CROP INFESTATION BY APHIDS IS RELATED TO FLIGHT ACTIVITY DETECTED WITH 7.5 METRE HIGH SUCTION TRAPS

D.A.J. TEULON, M.A.W. STUFKENS and J.D. FLETCHER

Crop & Food Research, Private Bag 4704, Christchurch, New Zealand
Corresponding author: teulond@crop.cri.nz

ABSTRACT

The flight activity of aphid pests of wheat, potato, lettuce and squash is currently monitored in New Zealand using 7.5 m suction traps. However, there has been little research comparing aphid suction trap catches with crop infestation levels. The relationship between the average number of aphids (*Rhopalosiphum padi*) sampled from wheat plants and the average number of aphids caught in weekly 7.5 m suction trap samples was examined. A significant positive relationship indicated that numbers of aphids caught in suction traps reflected the numbers of aphids infesting wheat fields. In another experiment, potato aphid flights (mostly *Myzus persicae*) caught in a 7.5 m suction trap were compared with a nearby wind-vane trap. Aphid numbers in both traps reflected similar trends. However, the suction trap caught approximately 10 times more aphids than the wind-vane trap. Thus 7.5 m suction traps provide a useful tool for assessing aphid infestation levels in crops.
Keywords: suction traps, wind-vane traps, crop infestation, cereals, potatoes.

INTRODUCTION

Aphid flight activity, measured using 7.5 m high suction traps, is being used to assist in the pest management of aphids, and the viruses they transmit, in a number of vegetable and arable crops in New Zealand. Suction traps, funded with industry support, are currently being operated at four sites in Canterbury (Lincoln (established 1981), Hilton (1997), Rokeby (1998) and Courtenay (1999)), and two in the North Island (Hastings (1999) and Pukekohe (2003)). The aphid pests of autumn-sown wheat, potato, lettuce and squash caught in the traps are recorded (Teulon & Stufkens 2001; Fletcher et al. 2003; Stufkens & Teulon 2003; Teulon et al. 2004; http://www.AphidWatch.com). Similar suction trap systems for monitoring aphid pests are also used in a number of other countries (see http://examine.res.bbsrc.ac.uk/examine/ for UK and Europe, and http://ipmworld.umn.edu/alert.htm for USA).

Farrell & Stufkens (1992) reported a positive relationship between the number of aphids capable of transmitting barley and cereal yellow dwarf viruses (YDVs) caught in a 7.5 m suction trap at Lincoln and YDVs incidence in autumn-sown cereal crops in Canterbury from 1983 to 1991. However, there is little information on how aphid flight activity reflects crop infestation or results produced by other commonly used sampling methods in New Zealand.

To validate the value of suction trap aphid flight data the relationship between the numbers of *Rhopalosiphum padi* aphids caught in 7.5 m suction traps and their infestation of wheat in autumn and winter was examined. The trap catch of aphids inhabiting potato crops from a 7.5 m suction trap with that from a wind vein trap placed just above crop height was also compared.

METHODS

Suction traps

Suction traps were of the enclosed-cone type (Johnson & Taylor 1955) equipped with a 305 mm diameter aerofoil fan drawing air at about 60 m^3/min. A long metal cylinder

(300 mm diameter x 6.5 m) was attached to the top of the suction trap and both were supported on a wooden pole. The fan of the suction trap was at a height of 1 m. Flying aphids were sucked through the open end of the cylinder 7.5 m above the ground, and then into a collecting jar. Trap catches were removed at weekly intervals and aphids were sorted and identified according to a morphological key to New Zealand aphids (Teulon 1999).

Suction trap versus ground samples

The relationship between the number of winged *R. padi* sampled from autumn- and winter-sown wheat plots from various field trials (three to four unsprayed plots per trial) (Table 1) (D.A.J. Teulon, unpubl. data) and the number of winged *R. padi* caught in a nearby 7.5 m high suction trap (Teulon et al. 2004) was examined in Canterbury from 1999 to 2001. Aphids were sampled from wheat plants either with a ground suction sampler similar in design to that of Arnold (1994) (in all cases 50 sucks of 0.02 m^2 for a total of 1 m^2 per plot) or counted directly on plants (six 0.3 m length strips per plot or 30 plants per plot). All direct counts were converted to number of aphids per m^2 to enable direct comparison. The average number of aphids sampled from wheat plants (number of sample dates ranged from 1 to 6) and the average number of aphids caught in weekly suction trap samples (number of sample dates ranged from 6 to 10) were compared for the period between crop emergence and crop growth stage 21 (early tillering). The number of days on which samples could be taken was sometimes restricted by weather conditions during the winter months, since the ground suction sampler does not work well on wet or damp plants. Average values were used to overcome the confounding effects associated with the length of time an aphid might be on the crop, overlapping periods between different samples, the influence of weather on different samples and missing samples.

