APPLE GRASS APHID (*RHOPALOSIPHUM INSERTUM*) ON CEREALS IN CANTERBURY

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

*New Zealand Institute for Crop & Food Research Limited,
Private Bag 4704, Christchurch, New Zealand*

ABSTRACT

A substantial proportion (15-56%) of *Rhopalosiphum* species caught in suction traps, on sticky thread traps and in suction ground samples, above or in cereal crops at Hilton, South Canterbury in autumn of 1997 and 1998 were apple grass aphids (*Rhopalosiphum insertum*). The remaining *Rhopalosiphum* specimens were *R. padi*. At two other sites in Canterbury (Lincoln: 1996, 1997 and 1998, and Rokeby: 1998), and at Hilton in 1996, *R. padi* was the most common *Rhopalosiphum* species caught (>96%). Few other cereal inhabiting species were found. The apple grass aphid was previously thought to be uncommon in Canterbury but our results indicate that it may be a potentially important vector of BYDV in cereal crops in some situations and should be taken into account in aphid monitoring - virus forecasting programmes.

Keywords: apple grass aphid, *Rhopalosiphum insertum*, cereal crop pest, virus forecast.

INTRODUCTION

Barley yellow dwarf virus (BYDV) is a serious aphid-transmitted disease of cereal crops in many countries including New Zealand (D'Arcy and Burnett 1995). In Canterbury, where about 70% of New Zealand cereals are grown, a forecast for BYDV risk in autumn and winter sown crops, has been developed, which is based on flights of aphid vectors of BYDV. The forecast allows growers to initiate timely and effective control measures (Lowe 1963; Farrell and Stufkens 1992; Teulon and Stufkens 1998; Teulon *et al.* 1999). In the past BYDV aphid vectors in autumn flights and in autumn crop infestations have largely consisted of the cereal aphid (*Rhopalosiphum padi*) (also known as the bird cherry oat aphid), with the corn leaf aphid (*Rhopalosiphum maidis*) and the rose grain aphid (*Metopolophium dirhodum*) sometimes being common (Farrell and Stufkens 1989; 1992). These species, with *Sitobion* (*S. miscanthi* and *S. nr. fragariae*) have been implicated as vectors of BYDV in New Zealand (Farrell and Sward 1989; Farrell and Stufkens 1992) and have been monitored in suction traps to establish virus forecasts.

Another BYDV aphid vector, the apple grass aphid (*R. insertum*), was first recorded in New Zealand in 1987, but this insect has not been common in autumn flights or crop infestations (Farrell and Stufkens 1989; 1992). Elsewhere, research has shown the apple grass aphid is an efficient vector of at least some BYDV serotypes but its importance as a crop pest is considered to be minor because it seldom colonises cereal crops (A'Brook and Dewar 1980; Jedlinski and Voegtlin 1986; Blackman *et al.* 1990; Halbert *et al.* 1992a; b). However, its importance may have been underestimated because of its subterranean habit and its morphological similarity to *R. padi* (Halbert and Voegtlin 1995).

This paper reports work that shows that the apple grass aphid is locally common in autumn aphid flights and autumn-sown cereal crops in South Canterbury. The potential pest status of this insect and implications for the aphid monitoring - BYDV forecasting are discussed.

METHODS

Suction traps

Aphids flights were monitored with enclosed-cone suction traps (Johnson and Taylor 1955) from April to July during 1996, 1997 and 1998 at 3 sites in Canterbury situated at Lincoln (Canterbury Agricultural and Science Centre), Hilton (Earl Rd, South Canterbury) and Rokeby (Farquhars Rd, Mid Canterbury, 1998 only). Each trap had a 305 mm diameter aerofoil fan drawing about 60 m³ of air per minute and sampled aphids at 7.5 m above ground level (2.5 m at Hilton in 1996). Insects were sucked through a long metal cylinder (300 mm diameter x 6.5 m long) into collecting jars. Traps were emptied weekly and aphids collected, identified and counted in the laboratory.

Sticky thread traps

In 1998 sticky thread traps (Labonne *et al.* 1983) were used to monitor aphid flights just above crop height (<1 metre above ground) at all three sites in May and early June. Each trap consisted of a black aluminium frame (28 x 28 cm) with 75 parallel nylon threads (0.42 mm diameter) approximately 3.5 mm apart. The threads of each trap were sprayed with a tacky glue so that aphids flying through the trap would adhere to the sticky threads. At the end of a sampling period the traps were placed in white spirits or unleaded petrol and aphids gently removed with a soft paintbrush, before briefly washing in detergent (1% teepol) then water. The aphids were finally placed in 70% ethanol, and identified and counted.

