Report prepared for the
Horticultural Development Council

FV 162c
EVALUATION OF DIFFERENT FORMULATIONS OF IMIDACLOPRID FOR APHID CONTROL ON OUTDOOR LETTUCE

Final Report

By

Dr William E Parker
Dr Julia J Howard

Project Title

Evaluation of Different Formulations of Imidacloprid for Aphid Control on Outdoor Lettuce

Project number:	FV 162c
Project Leader:	Dr W E Parker, ADAS, Woodthorne, Wolverhampton WV6 8TQ
Current report:	Final report (April 1997 to January 1999)
Previous Reports:	First Annual Report – January 1998
Key Workers:	Dr W Parker, Dr J Blood Smyth, Mrs J Town, Mr I Ordidge, Mrs A Shearan, Dr J Howard.
Location of project:	Commercial farms in Cambridgeshire (courtesy of G S Shropshire & Sons) and Derbyshire (courtesy of Trent Valley Growers).
Project Co-ordinator:	Mr Peter Barton, Trent Valley Growers Ltd, Bridge Farm, Barrow-on-Trent, Derby DE73 1HH
Project timeline:	Commenced April 1997, completion due 31 January 1999.
Keywords:	Lettuce, aphids, insecticides, imidacloprid, Gaucho, Admire, Intercept.

CONTENTS

PRACTICAL SECTION FOR GROWERS

Project background & objectives

The wide-scale commercial use of Gaucho (imidacloprid seed treatment) for aphid control in outdoor lettuce in 1996 highlighted some practical problems. The most critical of these was poor germination (10-25% losses) of some seed lots treated with imidacloprid. In addition, imidacloprid-treated seed is expensive, and decisions on seed treatment also have to be made well in advance of the actual planting date of the crop. Growers would like more flexibility to tailor their insecticide strategy on particular lettuce plantings to the perceived aphid risk at or near planting. One way of achieving the same level of aphid control offered by Gaucho, with the ability to decide nearer planting whether treatment is required, is to apply imidacloprid by methods other than seed treatment.

The commercial aim of the project therefore, was to assess the viability of using different formulations of imidacloprid for aphid control on outdoor lettuce and to define the circumstances for their effective use. The alternative formulations investigated were a sprayable formulation (Admire, 70% w/w water dispersible granule) and Intercept (5% granule). The specific objectives of the project were:

1. To investigate the germination and vigour of lettuce plants treated with different formulations and rates of imidacloprid.
2. To investigate the relative field efficacy and persistency of different formulations of imidacloprid for foliar and root aphid control on lettuce.

Results summary

- None of the imidacloprid treatments had any lasting adverse effect on plant growth during germination and propagation, although Gaucho seed treatment did cause a temporary check in plant growth prior to planting in both 1997 and 1998. However, establishment in the field was unaffected, as was final head weight.
- In 1997, aphid numbers were too low to draw meaningful conclusions on the relative efficacy of the imidacloprid formulations. In 1998, both seed treatment (Gaucho) and compost drench (Admire) formulations significantly lowered foliar aphid numbers at all concentrations in comparison to untreated plots one week after harvest. This effect was still numerically apparent, but not statistically significant, at hearting. At harvest, control was diminished in all treatments, although there was a suggestion that Gaucho was still providing some measure of control, although again this could not be statistically demonstrated.
- Lettuce root aphid infestations were too low to allow meaningful conclusions to be drawn.
- The project has provided evidence that Admire drenches could be a useful armoury for lettuce growers as there is no risk of phytotoxicity and a useful degree of aphid control between planting and hearting can be obtained. However, additional foliar treatments may still be required close to harvest.

Action points for grower

Currently, there is no prospect of the immediate application of these results as neither Admire or Intercept are Approved (either as on- or off-label approvals) for use on lettuce.

- Growers should consider whether an HDC-supported SOLA (Specific Off-label Approval) application should be made.

