QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
DIVISION OF PLANT INDUSTRY BULLETIN No. 385

PASSION-FRUIT WOODINESS VIRUS AS THE CAUSE OF PASSION VINE TIP BLIGHT DISEASE

By R. S. GREBER, B.Sc.

SUMMARY

A disease of the passion vine (*Passiflora edulis*) which causes terminal necrosis, severe stunting and complete commercial loss in affected vines is shown by transmission tests, physical properties, cross-protection experiments and serological tests to be caused by a strain of passion-fruit woodiness virus.

The virus is transmitted efficiently by *Myzus persicae* and *Aphis gossypii*, has a dilution end point in bean sap between 10^{-4} and 10^{-5} and a thermal end point between 55 and 60°C. The long flexuous rod particles are within the range 700-800 $m\mu$ long.

An ecological association between the virus and *P. suberosa* L., where it is tolerated without necrosis, is suggested.

I. INTRODUCTION

It was noted by McKnight (1953) that some strains of passion-fruit woodiness virus could cause necrotic stem lesions together with death of terminal leaves and tendrils. Subsequently, in 1954, during collection of isolates for mild strain protection experiments, J. H. Simmonds noted (unpublished records) that virus from collections of the corky passion vine (*Passiflora suberosa* L.) caused a severely necrotic reaction in *Passiflora edulus* Sims terminals when transmitted by grafting.

Commercial plantings of passion vines in central Queensland coastal districts are affected by a disease known locally as "tip blight". Characteristics of this disease are epinasty, vein clearing and abscission of the terminal leaves, followed by a quick necrosis of the stem often extending for several inches back from the tip of all vigorously growing shoots (Figure 1). Sunken brown lesions often develop on the stem behind the wholly necrotic portion and affected plants show little tendency to climb but remain stunted, have mottled leaves and bear a few woody fruit only. Small plants may be killed. During experiments in

central Queensland in 1958 it was found that *P. suberosa* scions showing mottle symptoms when taken from the field and grafted to *P. edulis* plants induced a reaction identical with the natural disease. The results of subsequent transmission tests and other studies are reported in this paper.

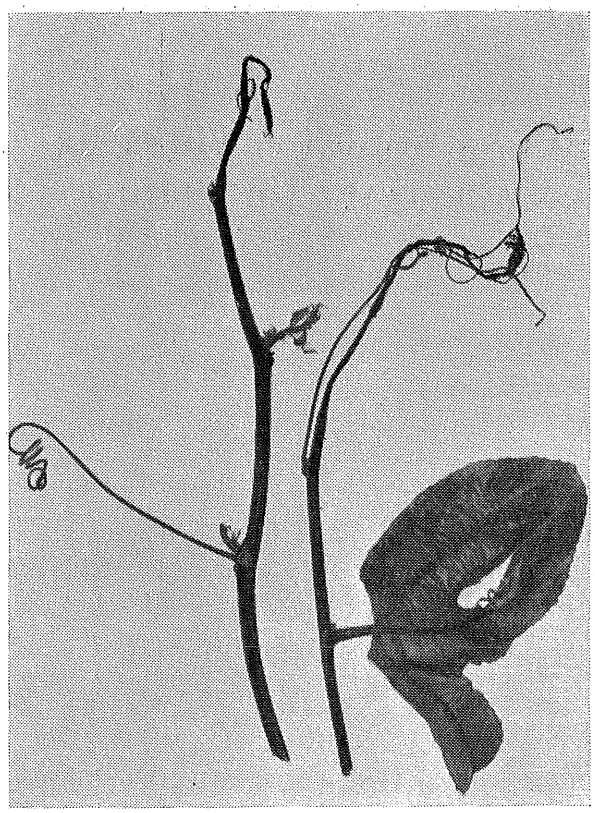

Fig. 1.—Passion-vine terminals showing the tip blight symptom.

II. EXPERIMENTAL RESULTS

Mechanical transmission to passion vine seedlings.—Mechanical transmission tests were carried out, using leaves from affected passion vines or field collections of *P. suberosa* as the virus source. The leaves were ground with a small quantity of pH 7, 0.1M phosphate buffer and inoculations performed by application with the finger on carborundum-dusted plants. These tests established that the disease could be transmitted in sap from infected plants, though the rate of transfer was usually only 50%. All seedlings infected in this way developed typically severe symptoms and most subsequently died.

Aphid transmission.—Transmission tests using two species of aphids, *Myzus persicae* (Sulz.) and *Aphis gossypii* Glover, were carried out. The insects were reared in cages as virus-free colonies and after starving for ½–1 hr acquisition

times of 20–60 sec (one probe) with five aphids per plant were used. The results (Table 1) indicate that the virus from both *P. edulis* and *P. suberosa* is readily transmitted by the two vectors.

