FINAL REPORT

GRDC Grains Research & Development Corporation

# Epidemiology and management of tobacco streak virus in sunflower and pulse crops of the Northern Region

# DAQ00118

## Project Details

- **Project Code:** DAQ00118
- **Project Title:** Epidemiology and management of tobacco streak virus in sunflower and pulse crops of the Northern Region
- **Start Date:** 01.07.2007 **End Date:** 30.06.2008
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## Summary

A one-year scoping study was undertaken to identify measures to counter Tobacco streak virus (TSV), which causes yield loss of up to 70% in sunflower and pulse crops.

This study found:

- parthenium weed (*Parthenium hysterophorus*) is a major non-crop host of TSV and the major source of TSV moving into adjacent crops
- there is a range of tolerance to TSV in hybrid sunflower varieties, so variety choice may be an effective option for reducing the impact of this virus in sunflower
- controlling parthenium or not planting susceptible crops near high densities of parthenium will reduce the risk of infection with TSV
- although TSV is transmitted by thrips and TSV-infective pollen, in-crop applications of insecticides for thrips may not provide effective control of TSV disease because most of the TSV-infective pollen and thrips are likely to be entering crops from surrounding areas.

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## Conclusions

This project has identified many alternative field hosts of the central Queensland (Qld) strain of TSV. Crops found to be the most likely to be severely affected by TSV include sunflowers, mung beans and soybeans. The cropping period (i.e. winter months) for chickpeas in central Queensland may allow the crop to avoid high TSV disease pressure. Therefore, very low disease incidence was observed in chickpea crops. The likely impact on other crops such as peanuts and cowpea is still uncertain.

Proximity of susceptible crops to *Parthenium hysterophorus* is likely to be one of the most important factors in the development of disease epidemics. Extensive surveys have identified TSV-infected parthenium to occur across central Qld regardless of its proximity to cultivated areas. This suggests that the presence of high-density parthenium may be used as a risk indicator for the likelihood of TSV disease damage occurring in susceptible crops nearby. Results indicate that areas most at risk appear to be downwind of high-density, TSV-infected parthenium.

Field trial results demonstrated that there are significant differences between commercially available sunflower hybrids in their tolerance to TSV infection. This indicates that there may be better planting options in areas with high risks of TSV infection, however these results need to be confirmed in future trials. There were no obvious differences between mung bean cultivars; all were severely affected by TSV in the field trial.

Thrip species commonly collected from many locations and hosts throughout central Qld included: *Microcephalothrips abdominalis*, *Thrips tabaci*, *Frankliniella schultzei* and *Desmothrips propinquus*. The first three species have been identified by other workers as vectors of other TSV strains and as such would be key species to test for ability to transmit the central Queensland strain of TSV.

## Recommendations

Use sunflower cultivars most tolerant to TSV identified in this project (results need to be confirmed in future field trials).

Avoid planting susceptible crops in high-risk locations i.e. close to high density, TSV-infected parthenium.

Practice effective farm hygiene to control flowering parthenium, particularly when crops are young.

In-crop applications of insecticides for thrips may not provide effective control of TSV disease because most of the TSV-infective pollen and thrips are likely to be entering crops from surrounding areas. The risk of disruption to effective Integrated Pest Management (IPM) strategies should also be considered.

## Outcomes

Economic outcomes

The results of this project are expected to assist northern region sunflower and pulse industries to minimise risk of serious losses due to TSV and thus increase confidence in crops. This should in turn provide economic benefits to these industries and the regions' growers.

Environmental outcomes

Increased knowledge of the nature and epidemiology of the diseases caused by TSV should allow growers to minimise pesticide usage, and encourage the control of parthenium, a declared noxious weed.

Social outcomes

Flow-on effects of the economic benefits to the sunflower and pulse crop industries should result in greater economic security to the cropping regions in general.

## Achievement/Benefit

Background

A severe sunflower  disease, now known to be caused by TSV, has caused an estimated 20% loss across the sunflower industry in central Queensland (CQ) since 2004. TSV also caused major losses in mung bean crops throughout CQ in early 2007, with up to 70% yield reductions in severely affected crops. Losses have been both direct, from crop damage caused by the virus, and indirect, from reduced grower confidence in sunflower. TSV was identified as the cause of the sunflower disorder in 2006 and research (jointly funded by the GRDC and the Cotton Research and Development Corporation (CRDC)) has continued since then to characterise the life cycle of the virus, including identification of alternative weed hosts and insect vectors. Work has also begun to develop management strategies to minimise the risk of severe disease in crops due to TSV.

Host range

TSV has a very wide host range which includes many weed and crop species. Extensive surveys in CQ have identified TSV-infected parthenium (*P. hysterophorus*) populations at over 30 sites between Townsville and Springsure. Several sites are in grazing land well removed from cropping regions. This indicates that parthenium is a widespread, key host of TSV in CQ. Parthenium and some other weed hosts do not develop visible symptoms of TSV infection, but provide a source of virus for transmission into susceptible crops. Other natural hosts identified to date include the following:

Crop hosts

Sunflower - *Helianthus annuus*
Mung beans - *Vigna radiata*
Chickpea - *Cicer arietinum*
Soybean - *Glycine* max
Peanuts - *Arachis hypogaea*
Cotton - *Gossypium hirsutum*