Practical and financial anticipated benefits

Should Admire treatment become an option for lettuce growers (through a successful SOLA application), it will provide greater flexibility in tailoring aphid control programmes to pest pressure as:

- The need for the application can be made close to planting.
- It reduces the risk of over-use of imidacloprid which could lead to a build-up of resistance.
- It may be a more acceptable treatment in ICM systems than seed treatment.

In addition, the financial risks associated with poor germination resulting from Gaucho seed treatment could be effectively minimised.

The relative price of seed treatment versus drench is clearly unknown at present.

EXPERIMENTAL SECTION

Introduction

Foliar- and root-feeding aphids are the most serious pests of outdoor lettuce in the UK. They regularly cause severe crop loss, either through direct feeding damage or by contamination of harvested heads with live aphids. Prevention of severe aphid infestations on lettuce can require intensive foliar insecticide programmes to control both lettuce root aphid (*Pemphigus bursarius*) and a number of foliar aphid species, principally the currant-lettuce aphid (*Nasonovia ribisnigri*).

In 1994 and 1995, work done as part of a LINK research programme on lettuce aphid management (partly funded by HDC) and other additional work wholly funded by HDC, demonstrated the potential of imidacloprid seed treatment (Gaucho) for both foliar and root aphid control on lettuce (Parker & Blood Smyth, 1996). In 1996, Gaucho received a specific off-label Approval (SOLA) for aphid control on outdoor lettuce, and the product is now widely used in the lettuce industry.

However, the wide-scale commercial use of Gaucho in 1996 highlighted some practical problems. The most critical of these was poor germination (10-25% losses) of some seed lots treated with imidacloprid. In addition, imidacloprid-treated seed is expensive, and decisions on seed treatment have to be made well in advance of the actual planting date of the crop. There is therefore no flexibility for tailoring the insecticide strategy to the perceived aphid risk at or near planting.

Other formulations of imidacloprid have now become available for use in crops other than lettuce. These include a granular formulation for compost incorporation (Intercept 5GR, 5% w/w granule) and a sprayable formulation (Admire, 70% w/w water dispersible granule). These formulations may offer the industry alternative and possibly more flexible ways of applying imidacloprid to lettuce crops, provided they are not phytotoxic to the crop and give effective aphid control.

Objectives

1. To investigate the germination and vigour of lettuce plants treated with different formulations and rates of imidacloprid.
2. To investigate the relative field efficacy and persistency of different formulations of imidacloprid for aphid control on lettuce.

Materials and methods

Experiment site location

All work on germination and phytotoxicity in 1997 and 1998 was done at ADAS Arthur Rickwood. In 1997, field experiments were done at Wissington, Cambridgeshire (on organic soil), courtesy of G S Shropshire & Sons. In 1998, field work was done at Barrow-on-Trent, Derbyshire (on mineral soil) courtesy of Trent Valley Growers Ltd.

Imidacloprid treatments

Lettuce seed (cv Saladin) treated with different rates of imidacloprid (Gaucho, 70% w/w water dispersible powder) was obtained courtesy of Seedcote Systems Ltd. A sprayable formulation of imidacloprid (Admire, 70% w/w water dispersible granule) was supplied as commercial product courtesy of Bayer plc. In 1997, compost pre-treated with the required rates of imidacloprid (as Intercept, 5% granule) was obtained from Levington Horticulture.

Experimental treatments

A. Untreated seed and untreated compost.

B. Admire (70% w/w imidacloprid) compost drench at 125 g a.i./ha equivalent.

C. Gaucho seed treatment at 180 g a.i./100,000 seeds (approx. 125 g a.i./ha equivalent).

D. Intercept (5% w/w imidacloprid) blocking compost incorporation at 125 g a.i./ha equivalent

E. Admire compost drench at 82.5 g a.i./ha equivalent

F. Gaucho seed treatment at 120 g a.i./100,000 seeds (approx. 82.5 g a.i./ha equivalent).

G. Intercept (5% w/w imidacloprid) blocking compost incorporation at 82.5 g a.i./ha equivalent

H. Admire compost drench at 41.25 g a.i./ha equivalent

I. Gaucho seed treatment at 60 g a.i./100,000 seeds (approx. 41.25 g a.i./ha equivalent).

J. Intercept (5% w/w imidacloprid) blocking compost incorporation at 41.25 g a.i./ha equivalent.

In 1998, the Intercept treatments were removed from the experiment as it was felt that these offered no benefit over the existing Gaucho seed treatment in terms of flexibility in timing of application.

