Project title	Lettuce (transplanted outdoor): evaluation of new herbicides for crop safety and weed control.
Project number:	FV 310
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Report:	Final report
Previous report	Annual reports, December 2007, December 2008
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Location of project:	Majors Farm, Holbeach St. Marks (2007-2009), Kirton Research Centre (2007), Lincs; G's Plantation Farm, Little Ouse, Littleport (2008)
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AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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CONTENTS

Grower Summary

Headline

Three herbicides, BUK 9900H (code name), s-metolachlor and ethametsulfuron, all show potential for weed control in outdoor transplanted lettuce in future, but as yet, none are registered in the UK.

Background and expected deliverables

Poor weed control can result in reductions in yield and quality of lettuce. There is no tolerance to weeds, which give rise to seed contamination reducing product quality or can hinder hand-harvesting (nettles and thistles).

With the ongoing changes to pesticide approvals, growers of transplanted lettuce may be left with only propyzamide (Kerb and other products) for weed control, but there are water related issues for this active ingredient. When applied at 1.5 kg/ha, propyzamide has a 24-day harvest interval but it persists in the soil, which poses limitations on the following crops (e.g. wheat). Furthermore, only a narrow range of weeds are susceptible to propyzamide.

This project needed to investigate alternative herbicides that may extend the weed spectrum. Within the project, new soil-acting residual herbicides and a sulfonylurea product with potential for use on lettuce (identified in Project FV 256) were evaluated for both crop safety and weed control.

The overall aims were to:

- Further investigate new potential alternative herbicides identified in FV 256.
- Assess crop safety or 'phytotoxicity' to herbicides, assess efficacy against weeds; review the treatments and amend if necessary and assess tolerance of a range of lettuce varieties to herbicides.
- Find new solutions for weed control in transplanted outdoor lettuce as quickly as possible and through HDC, to obtain Specific Off-Label Approvals (SOLAs).

Summary of the project and main conclusions

New potential herbicides for lettuce were compared with the commercial standard (Kerb + Ramrod as a post-plant treatment), for efficacy and crop safety. In 2007 all treatments were applied as either pre-transplanting or post-transplanting to established lettuce, but before weed-emergence. There were different results for crop safety between two trial sites in 2007 and herbicides did not perform consistently. Although several treatments were safe at the first site, all treatments caused damage in the other trials. This may have been the result of extremely wet weather conditions. Soil containing oxadiargyl splashed onto lettuce by rain or irrigation, or blown by wind, resulted in damage at all sites. It was therefore decided not to proceed with evaluation of oxadiargyl in 2008.

Products containing propachlor (e.g. Ramrod) cannot be used after 18 March 2010. This meant that post-planting alternatives were needed. In 2008 a trial on organic soil was carried

out and a foliar-acting herbicide ethametsulfuron, that looked promising on lettuce in the FV 256 screen in 2007, was evaluated. The trial on mineral soil continued to evaluate pre- and post-planting and post-weed-emergence herbicides.

Herbicide Treatments 2008 (+ denotes a tank-mix, & denotes followed by)

Site 1 - Pre- and post-planting, and post-weed-emergence on mineral soil (light silt)

Herbicide	**g a.i./ha**	**L or g product/ha**
1. untreated		-
T1 Pre-transplant		
2. dimethachlor	750	1.5L
3. s-metolachlor	672	0.7L
4. s-metolachlor + Stomp	672 + 600	0.7L + 1.5L
5. BUK 9900	confidential	1.25L
6. Defy	3200	4L
T1 Pre-transplant & T2 6 days post-transplant (crop established)		
7. T1 s-metolachlor & T2 Defy	672 & 3200	0.7L & 4.0L
T2 6 days post-transplant & T3 emerged weeds		
8. T2 Kerb + Ramrod	800 + 1440	2.0L + 3.0L
9. T2 dimethachlor	750	1.5L
10. T2 s-metolachlor	672	0.7L
11. T2 s-metolachlor + Defy	672 + 3200	0.7L+ 4.0L
12. - T3 emerged weeds A7881(ethametsulfuron)	15	20g
13. T2 s-metolachlor & T3 emerged weeds A7881	672 & 15	0.7L & 20g

Ramrod Flowable (propachlor 480g/L); Kerb Flo (propyzamide 400g/L SC); Stomp 400SC (pendimethalin 400g/L); Defy (prosulfocarb 800 g/L)

Site 2 - Post-transplanting on organic soil

Herbicide	**g a.i/ha**	**L or g product/ha**
1. untreated	-	-
T_1 4 to 7days post-plant & T2 (T_1 + 7 to 10 days emerged weeds)		
2 .T1 Ramrod + Jupiter 40EC & T2 Ramrod + Jupiter 40EC	1440 + 800 & 1440 + 800	3.0L + 2.0L & 2.0L + 2.0L
3. T1 Defy & T2 Defy	1600 & 1600	2.0L & 2.0L
4. T1 Ramrod + Jupiter 40EC & T2 Defy	1440 + 800 & 3200	3.0L + 2.0L & 4.0L
5. T1 Defy + Jupiter & T2 Defy + Jupiter	1600 + 800 & 1600 + 800	2.0L + 2.0L & 2.0L + 2.0L
6. - T2 emerged weeds A7881	15g	- & 20g
7. T1 A7881 & T2 A7881	7.5 & 7.5	10g & 10g
8. T1 s-metolachlor & T2 A7881	672 & 15	0.7L & 20g

Jupiter 40EC (chlorpropham 400 g/L)

In 2008 trials the best post-planting treatment was with standard Kerb (propyzamide) + Ramrod (propachlor) on mineral soil, and with Ramrod + Jupiter (chlorpropham) followed by Ramrod + Jupiter on organic soil. The loss of propachlor - a safe, foliar-acting herbicide- will be a particular problem on organic soils, where activity of residual soil-acting herbicides is reduced or is damaging (eg BUK 9900) if applied post-planting to lettuce. Company data suggests that the activity of the residual herbicides dimethachlor and s-metolachlor is reduced on organic soils and that neither control emerged weeds.

Crop safety

At Site 1 *Light silt soil:* Pre-planting applications of BUK 9900, s-metolachlor at 0.7 L/ha alone or in tank-mix with Stomp 1.5 L/ha, or dimethachlor, were safe in Romaine lettuce on a light silt soil. The latter has only been tested in one trial.

Post-planting applications of Defy at 4.0 L/ha alone in a programme, or in tank-mix with s-metolachlor 0.7 L/ha caused severe damage, initially as scorch and blackening of leaf margins, followed by stunting and distortion. Effects were more severe for the tank-mix where 47% of the plants were unmarketable (undersized or distorted) compared with 15% for Defy as part of the programme. Dimethachlor was tested at site 1 only. It was applied at 1.5 L/ha post-planting and it also resulted in unacceptable damage: leaf margins were black and plants were stunted. At harvest stage. 31% of plants were unmarketable – undersized or distorted.

At Site 2 *Organic soil*: Defy treatments post-planting caused some scorch and stunting of lettuce. Because it was not applied in hot weather and there was frequent rainfall and irrigation the lettuce recovered, but the effects could be more severe in adverse weather.

