ECO FRIENDLY INSECT VECTOR MANAGEMENT

Ratnakar Vodnala

Scientist, Krishi Vigyan Kendra, Kothgudem, Bhadradri Kothagudem, Professor Jayashankar Telangana State Agricultural University, Telangana, India

ABSTRACT

Vector transmission is a specific event in the virus life cycle. Virus encoded determinants specifically interact with the vector (receptors), thereby facilitating virus transmission and various plant viruses utilize different, but specific vectors to facilitate their spread. For example, diverse organisms (fungi, nematodes and arthropods) are recognized as vectors for various plant viruses. About 94% of the animals known to transmit plant viruses are arthropods, and 6% are nematodes. Ninety nine per cent (99%) of the arthropod vectors are insects and 55% of these are aphids. Virus diseases cause serious losses in yield and quality of cultivated plants worldwide. These losses and the resulting financial damage can be limited by controlling epidemics using measures that minimize virus infection sources or suppress virus spread by an integrated approach. This chapter covers all measure for mitigation of insect vector control in detail.

Keywords: *vector, plant virus, cultural control*

1.INTRODUCTION

Virus diseases cause serious losses in yield and quality of cultivated plants worldwide. These losses and the resulting financial damage can be limited by controlling epidemics using measures that minimise virus infection sources or suppress virus spread. For each combination of virus, cultivated plant and production system, there is an 'economic threshold' above which the financial damage is sufficient to justify using such measures. However, individual measures used alone may bring only small benefits and they may become ineffective, especially over the long term. When diverse control measures that act in different ways are combined and used together, their effects are complementary resulting in far more effective overall control. Such experiences have led to the development of integrated management concepts for virus diseases that combine available host resistance, cultural, physical and chemical control measures.

2. CULTURAL PRACTICES

The biological factors that account for virus spread are as intricate as one might imagine considering that three factors (host, vector, and virus) are closely involved. Plant viruses, more so than any other group of pathogens, depend almost totally on insect vectors for their dissemination, which allows for some interesting phenomena. This almost total dependence is further complicated by the close association between host and pathogen that in some instances has made prevention and control by traditional methods more difficult to accomplish.

2.1 Following Isolation distances

Movement of vector from one place to another place, it results in spread of the disease. The isolation of crops from surrounding crops which may harbour both aphids and virus diseases can be an effective control measure.

Examples :

- *Cauliflower mosaic virus* (CaMV) can be reduced by if cauliflower seedlings raised half a mile from infected area.
- A distance of 15-20 miles between beet crops was necessary to prevent the spread of *Beet yellow virus* (BYV) and a distance of 12-15 miles in the case of beet mosaic.
- 3 mile isolation between carrot root and seed crop fields together with the eradication of volunteer carrots virtually eliminated *Carrot thin leaf virus* (CTLV) and reduced the incidence of carrot motley dwarf virus.
- *Lettuce mosaic virus* (LMV) can be reduced by growing the crop in an area where the climatic factors eliminate aphids during critical period. Wind velocity and rainfall plays an important role in eliminating vector population.

2.2 Removal of source of infection

To eliminate the sources of inoculum near the crop, it may be worthwhile to remove infected plants (rogue) from a crop. If the spread is occurring rapidly from sources outside the crop, rouging the crop will have no beneficial effect. In certain situations, rouging may increase disease incidence by disturbing vectors on infected plants. In many crops, newly infected plants may be acting as sources of virus for further vector infection before they show visible signs of disease.

Examples:

- One of the most successful examples of disease control by rouging of infected crop plants has been the reduction in incidence of *Banana bunchy top virus* (BBTV) in bananas in eastern Australia.
- BNV can be reduced by removing disease influenced by removing disease infected plants in the early stages and also the removal of the parthenium which acts as reservoir host for virus and vector, it greatly reduces the incidence.
- *Groundnut rosette virus* (GRV) can be reduced by removing the infected plants.

2.3 Use of barrier crops and Non host crops

Since the movement of vector from one crop to another, growing of tall growing crops acts as barrier prevents the infection to the main crop. The use of non-host crops in interplantings and barrier situations can significantly reduce the rate of virus spread in the field.

Examples:

- Oats and Wheat crops growing under barley crop, similarly Sunflower grown under Maize crop it results in reduced incidence of *Wheat yellow virus* (WYV) and *Sunflower mosaic virus* (SMV) even if diseased plants are 5 yards away from the healthy plants.
- A buffer crop such as corn, when grown between the source of peanut mottle and a susceptible soybean crop, would reduce the amount of separation required to prevent disease spread.
- The classic example of a cover crop used to protect another crop is the use of a cereal crop to protect beet seed plants from Beet Yellows.

