FRUITION®

FRUIT FLY LURE AND TRAP

FOR QUEENSLAND FRUIT FLY (*Bactrocera tryoni*)

TECHNICAL MANUAL 2018

FRUITION® TRAPS
TECHNICAL MANUAL

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EXECUTIVE SUMMARY

Fruition Traps were introduced into the Australian market in 2016 for monitoring and managing Queensland fruit fly (QFF; *Bactrocera tryoni*) in susceptible crops. The traps consist of a chemical lure which is attached to two blue interlocking circular discs coated with an adhesive which holds the insects on the trap once they alight on the surface (see photo below). The blue colour of the trap is designed to specifically attract QFF, although Fruition Traps also attract and trap other pest fruit flies. Further development work is being conducted to evaluate alternative trap colours for attracting other pest fruit flies such as *B. cucumis, B. jarvisi, B. neohumeralis* and *C. capitata*.

The chemical lure in Fruition Traps is designed to mimic the odour of ripe fruits, and attracts mature, egg-laying QFF. Fruition Traps are the only traps available which selectively attract and capture this important segment of the QFF population. The interlocking discs are a specific colour, shape and size, the combination of which is particularly attractive to QFF.

Tephritid fruit flies locate suitable oviposition sites on host plants using both olfactory and visual cues, with olfactory cues operating over longer distances than visual cues. The lure in Fruition Traps attracts mature, egg-laying QFF into the host plant canopy. Once the QFF are close to or in the canopy they are attracted to the colour and shape of the trap.

It is recommended that Fruition Traps are used as part of an Integrated Pest Management (IPM) program for monitoring and managing QFF populations in susceptible crops. An IPM program for management of QFF includes:

- Orchard hygiene (removal and destruction of infested fruit and fallen fruit from the orchard floor);
- Monitoring of QFF populations;
- Trapping of QFF and use of Fruition Natflav 500 protein bait spraying when the crop is susceptible to attack;
- Use of insecticide cover sprays where allowed; and, when required;
- Postharvest tree spraying and removal of unharvested fruit.

It is recommended that Fruition Traps are deployed at a rate of 15 traps/ha for monitoring of QFF populations, before fruit starts to ripen, and that this rate of trap deployment is increased to 30 – 50 traps/ha when implementing a full IPM program for management of QFF.

Figure 1: Fruition Trap placed in host tree, showing QFF on the trap surface.

Fruition Traps can be used to monitor crops for the presence of mature egg-laying QFF.

Fruition Traps can be used in IPM programs for monitoring and trapping QFF in combination with protein bait spraying and, where required and approved, cover spraying, for the management of QFF populations in horticultural crops.

Fruition Traps also attract and capture other adult stages of QFF: field trials indicate that approximately 75-80% of QFF caught on Fruition Traps will be mature females, with the remainder of trap catches being males and immature females.

Fruition Traps are unique in that they are effective in attracting and trapping all of the important pest fruit fly species in Australia, as shown in the table below.

Future development work will seek to add these economically important fruit flies to the Fruition Trap label.

LURE	*B. tryoni*	*B. neohumeralis*	*B. jarvisi*	*B. cucumis*	*C. capitata*	*D. pornia*
FRUITION TRAP						
Protein bait sprays						
Protein bait traps						
Cue-lure						
Methyl eugenol						
Trimedlure						
Zingerone						

Figure 2: Cucumber fly (*B. cucumis*) on yellow Fruition Trap.

Field work is currently planned or underway to evaluate the attractancy of different coloured traps to other important pest fruit flies, both in Australia and overseas, including:

- *Anastrepha fraterculus* (South American fruit fly)
- *A. obliqua* (West Indian fruit fly)
- *B. correcta* (Guava fruit fly)
- *B. cucurbitae* (Melon fruit fly)
- *B. dorsalis* (Oriental fruit fly)
- *B. latifrons* (Solanum fruit fly)
- *B. tau*
- *B. zonata* (Peach fruit fly)

BACKGROUND

Fruit flies are one of the most damaging pests of horticultural crops in Australia and around the world, directly infesting and spoiling a wide range of fruit and vegetables. A further cost attributed to fruit flies is associated with quarantine and trade barriers limiting trade in susceptible commodities between fruit fly-infested regions and fruit fly-free regions.

In Australia, the main pest species are *Bactrocera tryoni* (Queensland fruit fly; QFF; Qfly) on the east coast, and *Ceratitis capitata* (Mediterranean fruit fly; medfly) in Western Australia. There are occasional outbreaks of medfly in the eastern states and of QFF in declared fruit fly-free zones on the east coast. Other species of fruit fly of economic importance in eastern and northern Australia are *B. cucumis* (cucumber fly), *B. jarvisi* (Jarvis' fly) and *B. neohumeralis* (lesser Queensland fruit fly).

Dirioxa pornia, the island fly, is not considered to be an important pest of fresh produce due to its preference for over-ripe and damaged fruit. It is, however, an important quarantine pest particularly with regard to exports to New Zealand, USA, and Japan. Island fly is an Australian native insect, the larvae of which closely resemble and can be easily confused with those of pest fruit flies such as QFF.

The Fruition Trap lure (including the chemicals and their ratio for maximum attractancy), along with the size, shape and colour of the discs, were developed by the International Centre for the Management of Pest Fruit Flies at Griffith University over a number of years. The Fruition Trap technology was licensed to AgNova Technologies Pty Ltd for commercialisation in the global market.

Extensive field trial work was conducted in south-east Queensland from 2013 to 2015 to confirm several years of laboratory findings and to evaluate the composition and attractancy of the Fruition Trap lure and alternative trap systems to QFF. Field trials in 2015-2017 evaluated the commercial use of Fruition Traps and Fruition Natflav 500 programs for management of QFF. The early work with the Fruition Trap technology built on many years of research on fruit fly nutrition and behaviour, some of which is summarised overleaf.