TABLE 1

APHID TRANSMISSION OF PASSION-FRUIT TIP BLIGHT

Source Plant*	Symptoms in Source Plant	Vector†	Total Infected	Total Inoculated
P. suberosa	Mottle	*M. persicae*	12	16
P. edulis	Tip blight	*M. persicae*	5	6
P. suberosa	Mottle	*A. gossypii*	7	8

* Green-house-inoculated plants. Transmission rates from field plants were sometimes lower

† 5 aphids per plant.

Field sources of the virus.—In all cases of tip blight in commercial crops investigated during the years 1959-1964, adjacent wild *P. suberosa* was shown by grafting to *P. edulis* to be infected by a virus of the tip blight type. Also, most field specimens of *P. suberosa* which showed mottle symptoms produced a "tip blight" reaction when grafted to passion-fruit seedlings (Table 2).

TABLE 2

REACTIONS OF *P. edulis* SEEDLINGS GRAFTED WITH SCIONS FROM FIELD COLLECTIONS OF *Passiflora* spp.

Source Species	Collection Area	Source Symptoms	No. Tested	Transmission Reaction		
				Tip Blight	Mild	Nil
P. suberosa ..	Central Queensland	Mottle	8	8	0	0
P. edulis	Central Queensland	Tip blight	5	5	0	0
P. suberosa ..	South Queensland	Mottle	15	13	1	1
P. edulis	South Queensland	Tip blight	5	5	0	0

Seedlings of *P. suberosa* were shown to be immune to mechanical inoculation with typical strains of woodiness virus and highly resistant when grafted with infected scions of other species of *Passiflora.* In the latter case virus could be recovered only from a short portion of the *P. suberosa* stem adjacent to the graft.

Cross-protection.—A cross-protection experiment, using *P. edulis* seedlings infected by petiole grafts with a mild strain of passion-fruit woodiness virus (Simmonds 1959), was set up. After all grafted plants showed symptoms of infection, this was challenged by a virulent tip blight isolate grafted to the seedlings in *P. suberosa* scions. The results set out in Table 3 indicate that under these conditions a mild woodiness strain can adequately protect against the tip blight disease.

TABI E 3

CROSS-PROTECTION REACTION OF *P. edulis* SEEDLINGS TO TIP BLIGHT INOCULATION

Status Before Inoculation	Reaction after Inoculation		
	Tip Blight	Nil	Intermediate
Healthy control	8	0	0
Mild strain woodiness inoculated	0	11	1

Infection of other Passiflora species and forms by "tip blight" virus.—The reaction of the golden passion vine (*P. edulis* Sims f. *flavicarpa* Degener) was shown to be similar to that of the purple passion vine when infected by the tip blight virus either mechanically or by aphids. Hybrids between these two forms have some resistance to other woodiness strains, particularly in regard to fruit symptoms. However, they were found to show the usual severe necrotic reaction to tip blight inoculation. Similar severe effects were shown by *P. subpeltata* Ortega and *P. quadrangularis* L., while the symptoms on *P. foetida* L. resembled Fusarium wilt. However, in no instance was any necrotic reaction noticed after inoculation of the several forms of *P. suberosa* by mechanical, aphid or grafting techniques. Symptoms on *P. herbertiana* Lindl. were also of a relatively mild type.

Some properties and reactions of the virus.—Following the demonstration by Taylor and Kimble (1964) that passion-fruit woodiness virus reached a high concentration in French bean (*Phaseolus vulgaris* L.), a typical tip blight strain was inoculated to the bean variety Bountiful and then passed through a series of four single-lesion isolations at a dilution producing well-separated infection centres. The final isolate reproduced the typical disease in passion-vine seedlings. Flexuous rod particles 700-800 mμ long were observed on electron microscope grids prepared using sap exudates from lesions on bean leaves, negatively stained with neutralized phospho-tungstic acid. Negatively stained partially purified preparations (Figure 2) showed the most frequent particle length to be approximately 750 mμ when 65 apparently intact particles were compared with polystyrene latex balls.

The thermal end point of infecticity in sap from bean leaves for a 10-min exposure was between 55 and 60°C when inoculated back to Bountiful bean. The dilution end point for bean sap was between 10^{-4} and 10^{-5}.

In chloroplast agglutination tests with antiserum prepared by Taylor and Kimble (1964) against a severe woodiness strain, a positive reaction was obtained up to an antiserum dilution of 1/128 with sap from infected bean leaves. Healthy sap reacted only to a ½ dilution.