Suction traps versus distance

Two transect lines were constructed on the Canterbury plains to examine aphid abundance in cereal crops over distance in direct comparison with aphid abundance in suction traps at the time of the sample. The first transect was aligned with locations at Lincoln and Dorie (40 km apart, approx. 10-40 m above sea level) and the second aligned with locations at Courtenay and Rokeby (40 km apart, approx. 175 m above sea level) (Fig. 1). All locations except Dorie had 7.5 m high suction traps. Where possible, cereal fields were selected along (or close to) each transect line at the following sites: the closest field to the Courtenay, Rokeby, Lincoln and Dorie locations (i.e. 0 km); at sites 1, 5, 10, and 20 km from each location (note the 20 km site was in the middle of each transect and was sampled only once); and at 1 and 5 km from each location in the opposite direction. The Lincoln to Dorie transect was sampled on 9 and 10 July 2001, and the Courtenay to Rokeby transect was sampled on 25, 26 and 27 July 2001. Wheat crops were sampled in most cases but at some sites (two along the first transect, five along the second transect) oats and ryecorn were substituted because wheat crops could not be found. In the Courtenay to Rokeby transect no cereal fields could be found at the mid-point (20 km) or 10 km from Rokeby.

Fields were selected that had no insecticide application (including seed treatment) and were at about growth stage 12-13 (two to three leaf). One (first transect) and three fields (second transect) were at about GS 23 (main shoot and three tiller stage). Each field was sampled using a 0.3 m long wire that was placed at the plant base, enabling inspection for aphids on both sides. Two hundred lengths of 0.3 m were sampled in each field along a "W" formation within the field.

Suction versus wind-vane trap

Potato aphid flights (mostly green peach aphids, *Myzus persicae*) were monitored in the 7.5 m Courtenay suction trap and in a single wind-vane trap (mouth opening 23.5 cm diameter) (modified from Ashby 1976) on the edge of a potato seed crop in Courtenay during two sampling periods – January to June 1999 and October 1999 to May 2000. The wind-vane trap was positioned 2 m above ground level and approximately 500 m from the suction trap. Aphid samples were removed from both traps at weekly intervals, and identified and counted in the laboratory. Weekly and cumulative aphid catches from both traps were plotted to observe trends.

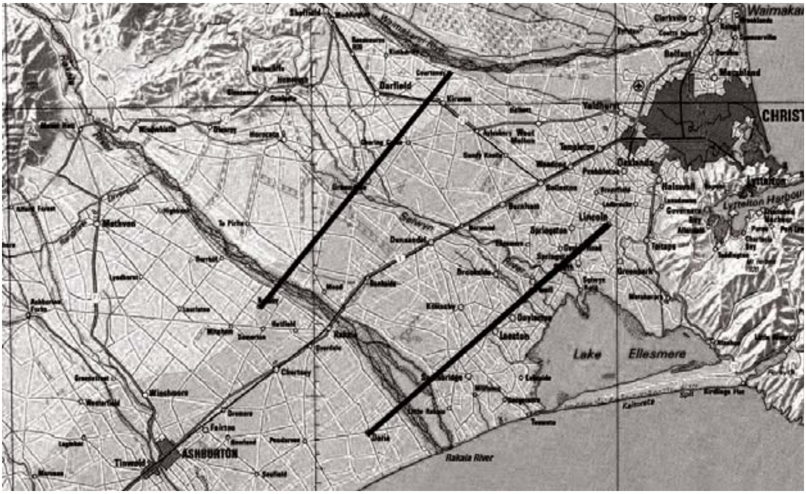

FIGURE 1: Location of the two transect lines used for aphid sampling in Canterbury in July 2001.

RESULTS AND DISCUSSION

Suction trap versus ground samples

Numbers of *R. padi* caught in suction traps in autumn and winter were relatively low in 1997, intermediate in 1998, high in 1999, but low in 2000 and 2001 (Teulon et al. 2004). This gave a wide range of values for comparison with numbers of *R. padi* from ground samples. However, a relatively high number of the experimental trials were from 2000 and 2001 (Table 1) when aphid numbers were low so there was a disproportionate number of data points with lower values in the analysis. Nevertheless, there was a significant positive relationship (R^2=0.49; $P<0.01$) between the average number of aphids from crop samples and the average number of aphids from the suction samples (Fig. 2). This relationship would have been considerably stronger except for three data points where far fewer aphids were found in the wheat crop than expected. This may have been the result of a worker being less experienced in aphid sampling than workers processing other samples. Nevertheless, the relationship between aphid flights and aphid field infestation was evident in data gathered using different sampling methods (ground suction sampler and visual observation), different distances between suction traps and experimental field sites, different personnel and a range of biological factors that may have influenced sampling precision (e.g. frosts and rainfall) and aphid infestation patterns (e.g. wind breaks and neighbouring crops).