S-metolachlor applied post-planting post-weed emergence was safe at both sites (mineral and organic soil). A7881 was very safe at 20 g/ha and as a split dose, to Romaine and Iceberg lettuce.

Weed control

At Site 1 *Untreated plots*: The main weed species were shepherd's purse, redshank, knotgrass and small nettle with low numbers of groundsel and mayweeds.

Pre-planting: BUK 9900 at 1.25 L/ha, dimethachlor at 1.5 L/ha or s-metolachlor + Stomp (0.7 + 1.5) L/ha gave very good control of these weeds. S-metolachlor at a low dose of 0.7 L/ha applied alone pre-planting (treatment 3) was the least effective treatment on knotgrass and redshank, but it controlled small nettle, mayweed and groundsel. Stomp was an obvious tank-mix partner, improving control of knotgrass and also shepherd's purse. Defy 4 L/ha did not control the low numbers of groundsel or mayweed but was effective on shepherd's purse.

In this trial the standard post-planting application of Kerb + Ramrod controlled all weed species. The programme of s-metolachlor followed by Defy (treatment 7) post-planting controlled all weed species, and the tank-mix (treatment 11) was also very effective, but both damaged the lettuce. S-metolachlor alone (treatment 13) was inadequate –small nettle and knotgrass remained. Dimethachlor performed well at T2 but was too phytotoxic to the crop. Dimethachlor and s-metolachlor have very little foliar activity but at the T2 post-planting timing very few weeds had emerged.

A7881 has foliar action only – it gave a rapid kill of redshank but was weak on groundsel and knotgrass when applied post-planting at T3 to emerged weeds, at a dose of 20 g/ha. The programme of s-metolachlor followed by A7881 did not control knotgrass.

At Site 2 *Organic soil*: the main weed species were redshank, black-bindweed, groundsel, annual meadow-grass, field speedwell, fat-hen and fig-leaved goosefoot.

Split applications of Defy at 2.0 L/ha followed by 2.0 L/ha post planting gave no control of groundsel and was ineffective on annual meadow-grass but it controlled redshank and black-bindweed. The tank-mix programme with Defy + Jupiter was marginally better - it was more effective on redshank but activity was also poor on groundsel and annual meadow-grass.

Foliar-acting A7881 was very effective on redshank. A7881 at 20 g/ha at the later post-planting timing was poor: groundsel, black-bindweed and fat-hen remained. The split dose of A7881 performed slightly better on fat-hen, field speedwell, annual meadow-grass and black-bindweed but groundsel was resistant.

When s-metolachlor was applied at 0.7 L/ha early post-planting (in the programme with A7881) it controlled groundsel and field speedwell and improved annual meadow-grass and black-bindweed control, although it has little foliar activity on emerged weeds. It did not control fat-hen.

***Potential herbicide solutions for weed control that are safe to lettuce*:**

Mineral (light silt) soil:

- Pre-planting - the best weed control was with BUK 9900 1.25 L/ha or s-metolachlor + Stomp (0.7 + 1.5) L/ha. Dimethachlor 1.5 L/ha also looked promising but was only evaluated in one trial.

- Post-planting - s-metolachlor at 0.7 L/ha and post-weed-emergence, foliar-acting A7881 (ethametsulfuron) at 20 g/ha were safe to lettuce. A programme of s-metolachlor followed by A7881 looked promising but not as effective as the standard Kerb + Ramrod.

Organic soil:

- Foliar-acting A7881 (ethametsulfuron) applied post-planting post-weed-emergence at 20 g/ha, or as a split dose 10 g/ha followed by 10 g/ha was safe to lettuce and controls emerged weeds. It is extremely effective on redshank, pale persicaria, shepherd's purse, chickweed and charlock (company data), but there are several gaps in the weed spectrum including groundsel and knotgrass.

None of the new herbicides are available to growers yet and residue trials will be needed before requests for SOLAs are made.

Crop safety in a range of varieties

The herbicides were evaluated on Romaine and Iceberg lettuce and information was needed on tolerance of other lettuce varieties. This work was deferred until 2009, following equivocal results on herbicides in the first year of trials 2007.

Dimethachlor was included on Annex 1 (June 2009) in the 91/414/EEC review but there were restrictions on use to only once in three years on the same field. Athough dimethachlor at 1.5 L/ha appeared promising pre-transplanting in 2008, it would be inappropriate for lettuce, which is grown frequently in the rotation.

S-metolachlor was only tested at 0.7 L/ha in previous trials, as it was judged the safe dose in Project FV 256. 1.4 L/ha was the 'overlap dose'.

Lettuce types requested by growers for assessment in 2009 included: Little Gem, Lollo Rosso, Green Oakleaf, Multileaf Frisée (Can-can) and Endive (Fine Frisée). They were screened on a light silt soil site for tolerance to the following herbicides:

Herbicide Treatments 2009

Herbicide	**g a.i./ha**	**L or g product/ha**
1. untreated		-
T1 Pre-transplant		
2. s-metolachlor + Stomp	672	0.7L + 1.5L
3. s-metolachlor	1344	1.4L(overlap)
4. BUK 9900	confidential	1.25L
T2 6 days Post-transplant & T3 emerged weeds		
5. s-metolachlor	672	0.7L
6. s-metolachlor	1344	1.4L (overlap)
T3 emerged weeds		
7. ethametsulfuron	15	20g

Herbicides applied pre-planting were BUK 9900 at 1.25 L/ha, s-metolachlor at 0.7 L/ha alone or in tank-mix with Stomp at 1.5 L/ha. Post-planting herbicides used include s-metolachlor at 0.7 L/ha and post-weed-emergence, foliar-acting A7881 (ethametsulfuron) at 20 g/ha. All were all safe to Romaine and Iceberg lettuce in 2008.

Pre-planting applications of BUK 9900H at 1.25 L/ha, s-metolachlor at 1.4 L/ha or s-metolachlor + Stomp 400SC (0.7 + 1.5) L/ha were safe on Little Gem, Lollo Rosso, Green Oakleaf, Multileaf Frisée (Can-Can), Endive (Fine Frisée). This was also true for post-weed-emergence applications of A 7881 (ethametsulfuron).

Lollo Rosso, and to a lesser extent Green Oakleaf were the most sensitive varieties to post-planting treatments. Little Gem and Endive were the least sensitive. Although damage from s-metolachlor at 0.7 L/ha was acceptable, damage from s-metolachlor at 1.4 L/ha was more severe with scorch of older leaves and stunting. In this trial all types recovered by harvest stage on July 9 and there were no unmarketable lettuces.

S-metolachlor was only tested at 0.7 L/ha in previous trials, as it was judged the safe dose in Project FV 256. 1.4 L/ha was the ‘overlap dose’.

Approval status of new herbicides

New Herbicides: Current Approval Status (December 2009)

Herbicide Product	***Company***	***active substance & formulation***	***EU active status***	**Registered now *or in future?***
BUK 9900H	Confidential	Confidential	Annex 1	*No EU registration yet*,
A5089H (Terridox)	Syngenta	dimethachlor 500 g/L SC	Annex 1#	*No UK registration yet*, EU for oilseed rape
(Dual Gold)	Syngenta	s-metolachlor 960 g/L EC	Annex 1	*Submitted UK registration maize,* sugar beet Belgium; dwarf beans, maize France
Defy	Syngenta	prosulfocarb 800 g/L SC	Annex 1	UK Approval for wheat, SOLAs carrots etc.
A7881	Dupont	ethametsulfuron 75% wg	-	*No EU registration yet*,

(names) are for products registered in other EU states; # restricted to application once in three years to the same field, not progressed for lettuce.

