DETERMINATION OF HOST STATUS OF TABLE GRAPES TO QUEENSLAND FRUIT FLY, *BACTROCERA TRYONI* (FROGGATT) (DIPTERA: TEPHRITIDAE), FOR EXPORT TO NEW ZEALAND

A.J. Jessup, S.P. Dalton and R.F. Slogget

NSW Agriculture, P.O. Box 581, Gosford, NSW 2250

Summary

Laboratory experiments were carried out according to a New Zealand Standard to test the host status of 'Flame Seedless', 'Thompson's Seedless', 'Menindee Seedless', 'Red Globe', 'Calmeria' and 'Red Emperor' table grapes to Queensland fruit fly, *Bactrocera tryoni*, Froggatt. Under the conditions prescribed by the Standard these table grape cultivars were able to support development of *B. tryoni* to the adult stage. Table grapes of these cultivars cannot be exported to New Zealand from Australian regions where *B. tryoni* is endemic, has become established or, having been trapped, has enforced a 'fruit fly outbreak' restriction unless an approved quarantine treatment has been applied.

INTRODUCTION

Australian table grape growers are interested in exporting their product to New Zealand without the requirement for postharvest treatments against *Bactrocera tryoni* because of the costs and the associated delay between harvest and resale. At present the only option, should Australian table grapes be exported to New Zealand from fruit-fly-endemic areas, is that the fruit should be stored at 1 °C for 14 days (Mr B. Tucker, Australian Quarantine and Inspection Service, pers. comm.). While table grapes can tolerate such treatment the fruit's shelf life is reduced and there is a delay between the time of harvest and when the consumer can purchase the fruit. This delay contravenes good marketing principles where product can be supplied at a 'moment's notice' to fill temporary market supply shortfalls.

In addition to affecting marketing procedures, the cold disinfestation treatment ties up cold room space for up to 3 weeks, by the time the load of fruit reaches the target temperature of 1 °C. It is also costly in terms of power.

The cold disinfestation treatment described above is required on Australian produce because of the existence of *B. tryoni* in Australia and its absence in New Zealand. Anecdotal evidence in the major table grape growing districts in Australia shows a complete lack of reports of *B. tryoni* found infesting table grapes. But there have been reports of *B. tryoni* infesting table grapes growing in other districts such as near Narrabri, in inland New South Wales (G. Fitt, New South Wales Agriculture, pers. comm.), and in Queensland (Dr R. Drew, Queensland Department of Primary Industries, pers. comm.).

Some fruits are not host to tephritid fruit flies because of the existence of toxic chemicals in the fruit such as benzyl isothiocyanate in unripe papaya (Seo and Tang 1982). In the laboratory *B. tryoni* can be forced to infest many fruit that would not be infested in the field. This is probably due to the presence of a high population pressure in the laboratory that is never experienced in the field (Jessup and McCarthy 1993). In fact *B. tryoni* eggs can hatch on damp filter paper and develop into adult fruit flies by surviving on larval carcasses and fungal growth. (Jessup, unpublished data). In the laboratory, table grapes can be infested with *B. tryoni* but with great difficulty (Jessup 1992).

The New Zealand Ministry of Agriculture and Fisheries (MAF) has produced a Standard for experimental procedures to test fruit, in the laboratory, for its host status to fruit flies of quarantine importance (Anon. 1994). A modification of this Standard was used by the Queensland Department of Primary Industries for access of several fruits from the *Bactrocera papayae* quarantine area in Northern Queensland to other Australian states (Leach and Corcoran 1996). A series of experiments on the host status of table grapes to *B. tryoni* was carried out by scientists at New South Wales Agriculture, Gosford. Table grape cultivars tested were 'Flame Seedless', 'Thompson's Seedless', 'Menindee Seedless', 'Red Globe', 'Calmeria' and 'Red Emperor'.

MATERIALS AND METHODS

These experiments were conducted under the requirements of the New Zealand Standard (Anon. 1994). Fruit flies were collected from a stock cage of *B. tryoni* which were 2 to 6 generations removed from wild *B. tryoni* collected from field-infested loquats in August 1994. These flies were two weeks old from adult eclosion and consequently gravid. The collection method was to place a 150 mL specimen jar containing a small portion of fresh orange into the stock cage. After 10 minutes the jar, now containing flies, was removed and the jar lid put on. After a further 10 minutes all flies had become 'narcotised' and were able to be segregated by sex. Fifty female

flies were placed into 250 x 250 x 450 mm wire framed cage covered with fine ('*Drosophila*-proof') cloth. Flies were allowed access to sugar and water. An egging device (a yellow plastic cup, punctured with 200 fine holes, used in the production of the Gosford colony) was placed into the cage into which the flies were allowed to oviposit. The egg cup contained a quarter of an orange and about 10 mL tap water to act as oviposition stimulants. After 24 hours the egg cup was removed from the cage and all eggs inside it were washed out and counted. The number of gravid females required to lay between 250 and 500 eggs per 500 g of fruit was calculated.

