

Project title: Establishment of best agronomic practice towards minimizing pesticide residues on herbs and speciality produce

Project number: FV 371

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Report: Final report, July 2010

Previous report: Not applicable

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Date project commenced: 1 January 2010

Date project completed (or expected completion date): 31 July 2010

Key words: herbs, lettuce, pesticide residues, minimisation

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The results and conclusions in this report are based on a desk study conducted over a six-month period. As the number of full data sets obtained from growers were limited in number care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

AUTHENTICATION

We declare that this report represents a true and accurate record of the results obtained.

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## CONTENTS

<b>GROWER SUMMARY</b>	<b>04</b>
HEADLINE	04
EXPECTED DELIVERABLES	04
SUMMARY OF PROJECT AND MAIN CONCLUSIONS	05
HERBS & WILD ROCKET	05
LETTUCE	07
<b>SCIENCE SECTION</b>	<b>08</b>
INTRODUCTION	08
DEVELOPMENT OF AN EXCEL TEMPLATE	09
CONTACTS WITH KEY GROWERS	10
DATABASE DESIGN AND DATA MANIPULATION	10
RESULTS	13
OVERALL FINDING	13
HERBS & WILD ROCKET	13
FUNGICIDES	14
AZOXYSTROBIN	14
BOSCALID	15
METALAXYL-M	15
PYRACLOSTROBIN	15
DITHIOCARBAMATES (MANCOZEB)	15
HERBICIDES	15
LINURON	16
PENDIMETHALIN	16
PROPYZAMIDE	16
OTHER HERBICIDES	17
INSECTICIDES	17
ALPHA-CYPERMETHRIN	17
DELTAMETHRIN	18
LAMBDA-CYHALOTHRIN	18
PIRIMICARB	18
LETTUCE	18
FUNGICIDES	18
AZOXYSTROBIN	19
BOSCALID	19
CYPRODINIL	19
FLUDIOXINIL	20
FENHEXAMID	20
DITHIOCARBAMATES (MANCOZEB)	21
PYRACLOSTROBIN	21
HERBICIDES	21
PROPYZAMIDE	22
OTHER HERBICIDES	22
INSECTICIDES	22
DELTAMETHRIN	23
CYPERMETHRIN	23
LAMBDA CYHALOTHRIN	24
PIRIMICARB	24
CONCLUSIONS	24
TECHNOLOGY TRANSFER	25
ACKNOWLEDGMENTS	26
APPENDIX 1a	PESTICIDE RESIDUES FOUND IN HERBS & WILD ROCKET 27
APPENDIX 1b	PESTICIDES RESIDUES FOUND IN LETTUCE 28
APPENDIX 2	RESIDUE PROFILES OF INDIVIDUAL PESTICIDES 30

## **GROWER SUMMARY**

### **Headline**

Usage and residue data have been collected from key UK herb and lettuce growers and fed into a database. The outputs from the database have been presented in this report to see which products/actives have given rise to the highest residue levels in crops of herbs and lettuce.

### **Expected deliverables**

The specific objectives of the project were:

1. To contact a number of key herb and lettuce growers and ask them to provide information on their usage of pesticides in 2009 (i.e. effectively since Regulation (EC) No 396/2005 came into force) and the results of residue tests performed on the crops at harvest.
2. A suitable database to be designed and the growers' information to be entered. The database could then be interrogated to identify the most problematic pesticides in terms of the frequency and levels of residues that remained in the crop at harvest.
3. Once the most problematic crop/pesticide combinations had been identified, suggestions for reducing residue levels could be formulated.

### **Summary of the project and main conclusions**

The paucity of information, based on only one growing season since the implementation of Regulation (EC) No 396/2005, particularly regarding pesticide usage on both herbs and lettuce makes it difficult to draw many hard and fast conclusions. Indeed now that an Excel template, it would merit collecting further data from selected growers for the 2010 season in order to strengthen the database.

The outputs from the database do confirm what might be expected: that residue levels are generally dependent on treatment rates, numbers of applications and harvest intervals.

For crops where usage information was available, all residues were below MRLs and in most cases <1/2 the MRL, or even lower.

It would appear that if GAP is observed then none of the products being currently used on herbs, wild rocket or lettuce are likely to lead to any MRL exceedance. Of course there are other approved pesticides, such as clomazone and lenacil, but as

no data were submitted, or were available from other sources then their potential to produce measurable residues remains unverified.

The results are encouraging from a grower's perspective as they do not indicate that any particular product or active is problematic in terms of producing residues close to an MRL.

If growers are under pressure to further reduce residues in their crops then this may be possible by alternating treatments between different products containing actives of the same chemical class. However, from the approved lists available to both sets of growers only the strobilurin & pyrethroid classes contain more than one active.

### **Herb & Wild Rocket Growers**

With the exception of a single crop of coriander (0.12 mg/kg of pendimethalin, which has an 'LOD MRL' of 0.05 mg/kg for herbs), none of the actives, where usage data had been supplied, gave rise to residues above the MRL. Indeed, in the vast majority of cases, the residues were < ½ MRL and often just above the limit of quantification of 0.01 mg/kg.

### **Fungicides**

- Quite a narrow range of products and actives were used to control fungal diseases on herbs and wild rocket.
- The most popular fungicide products used to control fungal diseases during the 2009 growing season were: Amistar (azoxystrobin), Fubol Gold (mancozeb/metalaxyl-M), Aliette / Standon Fullstop / Previcur Energy (fosetyl-aluminium), Invader (dimethomorph/mancozeb) and Signum (boscalid/pyraclostrobin).
- Only very low residue levels, just above the limits of quantification, of azoxystrobin and boscalid were found in a few samples of wild rocket. The MRLs for these actives are quite high at 70 mg/kg and 10 mg/kg, respectively.
- Two residues of dithiocarbamates (from mancozeb usage) and three residues of metalaxyl-M were found but at levels well below the MRL. Although these two actives are co-formulated in Fubol Gold, the residues appeared in five different crops.
- Fosetyl-aluminium is not amenable to multi-residue analysis and therefore none of the crops were analysed for this compound.

- With the exception of pyraclostrobin (always co-formulated with boscalid), all other actives showed incidences of measurable residues.
- If residues need to be minimised further and more than one treatment is necessary, alternating treatments of azoxystrobin and pyraclostrobin could be made. If within 21 days of harvest then a tank-mix of azoxystrobin and pyraclostrobin at 1/2 rate each could be used to perhaps 14 days before harvest. The efficacy of either of these approaches would need to be tested, and tank-mix compatibility of the products checked with the relevant agrochemical companies.

### **Herbicides**

- A much broader range of herbicide products, compared with the fungicides, was used. The most popular products were Alpha Linuron (linuron), Stomp (pendimethalin) and Kerb (propyzamide). All three products showed incidences of residues of 0.01 mg/kg, or above.
- Pendimethalin has a very low 'LOD MRL' of 0.05 mg/kg and all five crops of coriander that were treated with pendimethalin contained measurable residues. One was at the MRL and one at 0.12 mg/kg exceeded the MRL (see figure 11 in Appendix 2).
- The numbers of crops treated with other products were too few to be able to draw any conclusions regarding residue levels.

### **Insecticides**

- By far the most popular insecticides in 2009 were products containing pyrethroids.
- These were Decis & Decis Protech (delatmethrin), Contest (alpha-cypermethrin – not approved for use on herbs or wild rocket<sup>1</sup>) and Hallmark (lambda-cyhalothrin). Perhaps surprisingly, Toppel 100 (cypermethrin - approved for use on herbs and wild rocket) was not used by any of the growers that submitted both usage and residue data. Hence Toppel 100 does not appear in the table at Appendix 1a. About 20% of crops treated with pyrethroids contained measurable residue levels.

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<sup>1</sup> SOLA 1221/01 for Contest covers use on Brassica vegetables grown for baby leaf production, however CRD have confirmed that rocket is not considered a Brassica (family Brassicaceae, Genus Eruca)

- Crops treated with Tracer (spinosad) and Plenum (pymetrozine) did not give rise to any measurable residues, although crop numbers were few.
- If residues need to be minimised further and more than one treatment is necessary alternating treatments of deltamethrin, cypermethrin and lambda-cyhalothrin could be made. If within 10 days of harvest then a tank-mix of deltamethrin + cypermethrin + lambda-cyhalothrin at ¼ rate each could be used to perhaps 3 days before harvest. The efficacy of both these approaches would need to be tested and the compatibility of the tank-mix products checked with the relevant agrochemical companies.

## **Lettuce Growers**

### **Fungicides**

- The most popular fungicides used were the strobilurins and dithiocarbamates.
- Nearly all products gave rise to measurable residues, but none approached the MRLs.
- The use of Signum (boscalid/pyraclostrobin) gave rise to residues of boscalid in about 50% of treated crops and pyraclostrobin in around 5%.
- Just under 30% of crops treated with Amistar (azoxystrobin) gave rise to measurable residues.
- Fubol Gold was commonly used and contains metalaxyl-M as a co-formulant with mancozeb. Residues of mancozeb (measured as dithiocarbamates) were found in around 30% of treated crops, but a metalaxyl-M residue was only found in a single crop.
- The use of Teldor (fenhexamid) gave rise to residues in several crops.
- Aliette, which contains the active fosetyl-aluminium, was also used but it is not possible to see if measurable residues resulted as fosetyl-aluminium is not amenable to multi-residue analysis and therefore none of the crops were analysed for this compound.

### **Herbicides**

- A much broader range of herbicide products, compared with the fungicides, were used. The most popular products were Kerb (propyzamide), Alpha

Propachlor/Ramrod (propachlor – approvals for which expired on 18 March 2010), and Stomp (pendimethalin).

- Measurable residues of propyzamide were found in 5 out of 32 crops that had been treated. All residues were <0.1 mg/kg (MRL = 1 mg/kg) and generally had the shortest harvest intervals around the 42-day minimum harvest interval. See Figure 12 in Appendix 2).
- *The numbers of crops treated with other products were too few to be able to draw any conclusions regarding residue levels.*

### **Insecticides**

- The most commonly used products contained the pyrethroids.
- By far the most commonly used product was Decis, which contains the active deltamethrin and gave rise to measurable residues in just over 10% of treated crops.
- Cypermethrin (from the use of Toppel 100 EC) were found in nearly all treated crops.
- Hallmark (lambda-cyhalothrin) and Dovetail (lambda-cyhalothrin/pirimicarb) gave rise to measurable residues of lambda-cyhalothrin in less than 10% of treated crops. However, measurable residues of pirimicarb were found in just over 50% of treated crops.
- If residues need to be minimised further and more than one treatment is necessary alternating treatments of deltamethrin, cypermethrin and lambda-cyhalothrin could be made. If within 10 days of harvest then a tank-mix of deltamethrin + cypermethrin + lambda-cyhalothrin at ¼ rate each. The efficacy of both these approaches would need to be tested and the compatibility of any tank-mix products checked with the relevant agrochemical companies.