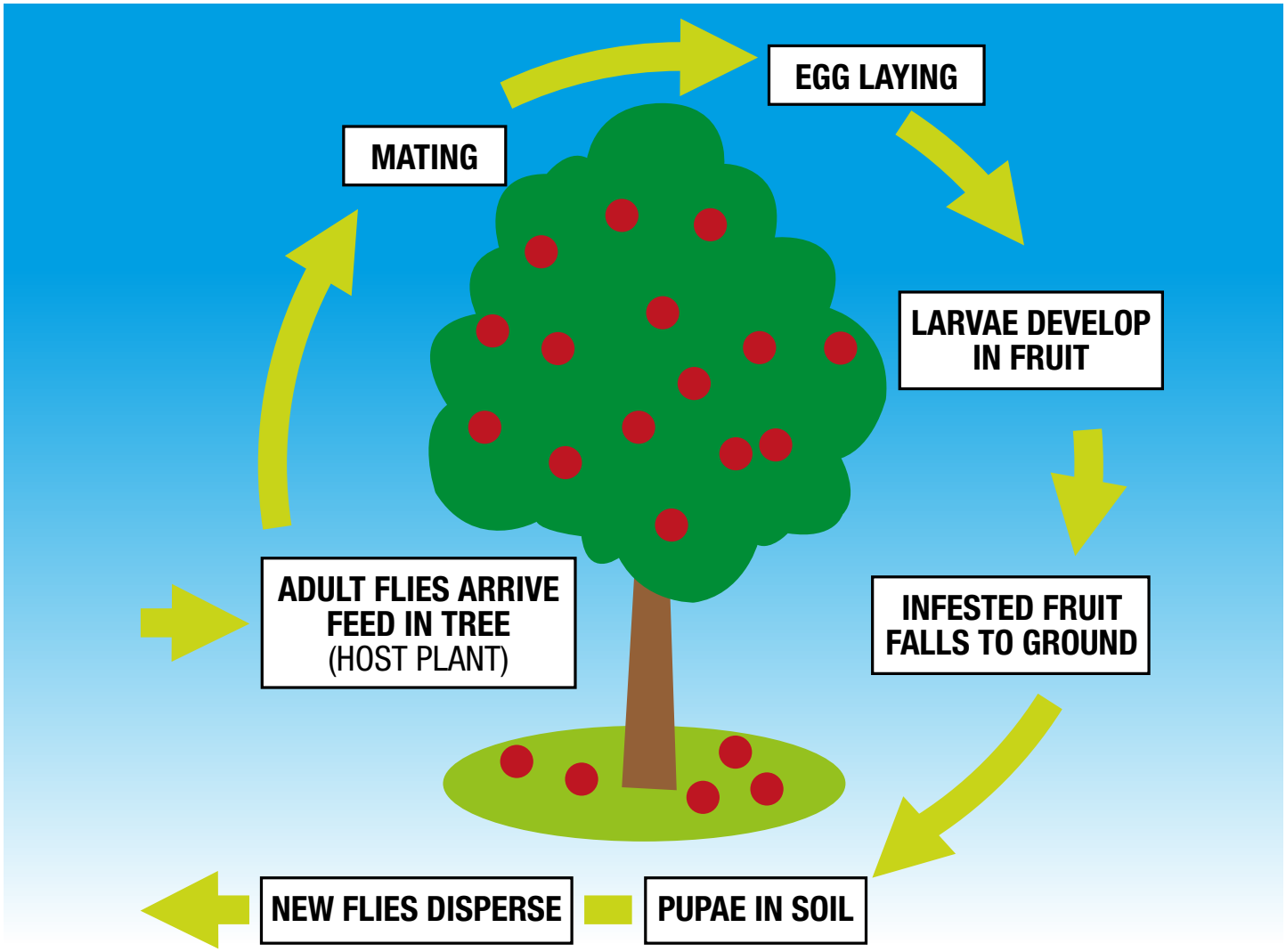

Figure 3: Lifecycle of QFF (Diagram: Robyn Barnes).

Key stages in the QFF lifecycle that control strategies target are:

Adult flies – Arrive in tree (host plant) and feed. Where the flies arriving are immature males and immature females, they require protein from leaf and fruit surfaces and will be attracted to Fruition Natflav 500 protein bait sprays. Once immature QFF have fed on protein and advanced to sexual maturity, they will no longer be attracted to protein bait sprays. When mature female QFF have mated, they actively seek maturing fruit in which to lay their eggs. At this stage of their lifecycle the mature egg laying QFF are attracted to the Fruition Trap.

Where the flies arriving are mature egg-laying females, they will be attracted to Fruition Traps.

Mature QFF lay eggs in batches of 6-10 eggs per fruit. They can live for three months and can lay over 1000 eggs in their lifetime.

Cue-lure traps placed in trees will attract sexually mature male QFF. Cue-lure is effective in attracting QFF up to 400 m from the lure.

Larvae – Eggs are laid under the fruit surface and hatch after 1-2 days. Larvae pass through 3 growth stages, or instars, in fruit. The larval stage lasts around 7-10 days. Larvae in fruit will be controlled by cover sprays, where this option is available, using approved insecticides.

Infested fruit may fall to the ground, hence orchard hygiene is essential to either remove or mulch fallen fruit which may contain developing larvae.

Pupae – Larvae leave the fruit and move to the soil where they burrow into the top 25-50 mm to pupate. The pupal stage lasts for 10-14 days. Pupae in soil can be controlled by either drenching with an approved insecticide, cultivation of the soil, or solarisation. After eclosion (emergence from the pupal case), newly emerged QFF disperse to seek a protein food source to allow them to develop to sexual maturity.

Immature adult QFF are attracted to protein bait sprays such as Fruition Natflav 500, and protein-baited traps.

Studies show that feeding on protein hydrolysate or yeast autolysate significantly increases fecundity in *Bactrocera dorsalis*, *B. cucurbitae* and *Ceratitis capitata*. These studies date back nearly 70 years (Hagen & Finney, 1950).

The effect of nutrition on mating performance of adult QFF has been reviewed by Taylor *et al*. (2013): tephritid fruit flies emerge from the pupal stage to the adult stage with immature reproductive organs and need to forage for the nutrients required for them to complete their reproductive development, and hence reach sexual maturity. Typically adult QFF require carbohydrates, amino acids, minerals, sterols, vitamins and water, and they can be seen foraging over leaf and fruit surfaces in their search for these nutrients. Yeast hydrolysates such as Fruition Natflav 500 are a rich source of these nutrients.

Protein-baited traps are less effective than protein bait sprays in reducing QFF numbers.

Mature, egg-laying QFF are attracted to ripening fruit; QFF are attracted to blue-coloured spheres.

A significant amount of research has demonstrated that fruit flies are attracted to oviposition sites on host plants by a range of chemicals emitted by ripening fruit (for example: Kamala Jayanthi *et al*., 2014; Kamala Jayanthi *et al*., 2012; Siderhurst & Jang, 2006), and that fruit flies exhibit colour and shape preferences when seeking host plants for oviposition (for example: Drew *et al*., 2006; Drew *et al*., 2003; Hill & Hooper, 1984; Jiji *et al*., 2005; Prokopy *et al*., 1990; Prokopy & Owens, 1983; Quilia *et al*., 2014; Rajitha & Viraktamath, 2005; Ravikumar & Viraktamath, 2007; Said *et al*., 2016; Wu *et al*., 2007). QFF show a colour preference for blue surfaces (Drew *et al*., 2003).

These two facts are the science behind the Fruition Trap.

Dispersal – fruit flies move from orchard to orchard and, in some circumstances, from region to region.

Research to determine the short and long range dispersal potential for QFF has been conducted by Fletcher (1973, 1974), MacFarlane *et al.* (1987) and Drew *et al.* (1984), amongst others, and reviewed by Meats & Edgerton (2008). Meats & Edgerton (2008) showed that the mean dispersal distance by adult flies emerging from the puparium was approx. 120 metres, with 90% of flies travelling less than 800 metres, although there was a consistent trend showing a small number of flies travelling at least 85 km. The work by MacFarlane *et al.* (1987) showed that flies can disperse up to 94 km, with trap catches indicating that flies moved together over long distances. This potential for long distance dispersal is confirmed by Drew *et al.* (1984). This suggests that mating could occur and that new infestations could result from the long-distance migration of adults.

Fletcher (1973, 1974) proposed that there are three distinct categories of dispersal for QFF which are independent of the availability of host trees at the point of emergence of the adult flies: a post-teneral dispersive stage (immediately after the adult emerges from the puparium), a phase of host-seeking, and dispersal flights as a response to adversity. Fletcher (1974) further demonstrated that laboratory reared flies can disperse over an area of several hundred square miles within a few weeks of being released into an orchard.

Work by Gilchrist & Meats (2009), based on survey data conducted in 2002-2004, suggests that QFF overwinter successfully in or around Deniliquin and Narrandera, and that the population which is established in the area bounded by

Temora, Cootamundra, Tumut, Henty, Wodonga, and Wagga Wagga acts as a source of infestation westwards.

Research over the past six decades has demonstrated that –

1. Protein (amino acids) is essential in the diet of newly emerged, sexually immature adult fruit flies in the first 1-2 weeks of their life to allow them to reach sexual maturity;
2. Protein bait sprays mixed with an appropriate insecticide are effective in attracting and killing immature male and immature female flies in crops before they reach sexual maturity;
3. Mature, mated females, with eggs to oviposit into fruit, do not seek protein;
4. Mature egg-laying females have a poor response to protein and protein bait sprays but a strong response to ripe fruit odours, and they exhibit colour and shape preferences in finding oviposition sites;
5. Mature egg-laying QFF that have oviposited and live longer may seek low levels of protein to develop another cycle of eggs;
6. QFF overwinter as adult flies, with adult females undergoing an ovarian diapause, after which they require a protein meal to re-commence egg laying;
7. QFF females do not lay eggs in fallen fruit;
8. Cue-lure-baited traps attract mainly sexually mature male fruit flies;
9. QFF adults can, in some circumstances, travel significant distances.

DEVELOPMENT OF THE FRUITION TRAP FOR MONITORING & TRAPPING OF QUEENSLAND FRUIT FLY

FRUITION

The lure used in the Fruition Trap was developed by comparing the volatile chemicals produced by unripe fruit to those produced by ripe fruit. Once the identity and relative importance of these volatiles was confirmed in laboratory trials, various combinations were tested in the laboratory in a range of ratios for QFF attractancy. Several combinations that showed the highest levels of QFF attraction were then chosen for further development until an optimum formulation was identified.