Financial benefits

Alternative herbicides for use on lettuce are urgently needed and would not have been found without development work through HDC (FV 256 and FV 310). This urgency has been created due to the widely used herbicide propachlor being withdrawn after 18 March 2010. The number of options for broad-leaved weed control will therefore be reduced to two (propyzamide and pendimethalin) in 2010 and pendimethalin could be lost in 2013.

Two new pre-emergence herbicides BUK 9900H and s-metolachlor could provide growers with alternatives that may extend the weed spectrum and improve crop profitability and competitiveness.

Ethametsulfuron is a potential post-emergence alternative.

Action points for growers

- Although the herbicides BUK 9900H (code name), s-metolachlor and ethametsulfuron show potential for future use in outdoor transplanted lettuce, none are yet registered for use in UK horticultural crops.

- Growers should monitor new herbicide approvals in future.

Science Section

Introduction

Outdoor lettuce is grown from transplants in blocks. Continuous lettuce production is carefully planned and any crop check or maturity delay caused by weed competition or herbicide must be avoided. Lettuce crops are short-term so several are grown on the same land in a single season. Continuous cropping on the same land and the short-term crop are limiting factors and there are few herbicide options. Poor weed control results in reductions in yield and quality of lettuce and cause delayed maturity thus affecting crop scheduling. There is zero tolerance of weeds whose seed contaminants reduce product quality or hinder hand harvesting (nettles and thistles).

The CSL Pesticide Usage Survey for 2007 shows that propachlor was used on 2125 ha of lettuce. The use of chlorpropham was also extensive, on 1194 ha, most of the area grown receiving two applications at approximately half rate. Propyzamide was used on 648 ha. Tank-mixes of propachlor with propyzamide or chlorpropham at reduced dose rates are often used.

Propachlor (SOLA) causes a growth check and the delay in maturity is usually 'built into' the sequence of croppings. It can be applied pre- or post-emergence but at the low dose rates used it only stunts Compositae. Propyzamide (SOLA) at 1.5 kg/ha now has a 24-day harvest interval but it is persistent in the soil, and this poses limitations on the following crops (e.g. wheat). Chlorpropham can be damaging and efficacy may be poor in the summer months. Only a narrow range of weeds is susceptible to propyzamide and chlorpropham and neither control mayweeds; propachlor does not kill cruciferous species or Polygonums; pendimethalin (SOLA) controls polygonums but has weaknesses on groundsel, mayweeds and charlock.

Herbicides propyzamide, chlorpropham and pendimethalin are all on Annex 1 (the positive list of the 91/414/EEC review programme). A decision for non-inclusion of trifluralin on Annex 1 has now been made and uses ceased on 20 March 2009. Propachlor (List 3B) also failed Annex 1 inclusion and it cannot be used after 18 March 2010. Herbicide uses of current chlorpropham products for the UK have now been revoked and must not be used after 31 July 2010, but it is possible that another one may appear in the future. Under the new Regulation 91/414/EEC pendimethalin may not be approved after 2013 (CRD impact assessment, January 2009). Growers of transplanted lettuce will then have only one option - Kerb (propyzamide) with approval for a narrow range of broad-leaved weeds, and propyzamide has water issues.

The risk of damage to tender leaves and harvest intervals required prevents the use of late herbicide applications. A residual herbicide that: covers a wide weed spectrum; avoids or reduces the need for post-weed-emergence applications, and does not persist and impose restrictions on following cropping would be useful. New soil-acting residual herbicides with potential for lettuce looked promising in the HDC FV 256 herbicide screens. Two replicated screening trials for efficacy and safety in each year, 2007 and 2008 were conducted to establish their potential as alternative herbicides. This work is needed before residue work for SOLAs is undertaken. The aim of the project was to:

- assess crop safety or 'phytotoxicity' to potential alternative herbicides in outdoor lettuce and assess efficacy against weeds in 2007 and 2008.
- review the treatments after the first year and amend if necessary.

- test the best treatments for safety in a range of lettuce types in 2009
- select the most promising candidates with the aim of obtaining residues data (use data from Crop Protection Companies if available) so that HDC (Vivian Powell) can submit applications for SOLAs.

New potential herbicides for lettuce (oxadiargyl, BUK 9900, s-metolachlor, Defy) were compared with the commercial standard, Kerb + Ramrod post-planting for efficacy and crop safety in 2007. Treatments were applied either pre-transplanting or post-transplanting to established lettuce but before weed-emergence. There were different results for crop safety between the sites in 2007 and herbicides did not perform consistently. This may have been the result of extremely wet weather conditions. Bayer CropScience registered oxadiargyl (on Annex 1) for lettuce in Spain, but in the 2007 UK trials soil containing oxadiargyl splashed onto lettuce by rain or irrigation, or blown by wind, resulted in damage at all sites. Growers therefore agreed that evaluation of oxadiargyl should not to continue in 2008.

The non-inclusion on Annex 1 of propachlor and loss after 18 March 2010 meant that post-planting options were needed. In 2008 a trial on organic soil was carried out and a foliar-acting herbicide A7881 (ethametsulfuron) that looked promising on lettuce in the FV 256 screen in 2007 was evaluated. The trial on mineral soil continued to evaluate pre- and post-planting and post-weed-emergence herbicides. Residual herbicide dimethachlor at 1.5 L/ha was also evaluated in 2008. Dimethachlor was included on Annex 1 (June 2009) in the 91/414/EEC review but there were restrictions on use to only once in three years on the same field. Athough promising pre-transplanting in 2008, it would be inappropriate for lettuce, which is cropped continuously on the same land.

Materials and methods

Trial sites in 2008 were in commercial lettuce crops Site 1 was on a light silt soil (ADAS classification) at Holbeach St. Marks, Site 2 at Little Ouse near Littleport on an organic soil. Both sites were typical of the main lettuce growing areas.

Herbicide Treatments 2008 *(+ denotes a tank-mix, & denotes followed by)*

Site 1 Holbeach St. Marks

Herbicide	**g a.i./ha**	**L product/ha**
1. untreated		-
T1Pre-transplant		
2. dimethachlor	750	1.5L
3. s-metolachlor	672	0.7L
4. s-metolachlor + Stomp	672 + 600	0.7L + 1.5L
5. BUK 9900	confidential	1.25L
6. Defy	3200	4.0L
T1 Pre-transplant & T2 6 days post-transplant		
7. T1 s-metolachlor & T2 Defy	672 & 3200	0.7L & 4.0L
T2 6 days Post-transplant & T3 emerged weeds		
8. T2 Kerb + Ramrod	800 + 1440	2.0L + 3.0L
9. T2 dimethachlor	750	1.5L
10. T2 s-metolachlor	672	0.7L

11. T2 s-metolachlor + Defy	672 + 3200	0.7L+ 4.0L
12. - T3 A7881	15	20g
13. T2 s-metolachlor & T3 A7881	672 & 15	0.7L & 20g