Suction traps versus distance

No winged *R. padi* aphids were collected in any of the three suction traps (Lincoln, Courtenay or Rokeby) during July 2001 when aphids were sampled from the transects. No aphids were found on 23 of the 24 cereal fields sampled along the transects. Only in one field, of green-feed oats along the Lincoln-Dorie transect, were wingless *R. padi* aphids found (two adults, one nymph). This crop had reached the tillering stage (GS 22-23) so it was likely to have been sown much earlier than the other fields (all GS <14). For this period of low aphid activity, the three suction traps accurately reflected the lack of winged aphids alighting in cereal fields over the neighbouring area of Canterbury. A greater research effort will be required to examine this relationship over varying aphid densities. Aphid flight activity has remained relatively low since 2001 (Teulon et al. 2004) so we have not been able to repeat this work during periods of high levels of aphid flight activity.

TABLE 1: Location, year, dates of sowing, emergence and growth stage 21, number and method of ground sampling for field trials, suction trap locations and number of weeks of suction trap sampling for aphids sampled in wheat crops.

Trial location and year[1]	Sowing date	Emergence date	Growth stage 21	No. ground samples and method	Suction trap	No. weeks of suction trap samples
Lincoln 1997	13 May	30 May	5 Aug	3 x suction	Lincoln	10
Lincoln 1998	18 May	3 June	4 Aug	3 x suction	Lincoln	8
Lincoln 1999	14 Apr	28 Apr	7 June	3 x suction	Lincoln	7
Lincoln 1999	15 May	30 May	1 Aug	1 x suction	Lincoln	9
Lincoln 1999	20 Apr	4 May	15 June	6 x 0.3 m	Lincoln	6
Lincoln 1999	21 May	4 June	6 Aug	1 x 0.3 m	Lincoln	8
Rakaia 2000	17 Apr	1 May	16 June	3 x 30 plant	Rokeby	7
Rakaia 2000	24 May	12 June	5 Aug	1 x 30 plant	Rokeby	6
Greendale 2000	15 Apr	28 Apr	7 June	3 x 30 plant	Courtenay	10
Greendale 2000	15 May	1 June	27 July	3 x 30 plant	Courtenay	9
Methven 2000	13 Apr	29 Apr	27 June	6 x 30 plant	Rokeby	9
Methven 2000	1 May	20 May	29 July	2 x 30 plant	Rokeby	7
Hilton 2000	15 Apr	29 Apr	17 June	4 x 30 plant	Hilton	7
Hilton 2000	1 May	21 May	1 Aug	1 x 30 plant	Hilton	7
Rakaia 2001	21 May	16 June	18 Aug	2 x 0.3 m	Rokeby	7

[1]The Lincoln and Hilton field trials were about 1 km from the Lincoln and Hilton suction traps, respectively. The Rakaia and Methven field trials were about 11 km and 14 km from the Rokeby suction trap, respectively. The Greendale trial was about 10 km from the Courtenay suction trap.

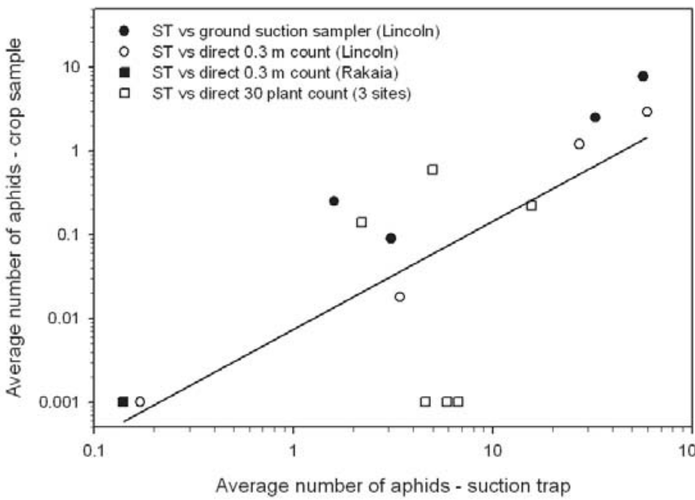

FIGURE 2: Relationship between average number of *R. padi* sampled from wheat plants and average number of *R. padi* caught in 7.5 m high suction traps (ST) for period from crop emergence to growth stage 21 (early tillering).

