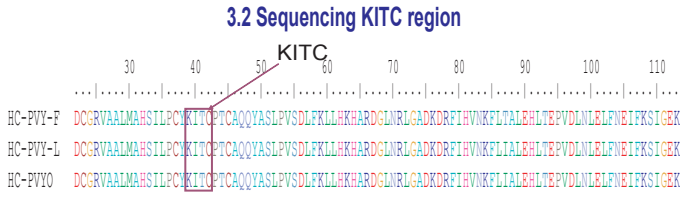
#### 3.1 Virus concentration

| Test plant | isolate | Exp.1 | Exp.2 |
|---|---|---|---|
| tobacco | PVY L | 0.888(0.140) | 1.067(0.049) |
| | PVY F | 1.107(0.117) | 1.142 (0.08) |
| potato | PVY L | **0.338(0.194)** | **0.35(0.168)** |
| | PVY F | 1.254(0.344) | 1.231(0.261) |

No difference was observed in ELISA absorbance values obtained in tests on tobacco plants infected with either isolate. However, on potato, the PVY-F isolate gave values 3-4 times greater than PVY-L.

The difference in virus concentration between PVY-F and PVY-L isolates in potato may explain the low level of transmissibility from potato of the PVY-L isolate.

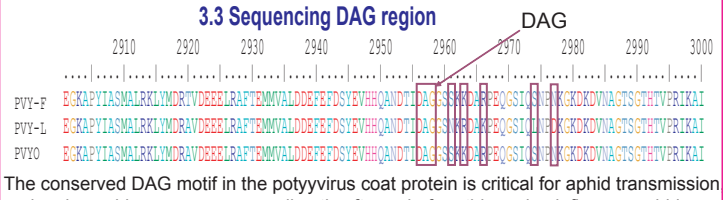
#### 3.2 Sequencing KITC region




The KITC motif links HC-Pro to the putative receptors on aphid stylet. All mutations or alterations of this region resulted in inhibition or greatly limiting transmission of mutated clones (Atreya et al., 1991; Blanc et al., 1998).

The KITC is retained in both isolate, and the sequence after this region is identical between both isolates and with the published sequence of PVYO HC-Pro

#### 3.3 Sequencing DAG region




The conserved DAG motif in the potyvirus coat protein is critical for aphid transmission and amino acid sequences occur directly after or before this region influence aphid transmission efficiency (Atreya et al;1991; Lopez-Moya et al.,1999). No such difference happens within,directly after, or before this region in any of the sequenced isolates. However, there are some substitutions in the amino acids S, K, R, S, and N to N, R, K, L, and D respectively in the coat protein of the PVY-L isolate which may suggest an effect on host adaptation.

## MATERIALS AND METHODS

**PVY Isolates:** Two isolates of PVYO (ordinary strain) were investigated; the stock SCRI laboratory isolate (PVY-L) and a field isolate (PVY-F) that was obtained from naturally infected potato cv Rosetta by Adrian Fox, Scottish Agricultural Science Agency (SASA) Edinburgh. PVY-F was maintained in potato plants grown from infected tubers and PVY-L isolate was maintained on tobacco and propagated by mechanical inoculation. Both isolates were mechanically inoculated into potato and tobacco plants to be used as a virus source.

**Plants**: Small plants of N. tabacum cv White Burley at the two-three leaf stage were used for aphid transmission studies. Infection by PVY induces symptoms of mild to severe mosaic after 1-2 weeks of infection potato plants cv Shula were produced by removing eye plugs from infected tubers after dormancy break and transplanted into 5-7 inch pots. Small plants at the three-four leaf stage were used for transmission studies

**Aphid transmissions:** Young wingless aphids (3-4 instars) of *M. persicae* (genotype E) were fasted for 2-3 hours at room temperature. Fasted aphids were allowed to acquire virus from detached leaves of potato or tobacco for 5 min acquisition access period (AAP) in groups of 5 individuals. Aphids were then removed and placed directly on test plants, Only aphids that were observed to probe the source plants were used for transmission experiments and the rest were excluded. After overnight transmission access period (TAA), the plants were transferred to fume chamber and aphids were killed with Plenum and fumigated with smoke from nicotine shreds. The plants were then left for 3 weeks in a glasshouse and tested for PVY by ELISA using anti-PVY-SCRI polyclonal antibody for coating and monoclonal antibody SCR39 for detecting.

### References

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