Preliminary samples

Eighteen sticky thread traps per field were placed along transects in single fields of volunteer wheat at Hilton (28 April), oats (2-3 leaf stage) at Rokeby (28 April) and oats (2-3 leaf stage) in Lincoln (29 April). There were nine vertically and nine horizontally oriented traps alternately placed 20 m apart along the transect. Four of the vertically oriented traps were placed at right angles to the other vertical traps to allow for different wind directions. The sticky thread traps were collected after 1 week.

Main samples

Sixteen sticky thread traps per field were placed in matrices in the same fields described above on 7 May (Hilton and Rokeby) and 8 May (Lincoln). On 7 May, 16 traps were also placed in a field of newly-sown autumn wheat at Hilton. There were eight vertically and eight horizontally oriented traps alternately placed in a 4 x 4 matrix (60 m x 40 m) in each field. Within each row the two vertical traps were placed at right angles to each other. The sticky thread traps were replaced at weekly intervals until 4 or 5 June. The wheat crop at Hilton was sprayed with an insecticide on 21 May.

Ground suction samples

In 1998 aphids were sampled from cereal plants in the autumn sown wheat crop at Hilton on 18 May and the oat crop at Lincoln on 20 May using a hand-held ground suction sampler (Macleod *et al.* 1994). Two separate sampling procedures were carried out in each field. The first comprised 12 samples of 10 single sucks (10 seconds per suck) and the second comprised 12 samples of 40 single sucks. Groups of 10 or 40 sucks were taken over a distance of about 40 m between the sticky thread traps. All samples were more than 20 m apart and more than 10 m from sticky thread traps. Each suck sampled 0.02 m² (or about six plants). Cereal-inhabiting aphids were separated from samples by sieving, then identified and counted in the laboratory.

Tree samples

In an attempt to ascertain the overwintering hosts of the apple grass aphid in 1998, trees were sampled on 28 May (n=9) and 4 June (n=7) in the vicinity of Hilton, South Canterbury. Trees included known overwintering host plants of *R. insertum* (i.e., rowan and apple) and of *R. padi* (i.e., plum). Two or three people searched leaves and twigs of each tree for 20 to 60 min. Aphids were collected, identified and counted in the laboratory. The apple trees (n=6) were re-examined in October 1998 for evidence of successful overwintering.

FIGURE 1: Total numbers of *Rhopalosiphum padi* and *R. insertum* per week caught 7.5 m above ground level in suction traps (2.5 m at Hilton in 1996) at Hilton, Lincoln and Rokeby (Canterbury) from April to July during 1996, 1997 and 1998. The percentage of *R. padi* as a proportion of the total catch is indicated.

RESULTS

Suction traps

Fig. 1 shows the number of *R. insertum* and *R. padi* caught in suction traps from April to July in three years for each site. Greatest flight activity was recorded in April and May with relatively low numbers caught in June and July. *Rhopalosiphum padi* was the dominant species (usually between 94-99% of *Rhopalosiphum* species) trapped at all sites in each year. However, 29% and 15% of *Rhopalosiphum* were *R. insertum* at Hilton in 1997 and 1998, respectively.

Other cereal-inhabiting aphid species trapped during the study included *R. maidis* (1998: Lincoln 6 aphids), *Metopolophium dirhodum* (1996: Lincoln 22, 1997: Lincoln 3, Hilton 2, 1998: Lincoln 1, Hilton 2), *M. festucae* (1997: Lincoln 1) and *Sitobion nr. fragariae* (1996: Lincoln 12, Hilton 1, 1997: Lincoln 2, Hilton 11, 1998: Lincoln 3, Hilton 1, Rokeby 1). The proportion of these species never exceeded 8% of the total cereal-inhabiting aphids trapped.

Sticky thread traps

Fig. 2 shows the numbers of *R. padi* and *R. insertum* captured on all sticky thread traps just above crop height for various cereal crops in 1998. Numbers for horizontal traps only are also indicated. Almost all cereal inhabiting aphids at Rokeby and Lincoln were *R. padi*. However, at Hilton, there were high proportions of *R. insertum* in autumn-sown (33.3%) and volunteer wheat (55.9%). No *R. insertum* were found in crops at Rokeby or Lincoln.

One *R. maidis* was trapped above oats at Lincoln (6 May) and one *S. nr. fragariae* (28 May) and one *M. dirhodum* (4 June) from wheat at Hilton. A number (up to 88 per trap per week) of non-cereal inhabiting aphids were also caught in these traps. In general vertically orientated traps caught between two and four times more cereal and non-cereal inhabiting aphids than horizontally oriented traps.

