



Final Report

Herbicide Evaluations

R408

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Report Author: Dr J I Keer

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1. SUMMARY

Prior to 2008, weed control in potatoes was most commonly achieved by using a tank mixture of PDQ (paraquat and diquat) and Linuron at crop emergence. The use of paraquat containing herbicides was revoked in Europe, with a last use-up date of 11th July 2008. In addition, a change to the maximum rate of Linuron in potatoes was implemented for the 2009 growing season. The maximum rate of Linuron was reduced to fifty percent of that previously used in potatoes. The combination of these herbicide regulatory changes has fundamentally altered options for weed control in potatoes.

This project evaluated the efficacy and crop safety of herbicide programmes based on alternatives to paraquat and higher rates of Linuron. The evaluations were based on a series of six replicated small plot trials undertaken during 2008-2009 in the east of England. This period consisted of two, very dry springs, which allowed good comparison of contact herbicides but did not provide good soil conditions for the comparison of efficacy and crop safety of residual herbicides.

The contact herbicides Basta (glufosinate), Retro (diquat) and Shark (carfentrazone) were compared with PDQ in terms of weed control and crop safety. The crop safety of Retro (2-4l/ha) and Basta (2-3l/ha) was similar to PDQ (2.0l/ha) when used early post-emergence of the crop. Shark was more damaging to the crop and should be considered for pre-emergence use only. All the alternative contact herbicides were less effective at controlling grassweeds (AMG) compared with PDQ. Basta provided the highest level of grassweed control, Retro was less effective and Shark provided no grassweed control. Increasing the rate of Retro did improve levels of AMG control but not to the levels obtained with PDQ. Therefore satisfactory post-emergence grassweed control can now, only be achieved by tank-mixing with another product with grassweed activity. Basta, Retro and Shark all provided good BLW control but the weed spectra of these herbicides did not match PDQ. Application of contact herbicides at 40% crop emergence did not affect tuber size distribution nor overall yield, although a very "growy" season may have helped to mitigate crop effects.

The reduced rates of Linuron (1.2l/ha), were shown to contribute very useful levels of grassweed and BLW control but in no situation did this rate provide sufficient residual weed control alone. Combinations of Linuron (1.2l) plus a residual herbicide, such as Gamit (clomazone), Sencorex (metribuzin), Defy (prosulphocarb) and Artist (metribuzin + flufenacet) were assessed for control of grassweeds and BLW. The tank-mix of Linuron plus Sencorex generally provided the most cost-effective weed control over a wide range of weed species. Gamit, Defy and Artist provided useful and equal pre-emergence control of cleavers although complete control was not achieved due to exceptionally dry soil conditions. In 2009, early applications of Stomp (pendimethalin), in programme with other herbicides applied at crop emergence, were evaluated to look for more effective polygonum weed control. Early Stomp did add to weed control but greater benefit can be expected in a wetter spring.

The suitability of Sencorex as a partner for Linuron (1.2l/ha) posed questions about crop safety on lighter soils. To answer such questions, a range of Sencorex rates (0.25kg/ha – 1.5kg/ha) was applied to a loamy sand in 2009. Surprisingly, no crop effects were observed. This lack of crop effect was almost certainly due to a dry spring and the results obtained here should not imply similar levels of crop safety in a spring with normal rainfall.

This work has highlighted the need for more complex mixtures of herbicides necessary to provide adequate contact / residual activity and maintain broad-spectrum weed control. The work gives guidance on the most effective mixtures for various weed species.

NOTE: FOR EXPERIMENTAL PURPOSES, SOME HERBICIDES WERE USED OUTSIDE THEIR LABEL RECOMMENDATIONS. SOME HERBICIDE TREATMENTS USED IN THIS PROJECT ARE NOT NECESSARILY APPROVED TREATMENTS.

2. INTRODUCTION

Recent independent development work on weed control in potatoes has been virtually non-existent. This lack of work is probably quite justified since the tactic of applying a mixture of contact and residual herbicide at crop emergence has served the industry very well over a long period. Although the residual component may vary, the contact herbicide used in the mix is almost exclusively PDQ, which is a formulated herbicide containing both paraquat and diquat. The recent revocation of paraquat will necessitate a major re-think on weed control in potatoes. Unfortunately, the revocation of paraquat could not have been foreseen and no time was available to develop alternative weed control programmes before the date of revocation (11th July 2008). As a result, weed control in potatoes was a “leap into the dark” for the 2008 season. This project aims to evaluate other contact herbicides which have a recommendation on potatoes but which have never been widely (or ever) used e.g. Retro (diquat), Basta (glufosinate-ammonium) and Shark (carfentrazone-ethyl). The work will evaluate the use of these herbicides pre-emergence, and at various post-emergence growth stages of the crop. Evaluation will focus on crop safety, as assessed by foliage symptoms and tuber yield / grade, and efficacy of weed control. The control of grassweeds will be targeted in trials since replacement herbicides are likely to have reduced efficacy compared with paraquat.

Another regulatory change to affect weed control was imposed for the 2009 growing season and involved Linuron which is the most commonly used residual herbicide in potatoes. The maximum rate of Linuron allowable in potatoes was reduced to 1.2l/ha from 3.7l/ha on mineral soils. This reduction in the rate of Linuron use posed many questions:

1. Would Linuron (1.2l) be a cost-effective treatment?
2. Does this low rate reduce the weed spectrum associated with the higher rates previously used?
3. How much residual activity is lost by the rate reduction?
4. Do complementary residual herbicides need to be added to Linuron (1.2l)?
5. Which other residual herbicide partners provide safe, complete and long-lasting weed control

The paraquat revocation and Linuron rate reduction also provides an ideal opportunity to compare different weed control strategies in terms of both weed control and crop safety. Despite growers' every effort at optimising early and even crop growth, there appears to be no concern about the subsequent crop damage caused by post-emergence application of contact herbicides. This project will assess potential crop benefits from applying herbicides earlier, well before crop emergence.

This project will provide independent information for growers on how to control weeds in potatoes without using paraquat. In addition, the crop safety of various weed control strategies will be compared.

3. MATERIALS AND METHODS

A series of three replicated small plot field trials was undertaken in 2008. A further series of three replicated small plot field trials was completed during 2009. Trial details, including experimental details, treatment list, and weed levels in untreated control plots are shown in Appendix 1 and 2.

Linuron rates in the 2008 trials were set at 1.3l/ha because the agrochemical industry widely believed that this rate of use would be the maximum allowable for the 2009 season. In fact, Linuron (1.2l) was the maximum dose approved. Therefore all 2009 trials were based on a maximum rate of Linuron (1.2l).

Retro was always tank mixed with the appropriate rate of Activator 90 where prescribed by the manufacturer.

All data was analysed using ANOVA and significance tests conducted at the 5% probability level.

4. RESULTS

4.1. Trial A 2008 – Thetford, Norfolk

This trial was sited on a sandy loam soil type and designed to assess the efficacy of a reduced rate of Linuron for annual meadow grass (AMG) control. Reduced rates of Linuron, tank mixed with various residual herbicides, were compared at an early pre-emergence (of crop and weed) timing. Later applications, just prior to crop emergence, of a reduced rate of Linuron, tank mixed with various contact herbicides, were also compared for efficacy against AMG.