## **SCIENCE SECTION**

### **Introduction**

Regulation (EC) No 396/2005 came into force on 1 September 2008 and has severely restricted the number of approved plant protection products that can be used on herbs, lettuce and associated leafy salad crops such as rocket. In addition EC Directive 178/2006 regrouped many of these crops into different MRL categories. These regulations have increased the risk of possible MRL exceedances occurring

for the most sensitive crops in each category and there is some evidence already that residue levels have been increasing in recent years. The aim of this first phase of the project is to gather together as much information as possible from a number of key experienced growers regarding their pesticide usage and the resultant residues that have been detected in their crops. The actives applied, their application rates, harvest intervals and resultant residues detected will be entered into a database that will then allow the 3-4 most problematic actives and the most sensitive crop species (in terms of highest residues) to be identified.

A second phase of the project could then be planned to design suitable field trials to practically establish the best practice that would result in a reduction of residue levels in the final marketed produce.

The specific objectives of the project were:

1. To contact a number of key herb and lettuce growers and ask them to provide information on their usage of pesticides in 2009 and the results of residue tests performed on the crops at harvest.
2. A suitable database to be designed and the growers' information to be entered. The database could then be interrogated to identify the most problematic pesticides in terms of the frequency and levels of residues that remained in the crop at harvest.
3. Once the most problematic crop/pesticide combinations had been identified suggestions for reducing residue levels could be formulated.

### **Development of an Excel Template**

An Excel template was designed to allow growers to be able to enter the necessary information on usage and residue testing in the same format. This template (as shown in Figure 1 below) allowed the entry of key information regarding usage and residues.



All suitable data, that is data supplied where both a complete spray programme and residue analytical package were provided, were processed from the excel spreadsheets supplied by growers. Growers were requested to supply information on the following attributes:

Crop

Sowing date

Transplant date

Outdoor or protected

Then, for each spray application:

Product applied

Reason for application

Product rate applied

Date of application

Age of crop at application (optional)

Remarks (optional)

Then, for each crop, information on residue analysis as:

Date of harvest (or test date)

Active ingredients sought

Residue results

**Figure 2 An example of one of the returned sheets for Cos lettuce**

HERBS & LETTUCE DATA

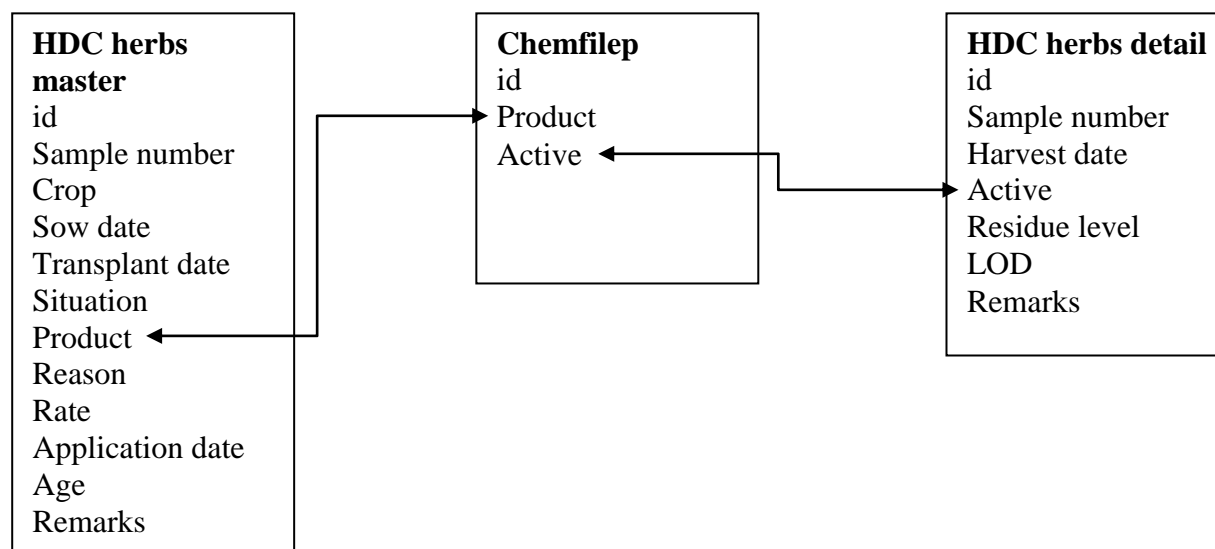
Crop  Sowing date  Transplant date   
 Outdoor  or Protected

30

Product applied	Reason for application	Product rate applied	Date of application	Age of crop at application	Remarks	Date of harvest	Active ingredient	Residue results (mg/kg)
Invader	mildew	1.259Kg/ha	11/08/2009		Tested 30/09/2009	28/09/2009	dimethomorph	<0.01
							dithiocarbamates	NA
Amistar	mildew	1L/ha	11/08/2009				azoxystrobin	<0.01
Designer	adjuvant	0.2L/ha	11/08/2009				None	
Fubol Gold WG (10184)	mildew	1Kg/ha	22/08/2009				metalaxyl-M	<0.01
							dithiocarbamates	NA
Plenum WG	aphids	0.4Kg/ha	22/08/2009				pymetrozine	<0.01
Switch	fungicides	0.576Kg/ha	22/08/2009				fludioxonil	NA
							cyprodinol	NA
Designer	adjuvant	0.199L/ha	22/08/2009				None	
Aliette 80 Wg	mildew	2Kg/ha	01/09/2009				fosetyl-AI	NA
Karamate Dry Flo Newtec	mildew	0.499Kg/ha	01/09/2009		mancozeb		dithiocarbamates	NA
Designer	adjuvant	0.199L/ha	01/09/2009				None	
Gazelle	insecticide	0.25Kg/ha	12/09/2009				acetamiprid	<0.01
Decis	insecticide	0.25L/ha	12/09/2009				deltamethrin	<0.01
Silwet	adjuvant	0.199L/ha	12/09/2009				None	

All data were then transposed into two database tables, within the **LIAISON®** database, allowing logical joins between product names across the two data sets to facilitate analysis. A diagrammatic representation of the Cartesian joins is given in Figure 3.

**Figure 3 Cartesian relationship of the database tables used for analysis**



Data were standardised so that all product names in HDC herbs master matched those in Chemfilep and all active names sought in HDC herbs detail matched those in Chemfilep. Tables were then updated to optimise performance by adding

appropriate integer joins representing products and actives, allowing a link to be made between the product applied, the actives it contained and the residues (actives) sought and found. Irrespective of complexity of formulation, chemfilep allows all the actives within a product to be considered separately.

Analysis was then undertaken relating actives applied (from conversion of product via chemfilep) to residues (actives) sought and found, using (harvest date minus application date) as the interval. Where a product was applied in sequence, only the most recent application date was considered for the interval, but analysis was also made on the number of applications with regard to the level of residue found. Similarly, the residue level was also examined against rate of application.

As many of the growers had not been able to supply usage data to accompany their residue results the number of data points for some herbs was extremely limited.

### **Results (Herbs & Lettuce)**

- All results should be viewed and interpreted with great caution because of the often very small numbers of crops involved for individual herbs and for lettuce.
- In all cases, the term 'measurable residues' relates to any residue at 0.01 mg/kg, or above.
- A list of the most commonly found pesticide residues in herbs/wild rocket and lettuce are presented in the tables in Appendix 1a and 1b, respectively.
- Residue profiles for each pesticide are presented in Appendix 2.

### **Overall Finding:**

With the exception of a single crop of coriander (0.12 mg/kg of pendimethalin, which has an 'LOD MRL' of 0.05 mg/kg for herbs), none of the actives, where usage data had been supplied, gave rise to residues above the MRL. Indeed in the vast majority of cases the residues were < ½ MRL and often just above the limit of quantification of 0.01 mg/kg.

## HERBS AND WILD ROCKET

### Fungicides

- Quite a narrow range of products and actives were used to control fungal diseases on herbs and wild rocket. *A list of the products and actives used and residues found is presented in Appendix 1a.*
- The most popular products used to control fungal diseases were: Amistar (azoxystrobin), Fubol Gold (mancozeb/metalaxyl-M), Aliette (fosetyl-aluminium), Invader (dimethomorph/mancozeb) and Signum (boscalid/pyraclostrobin).
- Only very low residue levels, just above the limits of quantification, of azoxystrobin and boscalid were found in a few samples of wild rocket. The MRLs for these actives are quite high at 70 mg/kg and 10 mg/kg, respectively.
- Two residues of dithiocarbamates (from mancozeb usage) and three residues of metalaxyl-M were found but at levels well below the MRL. Although these two actives are co-formulated in Fubol Gold, the residues appeared in five different crops.
- Fosetyl-aluminium is not amenable to multi-residue analysis and therefore none of the crops were analysed for this compound.
- With the exception of pyraclostrobin (always co-formulated with boscalid), all other actives showed incidences of measurable residues.

### Azoxystrobin (MRL = 70 mg/kg)

Table 1a

Type	Residue (mg/kg)	Days between last treatment and harvest Minimum HI = 14 Days
Parsley	<0.01	17
Wild Rocket	0.02	24
Wild Rocket	<0.01	31
Wild Rocket	<0.01	24
Wild Rocket	<0.01	20

### Boscalid (MRL = 10 mg/kg)

Table 1b

Type	Residue (mg/kg)	Days between last treatment and harvest Minimum HI = 12 Days	Number of treatments
Wild Rocket	0.01	28	1
Wild Rocket	0.01	21	1
Wild Rocket	<0.01	18	1

**Metalaxyl-M (MRL = 2 mg/kg)**

Table 1c

Type	Residue (mg/kg)	Days between last treatment and harvest Minimum HI = 12 Days	Number of Treatments
Parsley	<0.01	17	
Parsley	<0.01	99	
Wild Rocket	0.12	19	2
Wild Rocket	0.03	18	1
Wild Rocket	0.02	21	1

**Pyraclostrobin (MRL = 2 mg/kg)**

Table 1d

Type	Residue (mg/kg)	Days between last treatment and harvest Minimum HI = 21 Days
Wild Rocket	<0.01	28
Wild Rocket	<0.01	21
Wild Rocket	<0.01	18

**Mancozeb (Dithiocarbamates MRL = 5 mg/kg)**

Table 1e

Type	Residue (mg/kg)	Days between last treatment and harvest Minimum HI = 21 Days
Wild Rocket	0.11	27
Wild Rocket	0.13	22
Parsley	<0.01	17
Sage	<0.01	114

**Herbicides**

- A much broader range of herbicide products, compared with the fungicides, was used. The most popular products were Alpha Linuron (linuron), Stomp (pendimethalin) and Kerb (propyzamide). *A list of the products and actives used and residues found is presented in Appendix 1a.*
- All three products showed incidences of residues of 0.01 mg/kg, or above. Pendimethalin has a very low 'LOD MRL' of 0.05 mg/kg and
- The numbers of crops treated with other products were too few to be able to draw any conclusions regarding residue levels.

