DETECTING LOW POPULATIONS OF QUEENSLAND FRUIT FLY *BACTROCERA TRYONI* (FROGGATT) WITH MCPHAIL AND LYNFIELD TRAPS

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Summary

A comparison of the effectiveness of McPhail traps using citrus and protein autolysate wet baits and the Lynfield trap using cuelure showed that the cuelure system was significantly better at detecting low levels of sterile Queensland Fruit Fly present in March at Griffith, New South Wales. There is no value in the continued use of McPhail traps for monitoring Queensland Fruit Fly outbreaks New South Wales Fruit Fly Exclusion Zone in the March-April period.

Keywords: *Bactrocera tryoni*, fruit fly traps

INTRODUCTION

Fruit flies are a pest throughout the world and most countries monitor for endemic and potentially introduced flies. While the monitoring of high population numbers is generally not difficult for most species of fruit flies, the detection of small populations is more difficult.

For Queensland fruit fly, *Bactrocera tryoni* (Froggatt) (QFF), Wilson's lure or raspberry keytone {4-(*p*-hydroxyphenol)-2-butone} was discovered in Australia in about 1959. Cuelure, {4-(*p*-acetoxyphenol)-2-butone} the stabilised precursor of raspberry keytone, was reported by Alexander *et al.* (1962). Cuelure breaks down to raspberry keytone, particularly in the presence of moisture. Raspberry keytone occurs naturally in many plants and is accumulated in the rectal glands of male flies (Tan and Nishida 1995). This compound is produced by male QFF to attract other males into a mating site, and is one of the many signals used to entice females into the mating site.

Different devices were used to house mixtures of attractant and insecticide (to kill the flies attracted to the lure). O'Loughlin *et al*. (1983) reported that the Jackson trap was superior to Steiner traps and the Dak-pot® type of trap. Drew (1982) discussed the relative merits of Steiner, Israeli, Bateman, Jackson and McPhail traps. Cowley *et al*. (1990) reported on the improved performance of the Lynfield trap. These were subsequently adopted in the New South Wales portion of the Fruit Fly Exclusion Zone (FFEZ) (Keenan 1994, Anon. 1997).

Before the development of cuelure, QFF had been trapped using a "wet" trap, commonly the McPhail trap (McPhail 1939), using a solution of food-based lures such as orange concentrate or protein-based lures. Food-based lures attract both males and females but Lynfield traps using cuelure only catch QFF males. Cuelure attracts male flies over longer distances than food-based lures (Drew 1982).

According to the Code of Practice for the Management of Queensland Fruit Fly (Anon.1997), following the detection of two male flies in a standard monitoring grid using Lynfield traps, 15 supplementary Lynfield traps and 16 McPhail traps (using the citrus or protein food lure) are to be deployed within 200 m around the original trappings. This intensifies the trapping grid (Meats 1998) in an attempt to find any additional QFF in the area. While the reasons for the use of two trap types were not well documented, we assume that McPhail traps are intended to attract local flies while the cuelure baited Lynfield traps are to attract flies over longer distances. These supplementary traps are inspected twice weekly while the "normal" monitoring grid is inspected weekly. This intensive deployment and inspection is presumably designed to maximise the detection of QFF in the area and to act as an early warning system before QFF eggs have been laid in fruit. The Code states that if 5 flies are caught, then a fruit fly outbreak is declared. Consequently, domestic and international trade of produce from within up to 80 km of the site for up to one year after the detection of the last fly is suspended. Without fully explaining the variations of different bilateral agreements, suffice to say that considerable areas of horticulture production lose access to markets for many months, based on the detection of very few flies.

Since the deployment of this system, the McPhail

traps have rarely caught additional flies while Lynfield traps have regularly caught additional flies (unpub. data). Furthermore, McPhail traps are considerably more time consuming to deploy and service than Lynfield traps.

This paper reports a comparative trial with McPhail and Lynfield traps at Griffith, New South Wales, and reviews other publications on McPhail traps.

MATERIALS AND METHODS

Comparative trial at Griffith

The Lynfield trap is a 1 L clear plastic pot with a yellow screw lid. It measures 120 mm in diameter, and 120 mm deep. It has four 2.5 cm holes in the sides placed at 90º to each other and 15 mm below the lip of the trap. These allow the cuelure to exit and for insects to enter the trap. There are four 2 mm drainage holes on the bottom edge, diametrically opposing one another. The lure solution consists of a mixture of eight parts cuelure to one part Maldison, (1150 gL^{-1} active ingredient). Each lure consists of 4 dental wicks with 5 ml of solution. The wicks are held in a metal clip, with the clip suspended from the lid by a paper clip.