2.4 Removal of Volunteer crops Volunteer crops are important in the perpetuation of virus diseases from one season to the next.

Examples :

- Volunteer onions infected with onion yellow dwarf virus were the main overwintering source of the virus, and if growers rouged the infected plants before the new crop emerged, the incidence of disease was reduced.
- Volunteer carrots were the overwintering source for both *Carrot thin leaf virus* and *Carrot motley dwarf viruses*.
- Infected volunteer beets found in second year beet fields were a readily available source of infection of the new beet crop with both *Beet mosaic virus* (BMV) and *Beet western yellows virus* (BWYV).

2.5 Crop rotation and cultivation

Large continuous plantings of susceptible crops create a favourable environment for the succession of virus from one planting to another. Crop rotation and cultivation are two cultural methods that can serve to minimize the importance of volunteers.

- Delaying the ploughing of onion fields until just before the start of the spring crop was one measure suggested to reduce ***Onion yellow dwarf***.

- Cucumber is usually a poorer host for ***Cucumber mosaic virus*** (CMV) than pepper, and symptoms are too mild for diagnostic purposes.
- The transmission of ***Alfa-alfa mosaic virus*** from solanaceous plants in general was lower than from leguminous plants.
- Planting the beans next to a field of red clover infected with ***Yellow bean mosaic***, which was carried to the beans by migrating *Acyrthosiphon pisum* although the aphids did not colonize the beans.

2.6 Production of virus free seed and vegetative stocks

Where a virus is transmitted through the seed, such transmission may be an important source of infection, since it introduces the virus into the crop at a very early stage, allowing infection to be spread to other plants while they are still young. In addition, seed transmission introduces scattered foci of infection throughout the crop. Where seed infection is the main or only source of virus, and where the crop can be grown in reasonable isolation from outside sources of infection, virus-free seed may provide a very effective means for control of a disease. To obtain effective control by the use of virus-free or low-virus seed, a certification scheme is necessary, with seed plants being grown in appropriate isolation.

- For example, *Lettuce mosaic virus* (LMV) is a good example of controlling a virus problem through clean seed.
- *Tomato mosaic virus* (TMV) which is transmitted through seeds in Tomato can be reduced by fermenting the seeds for 10 days before sowing.

2.7 Propagation and maintenance of virus free stocks

For many vegetatively propagated plants, the main source of virus is chronic infection in the plant itself. With such crops, one of the most successful forms of control has involved the development of virus-free clones, *i.e.*, clones free of the particular virus under consideration.

Two problems are involved. First, a virus-free line of the desired variety with good horticultural characteristics must be found. When the variety is 100 percent infected, attempts must be made to free a plant or part of a plant from the virus. Second, having obtained a virus-free clone, a foundation stock or "mother" line must be maintained virus free, while other material is grown up on a sufficiently large scale under conditions where re-infection with the virus is minimal or does not take place. These stocks are checked that they are "virus free" (virus indexing) and are then used for commercial planting.

As a plant is usually infected with a virus for life, various techniques like thermotherapy (Plant is kept at a temperature usually in the range of 35-40^{o}C for periods of weeks) and chemotherapy (by treating select plants with antiviral compounds such as an analogue of Guanosine (Ribavirin, also called Virazole) are used in combination with in vitro tissue culture to free the plants of virus.

2.8 Modified planting and harvesting procedures

Virus infection can be reduced by modifying agronomic practices such as breaking the infection where one major susceptible annual crop or group of related crops is grown in an area and where these are the main hosts for a virus in that area by ensuring that there is a period when none of the crop is grown.

Examples:

- A good example of this is the control of planting date of the winter wheat crops in Alberta to avoid overlap with the previous spring- or winter-sown crop. This procedure, together with elimination of volunteer wheat and barley plants and grass hosts of *Wheat streak mosaic virus* before the new winter crop emerges, can give good control in most seasons.
- Early planting of groundnut also greatly reduces peanut bud necrosis and groundnut rosette disease.
- Early harvesting of potato reduces potato leaf roll, leaf mosaic and spindle tuber virus.
- Other examples illustrating that sowing dates could determine the amount of disease incidence are found in the cases of *Beet yellows virus* (BYV) of sugar beet and *Barley yellow dwarf virus* (BYDV) of cereals.

2.9 Plant Density

Incoming insects most often land on the edges of fields, and if they are viruliferous, a distinct border or edge effect is created. The amount of disease can be diminished if fewer and larger-sized fields are utilized. Plant density can also influence aphid flight behaviour and colonization.