**Linuron (MRL = 1 mg/kg)**

Table 2a

Type	Residue (mg/kg)	Days between last treatment and harvest Minimum HI = 90 Days
Coriander	0.03	60
Coriander	0.01	86
Coriander	<0.01	47
Coriander	<0.01	58
Coriander	<0.01	67
Dill	<0.01	61
Parsley	0.01	66
Parsley	0.01	49
Parsley	<0.01	67
Parsley	<0.01	91
Parsley	<0.01	104
Parsley	<0.01	149
Parsley	<0.01	91

**Pendimethalin (MRL = 0.05 mg/kg)**

Table 2b

Type	Residue (mg/kg)	Days between last treatment and harvest Minimum HI = 28 Days
Chives	<0.01	201
Coriander	0.05	47
Coriander	0.01	30
Coriander	0.01	60
Coriander	0.04	85
Coriander	0.12	40
Dill	<0.01	61
Mint	<0.01	82
Parsley	<0.01	67

**Propyzamide (MRL = 1 mg/kg)**

Table 2c

Herbs	Residue (mg/kg)	Days between last treatment and harvest Minimum HI = 42 Days
Basil	<0.01	45
Chives	<0.01	201
Mint	<0.01	63
Mint	<0.01	145
Parsley	0.03	57

## Other herbicides

No measurable residues were found for the following herbicides:

- **Chlorpropham** was used on a single crop of chives with a harvest interval of 201 days. Approvals for all products containing chlorpropham expired on 31 July 2010.
- **Prosulfocarb** was used on two crops of coriander with 58 and 67-day harvest intervals.
- **Metamitron** was used on a single crop of coriander with a 20-day harvest interval and on two crops of mint with harvest intervals of 82 and 184 days.
- **Ioxynil** was used on three crops of chives with harvest intervals of 73, 82 & 176 days.

## Insecticides

- By far the most popular insecticides were products containing pyrethroids. *A list of the products and actives used and residues found is presented in Appendix 1a.*
- These were Decis & Decis Protech (delatmethrin), Contest (alpha-cypermethrin – not approved for use on herbs or wild rocket) and Hallmark (lambda-cyhalothrin). About 20% of crops treated with pyrethroids showed measurable residue levels.
- Crops treated with Tracer (spinosad) and Plenum (pymetrozine) did not give rise to any measurable residues, although crop numbers were few.

## Alpha-cypermethrin (MRL<sup>2</sup> = 2 mg/kg)

Table 3a

Type	Residue (mg/kg)	Days between last treatment and harvest No minimum HI stipulated	Number of treatments
Wild rocket	0.06	14	3
Wild rocket	<0.01	14	3
Wild rocket	<0.01	13	1
Wild rocket	<0.01	21	2

<sup>2</sup> Residue definition = Cypermethrin (cypermethrin including other mixtures of constituent isomers (sum of isomers))

**Deltamethrin (MRL = 0.5 mg/kg)**

Table 3b

Type	Residue (mg/kg)	Days between last treatment and harvest No minimum HI stipulated	Number of treatments
Chives	<0.01	4	2
Dill	<0.01	7	2
Mint	<0.01	4	1
Mint	<0.01	63	1
Parsley	<0.01	19	1
Parsley	0.15	7	2
Parsley	0.16	17	2
Sage	<0.01	114	1
Wild Rocket	<0.01	7	3
Wild Rocket	0.08	6	2
Wild Rocket	0.09	6	5
Wild Rocket	0.12	10	3
Wild Rocket	0.21	10	3
Wild Rocket	0.23	10	3

**lambda-Cyhalothrin (MRL = 1 mg/kg)**

Table 3c

Type	Residue (mg/kg)	Days between last treatment and harvest Minimum HI = 7 Days
Wild Rocket	0.06	15
Wild Rocket	0.01	19

**Pirimicarb (MRL = 5 mg/kg)**

- Two crops of wild rocket, and one each of coriander, parsley and tarragon were treated with pirimicarb. The minimum harvest interval is 3 days and no measurable residues were found in any crops where the harvest intervals ranged from 5 to 43 days.

**LETTUCE****Fungicides**

- The most popular fungicides used were the strobilurins and dithiocarbamates. *A list of the products and actives used and residues found is presented in Appendix 1b.*
- Nearly all products gave rise to measurable residues, but none approached the MRLs.

- The use of Signum (boscalid/pyraclostrobin) gave rise to residues of boscalid in about 50 % of treated crops and pyraclostrobin in around 5%.
- Just under 30% of crops treated with Amistar (azoxystrobin) gave rise to measurable residues.
- Fubol Gold was commonly used and contains metalaxyl-M as a co-formulant with mancozeb. Residues of mancozeb (measured as dithiocarbamates) were found in around 30% of treated crops, but a metalaxyl-M residue was only found in a single crop.
- The use of Teldor (fenhexamid) gave rise to residues in several crops.
- Aliette, which contains the active fosetyl-aluminium, was also used but it is not possible to see if measurable residues resulted as fosetyl-aluminium is not amenable to multi-residue analysis and therefore none of the crops were analysed for this compound.

#### **Azoxystrobin (MRL = 3 mg/kg)**

Table 4a

<b>Residue (mg/kg)</b>	<b>Days between last treatment and harvest Minimum HI = 14 Days</b>
0.01	43
0.08	20

- A further 23 crops of lettuce with harvest intervals between 14 and 55 days contained no detectable residues (<0.01 mg/kg).

#### **Boscalid (MRL = 10 mg/kg)**

Table 4b

<b>Residue (mg/kg)</b>	<b>Days between last treatment and harvest Minimum HI = 14 Days</b>	<b>Number of treatments</b>
0.05	27	2
0.12	16	1
0.04	29	2
0.22	21	2
0.10	30	2
<0.01	25	1

- All residues well below the MRL, even following two treatments.
- No clear correlation between residue levels, numbers of treatments and harvest intervals.

#### **Cyprodinil (MRL = 10 mg/kg)**

Table 4c

<b>Residue (mg/kg)</b>	<b>Days between last treatment and harvest Minimum HI = 7 Days</b>	<b>Number of treatments</b>
0.11 (1)	18	2
0.20 (2)	23	2
0.65 (3)	18	1
0.03	23	1

- A further 9 crops of lettuce with harvest intervals between 20 and 68 days contained no detectable residues (<0.01 mg/kg).
- Crops 1, 2 & 3 correspond to the crops in the fludioxinil table as they were all treated with Switch.

#### **Fludioxinil (MRL = 10 mg/kg)**

Table 4d

<b>Residue (mg/kg)</b>	<b>Days between last treatment and harvest Minimum HI = 7 Days</b>	<b>Number of treatments</b>
0.22 (1)	18	2
0.12 (2)	23	2
0.14 (3)	18	1
0.03	29	1

- A further 9 crops of lettuce with harvest intervals between 20 and 68 days contained no detectable residues (<0.01 mg/kg)
- Crops 1, 2 & 3 correspond to the same crops in the cyprodinil table as they were all treated with Switch.

#### **Fenhexamid (MRL = 30 mg/kg)**

Table 4e

<b>Residue (mg/kg)</b>	<b>Days between last treatment and harvest Minimum HI = 3 Days</b>
0.04	14
0.08	21
0.38	14
0.06	13
0.06	22
0.91	16
<0.01	38

- All residues below 1/30<sup>th</sup> of the MRL of 30 mg/kg.
- All crops received the same treatment rates and there is some correlation between harvest interval and residue levels.

- The two significantly higher residues were found in the varieties lollo rosso and lollo verde

Crops 1, 2 & 3 correspond to the same crops in the cyprodinil table as they were all treated with Switch.

#### **Mancozeb (Dithiocarbamates MRL = 5 mg/kg)**

- Sixteen crops of lettuce were treated with mancozeb but no measurable residues were found, although not all crops were analysed for dithiocarbamates. The minimum harvest interval is 12 days and the harvest intervals used ranged from 20 to 42 days.

#### **Pyraclostrobin (MRL = 2 mg/kg)**

Table 4f

<b>Residue (mg/kg)</b>	<b>Days between last treatment and harvest Minimum HI = 21 Days</b>	<b>Number of treatments</b>
0.01	21	2
<0.01	25	1

- One very low residue following two treatments and minimum harvest interval.
- No measurable residue following single treatment and 25-day harvest interval.
- Data set too small to draw any definitive conclusions.

#### **Herbicides**

- By far the most popular herbicides were Kerb (propyzamide) and Alpha Propachlor & Ramrod (both containing propachlor, approval for which has since expired). *A list of the products and actives used and residues found is presented in Appendix 1b.*
- Residues of propyzamide were found at very low levels in just over 20% of treated crops.
- No residues of propachlor, or chlorpropham (from the use of Jupiter or Comrade) were detected in any of the treated crops. Approval for the use of both products expired on 31 July 2010.
- Roundup, which contains the active glyphosate, was also used but it is not possible to see if measurable residues resulted as glyphosate is not

amenable to multi-residue analysis and therefore none of the crops were analysed for this compound.

### Propyzamide (MRL = 1 mg/kg)

Table 5a

Residue (mg/kg)	Days between last treatment and harvest Minimum HI = 42 Days
0.02	34
0.08	42
0.02	44
0.02	54
0.02	40

A further 17 crops were treated but none contained measurable residues.

### Other herbicides

No measurable residues were found for the following herbicides:

- **Chlorpropham** was used on five crops with harvest intervals of between 41 & 70 days.
- **Diquat** was used as a pre-emergence treatment on two crops of lettuce, but no analyses for possible residues were performed.
- **Propachlor** was used on 38 crops but no measurable residues were found.
- **Glyphosate** was only used on 6 crops, but no analyses for possible residues were performed.

### Insecticides

- The most commonly used products contained the pyrethroids. *A list of the products and actives used and residues found is presented in Appendix 1b.*
- By far the most commonly used product was Decis, which contains the active deltamethrin and gave rise to measurable residues in just over 10% of treated crops.
- Cypermethrin residues (from the use of Toppel 100 EC) were found in nearly all treated crops.
- Hallmark (lambda-cyhalothrin) and Dovetail (lambda-cyhalothrin/pirimicarb) gave rise to measurable residues of lambda-cyhalothrin in less than 10% of treated crops. However, measurable residues of pirimicarb were found in just over 50% of treated crops.

**Deltamethrin (MRL = 0.5 mg/kg)**

Table 6a

<b>Residue (mg/kg)</b>	<b>Days between last treatment and harvest Minimum HI = 7 Days</b>	<b>Number of treatments</b>
0.03	7	3
0.03	8	3
0.04	6	3
0.04	14	3
0.05	5	2
0.05	54	2
0.06	0	4
0.11	5	4
0.11	8	4
<0.01	20	1
<0.01	27	1
<0.01	20	1
<0.01	10	1
<0.01	21	1
<0.01	31	1
<0.01	45	1
<0.01	28	1
<0.01	6	1
<0.01	12	1
<0.01	42	1
<0.01	35	1
<0.01	14	1
<0.01	18	1

- Nine of the twenty-three samples contained detectable residues between 0.03 and 0.11 mg/kg.
- None of the samples that received a single treatment contained measurable residues.
- In general, those that received the most treatments and had the shortest harvest intervals gave rise to the higher residues.
- There was no correlation between the different varieties of lettuce and the residue levels found.