Weed hosts

Parthenium weed - *Parthenium hysterophorus*
Crownbeard - *Verbesina encelioides*
Native jute - *Corchorus trilocularis*
Milkweed - *Sonchus oleraceus*
Native thornapple - *Datura leichhardtii*
Ground cherry - *Physalis lanceifolia*
Annual ground cherry - *Physalis angulata*
Phasey bean - *Macroptilium lathyroides*
Noogoora burr - *Xanthium occidentale*

Disease cycle

TSV is transmitted through infected pollen, which can be spread by wind or carried by insects. Thrips are the only known insect vector or carrier and are required for TSV infection to occur. Transmission of TSV to plants relies on the virus from infected pollen entering plant cells through the feeding injury caused by thrips. TSV can only survive in living plant tissue, pollen or in seeds. Many species of thrip are potentially capable of transmitting TSV. Work is continuing to identify the thrip species responsible for transmission of TSV into crops in CQ. It is likely that several species are involved.

Severe outbreaks of TSV are favoured by climatic conditions which enable high thrip populations to develop, and large amounts of infective pollen to be produced by host plants such as parthenium. These conditions generally occur during warmer months and are highly dependent on rainfall and weed growth patterns.

Seed transmission of TSV does occur in some hosts. In particular, seed transmission of TSV has been shown to occur at high rates in CQ parthenium populations. This mode of transmission enables the virus to survive through ad-

verse climatic conditions such as drought and provides a link between seasons and cropping cycles. When conditions again favour the growth of weed hosts and thrip populations, the virus can rapidly move from TSV-infected weeds (via infected pollen) into susceptible crops. There is also significant risk of long distance dispersal of TSV, if infected parthenium seed is moved with machinery or harvested goods.

Field trial of sunflower cultivars

Several field observations in early 2007 suggested that there may be significant differences in tolerance to TSV infection between sunflower cultivars. Consequently, a field trial was conducted in early 2008 at a site north of Clermont with a history of high TSV disease levels. Fifteen cultivars from three seed companies were tested with four replicates of each. Trial results were analysed using a repeated measures analysis and demonstrated that there are significant differences between cultivars in their tolerance to TSV infection. Most of the infected plants had severe symptoms of lodging, had severe tip necrosis, were dead or had a combination of these symptoms and would not have produced any yield. Hence, results of the disease incidence would correlate with differences in expected yield. These data are from only one trial at one location and will need to be confirmed and extended in the 2009 season.

In addition to the field trial for sunflowers, 18 sunflower hybrids/lines were screened for TSV tolerance in glasshouse trials using manual inoculation with a CQ strain of TSV. All 18 hybrids/lines developed severe systemic symptoms indicating there was no true genetic resistance. The manual inoculation method appears to be a more severe test of tolerance with little difference observed between the same cultivars that displayed significant differences in the field trial. This indicates that the use of field trial screening, with natural inoculation by thrip, may provide the most realistic assessment of field tolerance to the CQ strain of TSV.

As part of the same field trial, three commercial cultivars (Crystal[A], White Gold[A] and Emerald[A]) and experimental lines of mung bean were tested using four replicates of each. All four lines developed severe systemic disease symptoms indicating no observable differences in tolerance.

Thrip survey results

Thrips were collected and identified from 12 locations across CQ from Collinsville in the north to Springsure in the south. They were collected from a range of plant hosts including nine collections from parthenium, five from sunflower, one from mung bean and one from crownbeard. The following thrip species were the most commonly collected from most locations and hosts: *Microcephalothrips abdominalis*, *Thrips tabaci*, *Frankliniella schultzei* and *Desmothrips propinquus*. The first three species mentioned have been identified by other workers as vectors of other TSV strains.

Effect of crop location near TSV-infected parthenium

Several field observations in sunflower crops have indicated the highest rates of TSV disease incidence occur downwind of large areas of TSV infected parthenium. In these situations, disease levels can remain high for some distance into the crop. One example of this was a crop where TSV disease incidence was about 17% upwind of dense parthenium, 40% at the crop edge just downwind of the parthenium, but still about 20% at 350m downwind into the crop.

## Other Research

Continue work to characterise TSV tolerance differences between sunflower cultivars and communicate these results to industry.

A project proposal has been submitted for assessment to continue and extend investigations into a number of aspects related to TSV in the northern region.

This proposed project aims to:

1. continue epidemiological research on TSV
2. identify additional field weed hosts of TSV which could act as virus reservoirs and examine potential seed transmission of TSV in these species
3. increase the understanding of the thrip vectors of TSV

4. continue to survey for TSV in sunflowers and pulse and other crops, and weeds to determine sources of infection and possible spread of the disease
5. examine sunflower germplasm and breeding lines to search for tolerance/resistance to TSV
6. examine management systems to reduce the impact of the virus.

## Additional Information

GRDC project DAQ00130 (Management of Tobacco streak virus in sunflower and pulse crops) has continued and expanded on the objectives of project DAQ00118. Further information in relation to research outcomes from project DAQ00130 can be found in project Progress Reports and the Final Report (currently being prepared).

“Hybrids’ tolerance tested”. Article about sunflower field trials for tolerance to TSV. March-April 2010, Oilseed Breeding Supplement, GRDC Ground Cover magazine.

“Epidemiology of Tobacco streak virus in Queensland, Australia”. Presentation at Australian Summer Grains Conference, 2010. Follow this link: http://www.grdc.com.au/uploads/documents/summer_grains_conference_2010/Murray%20Sharman%20.pdf