Field cage data, as well as data from field releases of laboratory-reared QFF in south-east Queensland, demonstrated clearly the advantage of combining the Fruition lure with a trap using a specific combination of blue colour, spherical shape, and size preferred by QFF:

Table 1:
Field cage data comparing trap counts of sexually mature QFF caught on a blue spherical trap vs those caught on a combination of the blue spherical trap + lure.

	24 hour count			5 day count			Total fruit flies trapped
	MALE	FEMALE	Sex ratio	MALE	FEMALE	Sex ratio	
Blue sphere trap	73	82	1 : 1.2	39	34	1 : 0.9	228
Blue sphere trap + lure	112	241	1 : 2.2	221	277	1 : 1.25	851
Preference for trap + lure vs trap only	1.5 : 1	2.9 : 1		5.7 : 1	8.1 : 1		3.7 : 1

The 24-hour trap counts show clearly that sexually mature egg-laying QFF are more attracted to the trap + lure combination than mature males, although the males do show a slight preference for the trap + lure combination. The mature egg-laying QFF are more attracted to the trap + lure combination because they are seeking oviposition sites, and hence are attracted to the lure odours which mimic those emitted by ripe fruit.

In the 5-day trap counts, the sex ratio for the trap + lure combination is much closer to 1 : 1 because the trial was conducted in a field cage where resting surfaces were limited and, over this period of time, male flies had more chance to encounter the trap surface. The data also show that the trap + lure combination attracted significantly more flies of both sexes by day 5 compared to the trap only treatment.

Table 2:
Trap data comparing field performance of traps with and without Fruition lure in trapping lab-reared, field-released sexually mature QFF, south-east Queensland, 2014.

Trap Type	Female QFF trapped	Male QFF trapped	Total QFF trapped
Blue sphere	12	3	15
Blue sphere + Fruition lure	25	0	25

Approximately 200 mature, mated QFF were released. 50:50 male: female ratio. Traps were assessed at 4 hours after release.

This data shows clearly that the combination of the Fruition lure + blue spherical trap captures significantly more sexually mature egg-laying female QFF than the blue spherical trap alone.

Further work in the field in south-east Queensland confirmed that the combination of Fruition lure + blue trap was significantly better at trapping adult QFF than the trap alone, and that the Fruition Trap was effective against other pest fruit fly species (*B. neohumeralis*, *B. jarvisi*, *B. cucumis*) and *D. pornia*. Additional trials are being conducted to evaluate which colours are most efficient in attracting other important Australian pest fruit fly species.

Mount Tamborine, Queensland, 2014: A field trial was conducted in an avocado orchard to evaluate the attractancy of a blue spherical trap + Fruition lure to QFF and other fruit fly species, compared to a cue-lure trap. Assessments were carried out on a weekly schedule.

Table 3:
Mt Tamborine trial, 2014, avocados – sex and species of fruit flies caught on blue spherical traps combined with the Fruition lure over a 5-week period.

ASSESSMENT NUMBER	*B. tryoni*			*D. pornia*		
	FEMALE	MALE	TOTAL	FEMALE	MALE	TOTAL
1.	3	1	4	15	1	16
2.	5	1	6	16	1	17
3.	4	0	4	4	0	4
4.	5	0	5	2	0	2
5.	0	0	0	3	0	3
TOTAL	17	2	19	40	2	42
Sex ratios	% female flies trapped		89.5%	% female flies trapped		95.2%

Assessments were approximately 7 days apart

The blue spherical trap in combination with the Fruition lure was effective in trapping female QFF and female *D. pornia*, with some small numbers of male flies of each species also being trapped. The data demonstrated field efficacy of the lure in attracting field populations of QFF and *D.pornia*.

The cue-lure-baited trap captured only male fruit flies. It was effective in trapping QFF and *B. neohumeralis*, but had no effect on *B. cucumis* or *D. pornia*.

Beaudesert, Queensland, 2015: In a series of trials, the Fruition Trap was compared to two commercially available fruit fly traps for attractancy to sexually mature QFF. In one trial (Table 4, below) 3-week-old QFF adults (male and female flies) reared in a laboratory and fed protein were released at two sites and total trap catches recorded at 3 hours after release.

Table 4:
Comparison of Fruition Trap with two commercially available fruit fly traps for trapping sexually mature adult QFF in south-east Queensland.

	Site 1		Site 2	
	FEMALES	MALES	FEMALES	MALES
Fruition Trap (Fruition lure + Fruition Trap)	98	0	99	1
Hydrolysed protein liquid/ McPhail trap	1	0	10	0
Cue-lure & gel protein baited McPhail trap	1	61	0	71

This demonstrates that the Fruition Trap is highly effective in attracting and trapping mature, egg-laying female QFF, and confirm the findings of a significant body of scientific literature that mature, egg-laying female QFF are not attracted to either protein baits or cue-lure + protein traps. Immature fruit flies of both sexes are attracted to protein sources as they both require protein to progress to sexual maturity. Mature male fruit flies are attracted to cue-lure, as demonstrated by the high numbers of male QFF caught in the cue-lure + protein trap in this trial. It is mature, egg-laying QFF that cause crop damage and loss – this is the part of the population which is preferentially attracted to Fruition Traps.

Two further trials were conducted at Beaudesert, Queensland in 2015 to compare the Fruition Trap to two commercially available fruit fly traps for attractancy to sexually immature QFF. One-week old QFF adults (male and female flies) reared in a laboratory and starved of protein were released at two sites, and total trap catches recorded at 3 hours after release.

Table 5:
Comparison of Fruition Trap with two commercially available fruit fly traps for trapping sexually immature adult QFF in south-east Queensland.

	Site 1		Site 2	
	FEMALES	MALES	FEMALES	MALES
Fruition Trap (Fruition lure + Fruition Trap)	12	2	5	3
Hydrolysed protein liquid/ McPhail trap	34	39	27	58
Gel protein-only baited McPhail trap	20	25	48	71

These two trials show clearly that traps baited with protein are more effective than the Fruition Trap in attracting immature adult QFF, and that they attract roughly equal numbers of immature male and immature female flies as these flies need to feed on protein to progress to sexual maturity. Although the Fruition Trap was moderately successful in attracting immature females, it is not as effective as protein baits in attracting this segment of the population.

Spring Creek, Queensland, 2015 – Mangoes: In early 2015, a field trial was conducted at Spring Creek, near Gatton, in south-east Queensland in a commercial orchard of Kensington Pride mangoes to evaluate an early prototype Fruition Trap consisting of blue-coloured adhesive-coated interlocking discs and a wicked tube to release the lure for its ability to attract QFF. Fruition Traps were the only control strategy used over a 5-week period as the mangoes transitioned from the mature green stage to fully ripe and they were deployed at a rate of one trap per tree. The trees under the Fruition Trap program were compared to two untreated Kensington Pride mango trees, approximately 250 metres away from the trial site. Trapped flies were counted and identified on a weekly basis and fruit were sampled on several occasions during the trial.