For the 1998 experiment only, loading analysis of the Gaucho seed treatment done by Seedcote Systems Ltd showed that treatment C (in theory the highest imidacloprid concentration) was in fact almost identical to treatment I (the lowest concentration). These tests were done after the experiments had been set up and therefore there was no opportunity to use seed treated at the correct rate. Data from treatment C was therefore combined with that from treatment I in the analyses.

Application of Admire drenches

The Admire drenches were applied to the blocks approximately one week pre-planting. The product was applied in sufficient water to carry the drench into the compost without the risk of leaching the insecticide out through over-watering Thus the drenches were applied when the blocks required watering anyway. Application was a two-stage process:

1. Application of the insecticide drench.
2. Rinsing treated leaves with clean water.

The amount of water required to treat the plants was calculated as follows:

1. An estimation of the amount of water required to wet one block to capacity was made.
2. The volume obtained in 1) was multiplied by the number of blocks to be treated to obtain the total water volume to be used.
3. 75% of the total water volume required was used to apply the insecticide drench.
4. The remaining 25% of the total water volume was used to rinse the leaves immediately after treatment.

Experimental design & analysis

The experiment comprised two separate phases: a) germination/propagation phase; b) field crop phase. The treatments from the propagation work were carried through to the field. The propagation part of the work was done on plants in trays of 80 plants each. For each of the two experiments, 8 trays of plants were used for each treatment. The arrangement of trays of different treatments conformed to a randomised complete block design of 10 treatments in 5 replicates.

The field experiments were laid out as a randomised complete block design of ten treatments (1997) or 7 treatments (1998) replicated four times in a randomised block design. Plot size was 12 m long by one bed (1.8 m) wide. The lettuces were planted four rows to a bed with an in-row spacing of 30 cm. There were 2 m guards planted with untreated lettuce between the plots, and a 5 m guard around the experiment.

Analysis of all data was initially by analysis of variance. Where significant F tests were obtained, means were separated using the Least Significant Difference (LSD) test.

Plant propagation methodology

Plants were propagated at ADAS Arthur Rickwood. Seeds were placed in a refrigerator for 24 hours prior to sowing, then seeded into moist peat blocks (4.3 cm x 4.3 cm x 3 cm) using Levington B2 compost. The blocks were placed in a chitting cabinet at 17 ^{o}C for 3 days. On removal, a thin layer of vermiculite was sprinkled over the blocks. Trays of plants were placed in a polythene tunnel and watered regularly until ready for planting.

Sowing, planting and harvest dates

Date	**Expt. 1 (1997)**	**Expt. 2 (1997)**	**Expt. 3 (1998)**
Sowing	24 June 1997	1 July 1997	07 June 1998
Planting	23 July 1997	30 July 1997	08 July 1998
(Hearting)	18 August 1997	27 August 1997	13 August 1998
Harvest	03 September 1997	8 September 1997	26 August 1998

Treatment dates

Admire drenches were applied on the following dates: Experiment 1: 15 July 1997; Experiment 2: 22 July 1997; Experiment 3: 1 July 1998.

Germination and phytotoxicity assessments

1. *Percentage germination* was assessed 1, 2 and 3 weeks after sowing by counting the number of blocks in four trays/treatment which did not have any visible signs of lettuce growth. The same trays were used at each assessment.
2. *Plant vigour* was assessed 1, 2 and 3 weeks after sowing by counting the number of true leaves (i.e. excluding cotyledons) and measuring the height (in cm) of a sub-set of 40 plants per treatment selected at random.

