PHENOLOGY AND HOST PREFERENCE OF SPOTTED ALFALFA APHID ON LUCERNE AND WHITE CLOVER

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SUMMARY

Spotted alfalfa aphid (SAA) (*Therioaphis trifolii* forma *maculata*) populations increased up to minor levels of 24 per stem on lucerne (*Medicago sativa* cv. Wairau) at Pukekohe in March 1983 and reached approximately 1/10 of that density on white clover (*Trifolium repens*). In North America and Australia white clover is not a host of SAA. In laboratory experiments in 1983, SAA from both hosts preferred lucerne but also reproduced and built up on white clover. In 1984, white clover had a detrimental effect on subsequent reproduction. Temperature limited the number of generations in both years, and in 1984 moister conditions may have been an additional limiting factor.

INTRODUCTION

The colonising populations of spotted alfalfa aphid (SAA) in New Zealand showed a preference for *Medicago* spp, but populations also built up on white clover, an unexpected host of the aphid (Cameron *et al* 1983). Most *Trifolium* spp did not suffer damage from SAA, (Cameron *et al* loc. cit.), but there were sufficient deviations from the insect-host responses reported in Australia and North America (Wilson *et al* 1981) to warrant comparison of SAA populations and laboratory host responses on lucerne and white clover. SAA also prefers conditions which are hotter and dryer (Nielson and Barnes 1961) than occur in most lucerne growing areas of New Zealand.

This paper examines the possible limitations of climate on SAA populations on lucerne and white clover during 1983 and 1984, and the ability of SAA from lucerne or white clover to establish and reproduce on both these host plants.

METHODS

SAA, pea aphid (PA; *Acyrtosiphon pisum*) and blue green lucerne aphid (BGLA; *A. kondoi*) were sampled at the Pukekohe Research Station following the discovery of SAA in April 1982. Populations on an established lucerne (cv. Wairau) stand were compared weekly with those on white clover (cv. Grasslands Huia) in established grassland. The lucerne was harvested at 5 to 8 week intervals, while the grassland site was cut in alternate strips (5-10 m wide) every 2 to 4 weeks. Sampling was carried out on the longer growth (10-15 cm). Cutting times are indicated in the results.

Several sampling methods were used at both sites to cope with the range of population levels encountered. Stem samples consisted of 30 stems picked at the base into a plastic tray and examined individually for aphids. Ten sweep-net samples, each of 20 sweeps, were taken as described in Cameron *et al* (1983). Suction samples were added in 1984 with the use of a D'Vac (Dietrick *et al* 1959) to provide 10 samples of 2 x 0.093 m² in lucerne, and 10 samples of 5 x 0.093 m² in clover. Aphids were identified to species, and alates and sexuals recorded.

Weather records were obtained from the Plant Diseases Division meteorological site at the Pukekohe Research Station. Degree days were computed as (max + min) °C/2, rainfall was measured hourly and events > 1 mm recorded, and surface dryness was accumulated hourly using the inverse of measurements from a surface wetness sensor (developed by Dr K. Young, PDD).

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The establishment and reproduction of SAA on lucerne (cv. Wairau) and white clover (cv. Grasslands Huia) and the ability of SAA to switch host plants were examined in the glasshouse on potted plants grown from the same seed source and used after one cut. SAA was cultured on both host plants from aphids collected each November or December from the experimental site of the same legume. Individual 4th instar SAA were transferred from the cultures to the alternate host plant, with similar numbers of transfers to plants of the same species to provide controls. Establishment was recorded as percent survival of individuals after 3 days, and reproduction as the percentage of the original 4th instar nymphs which produced off-spring within 5 days of moulting to adults.

RESULTS AND DISCUSSION

Sampling

Stem samples were considered to provide the most-accurate population estimate of all three aphid species, but at low population levels suction samples covered more area and detected aphids more efficiently. Sweeping covered the greatest area but did not collect aphids low on the plants. Comparison of the techniques (Table 1) showed that sweep sampling was biased against SAA, and stem or suction samples collected 2 to 3 times the number of SAA. This bias was greater at low population levels of SAA when the aphid remained mainly on the lower leaves. There were significant relationships between all sampling methods therefore sweep samples were considered to provide a reliable population index for SAA. The precision of all techniques averaged close to 10% SE of the mean except for stem samples when populations fell below 1.0/stem. Sweeping was the most efficient method per unit effort and, in the absence of suction data for 1983, provided valid comparisons between years and crops. The leaf sampling technique recommended by Nielson (1957) was impractical at the low aphid population levels in this study. Suction sampling was more time consuming but provided the most comparable samples in different crops.

TABLE 1: Comparison of the accuracy (% SAA recovered), and precision (% standard error of mean) of sampling methods, and the relationship between techniques.