Results (Table 1) show that Linuron (1.3l) alone did not provide adequate control of AMG when applied early. However, when Linuron (1.3l) was mixed with another residual herbicide, satisfactory AMG control from an early application was achieved. Later application, pre-emergence of the crop but post emergence of AMG, of Linuron plus a contact herbicide did not provide adequate AMG control.

No treatment significantly ($P=0.05$) decreased crop groundcover relative to the untreated control. All Sencorex containing treatments were shown to be crop safe.

Broad leaf weed (BLW) populations were too low to accurately compare herbicide treatments. BLW species consisted of Fat Hen, Groundsel, Field Speedwell, Field Pansy and Knotgrass but not in sufficient numbers to enable an assessment for each individual species.

This trial indicates that an early, residual based herbicide programme can succeed when sufficient soil moisture is available and where a fine soil tilth exists.

Crop Variety	Maris piper	Maris piper	Maris piper
Rating Date	22/May/2008	5/Jun/2008	18/Jun/2008
Rating Unit	% Bio-reduction	% Bio-reduction	% Bio-reduction
Treatment	2	4	7
1 Untreated control	0 d	0 e	0 c
2 Alpha Linuron (1.3l) - T1	94 bc	82 bc	86 b
3 Alpha Linuron + Sencorex (1.3l + 0.5kg) - T1	99 a	99 a	98 a
4 Alpha Linuron + Sencorex (2.0l + 0.5kg) - T1	100 a	99 a	97 a
5 Alpha Linuron + Sencorex + Gamit (2.0l + 0.5kg + 0.15l) - T1	99 a	100 a	99 a
6 Artist (2.5kg) - T1	99 a	99 a	99 a
7 Alpha Linuron + Artist (1.3l + 1.5kg) - T1	100 a	100 a	100 a
8 Alpha Linuron + Artist (1.3l + 2.0kg) - T1	100 a	99 a	100 a
9 Alpha Linuron + Defy (1.3l + 4.0l) - T1	99 a	91 ab	97 a
10 Sencorex + Defy (0.5kg + 4.0l) - T1	98 a	99 a	99 a
11 Sencorex + Centium (0.5kg + 0.15l) - T1	98 ab	99 a	99 a
12 Alpha Linuron + PDQ (2.0l + 2.0l) - T2	100 a	95 a	86 b
13 Alpha Linuron + PDQ (1.3l + 2.0l) - T2	100 a	89 abc	85 b
14 Alpha Linuron + Retro + Activator 90 (1.3l + 2.0l + 0.2l) - T2	97 ab	78 cd	79 b
15 Alpha Linuron + Basta (1.3l + 2.0l) - T2	99 a	89 abc	82 b
16 Alpha Linuron + Shark (1.3l + 0.33l) - T2	92 c	67 d	78 b
LSD (P=.05)	4.2	12.1	9.2
Standard Deviation	2.5	7.2	5.5
CV	2.73	8.37	6.34
Replicate F	1.632	0.883	0.067
Replicate Prob(F)	0.2125	0.4242	0.9353
Treatment F	287.634	35.693	59.746
Treatment Prob(F)	0.0001	0.0001	0.0001

TABLE 1. TRIAL A 2008. THE EFFECT OF HERBICIDE ON ANNUAL MEADOW GRASS CONTROL - % WEED BIOMASS REDUCTION.

Means followed by the same letter do not significantly differ (P=0.05, LSD)

Crop Variety	Maris piper	Maris piper	Maris piper
Part Rated	Leaf	Leaf	Leaf
Rating Date	22/May/2008	5/Jun/2008	18/Jun/2008
Rating Data Type	Vigour	Vigour	Vigour
Rating Unit	% Ground cover	% Ground cover	% Ground cover
Treatment	1	3	6
1 Untreated control	5 a	30 a	90 a
2 Alpha Linuron (1.3l) - T1	5 a	30 a	90 a
3 Alpha Linuron + Sencorex (1.3l + 0.5kg) - T1	5 a	30 a	90 a
4 Alpha Linuron + Sencorex (2.0l + 0.5kg) - T1	5 a	30 a	90 a
5 Alpha Linuron + Sencorex + Gamit (2.0l + 0.5kg + 0.15l) - T1	5 a	30 a	90 a
6 Artist (2.5kg) - T1	5 a	30 a	90 a
7 Alpha Linuron + Artist (1.3l + 1.5kg) - T1	5 a	30 a	90 a
8 Alpha Linuron + Artist (1.3l + 2.0kg) - T1	5 a	30 a	90 a
9 Alpha Linuron + Defy (1.3l + 4.0l) - T1	5 a	30 a	90 a
10 Sencorex + Defy (0.5kg + 4.0l) - T1	5 a	30 a	90 a
11 Sencorex + Centium (0.5kg + 0.15l) - T1	5 a	30 a	90 a
12 Alpha Linuron + PDQ (2.0l + 2.0l) - T2	5 a	30 a	90 a
13 Alpha Linuron + PDQ (1.3l + 2.0l) - T2	5 a	30 a	90 a
14 Alpha Linuron + Retro + Activator 90 (1.3l + 2.0l + 0.2l) - T2	5 a	30 a	90 a
15 Alpha Linuron + Basta (1.3l + 2.0l) - T2	5 a	30 a	90 a
16 Alpha Linuron + Shark (1.3l + 0.33l) - T2	5 a	30 a	90 a
LSD (P=.05)	0.0	0.0	0.0
Standard Deviation	0.0	0.0	0.0
CV	0.0	0.0	0.0
Replicate F	0.000	0.000	0.000
Replicate Prob(F)	1.0000	1.0000	1.0000
Treatment F	0.000	0.000	0.000
Treatment Prob(F)	1.0000	1.0000	1.0000

TABLE 2. TRIAL A 2008. THE EFFECT OF HERBICIDE ON CROP VIGOUR - % CROP GROUNDCOVER.