Field experiment assessments

1. *Assessment of phytotoxicity of Admire drench treatment* was done 4 days post-treatment. 40 plants per treatment were assessed according to the following index:

   1 = no leaf discolouration or distortion
   2 = slight discolouration on single leaves at tips only, or slight leaf distortion.
   3 = <50% of leaves showing signs of moderate discolouration or distortion
   4 = >50% of leaves showing moderate discolouration or distortion.
   5 = >50% of leaves showing severe discolouration or distortion.

2. *Foliar aphid infestation levels* were assessed seven days post-planting, at hearting and at harvest. At each assessment, ten plants per plot were removed from the field and assessed in the laboratory by firstly examining the outside of the plant for aphids (especially the underside of the lower leaves), and then by carefully stripping off the leaves sequentially until the whole plant had been searched. The number of aphids found on each plant was recorded.

3. *Lettuce root aphid infestation* was assessed at harvest only using standard ADAS procedures on each of 20 plants/plot. This technique categorises the aphid infestation level on the roots of each plant according to a logarithmic index ranging from 0 (no infestation) to 7 (severe infestation).

4. *Trimmed head weight (in g) at harvest* of twenty plants harvested from each plot was recorded.

Results & discussion

Germination and plant vigour

None of the imidacloprid treatments had any effect on percentage germination. Data from Experiment 3 (1998) are presented in Appendix 1 as an example.

In all experiments, plant vigour was unaffected by treatment with Admire and Intercept (the latter product was used in Experiments 1 and 2 only), providing good evidence that these formulations of imidacloprid are plant-safe. However, Gaucho seed treatment used at 125 g a.i./ha in Experiment 2 (1997) caused a slight check in plant growth which significantly reduced plant height in comparison with other treatments when assessed on 22 July (Table 1). However, this effect was transitory and no differences were discernible one week later. Similarly in Experiment 3 (1998) plant growth was reduced by treatment both one week ($F=12.78$, d.f.=5, 279, $P<0.001$) and two weeks ($F=3.95$, d.f.=5, 279, $P<0.05$) after planting (Table 2). Observation of the data suggest that the Gaucho seed treatment was responsible for

this result due to a slight check in plant growth at both 82.5g a.i./ha and 41.25g a.i./ha in comparison with other treatments, over this two week period (Table 2). However, this effect was transitory and no differences were discernible by the third week.

Plant establishment

Establishment of plants post-planting was satisfactory in all experiments, and was not affected in any way by the imidacloprid treatments.

Foliar aphid control - 1997

Foliar aphid infestations were very low on both experiments. Maximum untreated populations (principally *Nasonovia ribisnigri*) only reached a mean of *c*. 1 aphid/plant on both experiments, with the highest numbers being found at the hearting assessments. None of the imidacloprid treatments significantly reduced the level of infestation (Table 3), and there was no evidence of any trend in the level of aphid control as a result of different product rates.

As a further comparison between the effect of the different imidacloprid formulations, data for each product was averaged across all three rates. The results are given in Figure 1, and confirm that there were no consistent trends in the effectiveness of the different formulations.

Foliar aphid control - 1998

A significant infestation of *N. ribisnigri* developed on this experiment, reaching a mean of c. 350 aphids per plant on untreated plots at harvest. Analysis of variance of the total number of aphids caught throughout the experiment revealed that there was no significant effect of treatment or formulation on foliar aphid infestation ($F=1.29$, d.f.=5, 104, $P=0.275$). However, when aphid numbers were examined over time, analysis showed an increase in aphid population numbers as the experiment progressed ($F=12.85$, d.f.=2, 104, $P<0.001$) with the population reaching a peak at harvest time. Further examination of the effect of treatment on aphid numbers at each, discrete sampling event revealed that there was a significant effect of treatment 7 days post planting ($F=9.82$, d.f.=5,24, $P<0.001$) with reduced infestation of all treated plants compared to untreated plants (Table 4). In terms of aphid numbers, the effect of Gaucho at the two higher rates appeared to persist until harvest. However, the differences were not statistically significant at either hearting or harvest. Similarly, the Admire drench at 82.5 g a.i./ha equivalent appeared to be still suppressing aphid numbers at hearting, but again this difference was not statistically significant.