Ramrod Flowable (propachlor 480g/L); Kerb Flo (propyzamide 400g/L SC); Stomp 400SC (pendimethalin 400g/L)

Site 2. Littleport: Post-transplanting on organic soil

Herbicide	**g a.i/ha**	**L or g product/ha**
1. untreated	-	-
T_1 4 to 7days post-plant & T2 (T_1 + 7 to 10 days emerged weeds)		
2 .T1 Ramrod + Jupiter 40EC & T2 Ramrod + Jupiter 40EC	1440 + 800 & 1440 + 800	3.0L + 2.0L & 2.0L + 2.0L
3. T1 Defy & T2 Defy	1600 & 1600	2.0L & 2.0L
4. T1 Ramrod + Jupiter 40EC & T2 Defy	1440 + 800 & 3200	3.0L + 2.0L & 4.0L
5. T1 Defy + Jupiter & T2 Defy + Jupiter	1600 + 800 & 1600 + 800	2.0 L+ 2.0L & 2.0L + 2.0L
6. - T2 A7881	15	- & 20g
7. T1 A7881 & T2 A7881	7.5 & 7.5	10g & 10g
8. T1 s-metolachlor & T2 A7881	672 & 15	0.7L & 20g

Jupiter 40EC (chlorpropham 400 g/L)

New Herbicides: Current Approval Status *(December 2009)*

Herbicide Product	***Company***	***active substance & formulation***	***EU active status***	**Registered now *or in future?***
BUK 9900H	Confidential	Confidential	Annex 1	*No EU registration yet*,
A5089H (Terridox)	Syngenta	dimethachlor 500 g/L SC	Annex 1#	*No UK registration yet*, EU for oilseed rape
(Dual Gold)	Syngenta	s-metolachlor 960 g/L EC	Annex 1	*Submitted UK registration maize,* sugar beet Belgium; dwarf beans, maize France
Defy	Syngenta	prosulfocarb 800 g/L SC	Annex 1	UK Approval for wheat, SOLs carrots etc.
A7881	Dupont	ethametsulfuron 75% wg	-	*No EU registration yet*,

(names) are for products registered in other EU states; # restricted to application once in three years to the same field, not progressed for lettuce in 2009.

Records/Assessments

Appendix 1 shows Common and Latin weed names.

The following records and assessments were undertaken following application of the various experimental treatments.

- Weather during and after application.
- Observations on weed control, scores (0=untreated, no control, 7=acceptable control, 10=complete control); number of weed species /m^2 in three 0.33 m^2 quadrats per plot; % weed cover per plot.
- Observations on any phytotoxicity symptoms, crop scores for damage (0=complete kill; 7=acceptable damage; 10=untreated no damage).

Crop tolerance score	*% Phytotoxicity*
0	Complete kill

1	80 – 95% damage
2	70 – 80% damage
3	60 – 70% damage
4	50 – 60% damage
5	40 – 50% damage
6	25 – 40% damage
7	20 – 25% damage (considered unlikely to cause reduction in yield or quality at cropping)
8	10 – 20% damage
9	5 – 10% damage
10	No damage (as untreated controls)

- Assessments of % crop cover per plot.
- Numbers of small undersized or unmarketable distorted lettuce per plot in the three replicates (total 150 plants) were counted just before harvest and the % calculated for each treatment.

Trials Design in 2008

There were three replicates of each treatment and an untreated plot. Each plot was 4 m long x 1.83 m wide bed with 5 rows per plot at site 1. At Site 2 Lettuce was grown on the flat and plots were 4 m long and 2 m wide with 4 rows per plot.

Site, soil type, planting date 2008

In 2008 the sites were in commercial crops.

Site 1. Majors Farm, Holbeach St. Marks, Lincs. silt loam (light soil), transplanted Romaine lettuce (cv. Daytona) on 2 May.

Site 2. Plantation Farm, Little Ouse, Littleport, Cambs., fen soil 17% organic matter, transplanted Iceberg lettuce (cv. Silverado) on 22 May.

Application Details 2008

Sprays were applied using an Oxford precision sprayer with a 2 m boom and four 110º flat fan nozzles (BCPC code F110/0.80/3) delivering 300 L/ha water volume at 2 bar pressure to give medium spray quality.

Date applied	Weather	Weeds Growth Stages True leaves (TL)
Site 1. Holbeach St. Marks planted 8 May		
8 May T1 pre-plant. Treatments 2 – 7	16.6ºC; RH% 73; sunny cloud cover 1; soil surface dry fine seedbed; no rain after application.	none
14 May T2 post-plant Treatments 7, 8, 9, 10, 11, 13.	12.8ºC; RH% 77; cloud cover 7; soil surface dry; leaf surface dry; no rain after application.	none
2June T3 post-weed-emergence Treatments 12,13	15.3ºC; RH 87%; overcast cloud cover 8; soil surface wet; 8.1mm rain on 3 June, 13.5mm on 3 June.	small nettle 2TL, groundsel 1-2 TL Shepherd's purse 4TL, redshank 1TL,
Site 2. Litleport planted 22 May		
2 June T_1 4 to 7days post-plant. Treatments 2, 3, 4, 5, 7, 8	15.3ºC; RH 87%; overcast cloud cover 8; soil surface wet; 8.1mm rain on 3 June, 13.5mm on 3 June	mustard 2 TL, tiny weeds of other species.
11 June T2 (T_1 + 7 to 10 days emerged weeds) Treatments 3, 4, 5, 6, 7, 8	17.0ºC, 19.4ºC max later; sunny, cloud cover 2; soil surface dry; rainfall later 2.5 mm	cot black-bindweed, chickweed; cot-1TL groundsel; speedwell cot-2TL, mustard 2TL, annual meadow-grass 2L

Irrigation was applied at both sites: Site 1 30mm in May; 17mm in June; Site 2 15mm applied 23 May, 15mm 30 June.

Results 2008

Crop safety

Site 1, Holbeach St. Mark (lettuce transplanted 8 May)
No damage to Romaine lettuce was observed from the pre-planting treatments on the 14 May or at any later assessment dates (Table 1).

Post-planting Defy at 4.0 L/ha either following s-metolachlor (treatment 7) or in tank-mix with s-metolachlor (treatment 11) caused unacceptable damage in the form of scorch, stunting and blackening of leaf margins (27 May). Plants closed up, were more erect, and plot cover was less than on untreated plots, a few had died (8 June) others were stunted, distorted and unmarketable. Effects were more severe for the tank-mix and 47% of plants were dead or unmarketable (stunted or distorted) compared with 15% for Defy as part of the programme.

Dimethachlor applied at 1.5 L/ha post-planting also gave unacceptable damage: leaves were darker in colour initially, margins were black and plants were stunted. By 8 June some leaves were dead, plants closed up and crop cover was less than on untreated plots. At harvest stage 31% of plants were unmarketable (undersized or distorted).

There was a slight growth check from the post-planting treatment Kerb + Ramrod.

S-metolachlor at 0.7 L/ha, applied alone to established lettuce six days after transplanting, caused no damage and appears safe to lettuce.

A7881 (ethametsulfuron), a sulfonylurea, applied at 20 g/ha post-weed-emergence 25 days after planting was safe to lettuce.