**Cypermethrin (MRL = 2 mg/kg)**

Table 6b

<b>Residue (mg/kg)</b>	<b>Days between last treatment and harvest No Minimum HI stipulated</b>	<b>Number of treatments</b>
0.04	11	1

<0.01	15	1
<0.01	24	2
<0.01	9	2
<0.01	29	1
<0.01	19	1
<0.01	26	1
<0.01	29	1

- Only one of the eight crops contained a measurable residue, but well below the MRL.
- No correlation between residue levels, harvest intervals and numbers of treatments.

**lambda-Cyhalothrin (MRL = 0.5 mg/kg)**

Table 6c

<b>Residue (mg/kg)</b>	<b>Days between last treatment and harvest No Minimum HI stipulated</b>	<b>Number of treatments</b>
0.01	15	1
<0.01	35	1
<0.01	40	2
<0.01	37	1
<0.01	43	1
<0.01	33	1
<0.01	21	1
<0.01	20	1
<0.01	26	1
<0.01	34	1
<0.01	25	1

**Pirimicarb (MRL = 5 mg/kg)**

Thirteen crops were treated with pirimicarb and none contained measurable residues. The minimum harvest interval is 3 days and the individual crop harvest intervals ranged from 10 to 48 days.

## **Conclusions**

The paucity of information, particularly regarding pesticide usage, makes it difficult to draw many hard and fast conclusions. Strengthening the database by collecting further data from selected growers at the end of the 2010 season should be considered.

The outputs from the database do confirm what might be expected: that residue levels are generally dependent on treatment rates, numbers of applications and harvest intervals.

For crops where usage information was available, all residues were below MRLs and in most cases <1/2 the MRL or even lower.

It would appear that if GAP is observed then none of the products being currently used on herbs, wild rocket or lettuce are likely to lead to any MRL exceedance.

The results are encouraging from a grower perspective as they do not indicate that any particular product or active is problematic in terms of producing residues close to an MRL.

If growers are under pressure to further reduce residues in their crops then this may be possible by alternating treatments between different products containing actives of the same chemical class. For example, Decis (deltamethrin), Hallmark (lambda-cyhalothrin) and Toppel 100 EC (cypermethrin), or Amistar (azoxystrobin) and Signum (pyraclostrobin/boscalid). Alternatively, mixed treatments containing 2 or 3 actives at 1/2 or 1/3 rates could be made providing that the compatibility of the products is checked. The efficacy of either of these approaches would need to be tested, and tank-mix compatibility of the products checked with the relevant agrochemical companies.

## **Technology transfer**

A presentation of the project has been requested at the British Herb Trade Association Technical meeting on 12 October 2010, and is to be arranged with the British Leafy Salads Association Technical Committee.

## Acknowledgements

Provision of information from the following key growers regarding pesticide usage and residue results is much appreciated.

Herb Growers	Lettuce Growers
<p><b>Humber VHB</b> Runcton Nursery Lagness Road Runcton Chichester West Sussex PO20 1LJ</p>	<p><b>Anglia Salads Ltd</b> Hockley Farm Church road Frating Colchester Essex CO7 7HG</p>
<p><b>Intercrop Ltd</b> Off Broad Lane Betteshanger Deal Kent CT14 0LU</p>	<p><b>J &amp; T. W. Cropper Ltd</b> Gore Hall Farm Rydings Lane Banks Southport Merseyside PR9 8EB</p>
<p><b>Lighthorne Herbs Ltd</b> Morton Morrell Warwick CV35 9DB</p>	<p><b>G's Marketing</b> Barway Ely Cambs CB7 5TZ</p>
<p><b>R&amp;G Fresh Herbs</b> Lucas Green Nurseries Lucas Green Road West End Woking Surrey GU24 9LY</p>	<p><b>Intercrop Ltd</b> Off Broad Lane Betteshanger Deal Kent CT14 0LT</p>
<p><b>Red Deer Herbs</b> Earls Croome Worcester WR8 9DF</p>	<p><b>Kettle Produce Ltd</b> Balmalcolm Farm Cupar Fife KY15 7TJ</p>
<p><b>Scot Herbs</b> Longforan Dundee D22 5HU</p>	<p><b>Langmead Farms Head Office</b> Main Road Bosham Chichester West Sussex PO18 8EH</p>
<p><b>Vitacress Salads Ltd</b> Lower Link Farm St Mary Bourne Andover Hampshire SP11 6DB</p>	<p><b>Vitacress Salads Ltd</b> Lower Link Farm St Mary Bourne Andover Hampshire SP11 6DB</p>

## Appendix 1a

### Pesticides and Residues Found in Herbs and Rocket Data

Product	Active Substance(s)	Number of times applied across all crops	Numbers of Residues Found (all data *)
<b>Fungicides</b>			
Amistar	Azoxystrobin	8	4
Invader	Dimethomorph/ Mancozeb	4	2
Fubol Gold WG	Mancozeb/ Metalaxyl-M	8	6 (Dithiocarbamates)
SL 567A	Metalaxyl-M	1	3
Aliette 80WG	Fosetyl-aluminium	5	Not analysed
Standon Fullstop	Fosetyl-aluminium	1	
Previcur Energy	Fosetyl-aluminium/ Propamocarb	1	
Signum	Boscalid/ Pyraclostrobin	3	8
Teldor	Fenhexamid	1	0
Folicur	Tebuconazole	1	0
<b>Herbicides</b>			
Alpha Linuron 50 SC	Linuron	15	7
Afalon	Linuron	1	
Stomp 400 SC	Pendimethalin	9	9
Kerb 50W	Propyzamide	5	3
Kerb Flo	Propyzamide	2	
Dacthal W75	Chlorthal-dimethyl	4	4
Betanal Flow	Phenmedipham	4	0
Alpha Phenmedipham 320 SC	Phenmedipham	2	
Asulox	Asulam	3	Not analysed
Totril	loxynil	3	0
Dow Shield	Clopyralid	3	Not analysed
Defy	Prosulfocarb	2	1
Goltix Flowable	Metamitron	2	1
Goltix WG	Metamitron	1	
Shogun	Propaquizafop	2	0
Falcon	Propaquizafop	1	
Roundup	Glyphosate	1	Not analysed
Roundup Ace	Glyphosate	1	
Ashlade CP	Propachlor/ Chloridazon	1	0
Pyramin DF	Chloridazon	1	0
Treflan	Trifluralin	1	1
Fusilade Max	Fluazifop-P-butyl	1	Not analysed
Croptex Pewter	Chlorpropham	1	0

\*This column also includes residue data from PRC surveys and other growers where no matching usage information was available.

### Pesticides and Residues Found in Herbs and Rocket Data (Cont)

Product	Active Substance(s)	Number of times applied across all crops	Numbers of Residues Found (all data *)
<b>Insecticides</b>			
Decis Protech	Deltamethrin	19	8
Decis	Deltamethrin	18	
Contest	Alpha-cypermethrin	9	2
Hallmark with Zeon Technology	Lambda-cyhalothrin	7	2
Tracer	Spinosad	6	0
Phantom	Pirimicarb	4	5
Aphox	Pirimicarb	3	
Stalwart	Nicotine	3	Not analysed
Plenum WG	Pymetrozine	2	0
Gazelle	Acetamiprid	1	1
	Chlorpyrifos		2
	DDT		1

\* This column also includes residue data from PRC surveys and other growers where no matching usage information was available.

### Appendix 1b

#### Pesticides and Residues Found in Lettuce Data

Product	Active Substance(s)	Number of times applied across all crops	Numbers of Residues Found (all data*)
<b>Fungicides</b>			
Signum	Boscalid/ Pyraclostrobin	32	16 5
Amistar	Azoxystrobin	29	9
Fubol Gold WG	Mancozeb/ Metalaxyl-M	27	17 (Dithiocarbamates) 1
Fubol Gold WG (10184)	Mancozeb/ Metalaxyl-M	8	
Invader	Dimethomorph/ Mancozeb	25	0
Karamate Dry Flo Neotec	Mancozeb	24	
Agrichem Flowable Thiram	Thiram	1	
Switch	Cyprodinol/ Fludioxonil	26	17 9
Rovral WG	Iprodione	11	5
Teldor	Fenhexamid	10	16
Aliette 80 WG	Fosetyl- aluminium	7	Not analysed
Proplant	Propamocarb	4	13
Basilex	Tolclofos-methyl	2	1
	Oxadixyl		3
	Pyrimethanil		2

\* This column also includes residue data from PRC surveys and other growers where no matching usage information was available.

### Pesticides and Residues Found in Lettuce Data (Cont)

Product	Active Substance(s)	Number of times applied across all crops	Numbers of Residues Found (all data *)
<b>Herbicides</b>			
Kerb Flo	Propyzamide	36	10
Kerb 50W	Propyzamide	10	
Alpha Propachlor 50SC	Propachlor	20	0
Ramrod Flowable	Propachlor	18	
Stomp 400 SC	Pendimethalin	4	0
Roundup Max	Glyphosate	3	Not analysed
Roundup Biactive	Glyphosate	3	
Jupiter 40 EC	Chlorpropham	3	0
Comrade	Chlorpropham	2	
Retro	Diquat	2	Not analysed
Lenacil			2
<b>Insecticides</b>			
Decis Protech	Deltamethrin	48	11
Decis	Deltamethrin	33	
Cleancrop Decathlon	Deltamethrin	3	
Plenum WG	Pymetrozine	29	5
Chess WG	Pymetrozine	2	
Hallmark with Zeon Technology	Lambda-cyhalothrin	26	4
Dovetail	Lambda-cyhalothrin/ Pirmicarb	19	
Aphox	Pirimicarb		
Phantom	Pirimicarb	1	12
Toppel 100 EC	Cypermethrin	15	16
Gazelle	Acetamiprid	15	8
Tracer	Spinosad	13	
Cruiser SB	Thiamethoxam	3	6
Dimilin Flo	Diflubenzuron	2	0
Gauche	Imidacloprid	1	12
Stalwart	Nicotine	1	Not analysed
	Chlorpyrifos		1
	p,p'-DDE		1
	Thiacloprid		2

\* This column also includes residue data from PRC surveys and other growers where no matching usage information was available.