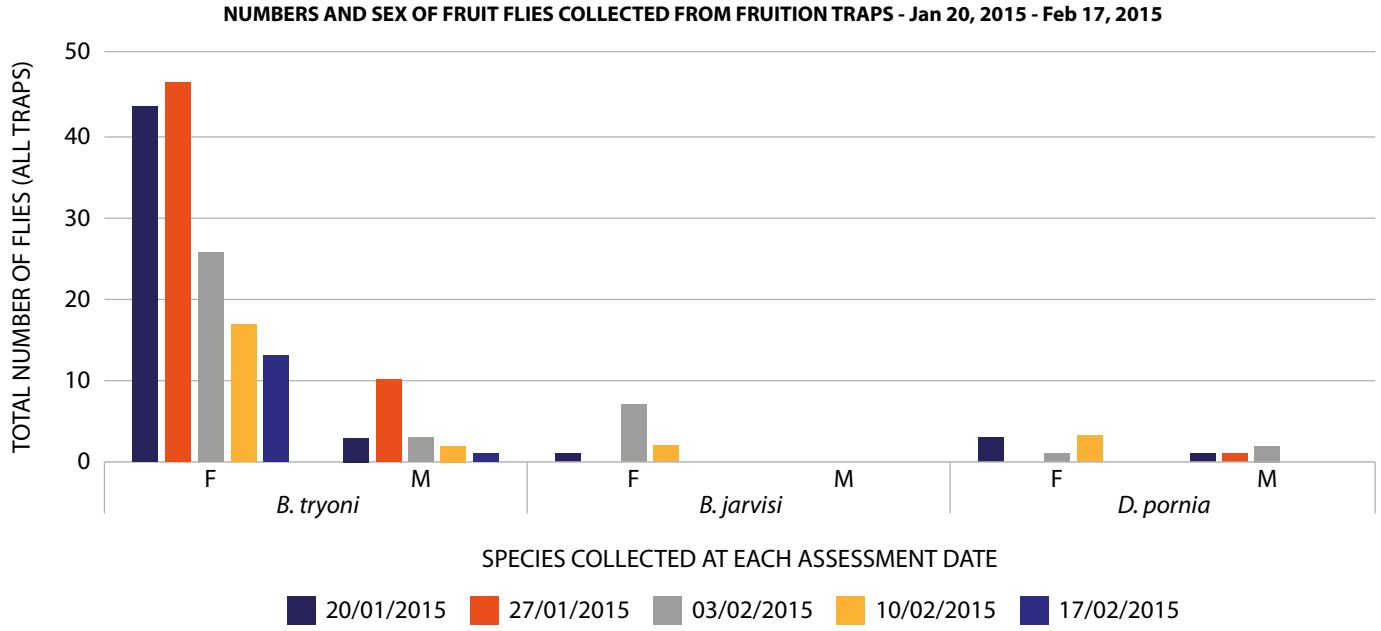

Figure 4: Numbers and sex of fruit flies collected from Fruition Traps – mangoes, Spring Creek.

Mango fruit harvested from trees in which traps were located had lower levels of infestations of QFF larvae than trees without traps, 2.8–8% compared to 20–25% infestation. Results indicated that Fruition Traps may be used in low susceptibility crops in the presence of low populations of fruit flies as the only control technique.

The trial demonstrated the effectiveness of the Fruition Trap technology in monitoring QFF populations and providing a level of control of larval infestations in fruit, despite the absence of the regular applications of appropriately timed protein bait sprays and other fruit fly management treatments.

Gatton, Queensland, 2016 – Feijoa: A trial was conducted in a commercial feijoa orchard to evaluate the efficiency of the Fruition Trap in attracting and trapping QFF under field conditions. The feijoa orchard was a part of a mixed fruit farm which grew low chill stone fruit (maturing in September–October, 2015), mangoes (maturing November 2015–January 2016), persimmons (maturing February–March 2016), and custard apples (maturing April 2016). The feijoa matured February–April 2016. This crop ripening sequence ensured heavy pest pressure in the trial site.

The farmer used spinosad + protein bait spray, applied weekly from January 4 2016 until March 2 2016, with very little control, hence the significant pest pressure at the start of the trial.

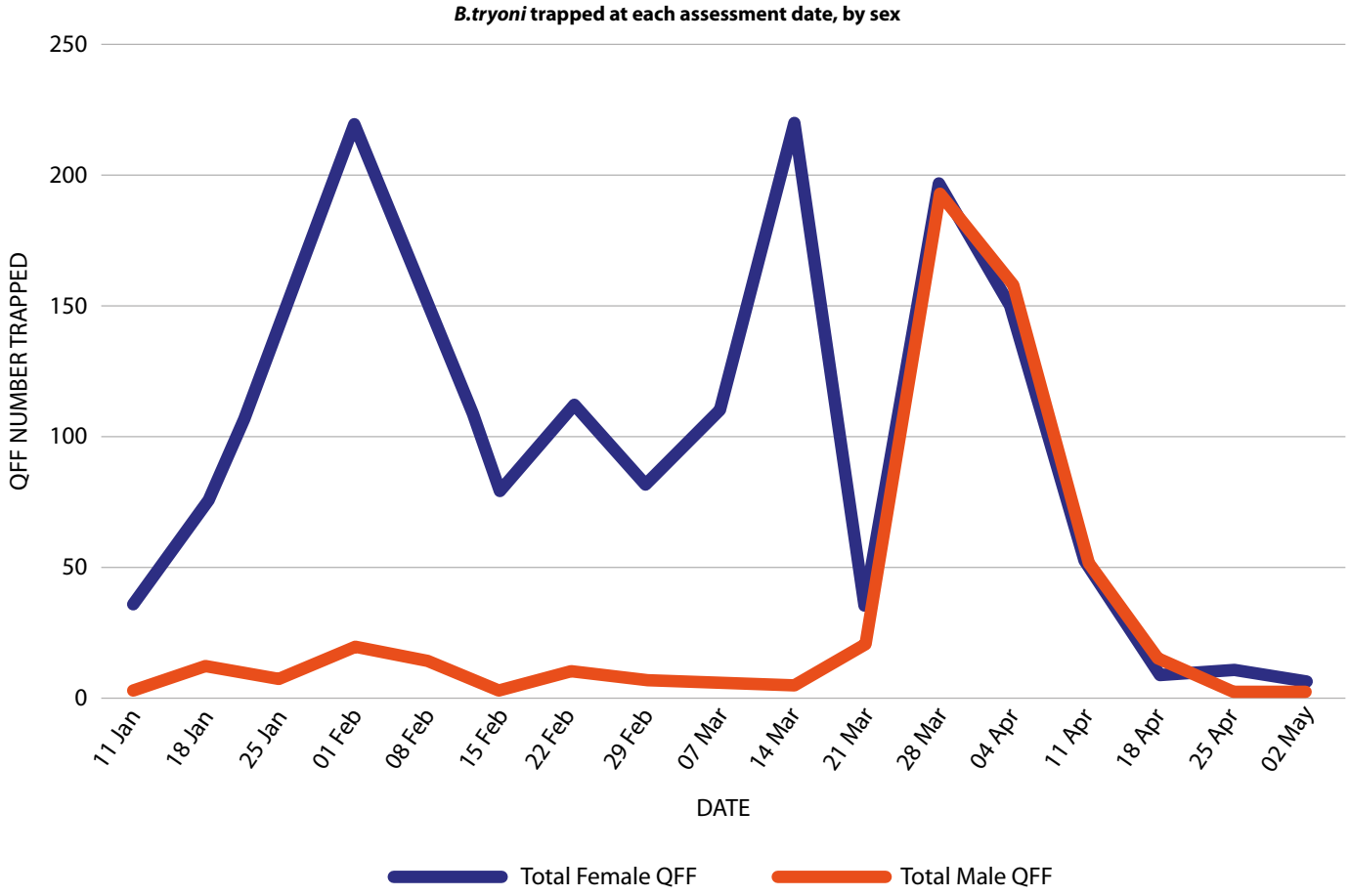

Figure 5: Numbers and sex of QFF collected from Fruition Traps – feijoas, Gatton

The majority of QFF trapped prior to March 21 were females, with relatively few male QFF trapped (Fig. 4). This is because these flies were mature adults, with the females being attracted to the Fruition Trap by the lure mimicking the aromas of ripe fruit. After this date, the sex ratio was close to 1:1 due to the emergence of large numbers of immature QFF in the trial site. This can be explained by the fact that immature male and female QFF are attracted to both the colour and shape of the trap, rather than mature egg-laying females being attracted to the aroma of the lure.

The trial demonstrated that the Fruition Trap is effective in trapping mature egg-laying QFF. Newly emerged male and female QFF are attracted only to the colour and shape of the Fruition Trap, while mature egg-laying QFF are attracted to the lure and to the colour and shape of the trap.

Increasing numbers of trapped mature egg-laying QFF over time give a good indication as to when additional control measures, such as protein bait spraying should commence.

Over the duration of the trial, the Fruition Traps also attracted and trapped considerable numbers of *B. cucumis*, *B. jarvisi*, *B. neohumeralis* and *D. pornia*, thereby demonstrating the potential for the Fruition Trap to be developed for the monitoring and control of these other pest species.