Table 1. Site 1: Crop tolerance to herbicides, score (0 plant death, 7 acceptable damage, 10 no damage = untreated); growth stage of untreated crop; % plot cover; % by number of dead, or unmarketable (undersized or distorted) lettuce in the four rows/plot for the three replicates (total 150 plants) on 23 June (harvest stage)

Herbicide	*Product L/ha*	*19 May score*	*27 May score*	*8 June score*	*8 June % plot cover*	*16 June score*	*16 June % plot cover*	*23 June % dead/ unmktable*
1. untreated	-	10	10	10	70	10	95	0
T1 Pre-plant 8 May								
2. dimethachlor	1.5	10	10	10	70	10	95	0
3. s-metolachlor	0.7	10	10	10	70	10	95	0
4. s-metolachlor + Stomp	0.7 + 1.5	10	10	10	70	10	95	0
5. BUK 9900	1.25	10	10	10	70	10	95	0
6. Defy	4	10	10	10	70	10	95	0
T1 Pre-plant & T2 post-transplant 14 May								
7. T1 s-metolachlor & T2 Defy	0.7 & 4.0	10	7.3 bl cl sc st	7cl st	50	6	73.3	15
T2 Post-transplant & T3 emerged weeds 2 June								
8. T2 Kerb + Ramrod	2.0 + 3.0	10	9.3	9.3st	70	9.7	92	0
9. T2 dimethachlor	1.5	10	8 st bl	6.7st	40	5st	70	31
10. T2 s-metolachlor	0.7	10	10	10	70	10	95	0
11. T2 s-metolachlor + Defy	0.7+ 4.0	10	6 bl cl st	4.7	40	3	47	47
12. - & T3 A7881	20	-	-	10	70	10	95	0
13. T2 s-metolachlor & T3 A7881	0.7 & 20	10	10	10	70	10	92	0

Key: bl blackened leaf margins; st stunting; sc scorch; cl plants erect/closed up appearance

Weed control

Site 1, Holbeach St. Mark

Numbers of each weed species remaining after each herbicide application were counted on 8 June, except for the T3 timing on the 16 June (Table 2). The predominant weed species at this site were shepherd's purse, redshank, knotgrass and small nettle. Total weed numbers on untreated plots were low, 68.3/m^2. May was a dry month but the crop was irrigated after the herbicides were applied.

Table 2 Site 1 Holbeach St. Marks: Weed species numbers/m^2 (mean of 3 counts in 0.33m^2 quadrats for 3 replicates) 8 (T1 and T2 treatments) and 16 June (T3 in italics)

Herbicide	*Product L/ha*	*Shepherd's purse*	*Small nettle*	*Black bindweed*	*Redshank*	*Groundsel*	*Knotgrass*	*Mayweed*	*Fat-hen*	***TOTAL***
1. untreated	-	39.3	4	1	8.7	3	9.3	2	1	**68.3**
T1 Pre-plant 8 May										
2. dimethachlor	1.5	0	0	1	1	0	0.3	0	0	**2.3**
3. s-metolachlor	0.7	7	0	0.3	2	1	3	0	0	**13.3**
4. s-metolachlor + Stomp	0.7 + 1.5	0.3	0	0	2	1	0	0	0	**3.3**
5. BUK 9900	1.25	0.3	0	0.3	0.7	1	0	0	0	**2.3**
6. Defy	4	0.3	1.7	0	2	3.3	1.7	2	0	**11**

T1 Pre-transplant & T2 6 days post-transplant 14 May										
7. T1 s-metolachlor & T2 Defy	0.7 & 4.0	0	0	0	0	0	0	0	0	**0**
T2 6 days Post-transplant & T3 emerged weeds										
8. T2 Kerb + Ramrod	2.0 + 3.0	0	0	0	0	0	0	0	0	**0**
9. T2 dimethachlor	1.5	0	0	0	1.3	0	2	0	0	**3.3**
10. T2 s-metolachlor	0.7	6	2	0.3	5.3	0.3	7.3	0	0	**21.3**
11. T2 s-metolachlor + Defy	0.7+ 4.0	0	1.3	0	0	0	0	0	0	**1.3**
12. T3 A7881	*20*	*1.7*	*3.3#*	*1.3*	*0*	*5.3*	*8.3*	*0.7*	*0*	***20.7***
13. T2 s-metolachlor	0.7	7.3	4	0	2.7	0.7	6.7	2	0	**24**
& T3 A7881	*& 20*	*0*	*1.7*	*0*	*0*	*1.7*	*7*	*0*	*0*	***10.4***

stunted and chlorotic

Pre-planting BUK 9900 1.25 L/ha, dimethachlor 1.5 L/ha or s-metolachlor + Stomp (0.7 + 1.5) L/ha gave excellent weed control.

S-metolachlor at the low dose of 0.7 L/ha applied alone pre-planting (treatment 3) was the least effective treatment pre-planting. Efficacy on knotgrass and redshank was poor but it controlled small nettle, mayweed, groundsel and 82% of shepherd's purse. The tank-mix + Stomp (treatment 4) performed better on knotgrass (and shepherd's purse).
Defy 4 L/ha pre-planting did not control the low numbers of groundsel or mayweed. The programme of s-metolachlor followed by Defy (treatment 7) post-planting controlled all weed species, and the tank-mix (treatment 11) was also very effective, but both damaged the lettuce. S-metolachlor alone (treatment 13) was inadequate –small nettle and knotgrass remained. Dimethachlor performed well at T2 but was too phytotoxic to the crop. Dimethachlor and s-metolachlor have very little foliar activity but at the T2 post-planting timing very few weeds had emerged.

In this trial the standard, Kerb + Ramrod post-planting controlled all weed species.

A7881 has foliar action only – applied to emerged weeds at a dose of 20 g/ha it gave a rapid kill of redshank but was weak on groundsel and knotgrass, and the programme of s-metolachlor followed by A7881 also left knotgrass.

Weed control scores are shown in Table 3. The best weed control pre-planting was with dimethachlor, BUK 9900 and s-metolachlor + Stomp tank-mix. The best treatment post-planting was with Kerb + Ramrod.

Defy pre-planting gave acceptable control except for groundsel, and a few nettle. Weed control with s-metolachlor 0.7 L/ha alone was unacceptable pre- or post-planting. Remaining weeds were knotgrass and redshank, and these were a greater problem on post-planting treatment 10. Treatments 7 and 11 with post-planting Defy were effective but not crop safe.

Although A7881 controlled shepherd's purse and removed redshank which might have interfered with harvesting, knotgrass remained and control was unacceptable.

A few nettles (a deterrent to hand harvesting) remained on treatments 6, 10, 12 and 13 only.