Possibly because of the severe necrotic local lesion reaction in Bountiful bean, the virus did not always become systemically established in this variety. Tip blight virus was not seed-borne in limited tests using four different commercial varieties of *P. vulgaris*.

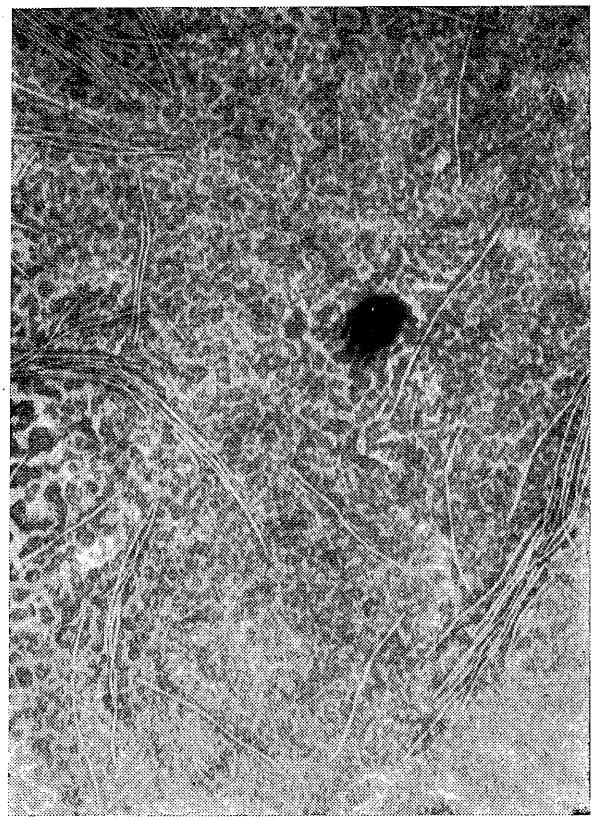

Fig. 2.—Electron micrograph of virus particles from semi-purified preparation of tip blight isolate. (PTA stain, magnification approximately 30K).

III. DISCUSSION

The association of tip blight disease in commercial passion vines with infection sources in the weed species *P. suberosa* apparently represents an ecological phenomenon. The disease appears to be most severe in those areas which satisfy two conditions:

(1) The available wild inoculum sources are predominantly *P. suberosa,* rather than other species such as *P. subpeltata.*

(2) The inoculum sources available from wild species exceed those from within the areas of cultivated vines.

The effect is accentuated because *P. suberosa* is immune to strains of woodiness other than tip blight and thus represents a selective source. The comparatively high rate of commercial roguing of vines infected by the more severe disease prevents any large build-up of this inoculum in *P. edulis,* whereas cultivated vines infected by other strains of woodiness are usually allowed to remain and serve as major sources of infection.

Green-house cross-protection experiments and observations of field plantings show that use of purple passion vines inoculated with mild strains of woodiness (Simmonds 1959), or of hybrid vines (*P. edulis* x *P. edulis* f. *flavicarpa*) carrying woodiness virus, represents an adequate commercial control of the disease. Use of these measures can be conveniently combined with the production of grafted vines at present widely used for protection against Fusarium wilt (Purss 1958).

IV. ACKNOWLEDGEMENTS

I am indebted to the University of Queensland for provision of time and facilities by the Electron Microscope Unit and the use of an ultracentrifuge at the Microbiology Department.

The Queensland woodiness virus antiserum used was provided by Mr. R. H. Taylor, Burnley, Victoria.

REFERENCES

McKNIGHT, T. (1953).—The woodiness virus of the passion vine (*Passiflora edulis* Sims). *Qd J. Agric. Sci.* 10:4-35.

PURSS, G. S. (1958).—Studies of the resistance of species of *Passiflora* to Fusarium wilt (*F. oxysporum* f. *passiflorae*). *Qd J. Agric. Sci.* 15:195-9.

SIMMONDS, J. H. (1959).—Mild strain protection as a means of reducing losses from the Queensland woodiness virus in the passion vine. *Qd J. Agric. Sci.* 16:371-80.

TAYLOR, R. H., and KIMBLE, K. A. (1964).—Two unrelated viruses which cause woodiness of passion fruit (*Passiflora edulis* Sims). *Aust. J. Agric. Res.* 15:560-70.

(Received for publication June 1, 1966)

The author is an officer of the Plant Pathology Section, Division of Plant Industry, Department of Primary Industries, and is stationed at the Department's Science Laboratories at Indooroopilly, Brisbane.