Means followed by same letter do not significantly differ (P=.05, LSD)

Crop Variety	Maris piper	Maris piper
Rating Date	5/Jun/2008	18/Jun/2008
Rating Unit	% Bioreduction	% Bioreduction
Treatment	5	8
1 Untreated control	0 c	0 c
2 Alpha Linuron (1.3l) - T1	87 b	96 a
3 Alpha Linuron + Sencorex (1.3l + 0.5kg) - T1	99 a	100 a
4 Alpha Linuron + Sencorex (2.0l + 0.5kg) - T1	99 a	99 a
5 Alpha Linuron + Sencorex + Gamit (2.0l + 0.5kg + 0.15l) - T1	100 a	100 a
6 Artist (2.5kg) - T1	100 a	100 a
7 Alpha Linuron + Artist (1.3l + 1.5kg) - T1	100 a	99 a
8 Alpha Linuron + Artist (1.3l + 2.0kg) - T1	100 a	100 a
9 Alpha Linuron + Defy (1.3l + 4.0l) - T1	99 a	99 a
10 Sencorex + Defy (0.5kg + 4.0l) - T1	95 ab	67 b
11 Sencorex + Centium (0.5kg + 0.15l) - T1	100 a	100 a
12 Alpha Linuron + PDQ (2.0l + 2.0l) - T2	98 a	98 a
13 Alpha Linuron + PDQ (1.3l + 2.0l) - T2	97 a	98 a
14 Alpha Linuron + Retro + Activator 90 (1.3l + 2.0l + 0.2l) - T2	99 a	98 a
15 Alpha Linuron + Basta (1.3l + 2.0l) - T2	100 a	98 a
16 Alpha Linuron + Shark (1.3l + 0.33l) - T2	96 a	95 a
LSD (P=.05)	8.0	15.0
Standard Deviation	4.8	9.0
CV	5.22	9.93
Replicate F	1.452	1.254
Replicate Prob(F)	0.2501	0.3000
Treatment F	79.634	24.080
Treatment Prob(F)	0.0001	0.0001

TABLE 3. TRIAL A 2008. THE EFFECT OF HERBICIDE ON BROAD LEAF WEED CONTROL - % WEED BIOMASS REDUCTION.

Means followed by same letter do not significantly differ (P=.05, LSD)

4.2. Trial B 2008 – Lutton, South Lincolnshire.

This trial contained the same treatment list as Trial A 2008. However, the soil type was a “bodied” silt loam and the T2 timing was 40% crop emerged. The trial was designed to compare a residual herbicide approach with a later tank mix of Linuron plus contact herbicide for the control of “difficult” BLW such as Black bindweed on a soil type where a fine tilth is not possible.

The T1 (pre-emergence of crop and weed) application of Linuron (1.3l) failed to provide satisfactory control of Groundsel, Black bindweed and Ivy leaved speedwell. When this low rate of Linuron was tank-mixed with Sencorex, Artist or Defy the level of weed control was improved. However satisfactory control of these weed species was not achieved with any combination of herbicides applied at T1.

The success of the late (40% crop emergence) herbicide treatments shows clearly, the advantages of a contact based approach to weed control over an earlier, residual based programme on a coarse tilth in a dry spring. Although little residual herbicide (Linuron at 1.3l) was used with the contact partner, good control of BLW was obtained. It is doubtful if similar good results would be achieved if crop competition had not developed as quickly or if the application was timed just pre-emergence to negate crop damage. Weed control is largely obtained from the contact herbicide component in a dry spring on soils of coarse tilth.

All alternative contact herbicides showed complete control of Field speedwell, Groundsel and Black bindweed, which was equivalent to PDQ, when mixed with Linuron (1.3l).

The crop safety of treatments was compared by assessment of % crop groundcover as a measure of crop vigour. All early (T1) treatments were significantly ($P=0.05$) crop safe when compared with the untreated control.

At 20 DAT the late (T2) applied treatments all significantly ($P=0.05$) reduced crop vigour compared to the untreated control, except for Linuron (1.3l) + Retro which was significantly ($P=0.05$) similar to the untreated control. Linuron (1.3l) + Basta was significantly ($P=0.05$) less damaging to the crop than Linuron (1.3l) + PDQ whilst Linuron (1.3l) + Shark was significantly ($P=0.05$) the most damaging treatment at T2.

A later assessment (35DAT) of crop vigour showed complete recovery of the crop compared to the untreated control for all treatments except Linuron (2.0l) + PDQ and Linuron (1.3l) + Shark. Linuron (1.2l) + Shark was especially damaging at this late application timing.

Pest Name	Common groundsel	Black bindweed	Ivy-leaved speedwell
Crop Variety	Maris piper	Maris piper	Maris piper
Rating Date	9/Jun/2008	9/Jun/2008	9/Jun/2008
Rating Data Type	Weed Biomass reduction	Weed Biomass reduction	Weed Biomass reduction
Treatment	2	3	4
1 Untreated control	0.0 c	0.0 d	0.0 c
2 Alpha Linuron (1.3l) - T1	45.0 b	40.0 c	53.3 b
3 Alpha Linuron + Sencorex (1.3l + 0.5kg) - T1	87.7 a	88.0 ab	100.0 a
4 Alpha Linuron + Sencorex (2.0l + 0.5kg) - T1	89.3 a	89.0 ab	98.3 a
5 Alpha Linuron + Sencorex + Gamit (2.0l + 0.5kg + 0.15l) - T1	91.3 a	87.7 ab	98.7 a
6 Artist (2.5kg) - T1	92.0 a	88.7 ab	100.0 a
7 Alpha Linuron + Artist (1.3l + 1.5kg) - T1	98.3 a	96.7 a	99.0 a
8 Alpha Linuron + Artist (1.3l + 2.0kg) - T1	99.7 a	95.0 ab	100.0 a
9 Alpha Linuron + Defy (1.3l + 4.0l) - T1	85.7 a	88.3 ab	99.3 a
10 Sencorex + Defy (0.5kg + 4.0l) - T1	43.3 b	48.3 c	100.0 a
11 Sencorex + Centium (0.5kg + 0.15l) - T1	81.7 a	79.3 b	88.3 a
12 Alpha Linuron + PDQ (2.0l + 2.0l) - T2	100.0 a	100.0 a	100.0 a
13 Alpha Linuron + PDQ (1.3l + 2.0l) - T2	100.0 a	100.0 a	100.0 a
14 Alpha Linuron + Retro + Activator 90 (1.3l + 2.0l + 0.2l) - T2	100.0 a	100.0 a	100.0 a
15 Alpha Linuron + Basta (1.3l + 2.0l) - T2	100.0 a	100.0 a	100.0 a
16 Alpha Linuron + Shark (1.3l + 0.33l) - T2	100.0 a	100.0 a	100.0 a
LSD (P=.05)	21.06	16.95	17.54
Standard Deviation	12.63	10.17	10.52
CV	15.38	12.51	11.71
Replicate F	1.066	1.045	1.799
Replicate Prob(F)	0.3570	0.3641	0.1828
Treatment F	15.138	22.877	19.258
Treatment Prob(F)	0.0001	0.0001	0.0001

TABLE 4. TRIAL B 2008. ASSESSMENT OF WEED CONTROL AS % WEED BIOMASS REDUCTION VERSUS UNTREATED CONTROL - 09.06.2008 (20DAT2).