Table 3 Site 1: Weed control scores (0 no control, 7 acceptable control, 10 complete control) assessed on several dates; % weed cover. Harvest stage 23 June

Herbicide	*Product L/ha*	*31 May score*	*8 June score*	*16 June score*	*16 June % weed cover*	*23 June score*
1. untreated	-	0	0	0	30	0
T1Pre-plant 8 May						
2. dimethachlor	1.5	10	10	9.9	0.03	9.9
3. s-metolachlor	0.7	7.3	7.3	7	2.2	6.7
4. s-metolachlor + Stomp	0.7 + 1.5	9.3	9.3	9.3	0.7	9.3
5. BUK 9900	1.25	10	9.7	9.7	0.2	9.7
6. Defy	4	8.7	8.7	8.5	1.2	8.5
T1 Pre-transplant & T2 6 days post-transplant (crop established) 14 May						
7. T1 s-metolachlor & T2 Defy	0.7 & 4.0	10	10	10	0	9.5
T2 6 days Post-transplant & T3 emerged weeds						
8. T2 Kerb + Ramrod	2.0 + 3.0	9	9.7	10	0	10
9. T2 dimethachlor	1.5	9.3	6	9.5	0.5	9
10. T2 s-metolachlor	0.7	7	6	4.7	7.3	4.3
11. T2 s-metolachlor + Defy	0.7+ 4.0	9.3	10	10	0	9
12. - & T3 A7881	20	-	-	3.7	8.3	4
13. T2 s-metolachlor & T3 A7881	0.7 & 20	-	5.7	7	2.7	6.3

Crop safety

Site 2, Littleport

Assessments of crop safety are shown in Table 4. There were no effects on the crop from the programme with Ramrod + Jupiter treatment 2 at any stage, or from the T1 treatment 4 when assessed on 7 June.

Applications of Defy at T1 (3 and 5) caused slight stunting and a ‘closed up’ appearance on 7 June. Applications of Defy alone at 2.0 or 4.0 L/ha (treatments 3 and 4 respectively) or in tank-mix with Jupiter (5) caused chlorosis, scorch and stunting and the most severe scorch was from the higher dose rate of Defy 4.0 L/ha recorded on 23 June. Later the tank-mix caused more stunting. However all new growth appeared normal and by harvest no differences were observed between Defy-treated and untreated plots.

No damage was observed from A7881 at 20 g/ha dose rate (treatments 6 and 8) or as a split dose (treatment 7) appeared very safe at T1 10 days and T2 20 days post-transplanting iceberg lettuce.
There were no visible differences in damage between treated and untreated lettuce at harvest stage.

Table 4 Site 2 (lettuce transplanted 22 May) Crop tolerance to herbicides, score (0 plant death, 7 acceptable damage, 10 no damage=untreated); growth stage of untreated crop; % crop cover. Harvest stage 14 July

Herbicide	L or g product/ha	7 June score	14 June score	20 June score	23 June % cover	2 July score	2 July % cover	11July score	11July % cover
1. untreated	-	10	10	10	50	10	80	10	90
T1 post-plant 2 June & T2 on 11 June									
2 .T1 Ramrod + Jupiter & T2 Ramrod + Jupiter	3.0 + 2.0 & 2.0 + 2.0	10	10	10	50	10	80	10	90
3. T1 Defy & T2 Defy	2.0 & 2.0	9 st	8 cl sc st	6 cl sc st	40	8	75	10	90
4. T1 Ramrod + Jupiter & T2 Defy	3.0 + 2.0 & 4.0	10	8.3 sc	5 severe sc st	33	8	75	10	90
5. T1 Defy + Jupiter & T2 Defy + Jupiter	2.0 + 2.0 & 2.0 + 2.0	9 st	7.3 st	6.3 st	33	7.7st	73	10	90
6. - & T2 A7881	- & 20g	10	10	10	50	10	80	10	90
7. T1 A7881 & T2 A7881	10g & 10g	10	10	10	50	10	80	10	90
8. T1 s-metolachlor & T2 A7881	0.7 & 20g	10	10	10	50	10	80	10	90

Key: T1 4 to 7 days post-transplant; T2 (T1 + 7 to 10 days emerged weeds); sc scorch; cl chlorosis; st stunting

Weed control

Site 2 Littleport

Table 5. Site 2 Littleport: Weed species numbers/m^2 (mean of 3 counts in 0.33m^2 quadrats for 3 replicates) assessed on 23 June

Herbicide	**L or g product/ha**	*Redshank #*	*Black-bindweed*	*Groundsel*	*Chickweed*	*Small nettle*	*Annual meadow-grass*	*Fat-hen##*	*Black mustard*	*Field speedwell*	***TOTAL***
1. untreated	-	13	15	19	1	1.7	24.3	6	3	12	**95**
T1 post-plant 2 June & T2 on 11 June											
2. T1 Ramrod + Jupiter & T2 Ramrod + Jupiter	3.0 + 2.0 & 2.0 + 2.0	0	0	3.3	0	0	0	0.7	2 st	0	**6**
3. T1 Defy & T2 Defy	2.0 & 2.0	1.7	0	18	0	0	9	1	0	0	**29.7**
4. T1 Ramrod + Jupiter & T2 Defy	3.0 + 2.0 & 4.0	0	0.7	2	0	0	2.3	0.3	0	0	**5.3**
5. T1 Defy + Jupiter & T2 Defy + Jupiter	2.0 + 2.0 & 2.0 + 2.0	0	0.3	16	0	0	7.3	0	0	0	**26.6**
6. - & T2 A7881	- 20g	0	12.3	17.3	0	0	15.7	5.7	1.3	12.6	**65.0**
7. T1 A7881	10g										

& T2 A7881	& 10g	0	8	18	0	0	3.3	0.3	2	7	**38.6**
8. T1 s-metolachlor	0.7										
& T2 A7881	& 20g	0	7	1	0	0.3	1.3	4	2	0	**15.6**

Key: T1 4 to 7 days post-transplant; T2 (T1 + 7 to 10 days emerged weeds); st stunted; # and some pale persicaria in one replicate; ## and fig-leaved goosefoot

Only few weeds (mainly black mustard) had emerged at the time of the first T1 treatment. Several weeds on untreated plots had emerged by the T2 application on 11 June but some field speedwell and a few more annual meadow-grass and groundsel emerged later. The predominant species were redshank, black-bindweed, annual meadow-grass and groundsel. There were some fat-hen and fig-leaved goosefoot Weed species counts on June 23 are shown in Table 5.

The best weed control was with Ramrod + Jupiter followed by Ramrod + Jupiter (standard for this soil type), or Ramrod + Jupiter followed by Defy, but Defy was not crop safe.

Defy 2.0 followed by 2.0 L/ha gave no control of groundsel and was ineffective on annual meadow-grass, but controlled redshank and black-bindweed. The tank-mix programme with Defy + Jupiter was marginally better - it was more effective on redshank but activity was also poor on groundsel and annual meadow-grass.

At the T2 timing A7881 20 g/ha was ineffective on black-bindweed, mustard and annual meadow-grass (Table 5) and gave no control of groundsel or field speedwell and only stunted fat-hen. It gave a quick kill of redshank. The split dose of A7881 (treatment 7) performed slightly better on fat-hen, field speedwell, annual meadow-grass and black-bindweed but groundsel was resistant.

Although s-metolachlor has little foliar activity on emerged weeds, when applied at 0.7 L/ha at T1 (in the programme with A7881 treatment 8) it controlled groundsel and field speedwell and improved annual meadow-grass control. However, s-metolachlor at 0.7 L/ha did not control fat-hen.

Weed control scores and % of weed cover per plot are shown in Table 6. Growth was very vigorous and by harvest weeds covered 90% of untreated plots - redshank, fat-hen, nettle and even groundsel were above lettuce height, and black-bindweed had over-run the crop.