Lettuce root aphid control – 1997 & 1998.

In 1997, lettuce root aphid infestations at harvest were very low on both Experiments 1 and 2 (Table 5). Due to the very low aphid numbers, no formal statistical analysis was possible, and meaningful conclusions could not be drawn from the data. Lettuce root aphid infestations were virtually absent from Experiment 3 (1998).

Head weight

In 1997, mean head weights at harvest were largely unaffected by any of the treatments (Table 6). In Experiment 1, the head weight of all imidacloprid-treated plants was numerically higher than untreated plants, but only plants treated with Gaucho at 125 g a.i./ha were significantly heavier than untreated plants. In Experiment 2, head weights were more variable and mean weights of plants from different treatments were either numerically similar to, or lower than, those of untreated plants. However, none of the differences were statistically significant. In

Experiment 3 (1998), mean head weights at harvest were also unaffected by any of the treatments (Table 6).

Overall therefore, excluding the initial, transitory check in plant growth following treatment with Gaucho, these results are consistent with the results of the plant vigour and phytotoxicity assessments made during propagation, and indicate no adverse affect on plant growth from any of the treatments.

Conclusions

- None of the imidacloprid treatments had any lasting adverse effect on plant growth during germination and propagation, although Gaucho seed treatment did cause a temporary check in plant growth prior to planting in both 1997 and 1998. However, establishment in the field was unaffected.
- In 1997, aphid numbers were too low to draw meaningful conclusions on the relative efficacy of the imidacloprid formulations. In 1998, both seed treatment (Gaucho) and compost drench (Admire) formulations significantly lowered aphid numbers at all concentrations in comparison to untreated plots one week after harvest. This effect was still numerically apparent, but not statistically significant, at hearting. At harvest, control was diminished in all treatments, although there was a suggestion that Gaucho was still providing some measure of control, although again this could not be statistically demonstrated.
- The project has provided evidence that Admire drenches could provide a useful armoury for lettuce growers as there is no risk of phytotoxicity and a useful degree of aphid control between planting and hearting can be obtained. However, additional foliar treatments may still be required close to harvest.

Acknowledgments

We are grateful for the cooperation of G's Fresh Salads, Trent Valley Growers, Levington Horticulture, Seedcote Systems Ltd and Bayer plc for contributing land and material to the project.

Reference

Parker, W. E. & Blood Smyth, J. A. (1996). Insecticidal control of foliar and root aphids on outdoor lettuce. *Proceedings of the Brighton Crop Protection Conference - Pests and Diseases* **3** pp 861-866.

Table 1. Plant vigour assessments (plant height in cm and no. of true leaves) on different imidacloprid treatments - 1997 experiments.

a) Experiment 1 (1997)

Treatment	Height 8/7/97	Number leaves 8/7/97	Height 15/7/97	Number leaves 15/7/97	Height 22/7/97	Number leaves 22/7/97
Untreated	1.51	2.0	9.63	4.0	21.34	6.7
Admire 125g/ha	1.48	2.0	9.66	4.0	15.59	6.5
Gaucho 125g/ha	1.42	2.0	9.36	4.0	16.79	6.7
Intercept 125g/ha	1.66	1.9	8.61	4.0	16.41	6.5
Admire 82.5g/ha	1.45	2.0	9.02	4.0	16.70	6.6
Gaucho 82.5g/ha	1.34	2.0	8.32	4.0	17.39	6.7
Intercept 82.5g/ha	1.70	2.0	8.99	4.0	15.74	6.2
Admire 41.25g/ha	1.48	2.0	8.88	4.0	16.79	6.7
Gaucho 41.25g/ha	1.50	1.9	9.20	4.0	16.83	6.7
Intercept 41.25g/ha	1.84	2.0	8.66	4.0	16.78	6.5
SED (25 df)	0.147	(not analysed)	0.416	(not analysed)	0.692	(not analysed)

b) Experiment 2 (1997)

