The influence of orchard ground cover and introduced green lacewings on spring populations of western flower thrips in apple orchards

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ABSTRACT

Bare soil, grass and weedy ground covers were compared for their influence on population densities of western flower thrips, *Frankliniella occidentalis* (Pergande) (Thysanoptera:Thripidae), within a blossoming British Columbian apple orchard. Weedy ground cover harbored the thrips before and during their movement into the apple blossoms and more western flower thrips were found in the trees in weedy ground plots than in bare soil plots during the first week of bloom. These early season differences in thrips counts did not persist through the season, and were not consistently reflected in the percent of apples damaged by the thrips. The F_1 generation of western flower thrips in cluster samples were lower in trees where nymphs of the common green lacewing *Chrysopa carnea* (Stephens) (Neuroptera: Chrysopidae) were introduced at bloom. The introduced lacewings did not reduce thrips damage to the apples.

Key words: *Frankliniella occidentalis*, thrips, apples, ground cover

INTRODUCTION

In the Okanagan Valley of British Columbia, adult western flower thrips, *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae), overwinter in protected sites in the ground, emerging in the spring to feed on early flowering wild plants, such as arrow-leafed balsam root, *Balsamorhiza sagittata* Nutt. and saskatoon, *Amelanchier alnifolia* Fern. Adult thrips move into orchards as the apple trees begin to bloom (Madsen and Procter 1982).

Adult female western flower thrips cut pockets in epidermal apple cells while inserting the eggs into developing fruit within the blossom (Lewis 1973). The damage causes a circular discolouration of the apple skin, called a 'pansy spot', which varies in its evidence among apple varieties (Madsen and Jack 1966). Large pansy spots downgrade the quality of the apple (Madsen and Procter 1982) and more than one blemish per apple is common. To control the thrips effectively before damage occurs, chemical pesticides need to be applied when the orchard is in full bloom which could have a toxic effect on bees while they are actively pollinating the fruit blossoms. Effective thrips management techniques are needed as alternatives to chemical controls.

The potential of ground cover to influence arthropod complexes in apple orchards has been frequently addressed (Leius 1967; Gruys 1982; Hubscher 1989; Haley and Hogue 1990; Meagher and Meyer 1990; Bugg 1992). The studies were initiated with the general premise that a ground cover made up of selected plant species that are attractive to beneficial arthropods would augment the establishment of these arthropod populations. Watts (1936) however, suggested that a weedy ground cover might increase western flower thrips populations because of the attraction of the thrips to flowers and the availability of overwintering sites.

The purpose of this study was to determine if bare soil could discourage thrips entry into apple orchards relative to a grass cover, which is generally used in commercial British Columbian orchards, or a weedy cover. Early season populations of western flower thrips predators are insufficient to control the pest during bloom (Lewis 1973; Hubscher 1989). Within the ground cover study we integrated the release of the common green lacewing, *Chrysopa carnea* (Stephens) (Neuroptera : Chrysopidae), which is indigenous in apple orchards, feeds on the thrips (Lewis 1973; Beers *et al.* 1993), and is reared commercially. The common green lacewings were released at the time of the thrips' spring orchard immigration, to observe whether the predator could effectively lower the thrips populations.

MATERIALS AND METHODS

The floor of a 2- to 3-year-old Liberty/M9 slender spindle apple orchard was maintained in two replicates of three 25.5 x 24.5 m^2 sections as: 1)soil - maintained free of ground cover throughout the year with a combination of tillage, contact and residual herbicides; 2)grass - pure grass sod of perennial rye grass and creeping red fescue, maintained free of broadleaf weeds with 2,4-D and mecoprop; and 3)weedy - the same grass sod as in 2, rototilled lightly in the summer of 1994 and seeded with white clover (*Trifolium repens* L.) and a wide assortment of local broadleaf weeds including white cockle (*Lynis alba* Mill.), shepherd's purse (*Capsella bursa-pastoris* (L.)) and tumble mustard (*Sisymbrium altissimum* L.). Tree rows were maintained relatively weed-free with regular herbicide applications.