Means followed by same letter do not significantly differ (P=0.05, LSD)

Pest Name	Common groundsel	Black bindweed	Ivy-leaved speedwell
Crop Variety	Maris piper	Maris piper	Maris piper
Part Rated	Leaf	Leaf	Leaf
Rating Date	24/Jun/2008	24/Jun/2008	24/Jun/2008
Rating Data Type	% Weed biomass reduction	% Weed biomass reduction	% Weed biomass reduction
Treatment	6	7	8
1 Untreated control	0.0 e	0.0 e	0.0 c
2 Alpha Linuron (1.3l) - T1	15.0 de	18.3 e	66.7 b
3 Alpha Linuron + Sencorex (1.3l + 0.5kg) - T1	61.7 bc	66.7 bcd	81.7 ab
4 Alpha Linuron + Sencorex (2.0l + 0.5kg) - T1	90.0 ab	66.7 bcd	95.0 ab
5 Alpha Linuron + Sencorex + Gamit (2.0l + 0.5kg + 0.15l) - T1	61.3 bc	63.3 cd	100.0 a
6 Artist (2.5kg) - T1	98.3 a	94.0 ab	100.0 a
7 Alpha Linuron + Artist (1.3l + 1.5kg) - T1	80.0 ab	88.3 abc	100.0 a
8 Alpha Linuron + Artist (1.3l + 2.0kg) - T1	98.7 a	80.7 a-d	100.0 a
9 Alpha Linuron + Defy (1.3l + 4.0l) - T1	73.0 ab	73.3 a-d	76.7 ab
10 Sencorex + Defy (0.5kg + 4.0l) - T1	25.0 de	18.3 e	91.7 ab
11 Sencorex + Centium (0.5kg + 0.15l) - T1	41.7 cd	53.3 d	78.3 ab
12 Alpha Linuron + PDQ (2.0l + 2.0l) - T2	99.7 a	99.7 a	99.3 a
13 Alpha Linuron + PDQ (1.3l + 2.0l) - T2	99.7 a	100.0 a	99.7 a
14 Alpha Linuron + Retro + Activator 90 (1.3l + 2.0l + 0.2l) - T2	99.0 a	99.7 a	99.7 a
15 Alpha Linuron + Basta (1.3l + 2.0l) - T2	95.7 a	100.0 a	96.7 ab
16 Alpha Linuron + Shark (1.3l + 0.33l) - T2	99.0 a	99.3 a	99.3 a
LSD (P=.05)	28.98	27.65	30.11
Standard Deviation	17.38	16.58	18.06
CV	24.45	23.65	20.87
Replicate F	0.485	1.467	2.025
Replicate Prob(F)	0.6207	0.2467	0.1496
Treatment F	11.327	11.667	5.931
Treatment Prob(F)	0.0001	0.0001	0.0001

TABLE 5. TRIAL B ASSESSMENT OF WEED CONTROL AS % WEED BIOMASS REDUCTION VERSUS UNTREATED CONTROL - 24.06.2008 (35DAT2).

Means followed by same letter do not significantly differ (P=.05, LSD)

Crop Variety	Maris piper		Maris piper	
Part Rated	Leaf		Leaf	
Rating Date	9/Jun/2008		24/Jun/2008	
Rating Data Type	Vigour		Vigour	
Rating Unit	%	Ground cover	%	Ground cover
Treatment	1		5	
1 Untreated control	50	a	98.0	a
2 Alpha Linuron (1.3l) - T1	50	a	98.0	a
3 Alpha Linuron + Sencorex (1.3l + 0.5kg) - T1	50	a	98.0	a
4 Alpha Linuron + Sencorex (2.0l + 0.5kg) - T1	50	a	98.0	a
5 Alpha Linuron + Sencorex + Gamit (2.0l + 0.5kg + 0.15l) - T1	50	a	97.0	a
6 Artist (2.5kg) - T1	50	a	98.0	a
7 Alpha Linuron + Artist (1.3l + 1.5kg) - T1	48	ab	97.3	a
8 Alpha Linuron + Artist (1.3l + 2.0kg) - T1	50	a	98.0	a
9 Alpha Linuron + Defy (1.3l + 4.0l) - T1	50	a	97.3	a
10 Sencorex + Defy (0.5kg + 4.0l) - T1	48	ab	98.0	a
11 Sencorex + Centium (0.5kg + 0.15l) - T1	48	ab	98.0	a
12 Alpha Linuron + PDQ (2.0l + 2.0l) - T2	45	c	92.3	b
13 Alpha Linuron + PDQ (1.3l + 2.0l) - T2	45	c	96.0	a
14 Alpha Linuron + Retro + Activator 90 (1.3l + 2.0l + 0.2l) - T2	48	ab	97.0	a
15 Alpha Linuron + Basta (1.3l + 2.0l) - T2	47	bc	96.7	a
16 Alpha Linuron + Shark (1.3l + 0.33l) - T2	30	d	88.3	c
LSD (P=.05)	3.2		3.38	
Standard Deviation	1.9		2.02	
CV	4.06		2.1	
Replicate F	2.944		0.290	
Replicate Prob(F)	0.0680		0.7505	
Treatment F	20.037		5.074	
Treatment Prob(F)	0.0001		0.0001	

TABLE 6. TRIAL B 2008– CROP VIGOUR/PHYTOTOXICITY ASSESSED AS PERCENTAGE GROUND COVER 09.06.2008 (20DAT2) AND 24.06.2008 (35DAT2).

Means followed by same letter do not significantly differ (P= 0.05, LSD)

4.3. Trial C 2008 – Holbeach Hurn, South Lincolnshire.

This trial, sited on Holbeach Marsh, was designed to compare the efficacy of contact herbicides on a range of weeds in potatoes. Another aim was to determine the effect of contact herbicide application timing on crop yield and tuber size distribution.

Pre-emergence applied (T1) Linuron + Sencorex mixtures gave good control of Small nettle, Mayweeds and Common Groundsel but less good control of Redshank.

At 40% crop emergence, when weed size was 2-4tl, all the contact herbicides gave good control of Redshank, Small nettle and Common groundsel. Mayweeds were significantly ($P=0.05$) less well controlled by Shark, compared with the other contact herbicides applied at T2.

At 100% crop emergence when weed size had reached 6tl, only Shark was providing complete control of Small nettle whilst Basta provided the lowest levels of control.

PDQ provided the best levels of overall control across this weed spectrum with weaknesses of Basta on Small nettle and Mayweeds on Shark apparent, especially when larger weeds were targeted.

Initial (7DAT2) crop damage from the T2 treatments was assessed as % chlorosis and necrosis. PDQ and Retro resulted in similar damage levels but Basta showed lower levels of damage and Shark caused almost complete necrosis of emerged shoots. Slight loss of vigour from the T2 treatments was still evident 40DAT2 compared to the untreated control. The addition of Linuron (1.3l) to each contact herbicide did not increase damage levels over the contact applied alone.

The damage caused by contact herbicide application at 100% crop emergence was considerable, as would be expected. The same differences between products emerged at this excessively late timing and recovery of the crop was slow, even 33DAT3.

Total yield and tuber size distribution was only significantly ($P=0.05$) affected by T3 application of Shark when compared to the untreated control. This lack of other yield affects may be partly due to inherent variation in yield data and crop compensatory growth in a very "growy" season.

