Thiamethoxam Seed Coating on Rape seed for the Control of Cabbage Aphid *Brevicoryne brassicae* (L.)

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ABSTRACT

A glasshouse and a field experiment were conducted to determine the efficacy of thiamethoxam as a seed treatment on forage brassica for the control of aphids. Cabbage aphid (*Brevicoryne brassicae* L.) survival and reproductive rates were measured from rape plants (*Brassica napus* spp. *biennis* cv. Emerald) grown in both experiments. The seed was treated with four different thiamethoxam rates (1, 2, 4 and 8 g ai/kg) and compared to the registered rate of imidacloprid (14.4 g ai/kg) and untreated seed over time. Six weeks after sowing, only thiamethoxam at 8 g ai/kg and imidacloprid at 14.4 g ai/kg had significantly lower ($P < 0.001$) adult aphid survival than untreated seed. These two treatments had significantly fewer ($P < 0.001$) aphid nymphs than untreated seed at the same sampling time. Eight weeks after sowing there were no significant differences in aphid survival and reproduction between the untreated seed plots and all other seed treatments in the field experiment.

INTRODUCTION

Cabbage aphid, *Brevicoryne brassicae* (L) (CA), like a number of other exotic and economically important aphids, produce parthenogenic, viviparous females throughout the year. Females overwinter on horticultural brassicas and forage crops of rape, swede, turnip and kale. In spring, these females change to winged forms, fly to seedling brassicas and produce offspring (nymphs). There are at least 15 generations per year, each lasting 10-15 days in summer and about 60 days in winter (Butcher 1984). Cabbage aphids are the most prolific aphids in Canterbury with peaks of activity during October-December and March-April.

The only seed treatment currently registered for aphid control in seedling forage brassica crops is imidacloprid (Gaucho 600 FS). The second-generation neonicotinoid, thiamethoxam (Cruiser 600 FS), has also shown potential as a seed treatment for the control of aphids found in seedling forage brassica crops (Koenig et al. 2000).

Two seed treatment-screening experiments were conducted to determine the efficacy of thiamethoxam for the control cabbage aphid on seedling rape plants.

MATERIALS AND METHOD

The first experiment was conducted at AgResearch (Ruakura Research Centre) in the Waikato using potted plants and sleeve cages in a glasshouse. The second experiment used field cages at the Kimihia Research Centre (Canterbury). The aim of these experiments was to determine the efficacy of thiamethoxam at a range of concentrations to control cabbage aphid in forage brassica crops.

Glasshouse experiment

Eight seeds were sown into 9 x 9 x 11 cm pots containing sterilised silt loam soil on 19 July 1999. One week after sowing, plant numbers were thinned so that each pot contained four healthy seedlings. Three parasite-free aphid colonies were established on seedling rape plants grown from untreated seed in isolation cages. Simple sleeve

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cages over a wire frame were used to contain the aphids on the potted plants after aphid applications. At each of the three aphid application dates, five winged (alate) aphids were placed in each cage, left for 2 days, then adult and nymph numbers were counted. Fresh plants were used for each of the three aphid infestations.

This experiment was conducted in an environmentally controlled (18-20°C air temperature) glasshouse. Six seed treatments (thiamethoxam at 2, 4, 6 and 8 g ai/kg, imidacloprid at 14.4 g ai/kg and untreated seed) were assessed on forage rape seed (cv. Emerald). The six seed treatments were replicated five times for each of three aphid application dates (2, 4 and 6 weeks after sowing (WAS)). The treatments for each aphid infestation date were randomly placed within a plastic-watering tray.

Field cage experiment

The second experiment was conducted in an irrigated forage rape crop (cv. Emerald), grown on a Templeton silt loam soil at the Kimihia Research Centre, Canterbury. Prior to planting the site received 200 kg/ha of CropMaster 20 fertiliser (19.5 % N, 10 % P, 12.5 % S) and a herbicide application of trifluralin 400 g ai/litre (Tridan) at 3 litres/ha.

Six seed treatments (thiamethoxam at 1, 2, 4 and 8 g ai/kg, imidacloprid at 14.4 g ai/kg and untreated seed) were assessed on rape seed (cv. Emerald). Each treatment was replicated five times in a randomised block design. Each plot was 1.5 m x 10 m, sown in 15 cm drill rows, using an Øyjord drill on 20 October 1999.

Field cages made of fine mesh windbreak material sleeves placed over steel frames (0.65 m x 0.65 m wide and 0.65 m high) were placed over each plot two days prior to aphid infestation. Each cage was sealed at the base with soil and a draw-string at the top. Cages were located in a different part of the plot at each infestation based on plant number uniformity. A non-residual insecticide dichlorvos, (Nuvan 1000EC) was applied at 200 g ai in 10 litres water a day before infestation to remove resident insects (Schroeder 1998). Forty 3rd to 5th instar aphids, collected from colonies similar to those described in the glasshouse experiment, were introduced into the cages at 2, 4, 6 and 8 WAS. Aphid and plant numbers were counted six days after infestation. Meteorological data were obtained from the Broadfields meteorological station (approximately 1 km East). All data were analysed by ANOVA using Statistix for Windows and mean separation was based on Least Significant Difference (LSD) tests at $P < 0.05$.