The McPhail trap consists of an invaginated plastic reservoir, with a clear top and a yellow bottom. The top is unscrewed from the bottom to allow addition or removal of liquid food attractant. These are termed a "wet" trap because the attractant is a solution (protein or citrus) compared with a Lynfield trap, which is "dry". The protein solution is 200 mL of autolysate protein solution. The orange or citrus solution is made of 280 g of pure orange juice, 25 g of ammonium carbonate and 1 g of potassium sorbate (preservative). The stock solution should stand for 24 hours in a refrigerator before use. Traps are charged with 10 mL of stock solution diluted with 90 mL of water.

When McPhail traps are inspected, the simplest way to separate the trapped insects from solution is to pour the solution slowly through a kitchen strainer. The trap is then recharged with fresh solution.

The trial was conducted at Griffith, New South Wales, between 21st March and 27th April, 2000 (Table 1). On each of six occasions, traps of each attractant were set out in eight replicate blocks located randomly in a small, mixed variety, avocado grove (25 March) and in an orange grove (five occasions). The traps were at different locations within the orange grove on each occasion. The Lynfield trap was not used on the first date. Four days after the traps were deployed, the trapped flies were collected and sent to Orange Agricultural Institute for identification and the results reported on the PestMon database (Dominiak *et al.* in press). Apart from *B. tryoni*, Island fruit fly *Dirioxa pornia* (Walker) was the only other species caught.

Griffith is in a QFF exclusion area and wild QFF are not likely to be present. Sterile QFF were released in the orange grove to provide a low level population to enter traps. We assume that sterile and wild QFF are attracted equally to food and pheromone lures as there are no published reports that suggest otherwise. Since wild flies were not present, we used the sterile flies in our model to replicate wild fly populations.

QFF has a flight threshold of about 16˚C (Meats and Fay 2000). Local climatic data was obtained from SILO (Jeffrey *et al.* 2001). The daily figures were averaged over the four days between trap deployment and trap inspection to demonstrate weather was not limiting QFF flight (Table 2).

Statistical analysis

The data consisted of counts of QFF and *D. pornia* from each trap on each occasion. The data were analysed by mixed model analysis of ln(x+1) transformed counts. The model included random block effects and fixed treatment by time interaction. The analysis was conducted using ASREML (Gilmour *et al*, 1999).

The Lynfield trap counts of other flies were omitted from the analysis because the count was always zero.

RESULTS

The mean retransformed numbers of QFF and *D. pornia* captured on each occasion are presented in Table 1. For both flies, there was a significant ($P<0.05$) difference between the McPhail traps and the Lynfield traps but rarely any difference among the McPhail traps.

Except for 25 March, captures of QFF during the six test weeks in McPhail protein traps were not significantly different from the McPhail citrus traps (Table 1). On this date, one citrus trap contained 21 QFF while the others contained none. During five weeks of trapping, Lynfield traps caught significantly ($P<0.01$) more QFF (20 flies in 40 traps) compared with the McPhail traps (2 flies in 80 traps) ($P<0.01$). The number of Lynfield traps catching QFF was higher in the second and third tests (14 of 16) than in the other tests (6 of 24). All QFF caught were sterile flies; no wild flies were detected.

Table 1. Mean transformed fly counts per trap for Queensland fruit fly (QFF) and *D. pornia* for each test periods (for each species on a particular date, counts followed by the same letter are not significantly difference at the 1% level).

Species	Date	Mean transformed counts per trap		
		McPhail protein	McPhail citrus	Lynfield cuelure
QFF	21 March 2002	0.54±0.23 a	0.25±0.19 a	*
	25 March 2002	0 a	0.47±0.23 b	0.72±0.27 b
	4 April 2002	0 a	0 a	1.45±0.38 b
	10 April 2002	0.09±0.16 a	0 a	1.98±0.46 b
	19 April 2002	0 a	0 a	0.19±0.18 a
	27 April 2002	0 a	0 a	0.09±0.17 a
D. pornia	21 March 2002	3.17±0.93 a	1.85±0.63 a	*
	25 March 2002	2.27±0.73 a	2.09±0.69 a	0
	4 April 2002	13.51±3.23 a	7.96±1.99 b	0
	10 April 2002	6.74±1.72 a	3.41±0.98 b	0
	19 April 2002	12.16±2.93 a	5.25±1.39 b	0
	27 April 2002	23.54±5.47 a	47.08±10.71 b	0

* Cuelure traps not included in test

Table 2. Average weather details for the 4 days between trap deployment and trap inspection.