At the pink bud stage of blossom development, five (1995) and one (1996) group(s) of six adjacent trees were tagged within each treatment plot. Tagged trees were sampled for western flower thrips prior to bloom using limb-taps, and the adjacent ground covers were also sampled with sweeps to determine western flower thrips densities. In the first 1995 release, wild adult western flower thrips were included in the releases in anticipation of inadequate thrips moving naturally into the blossoms. Predators and thrips were transferred into blossom clusters using a camel's hair brush when samples in 1995 indicated that the thrips were moving into apple blossoms. For the first release in 1995, 40 adult western flower thrips collected from arrow-leafed balsam root were released alone or in combination with 20 early-instar common green lacewing (Westgro Sales, Richmond, BC) nymphs/tree. Thirty *C. carnea* nymphs/tree were again released 11 days later when wild thrips population densities were high. A control plot into which no western flower thrips or predators had been released, was included in both years of the study.

In 1995, limb-taps and cover sweeps (to sample western flower thrips populations levels), were conducted 1, 2, 5 and 10 weeks after the predators were released. Three limb-taps per tree and three cover sweeps per release site were used. In 1995 six clusters were collected per monitored tree within the first release and in 1996 fifteen clusters were collected per monitored tree 2 weeks after western flower thrips entered the orchard. The thrips were counted with the aid of a stereoscopic dissecting microscope. In both years all fruit was harvested from each monitored tree in June and thrips damage was recorded. The count included any apples dropped from the trees, as damaged fruit may be aborted (Boivin and Stewart 1982). Variation among treatments was statistically compared using ANOVA. Separate analyses were done for each date the data were collected. Means were compared using Tukey's studentized range test after arcsin transformation of the data (SAS 1985).

RESULTS AND DISCUSSION

Influence of ground cover. Ground cover sweep samples of western flower thrips populations conducted in 1995 indicate that western flower thrips populations were present in the weedy ground cover before the apple blossoms opened (27 April) (Fig. 1a). Weekly thrips cover sweep counts increased within the weedy ground cover during the period of full bloom (8-15 May) . In comparison, thrips numbers in the bare soil and grass treatments remained negligible through this period and were significantly ($P<0.05$) lower compared to the weedy ground cover treatments.