## Appendix 2 Residue profiles for individual pesticides

Fig 1

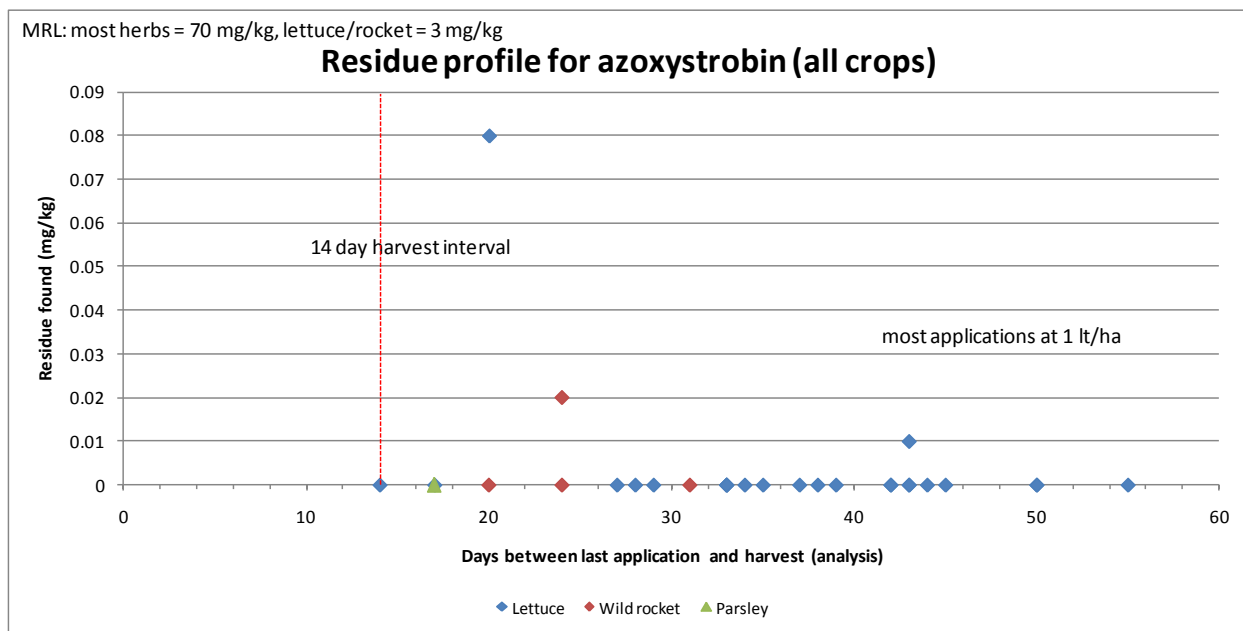
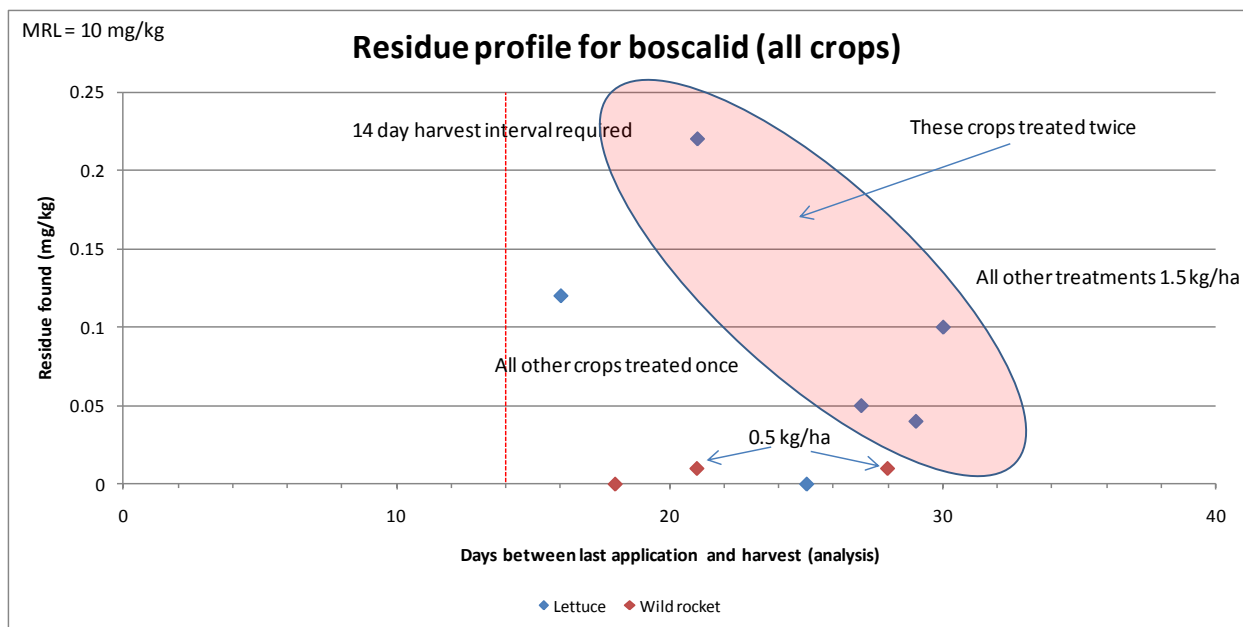


Fig 2



Appendix 2 cont.

Fig 3

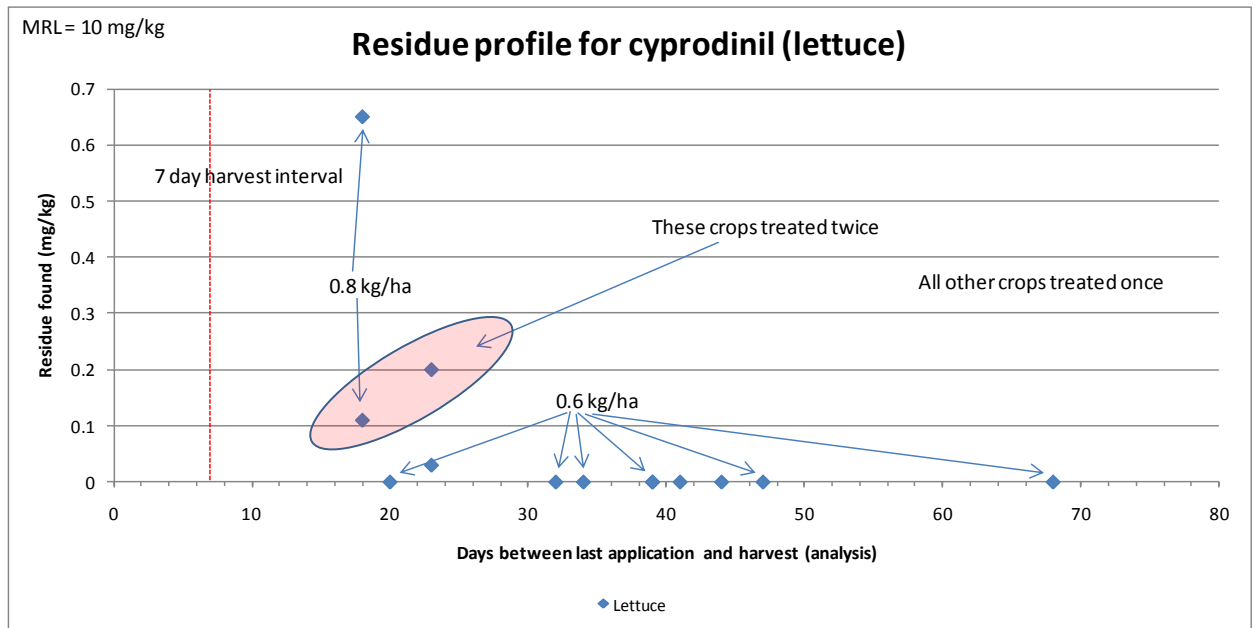
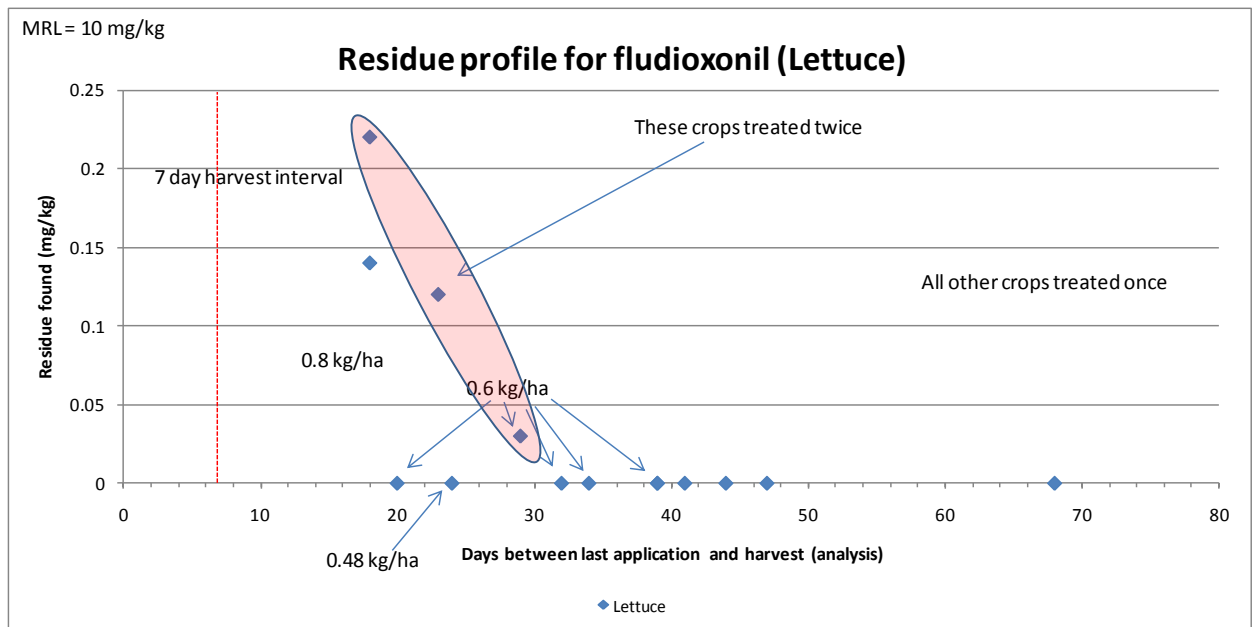


Fig 4



Appendix 2 Cont.