FIGURE 2: Mean number of *Rhopalosiphum padi* and *R. insertum* per week caught in sticky thread traps in cereal fields at Hilton, Lincoln and Rokeby (Canterbury), autumn 1998. Figures in brackets represent aphid numbers from horizontally oriented traps.

Ground suction samples

All cereal-inhabiting aphids collected in ground suction samples were *R. padi* in oats at Lincoln whereas a substantial proportion (33%) were *R. insertum* in autumn-sown wheat at Hilton. The density of *Rhopalosiphum* species was 0.5-0.8 aphids/m² at Lincoln and 2.2-6.3 aphids/m² at Hilton.

Flights of *R. padi* were high at both sites, but numbers of wingless and immature aphids of this species were low in ground suction samples. This suggests that cereal-inhabiting aphid colonies did not have time to develop before the sampling date of 18 and 20 May at either site. Subterranean colonies of *R. insertum* may have existed at Hilton, but may not have been collected by the ground suction sampler.

Tree samples

Winged (gynoparae) and wingless (oviparae) adults and immatures of *R. insertum* were found on apple and rowan trees in South Canterbury in late May and early June (Table 1). Gynoparae colonise primary hosts and lay live young, which develop into wingless egg-laying oviparae. No male *R. insertum* were found and no eggs were observed on the trees. Neither *R. insertum* nor *R. padi* were found on the one plum tree sampled. There was no evidence of successful overwintering (e.g., fundatrices and their offspring or exoskeletons or feeding damage) on the same trees in October.

TABLE 1: Sample date, tree species and number of apple grass aphids sampled from trees in South Canterbury, Autumn 1998.

Sample date	Tree species (no. of trees)	Winged adults (gynoparae)	Wingless adults (oviparae)	Nymphs	Other aphids
28 May	Apple (6)	113	5	104	3
28 May	Rowan (2)	4	3	16	1
28 May	Plum (1)	0	0	0	15
4 June	Apple (6)	49	0	142	1
4 June	Rowan (1)	0	3	2	0

DISCUSSION

The apple grass aphid is an efficient vector of at least some BYDV serotypes in cereals (see introduction). We found this aphid made up a substantial proportion of cereal-inhabiting aphids in autumn-sown cereal crops as well as in suction trap catches in some locations in some seasons. For these reasons, the apple grass aphid is potentially an important vector of BYDV in Canterbury and should be taken into account in the aphid monitoring-virus forecasting system.

The current BYDV forecast was developed from aphid flight records that included only small numbers of apple grass aphids (Farrell and Stufkens 1992). The accuracy of the virus forecast may be affected by the presence of substantial populations of aphid species exhibiting life cycles and/or virus transmission efficiencies that are different to those aphid species for which the model was developed. To further define the importance of the apple grass aphid, its efficiency as a BYDV vector needs to be compared with other BYDV aphid vectors under New Zealand conditions. Furthermore, an estimate of the proportion of apple grass aphids migrating to primary and secondary hosts in autumn is also needed. The proportion of apple grass aphids, as a percentage of both *Rhopalosiphum* species, increased from 15% in suction traps to over 30% in crop samples at Hilton in 1998. This suggests that the apple grass aphid may be a better invader of cereals than *R. padi*.

Elsewhere, the apple grass aphid normally overwinters as eggs on primary hosts such as *Malus*, *Pyrus*, *Crataegus*, *Sorbus* and *Cotoneaster*. This species then migrates in spring to various graminaceous secondary hosts, especially *Poa* and *Festuca*, where it feeds at the stem bases or below ground. Anholocyclic overwintering with cyclical parthenogenesis on secondary hosts does not normally occur (Blackman *et al.* 1990) although Ridland and Carver (1987) reported this occurring in Australia. At Hilton we

found winged migrants and oviparae on apple and rowan trees in autumn, indicating that some apple grass aphids attempted to overwinter on primary hosts. However, we found no males in suction trap, crop or tree samples, and no eggs from tree samples in autumn, or any evidence of successful overwintering on the same trees in spring. Furthermore, 8 aphids taken from ground suction samples and placed on caged barley seedlings in the laboratory immediately migrated to the plant roots and laid live young (M. Stufkens, pers. obs.). Possibly holocyclic overwintering is in the process of being replaced by anholocyclic overwintering in these Canterbury apple grass aphid populations.

This paper provides the first report of substantial populations of the apple grass aphid on cereal crops in New Zealand. More research is needed under New Zealand conditions to determine the efficiency of this aphid as a BYDV vector, as well as on the proportion of autumn migrants flying to primary and secondary hosts. Other important areas for research include the aphid's life history under New Zealand conditions, particularly its ability to overwinter on primary or secondary hosts; its geographical range and abundance and the factors that contribute to this; its ability to colonise cereal crops compared to other cereal-inhabiting aphid species; its ability to spread (underground?) from initial infestation loci within a crop and contribute to secondary virus infection; the effect of insecticides on subterranean populations; and its importance in spring sown cereal crops.