The only acceptable weed control on 11 July was from the standard, treatment 2 and treatment 4. The high population of groundsel not controlled by Defy or Jupiter (treatments 3 and 5) grew above crop height and annual meadow-grass was also a problem on these plots. The treatments with A7881 (6, 7 and 8) were very effective on redshank. Weed control with A7881 at 20 g/ha at the T2 timing was very poor, black bindweed and fat-hen were the main problem weeds. There were fewer fat-hen on plots treated with the split dose A7881 (7),

Table 6 Site 2 Littleport: Weed control scores (0 = no control, 7 = acceptable control, 10 = complete control); % weed cover on plots. Harvest stage 14 July

Herbicide	L or g product/ha	23 June score	23 June % plot cover	2 July score	11 July % plot cover
1. untreated	-	0	10	0	90
T_1 post-transplant 2 June & T2 emerged weeds 11 June					
2. T1 Ramrod + Jupiter & T2 Ramrod + Jupiter	3.0 + 2.0 & 2.0 + 2.0	9	0.1	8	7
3. T1 Defy & T2 Defy	2.0 & 2.0	5.3	1	4	50
4. T1 Ramrod + Jupiter & T2 Defy	3.0 + 2.0 & 4.0	9.5	0	9	4
5. T1 Defy + Jupiter & T2 Defy + Jupiter	2.0 + 2.0 & 2.0 + 2.0	7	0.3	6	20
6. T2 A7881	- & 20g	3	10	2.7	67
7. T1 A7881 & T2 A7881	10g & 10g	4.7	2.5	3	53
8. T1 s-metolachlor & T2 A7881	0.7 & 20g	6.3	0.4	4.3	37

Key: T1 4 to 7 days post-transplant; T2 (T1 + 7 to 10 days emerged weeds

Herbicide Treatments 2009

Lettuce types requested by growers Little Gem, Lollo Rosso, Green Oakleaf, Multileaf Frisée (Can-Can), Endive (Fine Frisée) were screened on a light silt soil site for tolerance to the herbicides in the Table below:

Dimethachlor was included on Annex 1 (June 2009) in the 91/414/EEC review but there were restrictions on use to only once in three years. Athough dimethachlor at 1.5 L/ha appeared promising pre-transplanting in 2008, it would be inappropriate for lettuce, which is grown more frequently on the same field.
S-metolachlor was only tested at 0.7 L/ha in previous trials judged the safe dose in FV 256, 1.4 L/ha was the 'overlap dose'.

Herbicide	**g a.i./ha**	**L or g product/ha**
1. untreated		-
T1 Pre-transplant		
2. s-metolachlor + Stomp	672	0.7L + 1.5L
3. s-metolachlor	1344	1.4L
4. BUK 9900	confidential	1.25L
T2 6 days Post-transplant & T3 emerged weeds		
5. s-metolachlor	672	0.7L
6. s-metolachlor	1344	1.4L
T3 emerged weeds		
7. ethametsulfuron	15	20g

Trials Design in 2009

There were three replicates of each treatment and an untreated plot. Each plot was 3 m long x 1.83 m wide bed for each variety with 4 rows per bed.

Site, soil type, planting date 2009

Majors Farm, Holbeach St. Marks, Lincs. silt loam (light soil), transplanted five lettuce types on 20 May.

Application Details 2009

Date applied	Weather	Weeds Growth Stages True leaves (TL)
Holbeach St. Marks planted 20 May		
20 May T1 pre-plant. Treatments 2, 3, 4	16ºC; RH 58%; cloud cover 50%; soil surface moist, fine seedbed	none
25 May T2 post-plant Treatments 5, 6	16ºC; RH 53%; 90% thin high cloud; soil surface wet irrigated the previous day; leaf surface dry	none
2June T3 post-weed-emergence Treatments 7	11ºC (22 ºC later); RH 45%; sunny cloud cover 0%; soil surface dry no rain the day of application.	Negligible weeds, soil capped after irrigation

Pre-emergence treatments were applied with an Azo precision plot sprayer, delivering 200 L/ha water volume through Lurmark flat fan nozzles 02F110 at 1.9 bar pressure. Post-planting treatments applied in 300 L/ha water volume using Lurmark flat fan nozzles 03F110 at 2.0 bar pressure to give medium spray quality.

Results 2009

There were virtually no weeds at this site because the silt soil capped after irrigation on 24 May.

Table 7 shows tolerance of the different lettuce types to the herbicide treatments in 2009.

Table 7. Crop Tolerance score (0 plant death, 7 acceptable damage, 10 no damage=untreated); (mean of 3 replicates) until harvest stage on 9 July. Lettuce planted 20 May

Herbicide	*L or g product/ha*	*Little Gem*				*Lollo Rosso*				*Green Oakleaf*				*Multileaf frisée*				*Endive fine frisée*			
		2 June	10 June	25 June	9 July	2 June	10 June	25 June	9 July	2 June	10 June	25 June	9 July	2 June	10 June	25 June	9 July	2 June	10 June	25 June	9 July
1. untreated	-	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
T1 pre-transplant 20 May																					
2. s-metolachlor + Stomp	0.7L + 1.5L	10	10	10	10	9.5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
3. s-metolachlor	1.4L	10	10	10	10	9.5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
4. BUK 9900	1.25L	10	10	10	10	9.8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
T2 5 days post-transplant 25 May																					
5. T2 s-metolachlor	0.7L	9.7	9	10	10	8sc	6	9	10	8sc	8	10	10	9.7	9	10	10	8.3	9	10	10
6. T2 s-metolachlor	1.4L	8.7	7	10	10	5st sc	4st	5.7st	9	5st sc	5st	7st	10	9	5st	7.3st	10	7st	7	9	10
T3 post transplant 2 June																					
7. ethametsulfuron	20g	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

st stunting; sc scorch

Crop safety

No damage was observed on the lettuce types from the pre-planting applications of BUK 9900H 1.25 L/ha, s-metolachlor 1.4 L/ha or s-metolachlor + Stomp 400SC (0.7 + 1.5) L/ha with the exception of Lollo Rosso where there was a slight growth check12 days after treatment (2 June) but the plants soon recovered by 10 June.

Post- planting treatments were applied on 25 May and hot weather followed. On 2 June slight scorch on the margins of older leaves from the low dose of s-metolachlor 0.7 L/ha was seen. It was negligible on Little Gem, Multileaf Frisée and Endive, but more severe on Lollo Rosso where effects increased by 10 June. Plants were not stunted and all lettuce types recovered by 25 June. Damage from s-metolachlor at 1.4 L/ha was more severe – leaves had a 'closed up' appearance, scorch was more severe and plants were stunted. Damage was acceptable for Little Gem and Endive; effects on Multileaf Frisée were slower to develop, (possibly because this type has good leaf wax) but suffered a temporary growth check. Lollo Rosso suffered the most damage in the form of severe scorch of older leaves and stunting and plants had a smaller frame than untreated. Although new growth was normal, recovery was slow and there was a slight harvest delay, Green Oakleaf also suffered unacceptable damage but recovery was quicker. All types recovered by harvest stage on 9 July and there were no unmarketable lettuces.