TABLE 1: Mean number of alate and nymphal aphids recovered from the pot trial over time from rape plants with various seed treatments, 2 days after infestation with five alates.

Treatment	2 weeks		4 weeks		6 weeks	
	Adults	Nymphs	Adults	Nymphs	Adults	Nymphs
Thiamethoxam 2 g ai/kg	1.2	3.4	2.2	6.4	3.0	1.2
4 g ai/kg	0.2	0.6	0.2	0.0	1.6	0.4
6 g ai/kg	0.0	0.0	0.4	0.4	2.0	0.4
8 g ai/kg	0.0	0.0	0.0	0.2	0.8	0.8
Imidacloprid	0.0	0.2	0.4	0.0	0.0	0.0
Untreated	4.8	25.6	4.6	19.6	3.8	9.6
Significance ($P < $) ¹	0.001	0.001	0.001	0.001	0.001	0.001
LSD ($P < 0.05$)	0.6	2.9	1.0	5.5	2.9	2.2

¹ANOVA was performed on $\log_{(n+1)}$ transformed data due to the high proportion of zero counts.

RESULTS

Glasshouse Experiment

In the untreated seed control, adult aphid survival decreased over time (ranging from 96% at 2 WAS to 79% at 6 WAS), as did the number of nymphs produced (Table 1). There was a general increase in adult survival and nymphs produced over time as the thiamethoxam and imidacloprid concentration decreased. Only thiamethoxam at 8 g ai/kg and imidacloprid at 14.4 g ai/kg adequately decreased aphid counts at each sampling period.

Field Cage Experiment

Temperatures during the experiment did not increase as expected during the spring/early summer period. There were several events where mean 24-hour air temperatures fell dramatically (Table 2) during the experiment.

TABLE 2: Mean 24-hour air temperatures during the different aphid infestations.

Infestation Period	Mean 24 hour air temperatures (°C)		
	Maximum	Minimum	Mean
First (2 WAS)	19.5	8.5	14.1
Second (4 WAS)	19.5	8.5	11.8
Third (6 WAS)	17.0	10.0	13.6
Fourth (8 WAS)	18.5	10.5	13.6

The aphid numbers on untreated seed plots decreased over time (Table 3). There were no differences ($P>0.05$) in aphid numbers recovered from the thiamethoxam 8 g ai/kg (5.8 aphids) and imidacloprid 14.4 g ai/kg (10 aphids) plots at 6 WAS. Aphid numbers increased in all treatments over time, with no difference ($P>0.05$) between all seed treatments and the untreated seed at 8 WAS. There were no differences ($P>0.05$) in plant numbers between all treatments at each sampling.

TABLE 3: Mean number of aphids and plants recovered per 0.42 m² field cage over time from rape plants with various seed treatments, 6 days after infestation with 40 third to fifth instar aphids.

Treatments	2 weeks		4 weeks		6 weeks		8 weeks	
	Aphids	Plants	Aphids	Plants	Aphids	Plants	Aphids	Plants
Thiamethoxam 1 g ai/kg	10	32	20	32	41	24	26	18
2 g ai/kg	7.0	36	18	35	26	31	24	22
4 g ai/kg	0.0	33	23	29	16	28	16	20
8 g ai/kg	0.2	38	2.8	32	5.8	29	26	19
Imidacloprid	0.2	33	7.4	31	10	25	18	21
Untreated	122	34	40	34	42	26	28	19
Significance ($P<$)	0.001	NS	0.001	NS	0.001	NS	NS	NS
LSD ($P<0.05$)	22	12.9	18	12.9	10	5.0	11	5.3

DISCUSSION

There were similar reductions in aphid survival and nymph production over time in both experiments. The reduction in aphid survival and production at 6 and 8 WAS compared to 2 and 4 WAS in the field experiment was most probably due to air temperatures remaining low with large fluctuations occurring. Cabbage aphid requires

20-25°C for optimum growth and reproduction (D. Teulon, pers. com.) and as the field experiment progressed, mean day/night temperatures did not increase. The incubator temperature could have been lowered to 10°C two days before aphids were released into the field to avoid cold shock (D. Teulon, pers. comm.).

Thiamethoxam at 8 g ai/kg and imidacloprid at 14.4 g ai/kg treatments gave the best overall reduction in aphid numbers in both the glasshouse and field experiment, with both seed treatments reducing ($P < 0.001$) aphid numbers at 6 WAS. Eight weeks after sowing all seed treatments in the experiment produced no reduction in aphid numbers, with there being no difference ($P > 0.05$) between all seed treatments and untreated seed.

The reduction in plant numbers observed in the field cage experiment was due to competition and is common in forage brassica crops. Under normal cropping conditions, between 40-60 rape plants/m² at 8 WAS should result in a high producing crop (7-8 t/ha). The plant numbers recorded in the field cage experiment fell within this plant density range.

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