Date	Average 4 day conditions				
	Maximum Temperature (˚C)	Minimum Temperature (˚C)	Rainfall (mm)	Evaporation (mm)	Vapour pressure
21 March	30	13	0	8.6	12
25 March	32.5	13.5	0	7.6	13
4 April	26	13.7	0	5.3	15
10 April	29.2	12.8	0	4.9	15.5
19 April	23.8	12.5	1.9	2.9	16.5
27 April	25	10.1	0	4.1	13.2

For *D. pornia*, the Lynfield trap was always significantly inferior catching no flies (0 of 40 traps) while the McPhail traps caught flies in 77 of 80 traps. Trappings in the citrus and protein baited McPhail traps were not significantly different during the first two weeks of trapping, but the protein-baited McPhail traps caught about twice as many flies ($P<0.05$) over the next three weeks. In the last week, the citrus-baited trap caught about twice as many as the protein-baited traps when both catches were high.

Climatically, the average maximum daily temperatures were at least 5˚C above the flight threshold of 16˚C indicating that temperature (Table 2) was not a limiting factor.

DISCUSSION

Of the two species, *D. pornia* is a pest of damaged fruit (Gurney 1912, White and Elson-Harris 1992) and is unlikely to be a quarantine pest. QFF is a significant quarantine pest that must be monitored.

McPhail traps frequently failed to catch QFF but were quite effective at attracting Island fly (Table 1). Conversely, the Lynfield traps were ineffective for *D. pornia* but consistently caught QFF.

It is unfortunate that the Lynfield traps were not deployed on 21 March when six of the 16 McPhail traps caught nine QFF between them. We cannot tell whether there were more QFF present at this time or whether the McPhail traps were more effective because there are no Lynfield traps present.

There was little difference between QFF catches in the McPhail protein-baited or citrus-baited traps. Very few of these traps attracted QFF and there were zero catches in all eight of these traps types for four of the six weeks. Fly catches in Lynfield traps were not significantly different to those in the McPhail traps on the last two dates. However catches were below 0.19±0.18 flies per Lynfield trap at this time. Catches in Lynfield traps were significantly better than in the protein-baited McPhail traps in the other three weeks, and better than the citrus-baited McPhail traps in two other weeks. The only week when catches in the citrus-baited McPhail traps were not significantly different was on 25 March 2002, when one citrus trap caught 21 flies, when no flies were caught in the other protein and citrus McPhail traps.

Lynfield traps caught no *D. pornia* flies during the five weeks they were deployed.

Our results suggest that there is no value in the continued use of protein McPhail traps to monitor QFF at this time of the year. There is also little support for the continued use of citrus-baited McPhail traps to monitor QFF. Drew and Hooper (1981) found McPhail traps baited with orange-ammonia were more effective than traps containing protein hydrolysate however their evaluation was conducted in Queensland in summer when fly populations were much higher than our test conditions.

There is no evidence to support the use of Lynfield traps to monitor Island fruit fly. For this species, citrus-baited McPhail traps were better than, or equal to protein-baited McPhail traps in all but one week. It is difficult to determine why this relationship reversed, however it could be due to the very high numbers caught or to a possible change in bait attractancy in late April as temperatures decreased.

In many countries, McPhail traps with food-based and other attractants continue to be used and improved to detect Mediterranean fruit flies *Ceratitis capitata* (Weidemann) (Katsoyannos *et al.* 1999, Epsky *et al.* 1999), cherry fruit fly *Rhagoletis cerasi* L. (Katsoyannos *et al.* 2000), *Bactrocera dorsalis* (Hendel) (Vargas *et al.*1997), and Mexican fruit fly *Anastrepha ludens* (Loew) (Robacker *et al.* 1990). Conversely Gopaul *et al.* (2000) reported that protein-based McPhail traps caught high numbers of *B. zonata* but caught very few *B. cucurbitae*, and virtually no *C. capitata* or *C. rosa.*

In Australia, Meats *et al.* (2002) reported that yeast autolysate McPhail traps caught very few flies of either sex. This paper also casts doubt on the value of persisting with the use of McPhail traps to monitor QFF in autumn. Regarding an early warning system, it seems more valuable to deploy all 32 supplementary traps as Lynfield traps to gain the increased trapping efficiency discussed by Meats (1998), rather than persisting with the use of McPhail traps at this time of year. Further trials in warmer weather will be needed to further examine this claim.

The Lynfield traps are species specific and more efficient than McPhail traps at trapping QFF. Conversely the McPhail traps are not species specific, and the identification of non-target flies is an unnecessary added cost to the monitoring program.

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