Pest Name	Redshank	Small nettle	Mayweed spp.	Common groundsel
Crop Variety	Marfona	Marfona	Marfona	Marfona
Description	2nd Early	2nd Early	2nd Early	2nd Early
Rating Date	9/Jun/2008	9/Jun/2008	9/Jun/2008	9/Jun/2008
Rating Data Type	% Weed biomass reduction	% Weed biomass reduction	% Weed biomass reduction	% Weed biomass reduction
Treatment	4	5	6	7
1 Untreated control	0.0 c	0.0 c	0.0 c	0.0 c
2 Alpha Linuron + Sencorex (1.3l + 0.5kg) - T1	96.0 b	100.0 a	100.0 a	100.0 a
3 Alpha Linuron + Sencorex (2.0l + 0.5kg) - T1	98.8 ab	99.4 a	96.3 a	100.0 a
4 Basta (2.0l) - T2	100.0 a	96.0 a	100.0 a	100.0 a
5 PDQ (2.0l) - T2	100.0 a	97.8 a	100.0 a	100.0 a
6 Retro + Activator 90 (2.0l + 0.2l) - T2	100.0 a	98.8 a	99.8 a	100.0 a
7 Shark (0.33l) - T2	99.0 ab	100.0 a	89.3 b	100.0 a
8 Basta (2.0l) - T3	96.3 b	66.3 b	98.0 a	100.0 a
9 Basta (3.0l) - T3	100.0 a	63.8 b	100.0 a	100.0 a
10 PDQ (2.0l) - T3	99.8 a	92.1 a	99.9 a	100.0 a
11 Retro + Activator 90 (2.0l + 0.2l) - T3	100.0 a	94.5 a	100.0 a	100.0 a
12 Shark (0.33l) - T3	100.0 a	100.0 a	89.0 b	99.0 b
13 Alpha Linuron + PDQ (1.3l + 2.0l) - T2	100.0 a	100.0 a	100.0 a	100.0 a
14 Alpha Linuron + Retro + Activator 90 (1.3l + 2.0l + 0.2l) - T2	100.0 a	99.8 a	100.0 a	100.0 a
15 Alpha Linuron + Basta (1.3l + 2.0l) - T2	100.0 a	100.0 a	100.0 a	100.0 a
16 Alpha Linuron + Shark (1.3l + 0.33l) - T2	100.0 a	100.0 a	97.3 a	100.0 a
LSD (P=0.05)	3.39	11.95	4.33	0.72
Standard Deviation	2.37	8.36	3.03	0.51
CV	2.54	9.5	3.3	0.54
Replicate F	0.737	0.799	0.707	0.993
Replicate Prob(F)	0.5358	0.5011	0.5530	0.4048
Treatment F	440.390	39.154	267.557	9772.163
Treatment Prob(F)	0.0001	0.0001	0.0001	0.0001

TABLE 7. TRIAL C 2008 ASSESSMENT OF WEED CONTROL AS % WEED BIOMASS REDUCTION VERSUS UNTREATED CONTROL - 09.06.2008 (25DAT2 AND 18DAT3).

Means followed by same letter do not significantly differ (P= 0.05, LSD)

Crop Variety	Marfona	Marfona	Marfona
Description	2nd Early	2nd Early	2nd Early
Part Rated	LEAF	LEAF	LEAF
Rating Date	22/May/2008	9/Jun/2008	24/Jun/2008
Rating Data Type	Phytotoxicity	Vigour	Vigour
Rating Unit	% Necrosis / chlorosis	% Ground cover	% Ground cover
Treatment	1	2	3
1 Untreated control	0.0 d	85.0 a	99.0 a
2 Alpha Linuron + Sencorex (1.3l + 0.5kg) - T1	0.0 d	83.8 a	98.8 a
3 Alpha Linuron + Sencorex (2.0l + 0.5kg) - T1	0.0 d	85.0 a	98.5 a
4 Basta (2.0l) - T2	18.8 c	67.5 bcd	92.5 b-e
5 PDQ (2.0l) - T2	50.0 b	68.8 bcd	96.5 ab
6 Retro + Activator 90 (2.0l + 0.2l) - T2	55.0 b	61.3 cd	94.3 bcd
7 Shark (0.33l) - T2	91.3 a	41.3 f	88.8 ef
8 Basta (2.0l) - T3	0.0 d	56.3 de	95.3 a-d
9 Basta (3.0l) - T3	0.0 d	45.0 ef	87.8 f
10 PDQ (2.0l) - T3	0.0 d	58.8 de	93.8 bcd
11 Retro + Activator 90 (2.0l + 0.2l) - T3	0.0 d	55.0 def	92.3 cde
12 Shark (0.33l) - T3	0.0 d	15.0 g	70.0 g
13 Alpha Linuron + PDQ (1.3l + 2.0l) - T2	52.5 b	77.5 ab	96.3 abc
14 Alpha Linuron + Retro + Activator 90 (1.3l + 2.0l + 0.2l) - T2	62.5 b	75.0 abc	95.8 abc
15 Alpha Linuron + Basta (1.3l + 2.0l) - T2	12.5 cd	61.3 cd	91.3 def
16 Alpha Linuron + Shark (1.3l + 0.33l) - T2	91.3 a	41.3 f	88.5 ef
LSD (P=.05)	14.69	13.76	4.12
Standard Deviation	10.28	9.63	2.88
CV	37.91	15.76	3.12
Replicate F	3.880	1.893	1.579
Replicate Prob(F)	0.0150	0.1444	0.2077
Treatment F	44.419	15.687	23.433
Treatment Prob(F)	0.0001	0.0001	0.0001

TABLE 8. TRIAL C 2008– CROP EFFECTS ASSESSED AS VIGOUR / PHYTOTOXICITY OR PERCENTAGE GROUND COVER 22.05.2008 (6DAT2), 09.06.2008 (24DAT2 / 18DAT3) AND 24.06.2008 (39DAT2 / 33DAT3).

Means followed by same letter do not significantly differ (P= 0.05, LSD)

Crop Variety	Marfona	Marfona	Marfona	Marfona
Description	2nd Early	2nd Early	2nd Early	2nd Early
Part Rated	Yield	Yield	Yield	Yield
Rating Date	26/Aug/2008	26/Aug/2008	26/Aug/2008	26/Aug/2008
Rating Data Type	<45mm	45-60mm	60-80mm	Total Yield
Rating Unit	t/ha	t/ha	t/ha	t/ha
Treatment	12	13	14	15
1 Untreated control	2.2 abc	18.3 ab	40.4 a	60.8 ab
2 Alpha Linuron + Sencorex (1.3l + 0.5kg) - T1	2.2 abc	19.5 ab	44.2 a	65.8 a
3 Alpha Linuron + Sencorex (2.0l + 0.5kg) - T1	2.7 ab	21.4 a	40.7 a	64.8 ab
8 Basta (2.0l) - T3	2.2 abc	16.3 ab	40.3 a	58.8 ab
10 PDQ (2.0l) - T3	3.0 a	18.4 ab	38.7 a	60.1 ab
11 Retro + Activator 90 (2.0l + 0.2l) - T3	2.8 ab	16.4 ab	41.0 a	60.2 ab
12 Shark (0.33l) - T3	0.4 d	6.8 c	46.4 a	53.5 b
14 Alpha Linuron + Retro + Activator 90 (1.3l + 2.0l + 0.2l) - T2	1.3 cd	15.7 ab	46.5 a	63.5 ab
15 Alpha Linuron + Basta (1.3l + 2.0l) - T2	1.1 cd	11.9 bc	43.8 a	56.8 ab
16 Alpha Linuron + Shark (1.3l + 0.33l) - T2	1.6 bcd	15.5 ab	45.6 a	62.8 ab
LSD (P=.05)	1.31	8.69	15.10	12.15
Standard Deviation	0.75	4.96	8.62	6.94
CV	38.2	31.01	20.17	11.43
Replicate F	1.957	0.162	0.447	1.548
Replicate Prob(F)	0.1781	0.8521	0.6484	0.2470
Treatment F	3.890	2.077	0.333	0.875
Treatment Prob(F)	0.0116	0.1064	0.9491	0.5677

TABLE 9. TRIAL C 2008. EFFECT OF HERBICIDE TREATMENT ON POTATO YIELD AND GRADE AS ASSESSED 26.08.2008.