- About 51 % of sugar beets in a field with 17,500 plants/ha developed *Beet mild yellows virus*, while only 15% infected plants occurred when the field contained 126,500 plants/ha.

3. PHYSICAL METHODS

3.1 Heat therapy

- Most of the viruses inactivated by heat
- It is used in where the crops propagated through vegetatively.
- In Australia large acreage of sugarcane planted with sugarcane setts treated with hot water completely reduced Sugarcane ratoon stunting disease. Here the sugarcane subjected to hot water 50ºc for 20 min.

3.2 Control or avoidance of vectors

Plant viruses are usually transmitted by arthropod vectors, but some are transmitted by fungal vectors, and others, particularly *Tobacco mosaic virus* (TMV) and *Tomato mosaic virus* (ToMV), may be transmitted mechanically. Once TMV or ToMV enters a crop like tobacco or tomato, it is very difficult to prevent its spread during cultivation and particularly during such processes as tying-up of plants. Control measures consist of treatment of implements and washing of the hands. Worker's clothing may become heavily contaminated with TMV and thus spread the virus by contact.

3.3 Air-borne vectors

Before control of virus spread by air-borne vectors can be attempted, it is necessary to identify the vector. Some aphid species are more efficient vectors than others. For instance, the brown citrus aphid (*Toxoptera citricida*) is a much more efficient vector of *Citrus tristeza virus* (CTV) than is the melon aphid (*Aphis gossypii*).

3.4 Isolation by time

- By using crop scheduling to avoid peak insect flights and crop-free periods to break virus disease cycles, growers can usually eliminate or minimize the effects of disease spread.
- The inftuence of planting date and time of hilling on aphid populations and spread of *Potato leaf roll virus* PLRV in potato will be managed efficiently.
- Dent com planted in mid-April to early May was less affected by *Maize dwarf mosaic virus* (MDMV).
- Incidence of thrips will be high during July-Aug months and if the young crop is subjected to thrips incidence , it will be more prone to Peanut bud necrosis virus (PBNV). So early planting of 1 week of june will escape the susceptible stage attacked by the thrips.

3.5 Insect Deterrents

Oils

The application of various chemicals or materials can deter aphids from landing on or feeding on crop plants. Spraying mineral oils on plants affects the feeding behaviour of aphids and leafhoppers and can give some protection against non-persistent viruses.

Pheromones

Derivatives prepared from the pheromone trans-ß-farnesene and related compounds have been shown to interfere with the transmission of PVY by *Myzus persicae* in glasshouse experiments.

Reflecting mulches

Laying aluminium strips on the ground between crop rows repels aphids coming into the crop through reflecting UV light.

Eg : The repellency of reflective aluminum to transient aphids was used to reduce the spread of Cauliflower mosaic virus (CMV)

- In Tomato crop also laying of these reflective mulches reduces the incidence of aphids and whiteflies.

Sticky traps

- Use of yellow sticky traps in the field also reduces the whitefly incidence.
- Growing of resistance varieties reduces the disease incidence. *Solanum tuberosum spp. andigena* - resistance to PVY
- Removal of weed hosts like wild bhendi, parthenium species , greatly reduces the incidence of Bhendi yellow vein mosaic virus (BYVMV) and Peanut bud necrosis disease where more vector population present in weed hosts.

3.6 Agronomic Techniques

- A tall cover crop will sometimes protect an undersown crop from insect-borne viruses. For example, cucurbits are sometimes grown intermixed with maize. It is thought that incoming aphids land on the barrier crops, feed briefly, and either stay there or fly away.

- Non-preference of hosts involve, first, an adverse effect on vector behaviour, resulting in decreased colonisation, and second, the antibiosis involves an adverse effect on vector growth, reproduction, and survival after colonisation has occurred.

3.7 Trap crops

Some of the host they attract the vector more than the main crop.

Eg 1: Growing of Brinjal in and around Tomato crop and also bhendi crop and also pulses they greatly reduces Tomato leaf curl , *Bhendi yellow vein mosaic virus* (BYVMV) and *Yellow mosaic virus* (YMV) in pulses because act as a trap crop for the whiteflies. So preventing the incidence of viruliferous insects to the preferred host.

Eg 2: For *Cucumber mosaic virus* (CMV) many use a "trap crop" method. In this method farmers plant resistant varieties around the perimeter of their fields and place the susceptible plants in the middle.

Their intention is that the aphids carrying disease will first land on the resistant varieties and by the time they have eaten their way to the susceptible varieties they will no longer be carrying the virus.