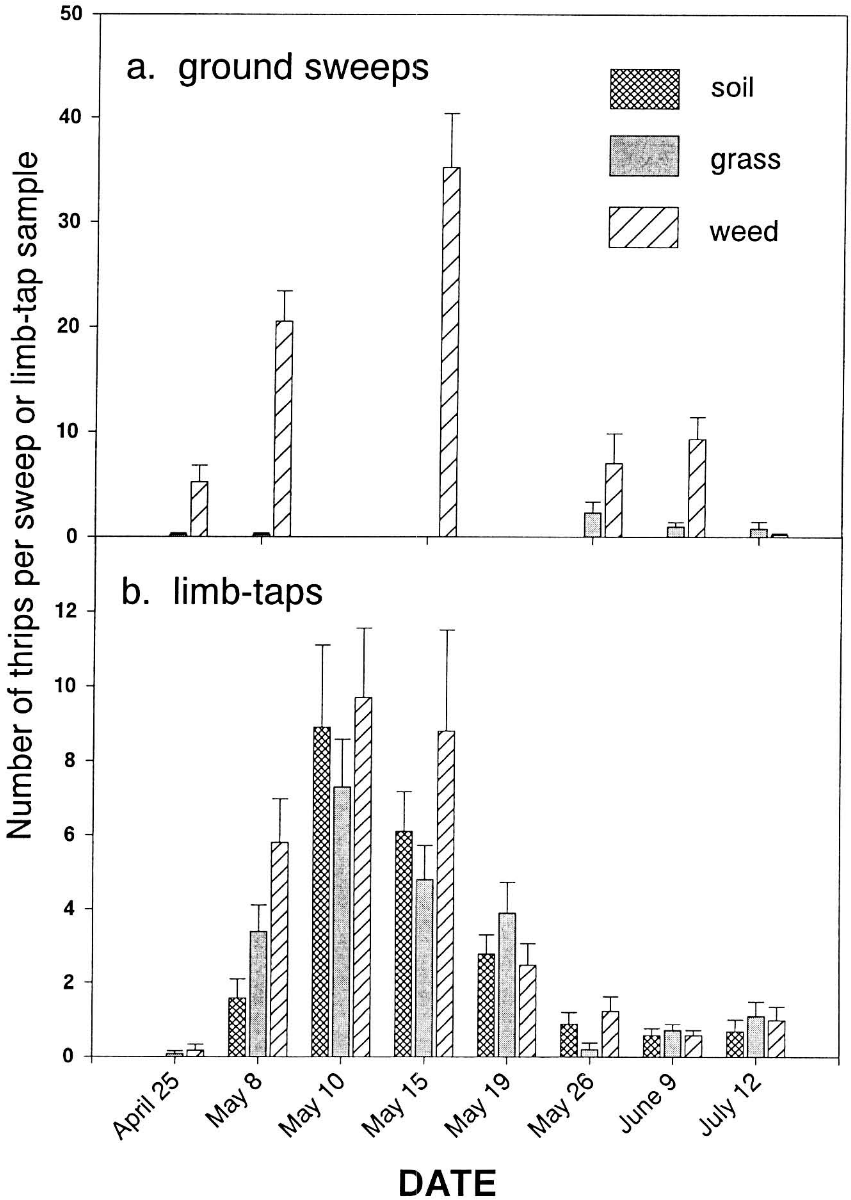

Figure 1. Mean western flower thrips per ground cover sweep (a) and limb-tap (b) in 1995 samples within bare soil, grass or weedy ground cover plots.

Pre-blossom limb-tap counts of western flower thrips in 1995 (25 April) were negligible for all three ground covers (Fig. 1b), indicating that large numbers of western flower thrips had not yet moved into the trees even in the weedy ground cover treatment. The limb-tap counts increased in all treatments through the period of apple bloom in a manner paralleling the sweep counts from the weedy ground cover. Limb-tap counts of the thrips from the weedy plots were generally higher than those in the soil and grass plots until petal fall (19 May); however, the difference in the number of western flower thrips was significantly (P<0.05) higher in the weedy ground cover trees only once (8 May), early in the bloom period (Fig. 1b).

Counts of western flower thrips within blossom clusters in bare soil plots were significantly (P<0.05) lower than in both the grass and weedy ground cover treatments in 1995. In 1996 counts of western flower thrips in the blossom clusters were made 13 days later than in 1995 and those from the bare soil plots did not differ from those in the weedy and grass plots (Table 1). The mean percent of apples harvested with pansy spot damage was not significantly different among the soil, grass and weedy ground cover plots in any of the 1995 and 1996 trials (Table 2).

Table 1

Mean number western flower thrips per apple blossom cluster, 17 May, 1995 and 30 May, 1996. Releases in 1995: 40 western flower thrips/tree with or without 20 *Chrysopa carnea* per tree.

		Ground cover[1,2]		
		soil	**grass**	**weeds**
Year	**Introduction**	mean (n) ±SE	mean (n) ±SE	mean (n) ±SE
1995	*C. carnea* + thrips	3.3 (11) ± 0.54 bB	3.8 (12) ± 0.78 bAB	5.6 (12) ± 0.61 bA
	thrips	5.4 (11) ± 0.38 aA	7.2 (12) ± 0.61 aA	8.0 (12) ± 1.11 bA
	control	2.9 (11) ± 0.50 bB	6.2 (12) ± 0.77 aA	7.4 (12) ± 1.17 bA
1996	control	4.0 (30) ± 0.65 B	6.3 (28) ± 0.87 B	4.9 (30) ± 0.63 B

[1]Means within year and ground cover followed by the same lower-case letter are not significantly different (Tukey's studentized range test, P>0.05).
[2] Means within year and introduction followed by the same upper-case letter are not significantly different (Tukey's studentized range test, P>0.05).

Table 2

Mean percent apples with western flower thrips damage harvested in late June. Releases included: 1995i: 40 western flower thrips with and without 20 *Chrysopa carnea* /tree; 1995ii: 30 C. *carnea*/tree. Six (1995) and 15 (1996) trees sampled per plot.