Treatment	Height 15/7/97	Number leaves 15/7/97	Height 22/7/97	Number leaves 22/7/97	Height 29/7/97	Number leaves 29/7/97
Untreated	4.19	2.0	12.28	3.8	20.75	7.0
Admire 125g/ha	4.15	2.0	12.99	4.0	20.36	7.0
Gaucho 125g/ha	3.78	2.0	10.51	3.6	20.03	7.0
Intercept 125g/ha	4.31	2.0	12.43	3.9	20.30	7.0
Admire 82.5g/ha	4.39	2.0	12.58	3.9	21.33	7.0
Gaucho 82.5g/ha	4.26	2.0	11.75	3.7	20.93	7.0
Intercept 82.5g/ha	4.18	2.0	12.48	3.8	20.69	7.0
Admire 41.25g/ha	4.15	2.0	13.03	4.0	20.95	7.0
Gaucho 41.25g/ha	4.15	2.0	11.63	3.7	20.61	6.8
Intercept 41.25g/ha	4.33	2.0	13.04	3.9	20.18	6.9
SED (25 df)	0.198	(not analysed)	0.550	(not analysed)	0.603	(not analysed)

Table 2. Plant vigour assessments (plant height in cm and no. of true leaves) on different imidacloprid treatments - Experiment 3 (1998).

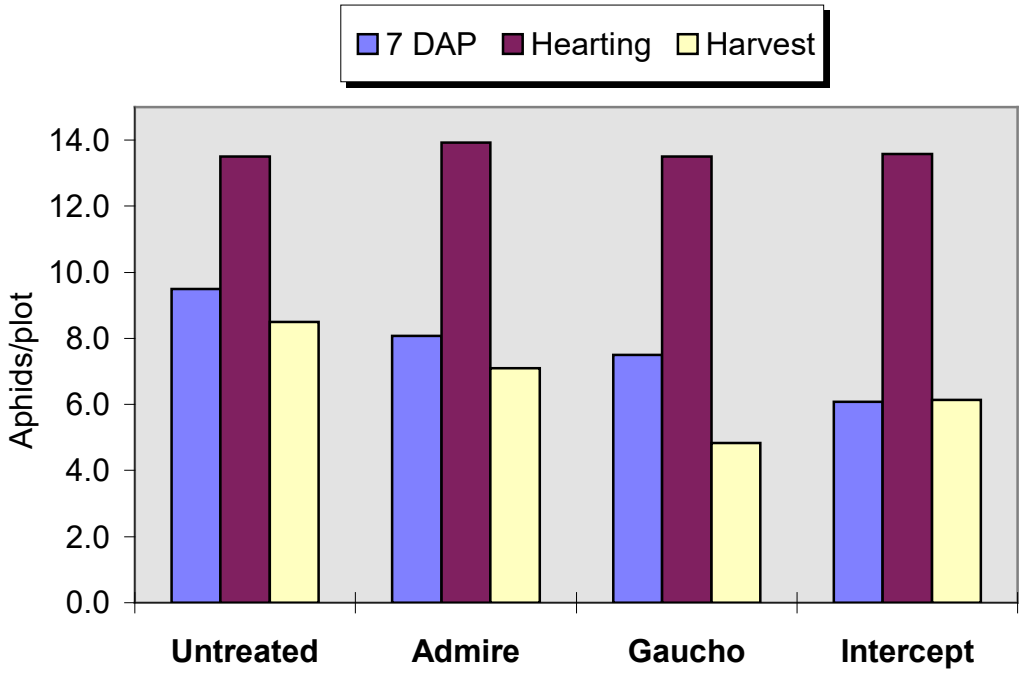
Treatment	Height 15/7/97	Number leaves 15/7/97	Height 22/7/97	Number leaves 22/7/97	Height 29/7/97	Number leaves 29/7/97
Untreated	1.0	0	6.4	3.0	11.2	4.7
Admire 125g a.i./ha	1.1	0	6.3	3.0	11.1	4.9
Admire 82.5g a.i./ha	1.1	0	6.6	3.0	11.1	4.8
Gaucho 82.5g a.i./ha	0.7	0	6.1	3.0	11.4	4.9
Admire 41.25g a.i./ha	1.1	0	6.3	3.0	11.4	4.9
Gaucho 41.25g a.i./ha	0.8	0	6.0	2.9	11.2	4.7
SED (274 df)	0.206	(not analysed)	0.468	0.091	0.577	0.326

Table 3. Mean number of foliar aphids per plant found on each treatment 7 days after planting (post-planting), at hearting and at harvest on Experiments 1 and 2 (1997).