ACKNOWLEDGEMENTS

We thank Dr Victor Eastop (Natural History Museum, London) for confirming the identity of *R. insertum*, Roger Slater (Hilton), John Honeywell (Rokeby) and Tony Whatman (Lincoln University) for making crops available for sampling. We especially thank Stuart Sheat (Hilton) and John and Mathew Honeywell (Rokeby) for emptying suction traps. Stephen Harcourt and Damien Coup provided technical support. This project was supported with grants from the Foundation for Arable Research and the Foundation for Research, Science and Technology.

REFERENCES

- A'Brook, J. and Dewar, A.M., 1980. Barley yellow dwarf virus infectivity of alate aphid vectors in Wales. *Ann. Appl. Biol.* 96: 51-58.
- D'Arcy, C.J. and Burnett, P.A., 1995. Barley Yellow Dwarf: 40 Years of Progress. APS Press, St Paul, Minnesota.
- Blackman, R.L., Eastop, V.F. and Brown, P.A., 1990. The biology and taxonomy of the aphids transmitting barley yellow dwarf virus. Pp. 197-214. *In: World Perspectives of Barley Yellow Dwarf*, P.A. Burnett, (Ed.); CIMMYT, Mexico, D.F., Mexico.
- Farrell, J.A. and Stufkens, M.W., 1989. Flight activity and cereal host relationships of *Rhopalosiphum* spp. in Canterbury. *N.Z. J. Crop Hort. Sci.* 17: 1-7.
- Farrell, J.A. and Stufkens, M.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.
- Farrell, J.A. and Sward, R.J., 1989. Barley yellow dwarf virus serotypes and their vectors in Canterbury, New Zealand. *Aust. Plant Pathol.* 18: 21-23.
- Halbert, S. and D. Voegtlin., 1995. Biology and taxonomy of vectors of barley yellow dwarf virus. Pp. 217 - 258. *In: Barley Yellow Dwarf 40 Years of Progress*. C.J. D'Arcy and P.A. Burnett (Eds.). APS Press, St Paul, Minnesota.
- Halbert, S.E., Connelly, B.J., Bishop, G.W. and Blackmer, J.L., 1992a. Transmission of the barley yellow dwarf virus by field collected aphids (Homoptera: Aphididae) and their relative importance in barley yellow dwarf epidemiology in southwestern Idaho. *Ann. Appl. Biol.* 121: 105-121.
- Halbert, S.E., Connelly, B.J., Lister, R.M., Klein, R.E. and Bishop G.W., 1992b. Vector specificity of barley yellow dwarf virus serotypes and variants in southwestern Idaho. *Ann. Appl. Biol.* 121: 123-132.
- Jedlinski, H. and Voegtlin D., 1986. Transmission of barley yellow dwarf virus by the aphid *Rhopalosiphum insertum* (Walker). Pp. 94-97 *In: Proceedings of Second*

- International Oats Conference, The University College of Wales, Welsh Plant Breeding Station, Aberystwyth, D.A. Lawes and Thomas. H. (Eds.). Martius Nijhoff, Dordrecht.
- Johnson, C.G. and Taylor L.R., 1955. The development of large suction traps for airborne insects. *Ann. Appl. Biol.* 43: 51-62.
- Labonne, G., Lauriant, F. and Quiot, J-B., 1983. Intérêt des pièges à fils dans l'étude des populations de pucerons ailés. *Agronomie* 3: 315-326.
- Macleod, A., Wratten, S.D. and Harwood, R.W.J., 1994. The efficiency of a new lightweight suction sampler for sampling aphids and their predators in arable land. *Ann. Appl. Biol.* 124: 11-17.
- Lowe, A.D., 1963. Warning services on aphid flights. *Proc. 16th N.Z. Weed Control Conf.*: 108-109.
- Ridland, P.M. and Carver, M., 1987. *Rhopalosiphum insertum* (Walker) (Homoptera: Aphididae) newly recorded from Australia. *J. Aust. Ent. Soc.* 26: 128.
- Teulon, D.A.J. and Stufkens M.A.W., 1998. Forecasting barley yellow dwarf virus in Canterbury winter-sown cereals. *Proc. 51st N.Z. Plant Prot. Conf.*: 263.
- Teulon, D.A.J., Stufkens, M.A.W., Nicol, D. and Harcourt, S.J., 1999. Forecasting barley yellow dwarf virus in autumn sown cereals in 1998. *Proc. 52nd N.Z. Plant Prot. Conf.*: (this volume).