The conclusion from this trial is that the Fruition Trap system can be used for monitoring QFF populations, and potentially for controlling QFF when used in combination with protein bait spraying.

COMMERCIAL EXPERIENCES WITH THE FRUITION FRUIT FLY MANAGEMENT SYSTEM

FRUITION

The Fruition Fruit Fly Management System comprises the use of Fruition Traps for monitoring and trapping of mature, egg-laying QFF, combined with the use of Fruition Natflav 500 protein bait spray for control of immature male and immature female QFF, in an Integrated Pest Management (IPM) system. This IPM system should include orchard hygiene and foliar cover sprays (where permitted) in a season-long program to manage QFF populations to below economic threshold levels.

Spring Creek, south-east Queensland, 2017 – Persimmons: A trial was conducted in a commercial persimmon orchard at Spring Creek, near Gatton, south-east Queensland, to determine which species of fruit fly would be trapped by the Fruition Trap. Forty-two Fruition Traps were deployed across the trial site, equivalent to a density of 51 traps per hectare, on January 18, 2017 and trap catches assessed on February 27 and April 10, 2017. At each of the two assessment dates, fruit flies were removed from the traps and taken to the laboratory for identification.

Significant numbers of QFF were trapped over the period February to April 2017:

Table 6:
Numbers of *B. tryoni* and *B. jarvisi* collected from all Fruition Traps

DATE	*B. tryoni*			*B. jarvisi*		
	FEMALES	MALES	TOTAL	FEMALES	MALES	TOTAL
27/02/2017	39	13	52	2	1	3
10/04/2017	85	23	108	0	0	0
Total	124	36	160	2	1	3

This trial demonstrated that the Fruition Trap was effective in attracting and capturing QFF, particularly mature egg-laying QFF, and also trapped numbers of *B. jarvisi*. The sex ratio of QFF caught on the traps over the duration of the trial was 124 females to 36 males (78% females).

The trial also demonstrated that the Fruition Trap can be used for monitoring QFF populations, and can be effective for the control of QFF when combined with appropriately timed protein bait spraying.

Spring Creek, south-east Queensland, 2017 – Custard apples: A trial was conducted in a commercial custard apple orchard at Spring Creek, near Gatton, south-east Queensland, to determine which species of fruit fly would be trapped using the Fruition Trap. Forty-four Fruition Traps were deployed across the trial site on March 21, 2017 at a density of 61 traps per hectare.

Significant numbers of QFF were trapped over the period March to May 2017. This trial demonstrated that the Fruition Trap was effective in attracting and trapping QFF, particularly mature egg-laying females. The sex ratio of QFF caught on the traps was 126 females to 44 males (74% females).

Table 7:
Numbers of females and males of *B. tryoni* collected from all Fruition Traps

DATE	09/05/2017								TOTAL
ROW	Row 1#	Row 2	Row 3	Row 4	Row 5	Row 6	Row 7	Row 8	
Females	4	15	11	12	19	30	21	14	126
Males	1	2	5	4	8	10	11	3	44
Total	5	17	16	16	27	40	32	17	170

= Note that row 1 had only two traps in it, the other seven rows each had six traps.

Fifteen island flies (*Dirioxa pornia*) were also collected on the Fruition Traps in this trial.

The trial demonstrated that the Fruition Trap can be used for the monitoring of QFF populations and can be effective for the control of QFF when combined with a program of appropriately timed protein bait spraying.

Hogarth's Range, Casino, NSW, 2017 – Low chill peaches: A commercial scale grower trial was conducted on an orchard of approximately 1.5 hectares of low chill peaches, varieties Beauty, QF1 and Gold at Casino, NSW. The peaches flowered in July, 2017.

The grower applied cover sprays of fenthion in previous seasons, while in 2016 he applied alpha-cypermethrin and clothianidin cover sprays.

2017 program	Fruition Fruit Fly Management System:
August 3	Deployed Fruition Traps at the rate of 15 traps/ha across the 1.5 hectares; Sprayed gelatinised Fruition Natflav 500 @ 5 L/100 L + maldison 1150 g/L EC @ 435 mL/100 L;
August 17	Sprayed gelatinised Fruition Natflav 500 @ 5 L/100 L + maldison 1150 g/L EC @ 435 mL/100 L;
August 18	A review of orchard monitoring data suggested an increase in Fruition Traps deployed (small numbers of flies detected on some traps); weather still cool;
August 24	Sprayed gelatinised Fruition Natflav 500 @ 5 L/100 L + maldison 1150 EC @ 435 mL/100 L;
September 12	Clothianidin 500 g/kg WG @ 40 g/100 L applied for control of Oriental Fruit Moth (*Cydia molesta*; OFM);
September 17	Trap density increased from 15 traps/ha to 30 traps/ha;
September 21	First picking commenced;
September 28	Clothianidin 500 g/kg WG @ 40 g/100 L applied for control of OFM; Most Fruition Traps had 1–2 fruit flies, some traps had no fruit flies, average around 0.8/trap;
September 30	Sprayed gelatinised Fruition Natflav 500 @ 5 L/100 L + maldison 1150 EC @ 435 mL/100 L;
October 1	Main picking began;
October 5	An additional 30 traps deployed across the orchard;
October 14	120 mm rain received; rain continued daily until October 30;
November 11	Fruit affected by wet weather – a significant percentage of the fruit were split following a number of days of showery weather;

Comments:

There would have been minimal control of immature fruit flies from the protein bait sprays due to the extended application intervals (the recommendation is to apply every 7 days).

Applications of clothianidin for control of OFM would have given some control of fruit flies for the latter part of September.

There was a significant delay between the decision being made to increase trap numbers (August 18) and traps actually being deployed (September 17).

This orchard had traditionally come under heavy pressure from QFF. Using the Fruition Traps and Fruition Natflav 500 protein bait sprays, the level of fruit fly infestation was very low, and limited to stings on 6 pieces of fruit.

Grower comments:

The use of cover sprays was reduced from an average of 6–8 in previous seasons to 2, with the advantage that there was less insecticide applied and less time spent on application.

The use of Fruition Traps resulted in the establishment of a good monitoring discipline for QFF; most Fruition Traps had 1–2 QFF, while some traps had none.

This season saw lower QFF pressure than normal, with few stings noted on fruit and no obvious fruit drop due to QFF damage.

The grower will use the system again now that he is more confident with a program that includes Fruition Traps.

Tatura, Victoria, 2017 – Packham pears: A trial was conducted in Packham pears in a commercial orchard in Tatura, Victoria. Fruition Traps were deployed at a rate of 35 traps per hectare in late November 2017 to a section of the orchard where QFF pressure had been very high in previous seasons. The number of traps was increased to 85 per hectare on December 22, given the history of very high pressure in the block and the fact that QFF had been caught in a Fruition Trap in the previous week. The block was bordered by residential areas of Tatura, and this was the source of the QFF pressure. The grower estimated that he had lost 20–30% of his fruit from the trial area in the previous season.