	Experiment 1			Experiment 2		
	Post-planting	**Hearting**	**Harvest**	**Post-planting**	**Hearting**	**Harvest**
Treatment	**30/7/97**	**18/8/97**	**5/9/97**	**6/8/97**	**28/8/97**	**12.9.97**
Untreated	0.95	1.35	0.85	0.57	1.03	0.23
Admire 125g a.i/ha	0.88	1.38	1.02	0.20	1.20	0.15
Gaucho 125g a.i/ha	0.83	1.13	0.50	0.25	1.33	0.15
Intercept 125g a.i/ha	0.70	1.50	0.80	0.48	1.33	0.13
Admire 82.5g a.i/ha	0.78	1.30	0.35	0.45	1.13	0.25
Gaucho 82.5g a.i/ha	0.60	1.50	0.80	0.38	0.58	0.30
Intercept 82.5g a.i/ha	0.40	0.93	0.63	0.23	0.88	0.28
Admire 41.25g a.i/ha	0.78	1.50	2.50	0.23	0.78	0.22
Gaucho 41.25g a.i/ha	0.78	1.43	0.15	0.55	1.03	0.20
Intercept 41.25g a.i/ha	0.73	1.65	0.43	0.45	0.98	0.25
SED (27 df)	0.182	0.274	0.222	0.110	0.219	0.092

Figure 1. Effect of different imidacloprid formulations on the mean number of foliar aphids/plot 7 days after planting (7 DAP), at hearting and at harvest averaged across all rates for each product.

a) Experiment 1



b) Experiment 2

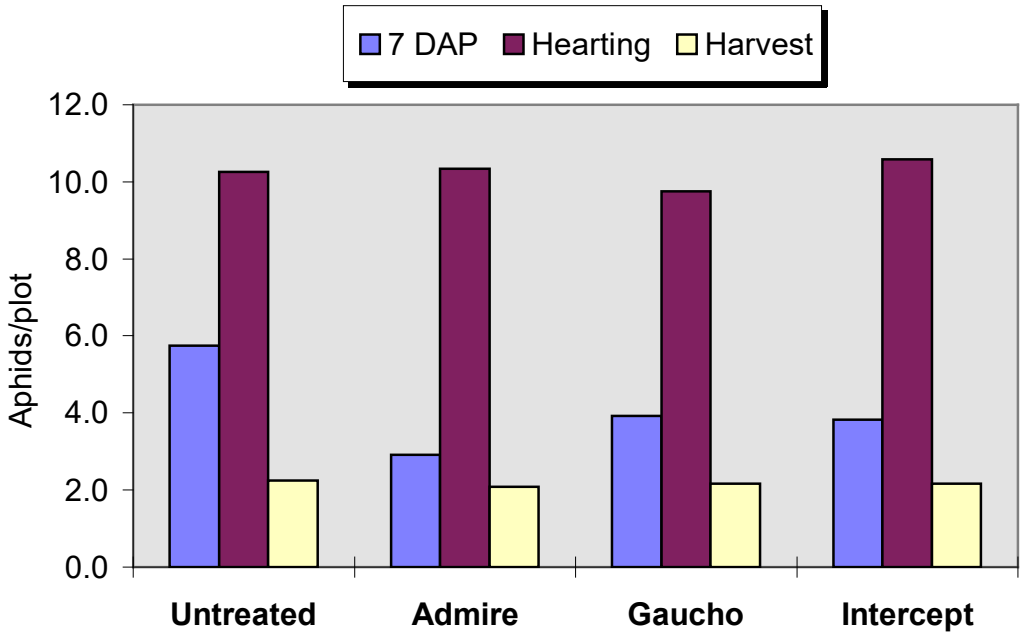


Table 4. Mean number of foliar aphids per plant found on each treatment 7 days after planting (post-planting), at hearting and at harvest.