Means followed by same letter do not significantly differ (P= 0.05, LSD)

4.4. Trial A 2009 – Holbeach, South Lincolnshire.

This trial was established to further examine a residual approach to weed control on heavier soils with a coarse tilth. Complex tank mixes of residual herbicides and programmes of residual herbicides were evaluated for control of polygonums and cleavers. An exceptionally dry spring in 2009 did not favour residual herbicide activity and resulted in low weed seed germination. In South Lincolnshire no rain fell between planting and 100% crop emergence. Therefore comparison of residual herbicides in 2009 was very difficult.

Herbicide programmes which included Stomp applied soon after planting (T0), followed by more residual herbicide applied just prior to weed and crop emergence (T1), were evaluated.

Stomp (2.0l) applied alone at T0 provided very low levels of Cleavers, Redshank and Black bindweed control. Control levels were significantly ($P=0.05$) improved by increasing the rate of Stomp. Weed control levels were never expected to be commercially acceptable from a single Stomp treatment but it was useful to evaluate each component of the programme. The use of T0 Stomp followed by Linuron (1.2l) + Sencorex (0.5kg) at T1 did not significantly ($P=0.05$) increase levels of weed control over Linuron (1.2l) + Sencorex (0.5kg) applied at T1. A better performance of T0 Stomp would be expected under moist soil conditions.

Complex three-way herbicide mixtures applied at T1 provided good weed control levels although low weed numbers resulted in high levels of natural variation.

The specific Cleaver active herbicides (Artist, Defy and Gamit) all provided significantly ($P=0.05$) similar levels of Cleaver control. However, these control levels were not commercially acceptable and over-spraying would have been necessary. The trial showed that in a very dry season on coarse-tilth soils, even high rates of residual herbicides will not provide adequate weed control.

A later application (10% crop emerged) of residual plus contact herbicide {Linuron (1.2l) + Sencorex (0.5kg) + Retro (2.0l) + Activator 90 (0.2l)} also failed to provide adequate Cleaver control due to weeds emerging from depth after the T2 timing.

All treatments in this trial showed no significant ($P=0.05$) crop effects when compared to the untreated control.

Pest Name	Cleavers	Cleavers	Redshank	Redshank
Crop Variety	Cara	Cara	Cara	Cara
Rating Date	28/May/2009	3/Jun/2009	28/May/2009	3/Jun/2009
Rating Data Type	Weed biomass reduction	Weed biomass reduction	Weed biomass reduction	Weed biomass reduction
Rating Unit	%	%	%	%
Crop Stage	80% GC	95% GC	80% GC	95% GC
Treatment	1	5	2	6
1 Untreated Control	0 h	0 f	0 e	0 e
2 T0 Stomp 400SC (2.0l)	11 gh	15 ef	5 de	7 de
3 T0 Stomp 400SC (3.3l)	35 efg	44 cd	33 cd	40 bc
4 T0 Stomp 400SC (2.0l) T1 Linuron (1.2l) + Sencorex (0.5kg)	49 def	35 de	98 a	70 ab
5 T0 Stomp 400SC (3.3l) T1 Linuron (1.2l) + Sencorex (0.5kg)	37 efg	23 def	98 a	98 a
6 T0 Stomp 400SC (2.0l) T1 Sencorex (0.75kg)	18 fgh	28 def	42 bc	35 cd
7 T0 Stomp 400SC (2.0l) T1 Linuron (1.2l) + Sencorex (0.75kg)	60 b-e	65 bc	97 a	95 a
8 T1 Linuron (1.2l) + Sencorex (0.5kg)	54 cde	45 cd	98 a	97 a
9 T1 Linuron (1.2l) + Sencorex (0.5kg) + Defy (4.0l)	97 a	98 a	10 0 a	10 0 a
10 T1 Linuron (1.2l) + Sencorex (0.5kg) + Gamit (0.15l)	83 abc	90 ab	10 0 a	10 0 a
11 T1 Linuron (1.2l) + Artist (2.0kg)	89 ab	86 ab	10 0 a	10 0 a
12 T1 Artist (2.5kg)	97 a	93 ab	98 a	10 0 a
13 T1 Artist (2.0kg) + Sencorex (0.25kg)	92 a	97 a	97 a	97 a
14 T1 Defy (4.0l) + Linuron (1.2l)	86 ab	93 ab	73 ab	10 0 a
15 T1 Defy (4.0l) + Sencorex (0.5kg)	97 a	93 ab	10 0 a	97 a
16 T2 Linuron (1.2l) + Sencorex (0.5kg) + Retro (2.0l) + Activator 90 (0.2l)	68 a-d	48 cd	10 0 a	10 0 a
LSD (P=.05)	31.3	29.3	32.2	32.8
Standard Deviation	18.8	17.6	19.3	19.7
CV	30.79	29.48	24.95	25.46
Replicate F	1.953	2.245	2.138	1.614
Replicate Prob(F)	0.1595	0.1234	0.1355	0.2159
Treatment F	9.283	10.909	10.415	9.927
Treatment Prob(F)	0.0001	0.0001	0.0001	0.0001

TABLE 10. TRIAL A 2009. ASSESSMENT OF CLEAVERS AND REDSHANK CONTROL 28.05.2009 AND 03.06.2009.