Traps were examined weekly for presence of QFF and numbers of trapped flies recorded. The area was sprayed weekly with gelatinised protein bait spray + maldison. On two occasions this weekly program was extended, resulting in increased pest pressure. Cue-lure traps were deployed in the trial area and data was collected from these weekly and compared to the district average cue-lure trap catch (Figure 6 below):

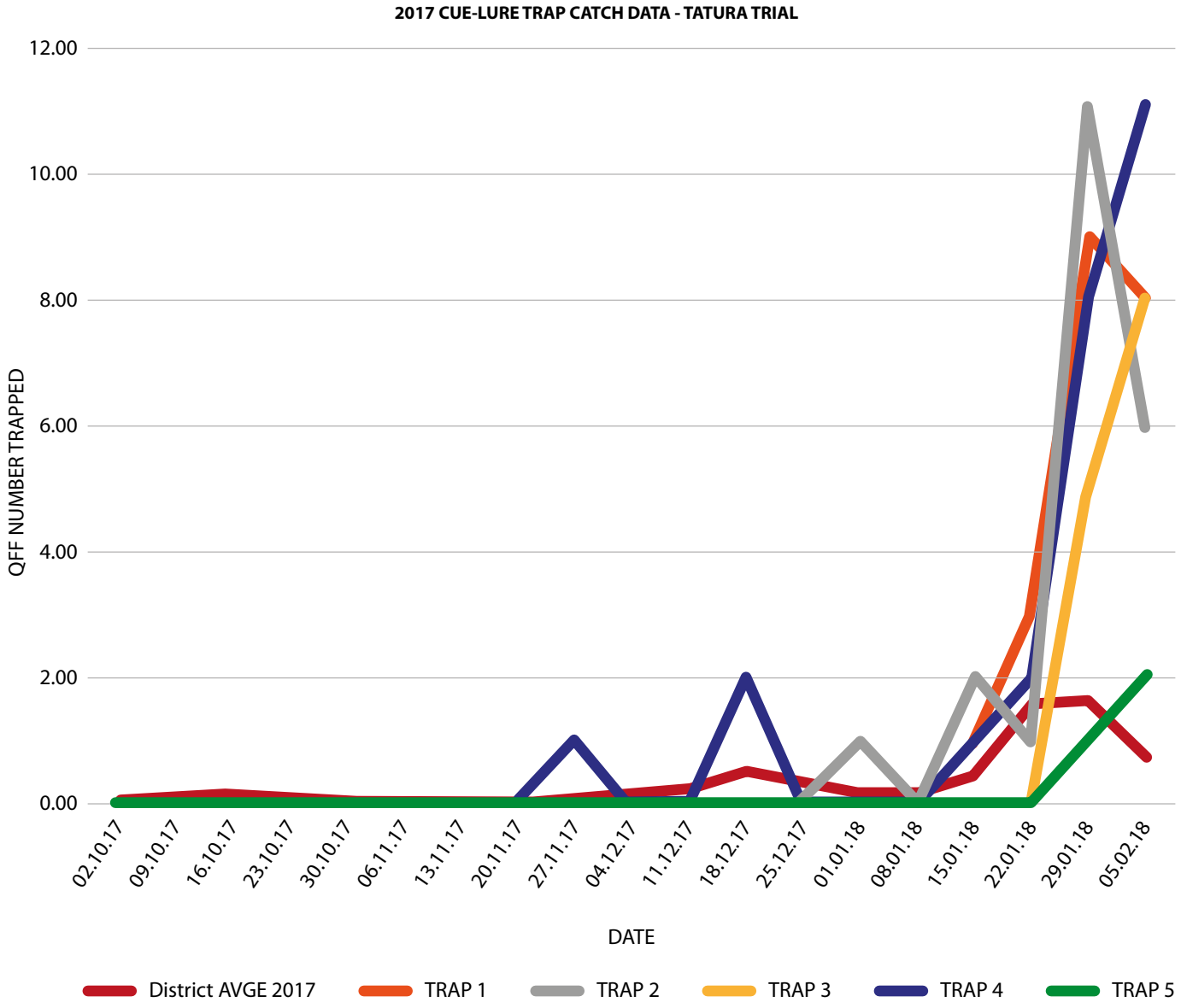

Figure 6: Weekly numbers of QFF caught in cue-lure traps - Packham pears, Tatura.

The population build up in the orchard started in late January, mirroring the population build-up in the district (Fig. 5).

Comparison of the cue-lure trap data with the Fruition Trap data (Figure 7 below) indicates that both trap types confirmed a build-up in the QFF population between January 22 and January 29. The average numbers of QFF caught in the Fruition Traps was significantly less than the number for the cue-lure traps and this is consistent with expectations from all of the previous trial data based on the percentage of egg-laying QFF in a normal population.

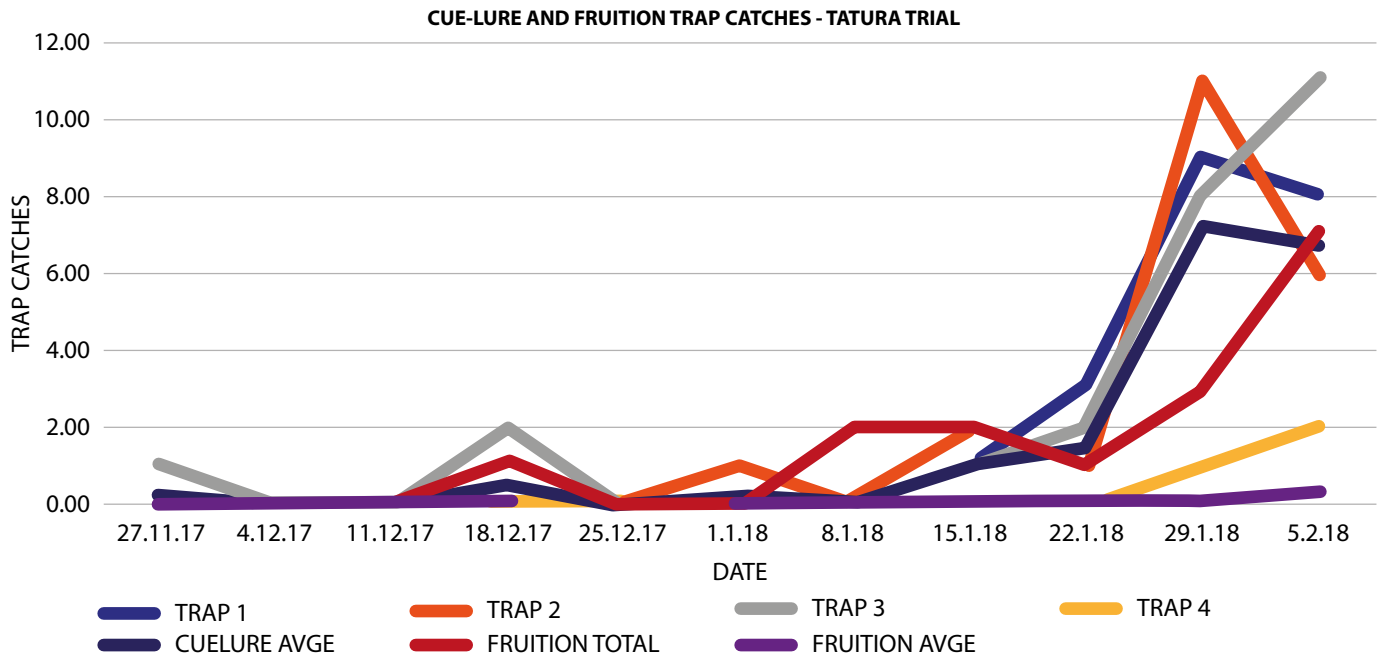

Figure 7: Tatura trial, 2017/18, Packham pears – weekly cue-lure trap catch data compared to weekly Fruition Trap catch data. A comparison of the cue-lure trapping data for the orchard between the 2016 season and the 2017 season indicated that the QFF pressure was approximately 4 times higher in 2017 than in 2016.

Despite the higher pest pressure in the 2017 season, the grower estimated that his damage in the Fruition Traps block was approximately 5–10% compared to 20–30% in the previous season.

Figure 8: Fruit fly infested pears (yellow fruit) compared to healthy pears (green fruit), Tatura, February, 2018.

ATTRACTANCY OF FRUITION TRAPS TO OTHER PEST FRUIT FLY SPECIES

Cucumber fly (*Bactrocera cucumis*)
Cucumber fly is present in Queensland and northern NSW and is recognised as a pest of cucurbit crops, tomatoes and, occasionally, capsicums. *B. cucumis* does not respond to cue-lure or zingerone but is attracted to the lure used in Fruition Traps. Fruition Traps may be able to be used in an IPM program to monitor, trap and manage *B. cucumis* populations. Field trials have demonstrated that *B. cucumis* is more strongly attracted to yellow Fruition Traps than to blue Fruition Traps.

Jarvis' fly (*Bactrocera jarvisi*)
Jarvis' fly is the major fruit fly pest in the Northern Territory and northern WA. It is also present along the Queensland and northern NSW coast from Cape York to Coffs Harbour. *B. jarvisi* is attracted to the lure in Fruition Traps, and the traps can be used in IPM programs to monitor, trap and manage *B. jarvisi* populations. *B. jarvisi* does not respond to cue-lure but does respond to zingerone. Like *B. cucumis*, field trials have demonstrated that *B. jarvisi* is more strongly attracted to yellow Fruition Traps than to blue Fruition Traps.