	Post-planting	**Hearting**	**Harvest**
Treatment	**15/7/98**	**13/8/98**	**26/8/98**
Untreated	11.8	78.2	353.4
Admire 125g a.i./ha	1.8	11.2	322.2
Admire 82.5g a.i./ha	2.8	2.8	217.8
Gaucho 82.5g a.i./ha	1.0	1.2	21.6
Admire 41.25g a.i./ha	1.4	30.2	193.4
Gaucho 41.25g a.i./ha	1.1	11.3	112.8
SED (29 df)	1.96	33.11	192.48

Table 5. Mean lettuce root aphid index score at harvest on Experiment 1 and 2 (1997).

a) Experiment 1.

Treatment	**Index score**
Untreated	0.213
Admire 125g a.i/ha	0.012
Gaucho 125g a.i/ha	0.000
Intercept 125g a.i/ha	0.138
Admire 82.5g a.i/ha	0.038
Gaucho 82.5g a.i/ha	0.038
Intercept 82.5g a.i/ha	0.063
Admire 41.25g a.i/ha	0.063
Gaucho 41.25g a.i/ha	0.088
Intercept 41.25g a.i/ha	0.038

b) Experiment 2.

Treatment	**Index score**
Untreated	0.86
Admire 125g a.i/ha	0.00
Gaucho 125g a.i/ha	0.05
Intercept 125g a.i/ha	0.00
Admire 82.5g a.i/ha	0.06
Gaucho 82.5g a.i/ha	0.00
Intercept 82.5g a.i/ha	0.04
Admire 41.25g a.i/ha	0.00
Gaucho 41.25g a.i/ha	0.00
Intercept 41.25g a.i/ha	0.00

Table 6. Mean head weight (g) of harvested lettuce.

a) Experiment 1 (1997)

Treatment	Mean head weight (g)
Untreated	461.0
Admire 125g a.i/ha	529.9
Gaucho 125g a.i/ha	623.1
Intercept 125g a.i/ha	521.0
Admire 82.5g a.i/ha	515.8
Gaucho 82.5g a.i/ha	531.5
Intercept 82.5g a.i/ha	550.5
Admire 41.25g a.i/ha	551.2
Gaucho 41.25g a.i/ha	524.6
Intercept 41.25g a.i/ha	539.5
SED (27 df)	20.66

b) Experiment 2 (1997)

Treatment	Mean head weight (g)
Untreated	431.8
Admire 125g a.i/ha	373.5
Gaucho 125g a.i/ha	437.3
Intercept 125g a.i/ha	377.8
Admire 82.5g a.i/ha	397.0
Gaucho 82.5g a.i/ha	361.3
Intercept 82.5g a.i/ha	413.9
Admire 41.25g a.i/ha	350.5
Gaucho 41.25g a.i/ha	432.6
Intercept 41.25g a.i/ha	424.2
SED (27 df)	29.48

c) Experiment 3 (1998)

Treatment	Mean head weight (g)
Untreated	588.4
Admire 125g a.i./ha	569.6
Admire 82.5g a.i./ha	567.0
Gaucho 82.5g a.i./ha	600.2
Admire 41.25g a.i./ha	543.0
Gaucho 41.25g a.i./ha	599.5
SED (29 df)	50.66

Appendix 1.

Percentage seed germination (% G) following different imidacloprid treatments – Experiment 3 (1998).

Treatment	%G 15/6/98	%G 22/6/98	%G 29/6/98
Untreated	97.43	95.95	97.43
Admire 125g/ha	96.60	96.28	98.78
Admire 82.5g/ha	99.10	99.70	97.20
Gaucho 82.5g/ha	97.20	98.15	98.45
Admire 41.25g/ha	98.15	96.90	99.70
Gaucho 41.25g/ha	95.43	94.88	96.75
SED (22 df)	4.215	4.014	4.568