Fig 5

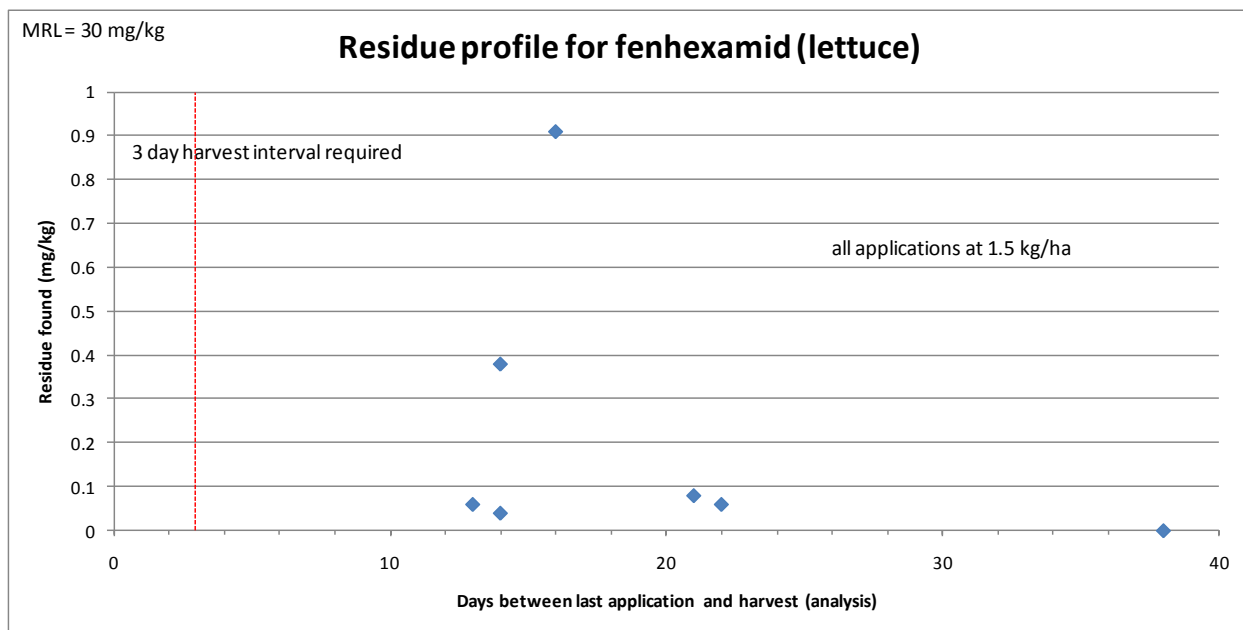
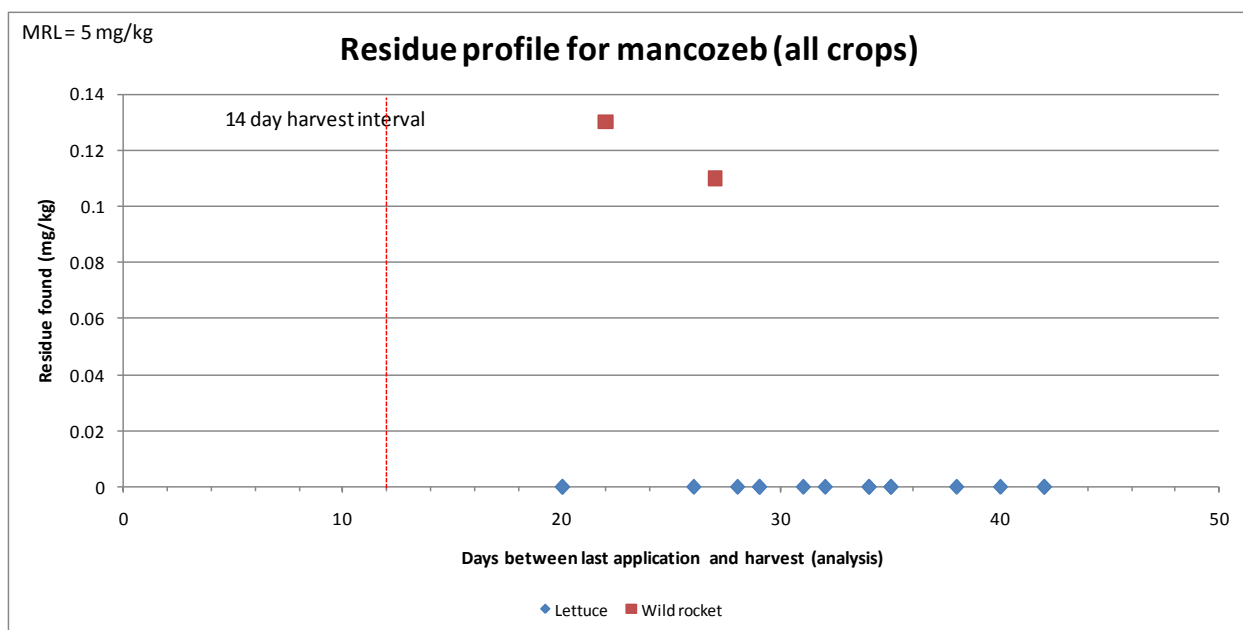


Fig 6



Appendix 2 Cont.

Fig 7

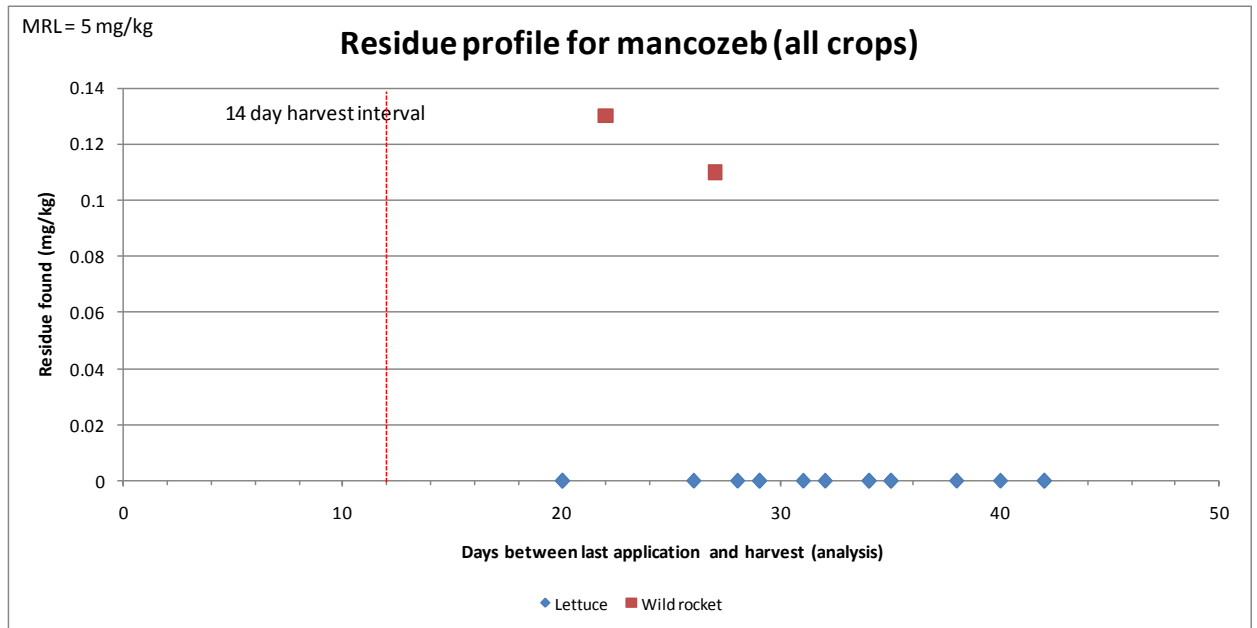
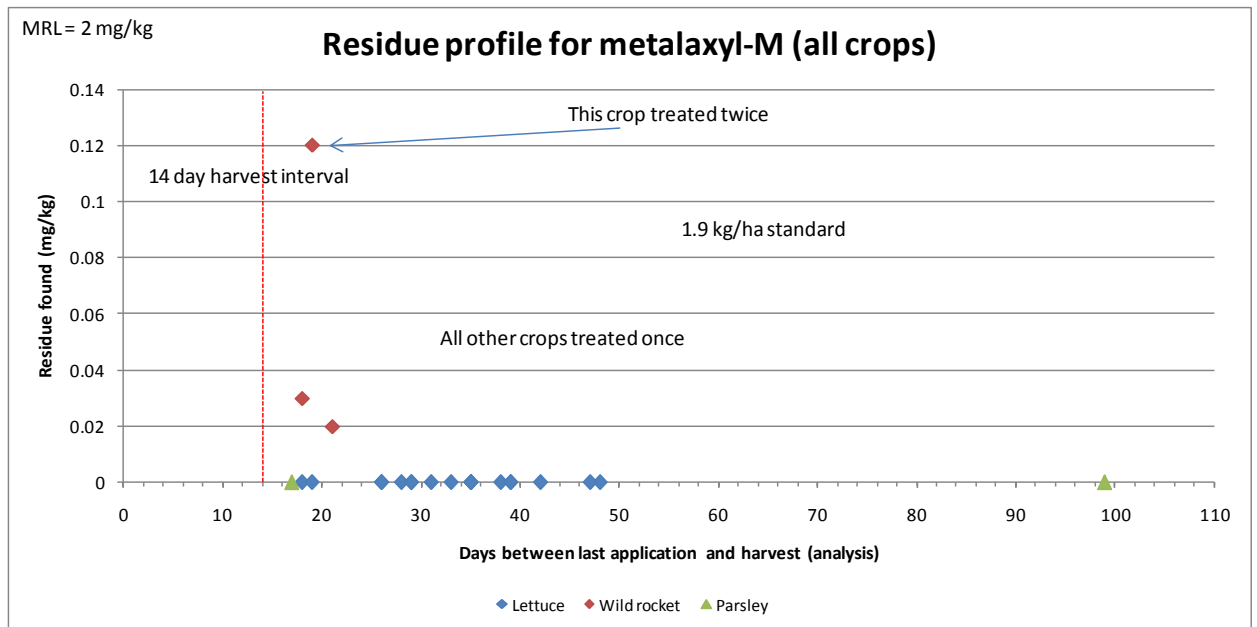


Fig 8



Appendix 2 Cont.