Lesser Queensland fruit fly (*Bactrocera neohumeralis*)
Lesser Queensland fruit fly has a similar geographic distribution to QFF on the east coast but it has not been recorded in the NT. It is very difficult to distinguish from QFF; it is attracted to Fruition Traps which can be used in IPM programs to monitor, trap and manage *B. neohumeralis* populations. Field trials have demonstrated that *B. neohumeralis* shows a preference for yellow Fruition Traps.

Mediterranean fruit fly (*Ceratitis capitata*)
Trials are being conducted in Western Australia to confirm that medfly are attracted to Fruition Traps, and to determine how Fruition Traps could best be used in IPM programs to manage medfly populations.

Island fly (*Dirioxa pornia*)
Island fly is not attracted to any of the commercially available male lures, or to protein bait sprays. However, it is attracted to the Fruition Trap, which can capture significant numbers of this pest. Fruition Traps can help reduce populations of island fly in the field, reducing the risk of produce being contaminated through oviposition in the field.

NON-TARGET IMPACT

Fruition Traps have no impact on bees or beneficial insects. There has been no indication in any of the trial work that either the blue trap colour and shape or the lure are attractive to bees or other beneficial insects.

CONCLUSION

Fruition Traps attract and capture mature egg-laying QFF through a unique combination of colour, shape and aromatic lure.

Fruition Traps will also attract and capture other adult stages of QFF: field trials indicate that approximately 75-80% of QFF caught on Fruition Traps will be mature female QFF, with the remainder of trap catches being males and immature females.

Fruition Traps can be used to monitor crops for the presence of mature egg-laying QFF.

Fruition Traps can be used in IPM programs to monitor and trap QFF in combination with protein bait spraying and, where required and approved, cover spraying for the management of QFF populations in horticultural crops.

Fruition traps will attract and capture adult *B. cucumis, B. jarvisi, B. neohumeralis* and *D. pornia*

GEOGRAPHIC DISTRIBUTION OF PEST FRUIT FLIES IN AUSTRALIA

Figure 9: Geographic distribution of *Bactrocera tryoni* (Froggatt) – Queensland fruit fly in Australia (Diagram: Robyn Barnes)

Figure 10: Geographic distribution of *Bactrocera jarvisi* (Tryon) – Jarvis' fruit fly in Australia (Diagram: Robyn Barnes)

Figure 11: Geographic distribution of *Bactrocera neohumeralis* (Hardy) – Lesser Queensland fruit fly in Australia (Diagram: Robyn Barnes)

Figure 12: Geographic distribution of *Bactrocera cucumis* (French) – Cucumber fly in Australia (Diagram: Robyn Barnes)

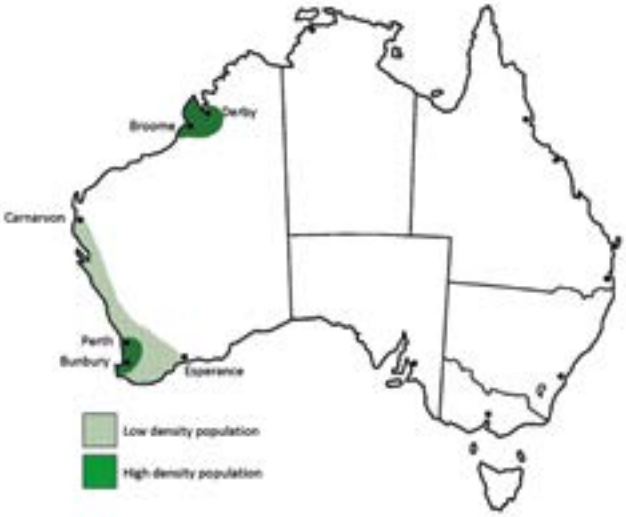

Figure 13: Geographic distribution of *Ceratitis capitata* (Wiedemann) – Mediterranean fruit fly in Australia (Diagram: Robyn Barnes)

Figure 14: Geographic distribution of *Dirioxa pornia* (Walker) – Island fly – in Australia (Diagram: Robyn Barnes)

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FRUITION TRAP LABEL

Fruition Traps are a unique new system for monitoring and, in conjunction with other control strategies, managing fruit fly populations, and were developed specifically to target mature egg-laying female Queensland fruit flies.

Fruition Traps are highly effective in attracting mature egg-laying female Queensland fruit fly (*Bactrocera tryoni*) through a unique combination of colour, shape and smell.

Mature egg-laying female Queensland fruit flies are drawn to the vicinity of the trap using aromas that resemble those of ripe fruit, and once in visual range, are able to detect the colour and shape of the trap structure. A sticky surface then traps flies in such a way that they can be easily identified and counted.
As soon as fruit flies are detected, growers should implement a full Integrated Pest Management (IPM) control program if not already commenced.

HOW TO USE FRUITION TRAPS

Fruition Traps can be used for both population monitoring and, in conjunction with other control strategies, for control of mature egg-laying female Queensland fruit flies as part of an IPM control program, when susceptible crops are fruiting. It is important to deploy Fruition Traps early in the crop for early detection and hence optimal management of fruit fly populations.

In all situations, begin protein bait spraying early, before fruit become susceptible to fruit fly infestation, and complement protein bait spraying with use of Fruition Traps to allow monitoring of fruit fly population dynamics. If numbers of mature egg-laying female fruit flies detected on Fruition Traps continue to increase following implementation of a program of Fruition Natflav 500 protein bait sprays and Fruition Traps, cover spraying of an approved insecticide may be required.

DIRECTIONS FOR USE:

PEST	SITUATION	TRAPS/HA	CRITICAL COMMENTS
Queensland fruit fly (*Bactrocera tryoni*)	Monitoring fruit fly populations	15 traps/ha	Fruition Traps are suitable for all crops where there is a need to monitor for the presence of mature egg-laying female fruit flies before crop damage occurs. For optimal management of fruit fly populations use of Fruition Traps for monitoring should commence well before the fruit becomes attractive to mature egg-laying female fruit flies i.e. from the early stages of fruit set, when fruit is still hard and green. Ideally neighbouring crops will also be monitored as these can be a source of fruit fly populations. Read section on PLACEMENT OF FRUITION TRAPS below. Fruition Traps should be monitored daily, with trap catches recorded and records maintained for each monitoring event. **As soon as fruit flies are detected on Fruition Traps a full IPM control program (as below) should be implemented to optimise fruit fly management for the season. This should include protein bait spraying with Fruition Natflav® 500 if this has not already begun.**
	Implementing a full fruit fly IPM program		Efficacy of a fruit fly control program is dependent on a range of factors including pest pressure during the season. For effective management of fruit fly, Fruition Traps should be used as part of a broader strategic control program, involving other approved products and strategies approved for the control of fruit fly. A fundamental part of any IPM program is practicing good crop hygiene, including removal of fallen fruit which may be infested with fruit fly larvae.
		15 – 30 traps/ha	Low susceptibility crops
		30 – 50 traps/ha	Moderate – High susceptibility crops
			Fruition Trap numbers may need to be greater than the minimum stated above based on a range of factors, including numbers of fruit flies trapped during the monitoring phase, crop history and susceptibility, crop canopy, size and density, crop value, surrounding crop type and maturity stage, seasonal conditions, etc. If a protein baiting program has not already started, commence applications of gelatinised Fruition Natflav 500 according to the label and reapply at least every 7 days. A registered insecticide must be included with Fruition Natflav 500 according to the insecticide label. Continue to monitor and record trap catches until immediately after final harvest to ensure that the control program is adequate. If trapped fruit fly numbers on Fruition Traps indicate high or erratic pest pressure as fruit develops and becomes more susceptible to fruit fly, additional fruit fly control measures may need to be implemented, such as insecticide cover sprays where product registrations and permits allow. Typically, an effective IPM control program will result in the number of freshly trapped fruit flies declining over time.

PLACEMENT OF FRUITION TRAPS

Fruition Traps should be placed evenly around and throughout the site.