		Ground cover[1,2]		
		soil	**grass**	**weed**
Year	**Introduction**	mean ±SE	mean ±SE	mean ±SE
1995i	*C. carnea* + thrips	14.5 ± 2.9 aA	11.4 ± 2.8 aA	15.1 ± 3.8 aA
	thrips	7.2 ± 1.7 aA	13.3 ± 3.2 aA	13.4 ± 2.9 aA
	control	15.9 ± 3.2 aA	14.7 ± 2.2 aA	18.9 ± 3.0 aA
1995ii	*C. carnea*	18.2 ± 4.2 aAB	9.0 ± 2.9 aB	26.7 ± 4.0 aA
	control	10.6 ± 2.9 aA	17.6 ± 2.2 aA	19.3 ± 3.6 aA
1996	control	20.6 ± 2.4 A	20.5 ± 2.3 A	22.6 ± 3.5 A

[1]Means within year, trial and ground cover followed by the same lower-case letter are not significantly different (Tukey's studentized range test, P>0.05).
[2]Means within year and introduction followed by the same upper-case letter are not significantly different (Tukey's studentized range test, P>0.05).

Influence of predator releases. Limb-tap counts of western flower thrips did not indicate that the pest populations were significantly (P<0.05) lower in trees in which predators had been released. Only a few *C. carnea* were recaptured by limb-taps in 1995 despite the large numbers initially released. It is possible that the species were not effectively retrieved using this sampling technique or that the predators had dispersed from the trees.

Cluster samples were conducted sufficiently late after blossom that the collected thrips represented the F1 generation from the damaging blossom population. In the first release of 1995, significantly fewer thrips were counted in cluster samples where the *C. carnea* and western flower thrips were released versus the clusters where only western flower thrips were released within the soil and grass ground cover plots (Table 1). However, there was no evidence of reduced apple damage in 1995 resulting from predator releases (Table 2). Temperatures during the first and second releases in the study (1 and 12 May, 1995) were low (minimum of 5^0C). *Chrysopa carnea* prey on adult western flower thrips at 15^0C in laboratory trials (Cossentine, unpublished data) and they may have remained inactive when temperatures were $\leq 10^0$C and fed more effectively on the subsequent F_1 generation.

Indigenous beneficial arthropods. Pre-blossom limb-taps and ground cover sweeps contained spiders ($\bar{x}$ =0.05/tree) and predaceous thrips ($\bar{x}$ =0.03/tree). There were few other arthropods found in samples until after the apples blossomed. There were no significant differences in the numbers of beneficials found during this period between ground covers.

CONCLUSIONS

The percentage of apples damaged by the western flower thrips was high for all ground cover treatments (7.2 - 26.7%) (Table 2). The test orchard is particularly susceptible to spring western flower thrips immigration as it is adjacent to wild arrow-leafed balsam root and saskatoon bushes. Commercial apple orchards in similar situations could suffer serious economic loss due to the western flower thrips, particularly if the fruit variety did not colour sufficiently to mask the damage. The removal of wild western flower thrips hosts adjacent to most orchards susceptible to the high numbers of immigrating thrips is impractical in most situations and alternative control strategies are needed.

It has been well documented that cover crops have positive influences on orchard ecosystems. The ground cover can reduce soil erosion, influence soil nutrients and water retention and reduce soil compaction (Bugg and Waddington 1994; Hogue and Neilsen 1987). Either by providing good overwintering habitat or by enticing migration into the orchard from native plants, the weedy ground cover in this study significantly influenced the number of western flower thrips on the orchard floor. It is possible that the high numbers of thrips found resident in the weedy ground cover plots may have influenced the counts in the other two vegetation treatments. The fruit damaged by thrips in the soil or grass plots was not significantly lower than fruit damaged in the weedy plots. The positive influences of grass or weed covers on the orchard ecosystem discussed above exceed the potential of the bare soil cover to cause a small, possibly unreliable reduction of the western flower thrips damage.

Introduction of *C. carnea* nymphs into apple orchards in full bloom, to control western flower thrips during the cool spring temperatures in the southern interior of British Columbia, does not appear to be an effective thrips management strategy. The possible use of indigenous spiders and/or predaceous thrips, that appear to be active at the cool spring temperatures, should be further investigated.

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