Means followed by same letter do not significantly differ (P= 0.05, LSD)

Pest Name	Black bindweed	Black bindweed
Crop Variety	Cara	Cara
Rating Date	28/May/2009	3/Jun/2009
Rating Data Type	Weed Biomas	Weed Biomas
Rating Unit	%	%
Crop Stage	80% GC	95% GC
Treatment		
	3	7
1 Untreated Control	0 d	0 e
2 T0 Stomp 400SC (2.0l)	12 cd	7 de
3 T0 Stomp 400SC (3.3l)	40 bc	42 bc
4 T0 Stomp 400SC (2.0l) T1 Linuron (1.2l) + Sencorex (0.5kg)	88 a	70 ab
5 T0 Stomp 400SC (3.3l) T1 Linuron (1.2l) + Sencorex (0.5kg)	95 a	97 a
6 T0 Stomp 400SC (2.0l) T1 Sencorex (0.75kg)	42 bc	35 cd
7 T0 Stomp 400SC (2.0l) T1 Linuron (1.2l) + Sencorex (0.75kg)	93 a	95 a
8 T1 Linuron (1.2l) + Sencorex (0.5kg)	98 a	98 a
9 T1 Linuron (1.2l) + Sencorex (0.5kg) + Defy (4.0l)	100 a	100 a
10 T1 Linuron (1.2l) + Sencorex (0.5kg) + Gamit (0.15l)	98 a	100 a
11 T1 Linuron (1.2l) + Artist (2.0kg)	98 a	100 a
12 T1 Artist (2.5kg)	94 a	96 a
13 T1 Artist (2.0kg) + Sencorex (0.25kg)	96 a	97 a
14 T1 Defy (4.0l) + Linuron (1.2l)	70 ab	75 a
15 T1 Defy (4.0l) + Sencorex (0.5kg)	95 a	95 a
16 T2 Linuron (1.2l) + Sencorex (0.5kg) + Retro (2.0l) + Activator 90 (0.2l)	99 a	100 a
LSD (P=.05)	32.7	33.7
Standard Deviation	19.6	20.2
CV	25.79	26.25
Replicate F	2.956	1.476
Replicate Prob(F)	0.0673	0.2446
Treatment F	8.749	9.229
Treatment Prob(F)	0.0001	0.0001

TABLE 11. TRIAL A 2009. ASSESSMENT OF BLACK BINDWEED CONTROL 28.05.2009 AND 03.06.2009.

Means followed by same letter do not significantly differ (P=.05, LSD)

Crop Variety	Cara	Cara	Cara
Rating Date	13/May/2009	28/May/2009	3/June/2009
Rating Data Type	Ground cover	Ground cover	Ground cover
Rating Unit	%	%	%
Treatment	9	10	11
1 Untreated Control	9.0 a	75.0 a	95.0 a
2 T0 Stomp 400SC (2.0l)	9.0 a	75.0 a	95.0 a
3 T0 Stomp 400SC (3.3l)	9.0 a	75.0 a	95.0 a
4 T0 Stomp 400SC (2.0l) T1 Linuron (1.2l) + Sencorex (0.5kg)	9.0 a	75.0 a	95.0 a
5 T0 Stomp 400SC (3.3l) T1 Linuron (1.2l) + Sencorex (0.5kg)	9.0 a	75.0 a	95.0 a
6 T0 Stomp 400SC (2.0l) T1 Sencorex (0.75kg)	9.0 a	75.0 a	95.0 a
7 T0 Stomp 400SC (2.0l) T1 Linuron (1.2l) + Sencorex (0.75kg)	9.0 a	75.0 a	95.0 a
8 T1 Linuron (1.2l) + Sencorex (0.5kg)	9.0 a	75.0 a	95.0 a
9 T1 Linuron (1.2l) + Sencorex (0.5kg) + Defy (4.0l)	9.0 a	75.0 a	95.0 a
10 T1 Linuron (1.2l) + Sencorex (0.5kg) + Gamit (0.15l)	9.0 a	75.0 a	95.0 a
11 T1 Linuron (1.2l) + Artist (2.0kg)	9.0 a	75.0 a	95.0 a
12 T1 Artist (2.5kg)	9.0 a	75.0 a	95.0 a
13 T1 Artist (2.0kg) + Sencorex (0.25kg)	9.0 a	75.0 a	95.0 a
14 T1 Defy (4.0l) + Linuron (1.2l)	9.0 a	75.0 a	95.0 a
15 T1 Defy (4.0l) + Sencorex (0.5kg)	9.0 a	75.0 a	95.0 a
16 T2 Linuron (1.2l) + Sencorex (0.5kg) + Retro (2.0l) + Activator 90 (0.2l)	9.0 a	75.0 a	95.0 a
LSD (P=.05)	0.00	0.00	0.00
Standard Deviation	0.00	0.00	0.00
CV	0.0	0.0	0.0
Replicate F	0.000	0.000	0.000
Replicate Prob(F)	1.0000	1.0000	1.0000
Treatment F	0.000	0.000	0.000
Treatment Prob(F)	1.0000	1.0000	1.0000

TABLE 12. TRIAL A 2009– CROP VIGOUR ASSESSED AS PERCENTAGE GROUND COVER 13.05.2009, 28.05.2009 AND 03.06.2009.

Means followed by same letter do not significantly differ (P=.05, LSD)

4.5. Trial B 2009 – Larling, Norfolk.

This trial was designed to assess the crop safety and grassweed control efficacy of a range of rates of Sencorex on a light (loamy sand) soil texture. Several complex residual plus contact herbicide mixtures were assessed for crop safety and grassweed control. All potential alternatives to PDQ were compared for grassweed activity. Three rates of Retro were compared for grassweed control efficacy.

All treatments were applied pre-crop emergence (T1) with grassweeds (AMG) at 1 leaf – three tillers.

A range of rates of Sencorex (0.25kg – 1.5kg) was found to cause no significant ($P=0.05$) crop phytotoxicity to the crop compared to the untreated control. Experience suggests that some of the higher Sencorex rates trialled would be expected to damage potato crops on a loamy sand. This anomaly can be explained by a lack of rainfall between planting and the crop meeting in the row. Heavy rain soon after Sencorex application can result in crop damage on light soils. The trial was designed to see if low rates of Sencorex were crop-safe in the event of such rainfall conditions. All other treatments in this trial were also safe to the crop.

Sencorex shows a typical dose response to AMG control. Even very low rates (0.25kg) of Sencorex made a worthwhile contribution to AMG control. The contact-only herbicides, Retro (2.0l), Basta (2.0l) and Shark (0.33l), showed a range of AMG control. Basta provided the highest level of grassweed control, Retro was intermediate and Shark had very little grassweed activity. All contact products would compare poorly with PDQ which could be expected to give complete control of AMG at 1 leaf – 3 tillers.

Increasing the rate of Retro significantly ($P=0.05$) improved the level of AMG control.

Three-way residual plus contact herbicide mixtures provided excellent control of AMG. The mixture which included Linuron + Sencorex + Gamit showed symptoms of vascular chlorosis, typical of Sencorex damage, which were not evident in the Linuron + Sencorex treatment.

Single applications of Defy, Artist, Linuron and Sencorex at T1 did not provide commercially acceptable levels of AMG control.

Groundsel control was evaluated. The two and three way residual mixes plus contact provided very good Groundsel control. Other treatments did not provide adequate Groundsel control.