Fig 9

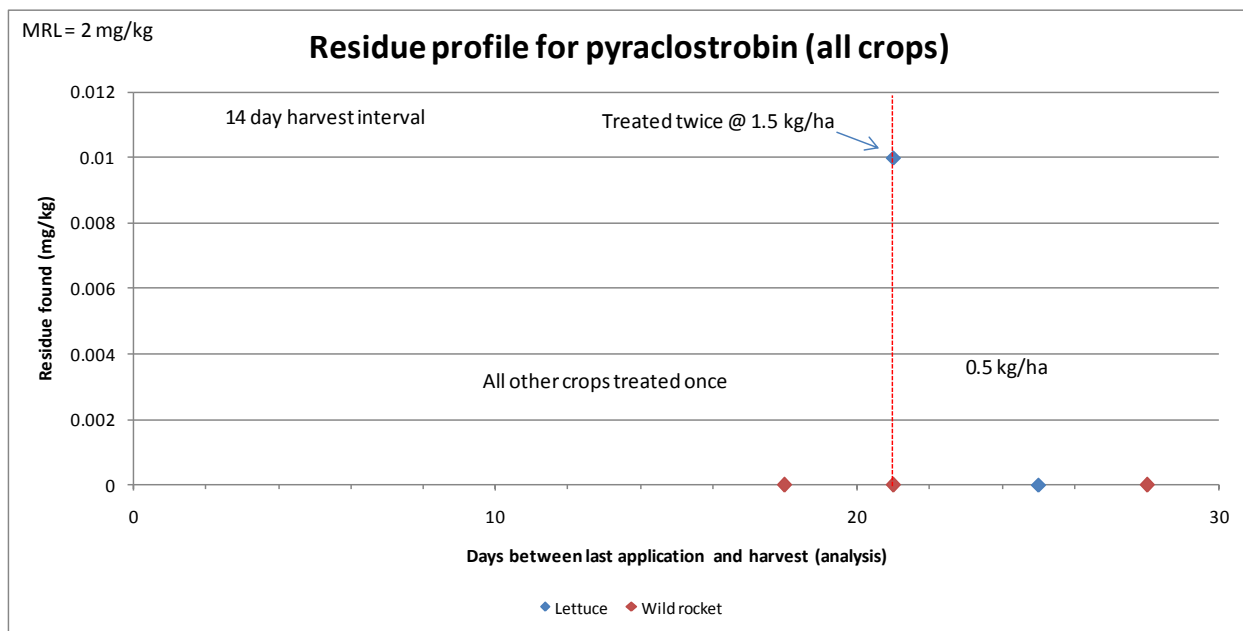
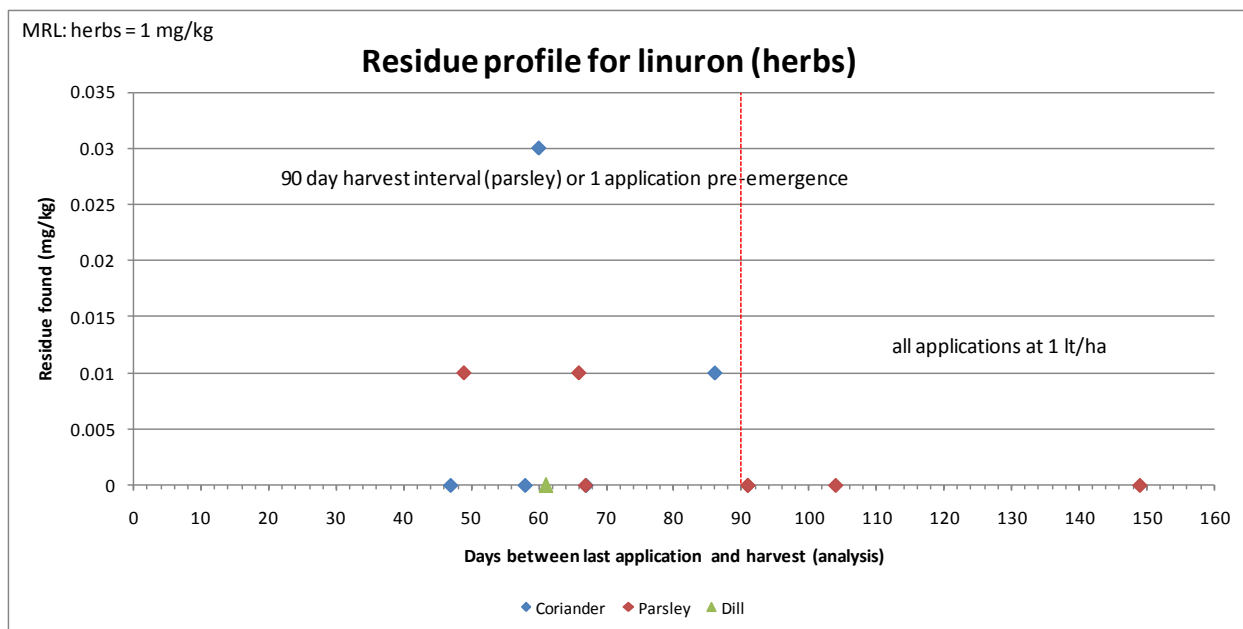


Fig 10



Appendix 2 Cont.

Fig 11

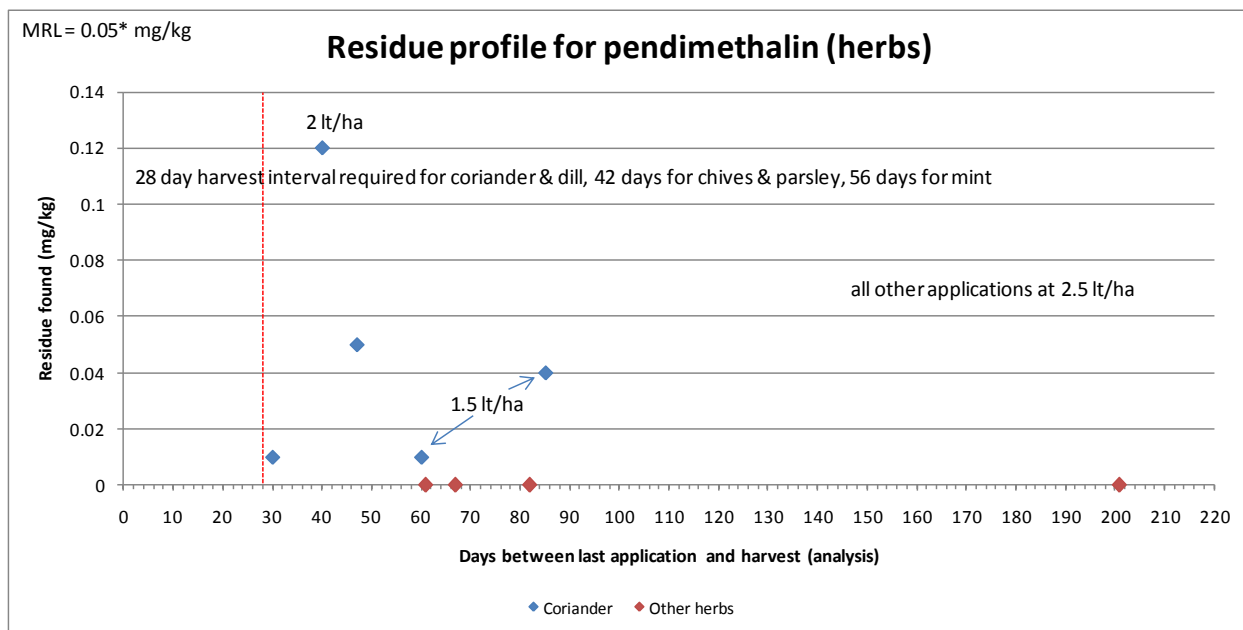
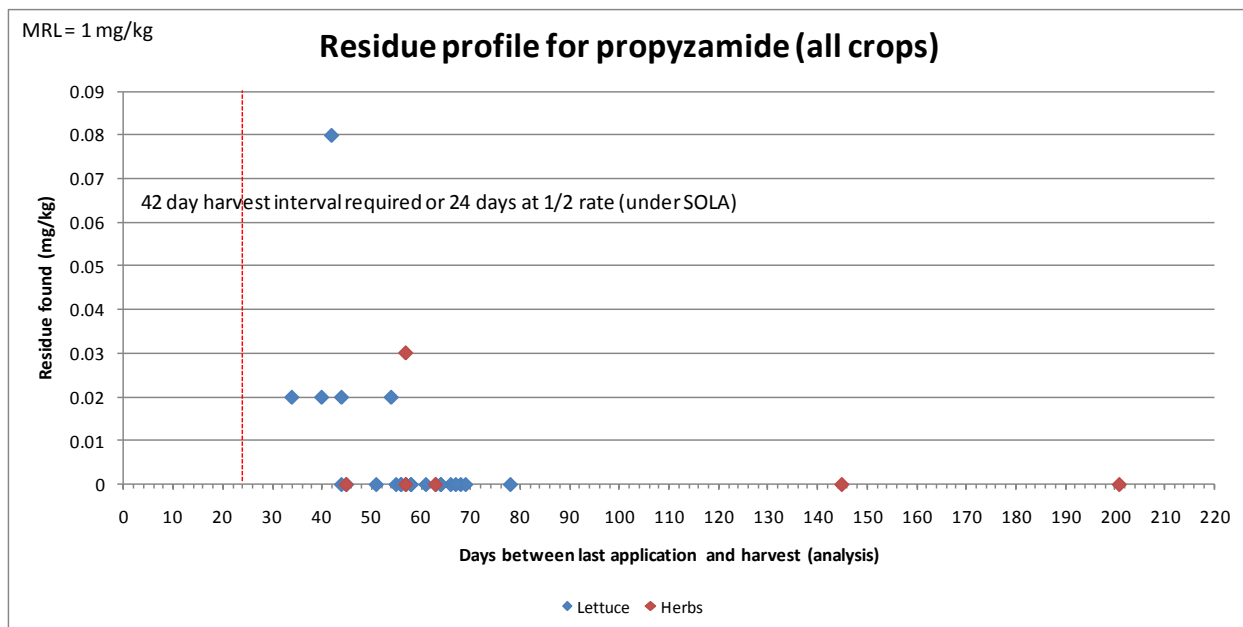


Fig 12



Appendix 2 Cont.