Twelve wire framed cages (250 x 250 x 450 mm) were prepared with sugar and water in open petrie dishes. Each cage was covered in fine terylene to exclude contamination by other fruit flies and *Drosophila*. Fruit fly were collected and segregated as described above. Gravid female flies, the number depending on the results of the fecundity trials, were placed into each cage. Six of these cages were for studies on the host status of intact fruit (termed 'non-punctured' in this report) and six were for studies on damaged ('punctured') fruit.

Two samples of about 2.7 kg of table grapes, one for the non-punctured fruit treatment and one for the punctured fruit treatment were cut from their bunches (leaving 3 mm of peduncle attached). For each treatment, grapes were equilibrated to room temperature then divided into 5 replicates each of approximately 500 g. Fruit for each replicate were placed in a single layer on a shallow tray (300 x 200 x 23 mm). For the punctured treatment, each replicate was punctured, on the fruits' exposed surface, a total of 50 times with a No. 5 entomological pin. Fruit for the non-punctured treatment were not wounded. Control fruit (three oranges, total weight 550 g) were placed on a shallow tray and each was punctured 15 times.

Fruit were offered to the flies for 24 hours at 26°C, 50% R.H. and 12 hour light : 12 hour dark. For each of the two treatments (punctured or non-punctured) five cages had table grapes and one (the Control) had oranges. After 24 hours fruit were removed from the flies and placed on a mesh tray suspended over damp vermiculite in a plastic tray (380 x 560 x 200 mm) covered with fine mesh terylene. Each replicate and the Control were separately boxed and covered and all were placed at 26°C for 14 days. After 14 days vermiculite was removed and new vermiculite placed under the fruit and returned to 26°C for a further 3 days. All vermiculite was then sieved and any surviving pupae recovered, counted and stored in clear specimen tubes (80 mm high x 65 mm diameter) with 10 mm layer of vermiculite over the pupae and capped with fine mesh terylene cloth and stored at 26°C for adult emergence. Remaining fruit were dissected and any live larvae were collected and counted.

Based on the number of eggs laid per day per female the potential number of eggs oviposited into each 500 g batch of grapes ranged from 300 to 600. Considering an average percentage hatch of 90% (Cruickshank, unpublished data), larval load per 500 g of grapes ranged from 270 to 500. To obtain this number of eggs laid the number of female flies in each replicate cage ranged from 5 to 60 depending on the number of eggs laid in 24 hours per adult fly in the female fecundity experiments.

RESULTS AND DISCUSSION

All table grape cultivars tested in these experiments were, under the New Zealand Standard, able to support the development of Queensland fruit fly. There was considerable variability between table grape cultivars in host status (table 1). Survival of *B. tryoni* in, for example, 'Menindee Seedless' table grapes was relatively high, where 116 fruit flies survived from 492 infested, undamaged table grapes. Survival of *B. tryoni* in 'Red Emperor' table grapes was low, where only 4 fruit flies survived from 466 infested, undamaged table grapes. Because, in these experiments, replication was based on separate cages of flies from the same cohort in fruit from the same batch there is insufficient evidence to prove that survival of *B. tryoni* in 'Menindee Seedless' is always more likely than in 'Red Emperor'. The New Zealand Standard is concerned with whether or not an adult fly will survive from a table grape.

Survival of fruit flies varied between replicates as evidenced in the high Standard Deviations of mean pupation and adult eclosion (table 1). All fruit were of commercially acceptable quality and were intact and not damaged in any visible way but it appeared that some berries were more attractive to ovipositing females than others. Fruit flies oviposited into berries that were slightly softer than the others. The softer fruit developed an area around the junction of the peduncle with the berry, probably the natural 'abscission layer', which was vulnerable to fruit fly attack. Fruit flies also tended towards contagious oviposition when, under constant fruit fly pressure, a wound formed on a berry which was then stung by most females in the test leaving the other berries untouched.

Under the New Zealand Ministry of Agriculture and Fisheries (MAF) Regulatory Authority Standard 155.02.02—'Specification for Determination of Fruit Fly Host Status as a Treatment' the table grapes cultivars: 'Flame Seedless', 'Thompson's Seedless',

Table 1. Survival of *B. tryoni* to pupation and adult eclosion in various table grape cultivars in the laboratory.