4. CHEMICAL METHODS

- Very attractive method
- Farmers are also readily adopted and used these methods
- Some of the plant extracts acts as virus inhibitor . sap extracted from tobacco crop when sprayed on the crop inactivate the *Tobacco leaf spot virus*.
- The sap obtained from some of the species of the plants which are rich in tannins they are known to inactivate *Tobacco mosaic virus*.

- To decrease virus spread in potato crops by spraying or dusting with nicotine, rotenone, or pyrethrum formulations to kill the aphid vectors.

- To control spotted wilt of tomatoes by dusting fortnightly for two months with sulphur, sulphur and nicotine, or a mixture of copper carbonate, lead arsenate, sulphur, and nicotine dusts.
- Tomato plants spraying with tartar emetic and sugar, a lethal bait for thrips, and decreased the incidence of spotted wilt from 100 percent in unsprayed plots to 5 per cent in the sprayed plots.

- To control leaf roll by spraying small plots of potato containing one row of infected plants with a mixture of lead arsenate, nicotine sulphate, and Bordeaux mixture it reduces the Leaf roll incidence was reduced from 81 per cent in an unsprayed plot to 31 per cent in a plot sprayed seven times.

- Nicotine sprays greatly increased yields of potatoes by decreasing injury by aphids, but even weekly applications failed to stop virus spread.

- Potato aphid control - Areas treated three or four times with derris dusts or sprays out yielded check areas by as much as a quarter.
- By dusting peas five times at six-day intervals with cube powder, even though only single rows were treated, decreased the viruses spreading from alfa-alfa and clover and got an economic increase in yield.
- Derris and pyrethrum dusts, applied to small plots of Lettuce, five times at ten-day intervals, prevented leafhopper infestation by decreasing their population to 96 per cent and the incidence of yellows was also decreased from 77 to 11 per cent.
- Some of the antibiotics they are known to inhibit virus multiplication .
    - ❖ Cytovirin – Extracted from *Streptomyces* species prevented *Tobacco mosaic virus* (TMV) @ 0.5-1 ppm.

- Blasticidin – Taken from roots of rice . Inhibited *Rice stripe virus* by leaf hopper (*Delphacodes striatella*)
- Use of milk prevented transmission of TMV.
- Use of oils to control a plant viruses.

Eg : Oil sprays reduced population levels of mealybug in pineapple and thereby controlling the mealybug wilt virus.

- Treatment of infected Cornation cuttings with 0.2 % $CaCl_2$ + 0.25 % $ZnSo_4$ eliminated the Cornation mosaic virus.

Chemical control

- The application of insecticides is currently one of the main ways of controlling insect pests of plants.
- To prevent an insect from causing direct damage to a crop, it is necessary only to reduce the population below a damaging level.
- Control of insect vectors to prevent infection by viruses is a much more difficult problem, as relatively few winged individuals may cause substantial spread of virus.
- Contact insecticides would be expected to be of little use unless they were applied very frequently.
- Persistent insecticides, especially those that move systemically through the plant, offer more hope for virus control.
- Viruses are often brought into crops by winged aphids, and these may infect a plant during their first feeding, before any insecticide can kill them.
- When the virus is non-persistent, the incoming aphid, when feeding rapidly, loses infectivity anyway, so killing it with insecticide will not make much difference to infection of the crop from the outside.
- On the other hand, an aphid bringing in a persistent virus is normally able to infect many plants, so killing it on the first plant will reduce spread.
- As far as subsequent spread within the crop is concerned, similar factors should operate.
- Spread of a virus that is non-persistent should not be reduced as much by insecticide treatment as a persistent virus where the insect requires a fairly long feed on an infected plant.
- Thus, spread of the persistent *Potato leaf roll virus* (PLRV) in potato crops was substantially reduced by appropriate application of insecticides, but spread of the non-persistent *Potato virus Y* (PVY) was not.
- Disease forecasting data can be an important factor in the economic use of insecticides.
- A warning scheme to spray against the vectors of beet yellows viruses was initiated in the United Kingdom in 1959 and is based on monitoring populations of aphids in crops from May until early July.
- For control of thrips spray Dimithoate , Fipronil granules
- For control of whiteflies spray Triazophos, Neonicotinoids after the 40 days which is the most wonderful time for crop infestation.
- Seed treatment with Imidachloprid, Chloripyriphos, Thiomethaxam.
- Using of stylet blockers like Pymetrizin which prevents the penetration of stylets into the plant tissue , greatly reduces the incidence.

  Newer insecticides for plant virus disease management (Castle et al. 2009)

Reference

Castle Steven, John Palumbo, Nilima Prabhaker. 2009. Newer insecticides for plant virus disease management. Virus Research 141:131–139