Fig 13

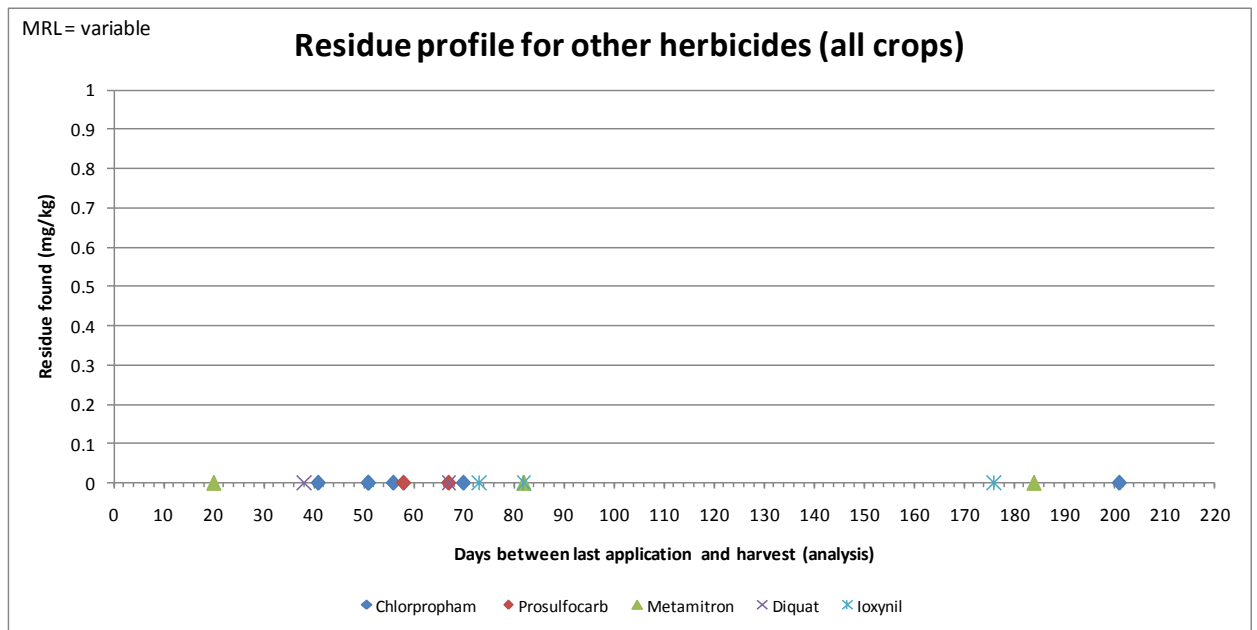
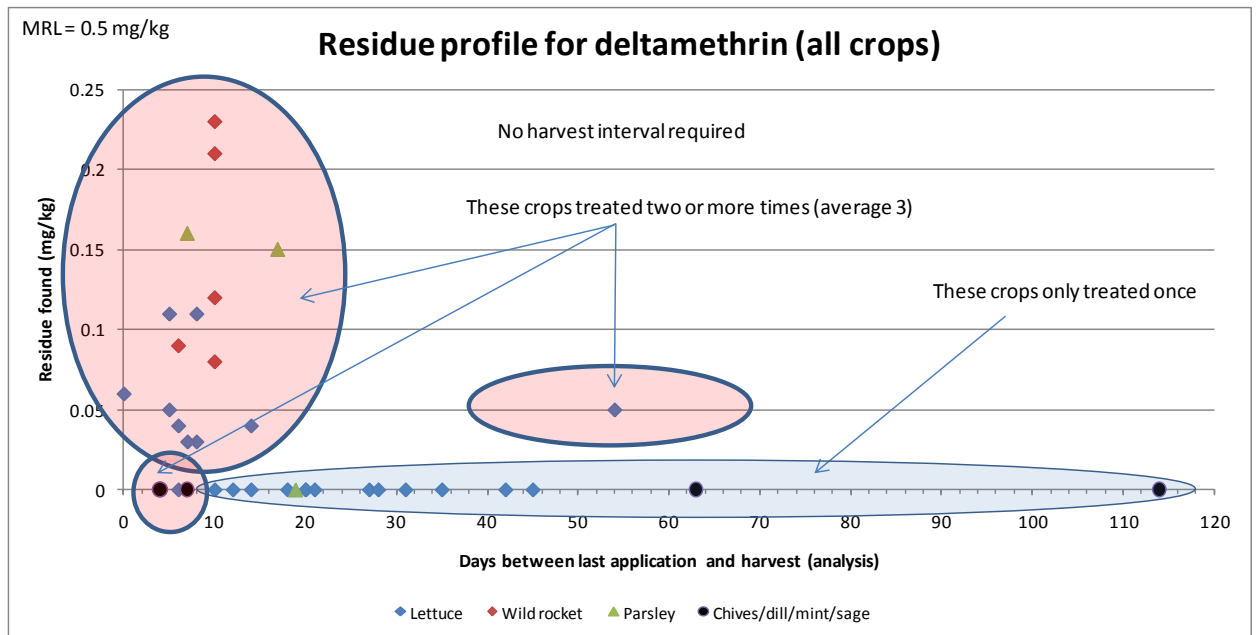


Fig 14



Appendix 2 Cont.

Fig 15

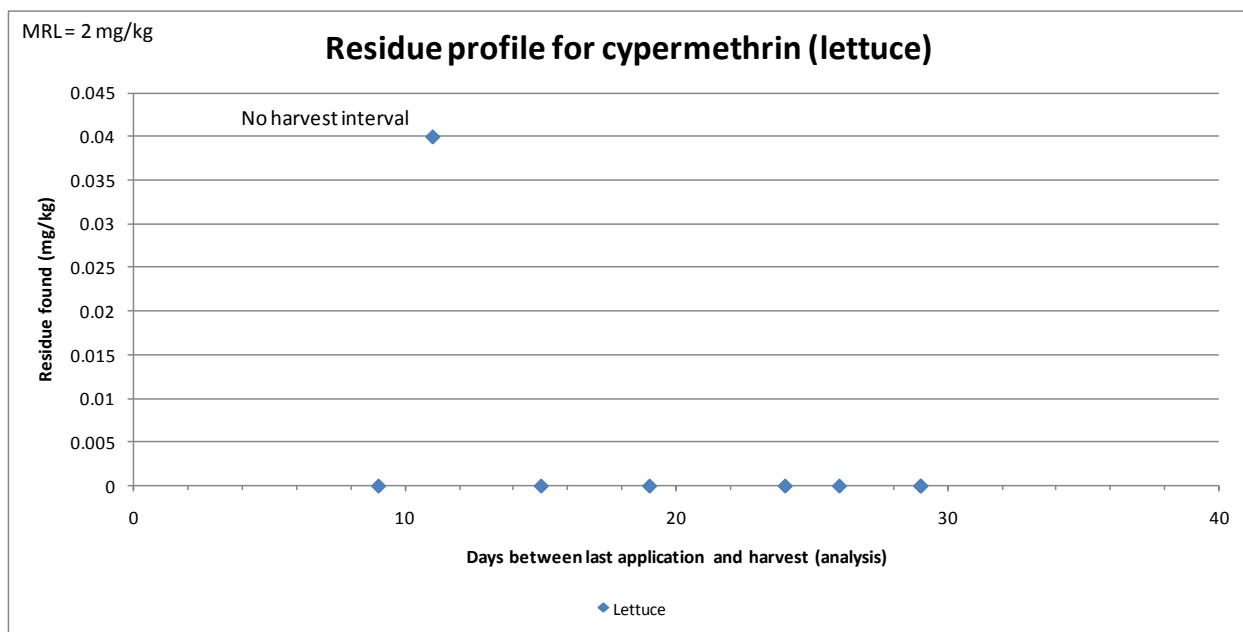
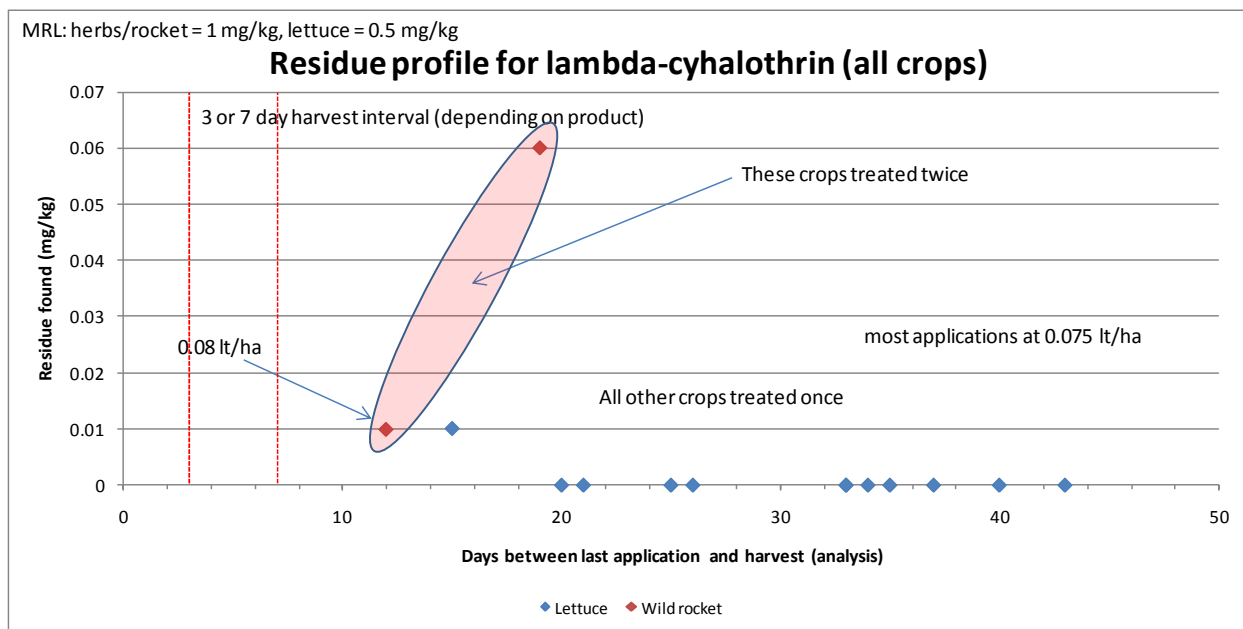


Fig 16



Appendix 2 Cont

Fig 17

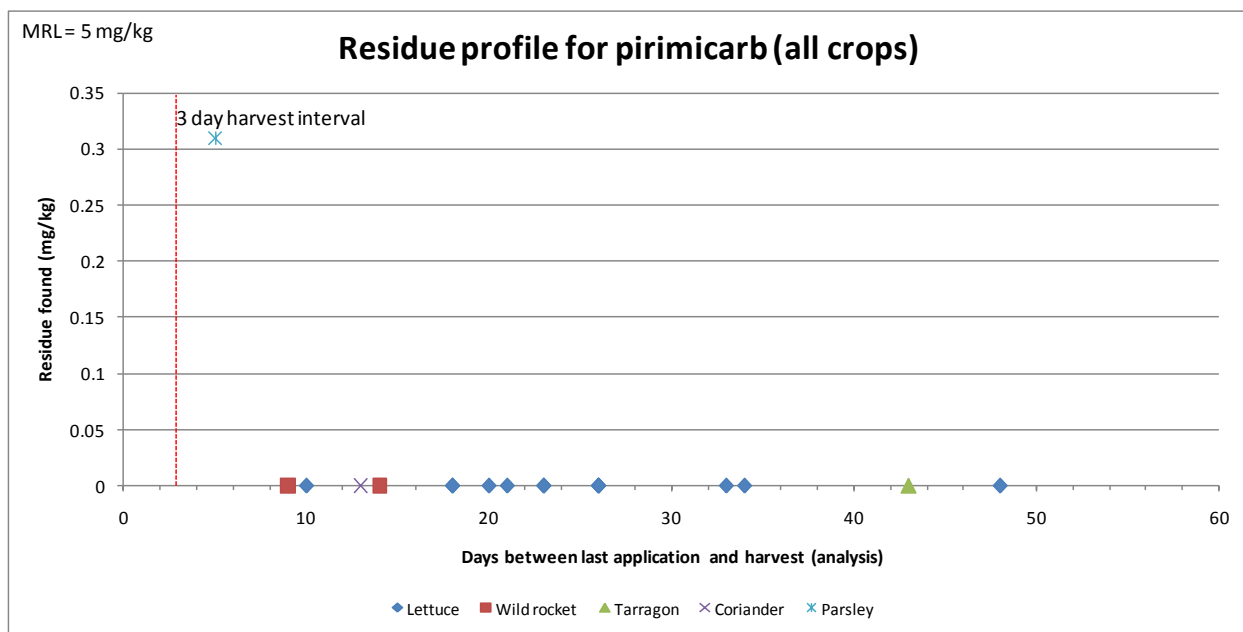


Fig 18 – non-approved use