Table grape cultivar	Punctured (P) or non-punctured (N)	Weight of fruit (g/rep)*	Number of fruit/rep*	Number of surviving pupae/rep*	Average pupal weight (mg/pupa)†	Number of surviving adults/rep*
Flame Seedless	P	530.0 (6.5)	132.8 (3.2)	83.8 (27.8)	10.2 (1.2)	73.4 (24.0)
	N	362.8 (1.8)	107.0 (1.4)	2.8 (1.8)	11.6 (0.9)	2.8 (2.2)
Thompson's Seedless	P	502.8 (3.6)	100.8 (7.8)	6.8 (5.2)	11.4 (1.3)	6.2 (4.5)
	N	500.2 (0.5)	79.6 (8.3)	20.0 (16.1)	12.0 (1.7)	17.4 (12.5)
Menindee Seedless	P	502.8 (2.7)	107.8 (7.7)	47.2 (18.8)	10.9 (0.6)	39.6 (30.4)
	N	500.4 (1.1)	98.4 (5.2)	28.8 (19.5)	10.4 (0.8)	25.0 (18.2)
Red Globe	P	500.0 (0)	62.0 (4.8)	17.2 (16.7)	7.9 (0.8)	15.2 (14.2)
	N	500.4 (0.5)	67.8 (6.2)	1.6 (1.3)	8.3 (1.5)	1.4 (1.1)
Calmeria	P	500.4 (0.5)	126.0 (10.8)	1.4 (1.1)	7.1 (0.3)	0.8 (0.8)
	N	500.2 (0.5)	146.2 (15.8)	1.0 (1.0)	8.2 (0.8)	0.8 (0.6)
Red Emperor	P	500.4 (0.5)	98.4 (6.5)	0.2 (0.2)	8.0 (3.0)	0.2 (0.2)
	N	500.2 (0.5)	93.2 (5.5)	1.0 (0.8)	9.3 (2.5)	0.8 (1.3)

*Numbers in brackets indicate Standard Deviation, n=5.
†Numbers in brackets indicate Standard Deviation

'Menindee Seedless', 'Red Globe', 'Calmeria' and 'Red Emperor' are able to host Queensland fruit fly. Results of the research reported here show that non-host status can not be used as a treatment for the export of Australian 'Flame Seedless', 'Thompson's Seedless', 'Menindee Seedless', 'Red Globe', 'Calmeria' and 'Red Emperor' table grapes to New Zealand.

If New Zealand MAF can be shown proof that there are no populations of *B. tryoni* in the region where the export table grapes are grown, and from which they are exported, then no quarantine treatment needs to be applied. This proof must follow the New Zealand MAF NASS Standard 158.03.06—'Specification for Fruit Fly Area Freedom Monitoring Within a Country Where Harmful Species of Fruit Fly Exist' or the New Zealand MAF NASS Standard 158.03.07—'Specification for Fruit Fly Area Freedom Monitoring in a Geographically Isolated Area'.

If unable to prove area freedom, or if a *B. tryoni* outbreak occurs in an otherwise fruit fly free area then a quarantine treatment must be applied to the product. Other research carried out at New South Wales Agriculture, Gosford has shown that storage at 1°C for 12 days will disinfest 'Flame Seedless', 'Thompson's Seedless' and 'Ruby Seedless' table grapes of *B. tryoni* (Jessup 1992). If industry cannot demonstrate area freedom from *B. tryoni* for their region and they want to export to New Zealand then they could apply to New Zealand MAF for approval to export following cold disinfestation treatment.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the provision of funding from the Australian Table Grape Growers Association and the Commonwealth Government through the Horticultural Research and Development Corporation for this project.

REFERENCES

Anon. (1994). New Zealand Ministry of Agriculture and Fisheries (MAF) Regulatory Authority Standard 155.02.02—'Specification for Determination of Fruit Fly Host Status as a Treatment'. MAF Regulatory Authority, Wellington, New Zealand.

Jessup, A.J. (1992). Low-temperature storage as a quarantine treatment for table grapes infested with Queensland fruit fly (*Bactrocera tryoni*, Froggatt). *New Zealand Journal of Crop and Horticultural Science*. **20**: 235–239.

Jessup, A.J. and McCarthy, D. (1993). Host status of some Australian-grown cucurbits to *Bactrocera tryoni* (Froggatt) (Diptera: Tephritidae) under laboratory conditions. *J. Aust. Ent. Soc.* **32**: 97–98.

Leach, P.L. and Corcoran, R.J. (1996). Determination of susceptibility of various fruits to infestation by papaya fruit fly, *Bactrocera papayae* Drew and Hancock (Diptera: Tephritidae). Queensland Department of Primary Industries. Internal reports prepared for the consideration of the Interstate Plant Health Regulatory Working Group, Melbourne, Victoria, Australia.

Seo, S.T. and Tang, C.S. (1982). Hawaiian fruit flies (Diptera: Tephritidae): toxicity of benzyl isothiocyanate against eggs or 1st instars of three species. *J. Econom. Entomol.* 75: 1132–1135.

This page left blank intentionally