	Lucerne						Clover
	Stem		Sweep		Suction		Sweep
	SAA %	Precision % SE	SAA %	Precision % SE	SAA %	Precision % SE	Precision % SE
> 1.0/stem	100	6.14	75	6-16	-	-	12-19
< 1.0/stem	80	30	40	11-19	100	7-22	14-24

Relationship

Sweep vs stem $r^2 = 0.92$ ($P < 0.01$, $n = 35$)

Sweep vs suction $r^2 = 0.94$ ($P < 0.01$, $n = 7$)

Aphid species composition

SAA was the minor lucerne aphid species in all except the February-March cut cycle of 1983 (Fig. 1). Until February of both years PA and BGLA were dominant in lucerne and SAA constituted no more than 10% of the aphids present. For 4 to 5 weeks in March 1983 over 50% of the aphids present in lucerne were SAA, whereas in 1984 when all aphid populations were lower BGLA remained predominant. It was notable that at low population levels SAA was more difficult to observe than PA and BGLA which occur higher on plants.

Fig. 1: Species composition of aphids in lucerne, from stem sampling, Pukekohe Research Station, 1982-84. Spaces indicate cutting.

Seasonal Patterns

SAA appeared on lucerne in the first week of November in both years but was not detected in white clover until December (Fig. 2). Early season population increases on lucerne were similar in both years but contrasted strongly between years in the February-March period. This pattern was repeated at the white clover site in 1983 at a lower population level, and in 1984 SAA was rare in clover. These seasonal population trends are consistent with the preference of the aphid for hot dry conditions (Graham 1959, Nielson and Barnes 1961). In Australia, Wilson *et al* (1981) correlated SAA population increases with temperatures exceeding 25 °C. The temperature accumulations at Pukekohe above the threshold for development of SAA (approx 10.5 °C (Walker and Cameron in prep.)) are shown in Fig. 2. These indicate a very similar seasonal pattern for both years, allowing barely two generations to develop in the 2nd cut cycle and 3.5 generations in the February-March period. The peak population at this time was 24 SAA/stem, which was maintained for 2 weeks until damp weather occurred. Although individual leaves were damaged no plant deaths occurred. Lower temperatures in April and May limited SAA to less than two generations in all three autumn periods since SAA first occurred.

Fig. 2: Seasonal trends in spotted alfalfa aphids per 20 sweeps in lucerne and white clover (in grassland) at Pukekohe Research Station, 1982-84.

TABLE 2: Influence of aphid source and new host plant on laboratory establishment and reproduction of spotted alfalfa aphid. Each value is mean % from three experiments.

Aphid source New host	Lucerne		White clover		Source of variation and significance
	Lucerne	White clover	Lucerne	White clover	
1983					
Establishment	86	18	91	30	New host **
Reproduction	54	18	76	27	New host **
1984					
Establishment	87	61	63	69	None
Reproduction	31	21	0	0	Aphid source **
Interactions and significance	Establishment		New host x year		**
	Reproduction		Aphid source x year		**
			New host x year		*

The 1983 build up of SAA was associated with infrequent rain and long dry periods but in 1984 when rainfall occurred every week in February-March and dry periods were 25% shorter over this period the aphid did not build up (Fig. 2). Although Neilson and Barnes (1961) reported increases of *Entomophthora* under wet conditions, fungal pathogens of SAA were rare at Pukekohe (Cameron *et al* unpub). No other biotic factors appeared to contribute to SAA decline in 1984. Parasitism was rare from January to March and overall aphid:beneficial insect ratios were similar in both seasons (Cameron *et al* unpub). Graham (1959) showed that high humidity adversely affects SAA reproduction although the mechanism is unclear. Physical effects of water on aphids as noted by Lewis and Siddorn (1972) are probably best correlated with surface wetness which may hinder movement or even drown smaller SAA.

Host plant

We have previously shown SAA to prefer *Medicago* spp but have also recorded population increases on white clover in the field (Cameron *et al* 1983). In 1983 SAA again built up on white clover but this did not occur in 1984 (Fig. 2). There are no records of SAA populations establishing on white clover overseas; indeed Wilson *et al* (1981) specifically noted the lack of SAA on white clover in South Australia. In North America, yellow clover aphid (*Therioaphis trifolii*) is the only *Therioaphis* species commonly found on white clover (Dickson 1959).

Variability between years was also found in the laboratory experiments on host preference. Table 2 shows significant interactions between year and aphid source for performance of SAA on new host plants. In 1983 SAA from lucerne or white clover showed similar preference for lucerne in both establishment and reproduction. This demonstrated the ability of SAA to switch hosts while displaying a preference for lucerne which was not measurably altered by previous host experience. Therefore the presence of biotypes of SAA was not indicated. The following year SAA was difficult to maintain on white clover because of very low reproduction rates for all material collected from white clover in the field. In experiments, SAA from white clover failed to reproduce at all, even when transferred to lucerne (Table 2). The reasons for the apparent loss of clover adaptation in SAA from this source are unclear. Peters and Painter (1957) noted that several *Trifolium* spp were susceptible to SAA but they did not record reproduction on white clover (including cv. Grasslands Huia). Geographic variations in preference for white clover do occur in *Therioaphis* spp (Dickson 1959). SAA in New Zealand may have originated from a source with unusual host preferences including the ability to colonise white clover. These preferences may now be changing.

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