Suction versus wind-vane trap

Numbers of aphids caught in the wind-vane and suction traps at Courtenay from January to June 1999 and October to May 2000 are detailed in Figure 3a & b. In general, numbers in both traps reflected similar trends. Peak numbers occurred in both traps in June 1999 and late February to early March in 2000. The same data are presented as a cumulative proportion of aphid catch in Figure 3c. This shows that aphids were caught in similar proportions in both traps over time, although catches were earlier in 1999-2000, when fewer aphids were caught, than in 1998-99. In both years the suction trap caught approximately 10 times more aphids than the wind-vane trap.

Although the initial installation and running costs of suction traps are much greater than wind-vane traps, suction traps have advantages in providing estimates of aphid flights over a much larger area (probably tens of kilometres) and sampling aphids at much lower population densities. Suction traps are much less influenced by local conditions such as the type of crop they are placed next to. Our results demonstrate that aphid flight activity monitored in 7.5 m suction traps provides a useful tool for assessing aphid infestation levels in crops.

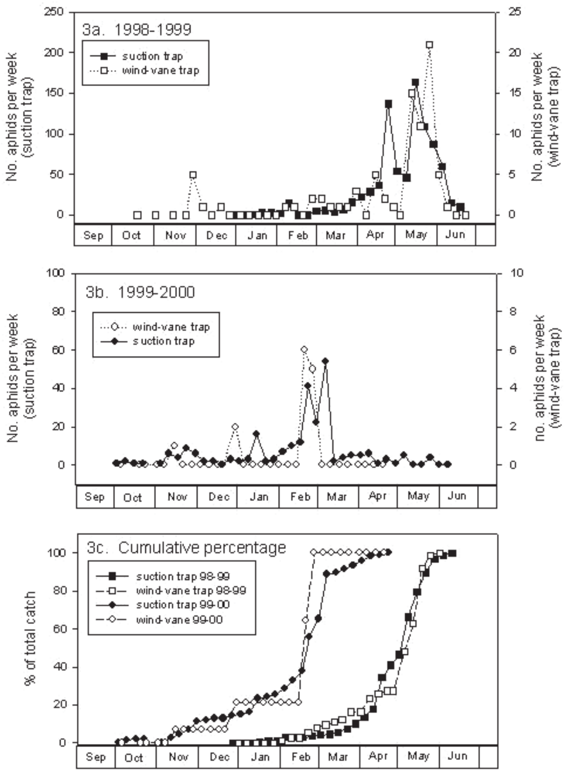

FIGURE 3: Number of aphids (mostly *M. persicae*) caught in a 7.5 m suction trap and a 2 m wind-vane trap at Courtenay, Canterbury, in (a) 1998-1999 and (b) 1999-2000. (c) Aphid catches from (a) and (b) represented as a cumulative percentage.

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REFERENCES

Arnold, A.J. 1994: Insect suction sampling without nets, bags or filters. *Crop Prot. 13*: 73-76.

Ashby, J.W. 1976: An aphid trap used in virus-vector studies. *N.Z. Entomol. 6:* 187.

Farrell, J.A.; Stufkens, M.A.W. 1992: Cereal aphid flights and barley yellow dwarf virus infection of cereals in Canterbury, New Zealand. *N.Z. J. Crop Hort. Sci. 20:* 407-412.

Fletcher, J.D.; Herman, T.J.B.; Dannock, J.; Rogers, B.; Lister, R.; Wallace A.R.; Butler, R.C. 2003: Management of squash mosaic viruses in Hawke's Bay, New Zealand. Abstracts from the Virus Epidemiology Workshop ICPP, Christchurch, New Zealand, 31 January 2003. *Australasian Plant Path. 32(3):* 435.

Johnson, C.G.; Taylor, L.R. 1955: The development of large scale suction traps for airborne insects. *Ann. App. Biol. 43*: 51-62.

Stufkens, M.A.W.; Teulon, D.A.J. 2003: Distribution, host range, and flight pattern of the lettuce aphid in New Zealand. *N.Z. Plant Prot. 56*: 27-32.

Teulon, D.A.J. 1999: Illustrated multiple-entry key for winged aphids in New Zealand. CropInfo Confidential Report No. 614. Crop & Food Research, Lincoln, New Zealand. 41 p.

Teulon, D.A.J.; Stufkens, M.A.W. 2001: Lack of relationship between aphid virus vector activity and potato leaf roll virus incidence. *N.Z. Plant Prot. 54:* 229-234.

Teulon, D.A.J.; Lankin, G.O; Stufkens, M.A.W.; Travis, G.R. 2004: Local variation in cereal aphid flight activity in Canterbury. *N.Z. Plant Prot. 57*: 221-226.