TREE CROPS: Fruition Traps should be hung in the fruit zone, usually 1.5 to 2 metres above the ground. Ideally traps will be in the tree canopy in a location away from surrounding branches and clearly visible within the orchard.

OTHER CROPS: Fruition Traps should be hung immediately above the crop canopy (around 0.5 metres), suspended from a firmly anchored rigid support such as a 'star picket' driven into the ground, and in adjacent trees or vegetation within 5 metres from the crop where the traps can intercept mature egg-laying female fruit flies flying into the crop to lay eggs.

Ideally neighbouring crops will also be monitored as these can be a source of fruit fly populations.

FRUITION TRAPS SHOULD BE REPLACED IF:

1. Sticky surfaces are heavily covered by fruit flies or foreign objects;
2. The lure sachet has expired – the Fruition Trap gel lure in the open sachet will continue to be effective for at least 8 weeks, at which time the Fruition Trap and lure should be replaced. The attractant gel will gradually change colour from blue to very pale blue or white.; or
3. The lure sachet or trap is damaged or missing.

FRUITION NATFLAV 500

GENERAL GUIDELINES

Fruition Natflav 500 is an autolysed yeast protein bait specifically designed for application in gelatinised water, in combination with an insecticide approved for the purpose, to attract and kill immature adult QFF. Fruition Natflav 500 attracts immature adults of QFF because it contains proteins and these are necessary for the immature adults to progress to sexual maturity, mate, and lay fertile eggs.

To obtain maximum efficacy from Fruition Natflav protein bait sprays it is necessary to follow some simple guidelines:

1. Always apply Fruition Natflav 500 in gelatinised water. Gelatinised water increases the efficacy of the protein bait spray significantly, killing more QFF over a longer period of time than Fruition Natflav 500 applied in non-gelatinised water;
2. Start spray programs with Fruition Natflav 500 when fruit is hard and green, before it becomes attractive to QFF and susceptible to attack;
3. Spray early in the morning, when QFF are actively feeding;
4. Always apply Fruition Natflav 500 to the foliage of the tree, not to the trunk or vegetation beneath the tree;
5. Apply Fruition Natflav 500 at 5-7 day intervals as there is little bait remaining on foliage after 5 days. If rain falls after application then re-apply Fruition Natflav 500.

FRUITION NATFLAV 500 LABEL:

Fruition® Natflav® 500 is a premium quality yeast bait for use as an attractant in a baiting mixture with any insecticide approved for this use. The gelatinised baiting mixture is used in a baiting program for newly emerged and immature fruit flies.

When used in conjunction with Fruition® Traps according to that product label, Fruition Natflav 500 in a gelatinised baiting mixture can form part of an IPM control program for Queensland fruit fly (*Bactrocera tryoni*).

Efficacy of a fruit fly control program is dependent on a range of factors including fruit fly numbers, crop history and susceptibility, crop canopy, size and density, crop value, surrounding crop type and maturity stage, seasonal conditions, etc.

For effective management of fruit fly, Fruition Natflav 500 should be used as part of a broader strategic control program. This should involve other products approved for the control of fruit flies, including Fruition Traps which will attract and trap mature egg-laying female Queensland fruit flies.

In all situations begin protein bait spraying early, before fruit become susceptible to fruit fly infestation, and complement protein bait spraying with use of Fruition Traps to allow monitoring of fruit fly population dynamics. If numbers of mature egg-laying female fruit flies continue to increase following implementation of a program of Fruition Natflav 500 protein bait sprays and Fruition Traps, cover spraying of an approved insecticide may be required.

DIRECTIONS FOR USE:

USE IN COMBINATION WITH AN INSECTICIDE APPROVED FOR THIS USE AS PART OF AN IPM PROGRAM FOR CONTROL OF FRUIT FLIES.

SITUATION	PEST	RATE	CRITICAL COMMENTS
Crops susceptible to fruit fly attack	For example: Queensland fruit fly (*Bactrocera tryoni*), Lesser Queensland fruit fly (*Bactrocera neohumeralis*), Jarvis' fly (*Bactrocera jarvisi*), Cucumber fly (*Bactrocera cucumis*)	Fruition Natflav 500: 2-6 L/100 L gelatinised water, PLUS Recommended rate of approved insecticide	The following recommendations are provided as a general guide. Always adhere to the approved insecticide label for specific directions for use. Yeast autolysate protein products can cause crop phytotoxicity. Always adhere to the approved insecticide label directions to reduce the risk of crop phytotoxicity. Follow the withholding period provided on the label of the insecticide being used. Protein bait sprays attract and kill immature male and female fruit flies both of which require protein to reach sexual maturity. Higher use rates of Fruition Natflav 500 will increase bait attractiveness. Apply 50-100 mL of gelatinised Fruition Natflav 500 plus insecticide baiting mixture per tree as a coarse spray. For optimal control of fruit flies, gelatinised Fruition Natflav 500 plus insecticide bait applications should commence well before the fruit becomes attractive to mature egg-laying female fruit flies i.e., from the early stages of fruit set, when fruit is still hard and green. Fruition Natflav 500 must ALWAYS be applied using gelatinised water for maximum efficacy and increased bait resistance to weathering. Repeat applications as per the instructions on the label of the insecticide being mixed with Fruition Natflav 500, and at least every 7 days. Rainfall will wash the baiting mixture off the crop: it will be necessary to reapply the baiting mixture following rainfall. Avoid application of the baiting mixture to fruit or other edible commodities.
Citrus – additional instructions			Critical comments as above for crops susceptible to fruit fly attack. Apply as above OR at 15-20 L/ha total volume as a 30 cm band at skirt level of trees for area wide control.
Vegetables and berry crops			Critical comments as above for crops susceptible to fruit fly attack. Do not apply directly to crop. Spray perimeter vegetation around the outside of the crop. Where Queensland fruit fly is specifically being targeted apply the spray at a height of 1.5-2 m onto the perimeter vegetation; where cucumber fly is being targeted, apply the spray at a height of 0.5-1 m onto the perimeter vegetation.
Crops susceptible to fruit fly attack	Mediterranean fruit fly (*Ceratitis capitata*)		The following recommendations are provided as a general guide. Always adhere to the approved insecticide label for specific directions for use. Yeast autolysate protein products can cause crop phytotoxicity. Always adhere to the approved insecticide label directions to reduce the risk of crop phytotoxicity. Follow the withholding period provided on the label of the insecticide being used. Protein bait sprays attract and kill immature male and female fruit flies both of which require protein to reach sexual maturity. Commence weekly bait spraying when fruit is half size. Where Mediterranean fruit fly pressure is expected to be high, begin bait spraying at fruit set. SPOT APPLICATION: Apply 50-100 mL of bait mixture in coarse droplets (4-6 mm in size) to foliage. Apply to every tree in a row; alternate the sides treated at each application. BAND SPRAY: Apply as a band spray to each tree in a row or, with a spray rig set up to spray both sides of a row, travel up and down every second row so that trees are not being double sprayed.

SITUATION	PEST	RATE	CRITICAL COMMENTS
Crops susceptible to fruit fly attack (continued)			It is recommended to continue bait spray applications for at least 4 weeks after harvest to ensure that flies emerging from the soil are controlled. Continue treating any citrus trees while fruit remains on other trees as citrus are favoured resting places for Mediterranean fruit fly. Bait spraying in Autumn is recommended as Mediterranean fruit flies present at this time are the source of infestation in the following spring.

PREPARATION

The day prior to spraying the baiting mixture prepare gelatinised water by adding Fruition Xanthan Gum powder to water at a rate of 5 g/L and agitating thoroughly.

On the day of application, mix the gelatinised water thoroughly until a uniform consistency is achieved. Prepare the baiting mixture by adding Fruition Natflav 500 at a rate of 2 to 6 L/100 L of gelatinised water in combination with HY-MAL® INSECTICIDE or an alternative insecticide approved for this use according to the DIRECTIONS FOR USE table on the insecticide label.

Agitation should be maintained throughout the mixing process and until application is completed. Only prepare enough baiting mixture for use on the day of application.

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Always refer to the product label for full directions for use.

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