Post-weed emergence ethametsulfuron at 20g product/ha was applied during a spell of hot weather on 2 June, when temperatures reached 22 ºC later that day. It was very safe to all lettuce types tested and no crop effects were observed at any stage.

Conclusions

Propachlor failed Annex 1 inclusion. It cannot be used after 18 March 2010 and it will be difficult to replace. In the trials 2008 post-planting the best treatment was with Kerb + Ramrod (propachlor) on mineral soil, and on organic soil with Ramrod + Jupiter (chlorpropham) followed by Ramrod + Jupiter. The loss of propachlor will be a particular problem on organic soils where activity of residual soil-acting herbicides is reduced or cause damage if applied post-planting to lettuce (BUK 9900). Company data suggests that residual activity of herbicides dimethachlor and s-metolachlor is poor on organic soils and neither control emerged weeds.

Applied pre-planting on a light silt soil, BUK 9900 1.25 L/ha, s-metolachlor 0.7 L/ha alone or in tank-mix with Stomp 1.5 L/ha, or dimethachlor 1.5 L/ha were safe in Romaine lettuce on a light silt soil. The latter has only been tested in one trial. BUK 9900 1.25 L/ha, dimethachlor 1.5 L/ha or s-metolachlor + Stomp (0.7 + 1.5) L/ha gave very good weed control of species at Site 1: shepherd's purse, redshank, knotgrass and small nettle. S-metolachlor at the low dose of 0.7 L/ha applied alone pre-planting was safe, but less effective on knotgrass and redshank was poor but it controlled small nettle, mayweed and groundsel. Stomp was an obvious tank-mix partner, improving control of knotgrass and also shepherd's purse. Defy 4.0 L/ha was also safe pre-planting but failed to control groundsel or mayweeds.

On the silt soil site Defy 4.0 L/ha post-planting, alone in a programme, or in tank-mix caused severe damage initially scorch, stunting and blackening of leaf margins followed by stunting

and distortion. Effects were more severe for the tank-mix and 47% of plants were unmarketable (undersized or distorted) compared with 15% for Defy as part of the programme. Dimethachlor tested at site 1 only, applied at 1.5 L/ha post-planting also gave unacceptable damage: leaf margins were black and plants were stunted. At harvest stage 31% of plants were unmarketable – undersized or distorted.

On organic soil Defy post-planting also caused some scorch and stunting of lettuce. The lettuces recovered in good growing conditions, but the effects could be more severe in adverse weather. On organic soil post-planting Defy 2.0 L/ha followed by 2.0 L/ha gave no control of groundsel and was ineffective on annual meadow-grass but it controlled redshank and black-bindweed. The tank-mix programme with Defy + Jupiter was marginally better - it was more effective on redshank but activity was also poor on groundsel and annual meadow-grass.

Post-planting s-metolachlor alone was safe at both sites (mineral and organic soil). Although s-metolachlor has little foliar activity on emerged weeds, when applied at 0.7 L/ha early post-planting on the organic soil site (in the programme with A7881) it controlled groundsel and field speedwell and improved annual meadow-grass control. However, s-metolachlor at 0.7 L/ha did not control fat-hen.

A7881, a sulfonylurea was also very safe at 20 g/ha and as a split dose to Romaine and Iceberg lettuce. It has foliar action only – applied to emerged weeds at a dose of 20 g/ha it gave a rapid kill of redshank but was weak on groundsel at both sites and knotgrass (at Site 1), and the programme of s-metolachlor followed by A7881 also left knotgrass. On the organic soil (Site 2) A7881 at 20 g/ha at the later post-planting timing was poor, black bindweed and fat-hen were the main problem weeds. The split dose of A7881 early and later performed slightly better on fat-hen, field speedwell, annual meadow-grass and black-bindweed but groundsel was resistant.

In some years a third herbicide application may be needed on organic soil if there are several weed flushes, here A7881 could be useful – depending on the weed species.

There are potential solutions for weed control and are safe to lettuce on:
Mineral (light silt) soil

- Pre-planting the best weed control was with BUK 9900 1.25 L/ha or s-metolachlor + Stomp (0.7 + 1.5) L/ha. Dimethachlor 1.5 L/ha also looked promising but was only evaluated in one trial
- Post-planting s-metolachlor at 0.7 L/ha and post-weed-emergence, foliar-acting A7881 (ethametsulfuron) at 20 g/ha were safe to lettuce. A programme of s-metolachlor followed by A7881 looked promising but not as effective as the standard Kerb + Ramrod.

Organic soil
Potential post-planting solutions on an organic soil safe to lettuce:

- Post-planting post-weed-emergence, foliar-acting A7881 (ethametsulfuron) at 20 g/ha, or as a split dose 10 g/ha followed by 10 g/ha but there are several gaps in the weed spectrum..
- A7881 in tank-mixes with, or in a programme with post-planting chlorpropham (not tested in the trial) or s-metolachlor.

None of the new herbicides are available to growers yet and residue trials will be needed before requests for SOLAs are made.

Herbicides applied pre-planting BUK 9900 1.25 L/ha, s-metolachlor 0.7 L/ha alone or in tank-mix with Stomp 1.5 L/ha; post-planting s-metolachlor 0.7 L/ha and post-weed-emergence, foliar-acting A7881 (ethametsulfuron) at 20 g/ha were all safe to Romaine and Iceberg lettuce in 2008.

Herbicides were evaluated in Little Gem, Lollo Rosso, Green Oakleaf, Multileaf Frisée (Can-Can), Endive (Fine Frisée) in 2009. All were safe to the pre-planting applications of BUK 9900H 1.25 L/ha, s-metolachlor 1.4 L/ha or s-metolachlor + Stomp 400SC (0.7 + 1.5) L/ha and to post-weed-emergence A 7881 (ethametsulfuron).

Lollo Rosso, and to a lesser extent Green Oakleaf were the most sensitive varieties to post-planting treatments. Little Gem and Endive were the least sensitive. Although damage from s-metolachlor 0.7 L/ha was acceptable, damage from s-metolachlor at 1.4 L/ha was more severe - scorch of older leaves and stunting. In this trial all types recovered by harvest stage on 9 July and there were no unmarketable lettuces. S-metolachlor was only tested at 0.7 L/ha in previous trials as judged the safe dose in FV 256, 1.4 L/ha was the 'overlap dose'.

Technology transfer

2008
HDC open day at Kirton 25 June 2008, lettuce trials reported.
Sites visited by Crop Protection Companies.

2009
Directions and Plan sent to growers through crop sector panel.
(Article FV 310 results 2009 trial to be submitted for HDC News for February issue)

Appendix 1: Weeds found on the untreated trial areas

Latin name	Common name
Brassica nigra	Black mustard
Chenopodium album	Fat-hen
Chenopodium ficifolium	Fig-leaved goosefoot
Capsella bursa-pastoris	Shepherd's purse
Field speedwell	Veronica persica
Matricaria discoidea	Pineappleweed
Persicaria lapathifolium	Pale persicaria
Persicaria maculosa	Redshank
Poa annua	Annual meadow-grass
Polygonum aviculare	Knotgrass
Senecio vulgaris	Groundsel
Sinapis arvensis	Charlock
Stellaria media	Common chickweed
Tripleurospermum inodorum	Scentless mayweed
Urtica urens	Small nettle