Crop Variety	L Rosetta	L Rosetta	L Rosetta
Part Rated	Haulm	Haulm	Haulm
Rating Date	15/May/2009	28/May/2009	17/Jul/2009
Rating Data Type	Groundcover	Groundcover	Groundcover
Rating Unit	%	%	%
Treatment	1	4	10
1 Untreated Control	9 a	25.0 a	100.0 a
2 Alpha Linuron (1.2l)	9 a	25.0 a	100.0 a
3 Sencorex (0.25kg)	9 a	25.0 a	100.0 a
4 Sencorex (0.5kg)	9 a	25.0 a	100.0 a
5 Sencorex (1.0kg)	9 a	25.0 a	100.0 a
6 Sencorex (1.5kg)	9 a	25.0 a	100.0 a
7 Artist (2.0kg)	9 a	25.0 a	100.0 a
8 Defy (4.0l)	9 a	25.0 a	100.0 a
9 Retro (2.0l) + Activator 90 (0.2l)	9 a	25.0 a	100.0 a
10 Retro (3.0l) + Activator 90 (0.2l)	9 a	25.0 a	100.0 a
11 Retro (4.0l) + Activator 90 (0.2l)	9 a	25.0 a	100.0 a
12 Basta (2.0l)	9 a	25.0 a	100.0 a
13 Shark (0.33l)	9 a	25.0 a	100.0 a
14 Linuron (1.2l) + Sencorex (0.5kg) + Retro (2.0l) + Activator 90 (0.2l)	9 a	25.0 a	100.0 a
15 Linuron (1.2l) + Sencorex (0.5kg) + Defy (4.0l) + Retro (2.0l)	9 a	25.0 a	100.0 a
16 Linuron (1.2l)+Sencorex (.5kg)+Gamit (0.15l) +Retro (2.0l)+Activator90 (0.2)	9 a	25.0 a	100.0 a
LSD (P=.05)	0.0	0.00	0.00
Standard Deviation	0.0	0.00	0.00
CV	0.0	0.0	0.0
Replicate F	0.000	0.000	0.000
Replicate Prob(F)	1.0000	1.0000	1.0000
Treatment F	0.000	0.000	0.000
Treatment Prob(F)	1.0000	1.0000	1.0000

TABLE 13. TRIAL B 2009– CROP VIGOUR ASSESSED AS PERCENTAGE GROUND COVER 13.05.2009, 28.05.2009 AND 17.07.2009.

Means followed by same letter do not significantly differ (P=.05, LSD)

Pest Name	Annual meadow grass	Annual meadow grass	Annual meadow grass
Crop Variety	L Rosetta	L Rosetta	L Rosetta
Part Rated			
Rating Date	15/May/2009	28/May/2009	17/Jun/2009
Rating Data Type	Weed biomass reduction	Weed biomass reduction	Weed biomass reduction
Rating Unit	%	%	%
Crop Stage	Rosette	25% GC	85% GC
Treatment	2	5	7
1 Untreated Control	0 f	0 f	0 h
2 Alpha Linuron (1.2l)	23 ef	11 ef	48 efg
3 Sencorex (0.25kg)	47 cde	47 d	57 ef
4 Sencorex (0.5kg)	43 cde	62 bcd	77 bc
5 Sencorex (1.0kg)	72 abc	93 a	93 a
6 Sencorex (1.5kg)	72 abc	88 ab	93 a
7 Artist (2.0kg)	86 ab	81 abc	89 ab
8 Defy (4.0l)	33 de	38 de	73 cd
9 Retro (2.0l) + Activator 90 (0.2l)	41 de	32 de	43 fg
10 Retro (3.0l) + Activator 90 (0.2l)	48 cde	33 de	40 g
11 Retro (4.0l) + Activator 90 (0.2l)	60 bcd	48 d	60 de
12 Basta (2.0l)	83 ab	53 cd	62 de
13 Shark (0.33l)	0 f	10 ef	0 h
14 Linuron (1.2l) + Sencorex (0.5kg) + Retro (2.0l) + Activator 90 (0.2l)	97 a	100 a	100 a
15 Linuron (1.2l) + Sencorex (0.5kg) + Defy (4.0l) + Retro (2.0l)	99 a	100 a	100 a
16 Linuron (1.2l)+Sencorex (.5kg) +Gamit (0.15l)+Retro (2.0l)+Activator90 (0.2)	97 a	99 a	100 a
LSD (P=.05)	29.8	31.4	13.4
Standard Deviation	17.9	18.8	8.0
CV	31.75	33.62	12.37
Replicate F	0.619	0.402	1.782
Replicate Prob(F)	0.5451	0.6725	0.1856
Treatment F	9.846	9.956	49.835
Treatment Prob(F)	0.0001	0.0001	0.0001

TABLE 14. TRIAL B 2009. ASSESSMENT OF ANNUAL MEADOW GRASS CONTROL 15.05.2009, 28.05.2009 AND 17.06.2009.

Means followed by same letter do not significantly differ (P=.05, LSD)

Pest Name	Common groundsel	Common groundsel	Common groundsel
Crop Variety	L Rosetta	L Rosetta	L Rosetta
Rating Date	15/May/2009	28/May/2009	17/Jun/2009
Rating Data Type	Weed biomass reduction	Weed biomass reduction	Weed biomass reduction
Rating Unit	%	%	%
Crop Stage	Rosette	25% GC	85% GC
Treatment	3	6	8
1 Untreated Control	0 d	0 e	0 e
2 Alpha Linuron (1.2l)	40 c	42 d	23 de
3 Sencorex (0.25kg)	77 b	57 bcd	35 cde
4 Sencorex (0.5kg)	87 ab	62 bcd	52 cd
5 Sencorex (1.0kg)	88 ab	43 d	68 abc
6 Sencorex (1.5kg)	89 ab	62 bcd	65 abc
7 Artist (2.0kg)	99 a	100 a	63 abc
8 Defy (4.0l)	38 c	52 cd	37 cde
9 Retro (2.0l) + Activator 90 (0.2l)	100 a	80 abc	67 abc
10 Retro (3.0l) + Activator 90 (0.2l)	100 a	100 a	67 abc
11 Retro (4.0l) + Activator 90 (0.2l)	100 a	100 a	67 abc
12 Basta (2.0l)	100 a	87 ab	93 ab
13 Shark (0.33l)	99 a	82 abc	60 bcd
14 Linuron (1.2l) + Sencorex (0.5kg) + Retro (2.0l) + Activator 90 (0.2l)	100 a	100 a	100 a
15 Linuron (1.2l) + Sencorex (0.5kg) + Defy (4.0l) + Retro (2.0l)	100 a	100 a	100 a
16 Linuron (1.2l)+Sencorex (.5kg) +Gamit (0.15l)+Retro (2.0l)+Activator90 (0.2)	100 a	100 a	100 a
LSD (P=.05)	21.8	34.8	39.8
Standard Deviation	13.1	20.9	23.9
CV	15.86	28.64	38.29
Replicate F	0.000	4.120	4.818
Replicate Prob(F)	0.9999	0.0262	0.0153
Treatment F	15.699	5.910	4.306
Treatment Prob(F)	0.0001	0.0001	0.0003

TABLE 15. TRIAL B 2009. ASSESSMENT OF GROUNDSEL CONTROL 15.05.2009, 28.05.2009 AND 17.06.2009.

Means followed by same letter do not significantly differ (P=.05, LSD)

4.6. Trial C 2009 – East Wretham. Norfolk.

This trial was designed to evaluate the crop safety and efficacy of Stomp based weed control programmes and complex residual herbicide mixtures over a range of weed species on a loamy sand soil texture.

Stomp treatments were applied prior to weed and crop emergence (T0). Other residual treatments were applied pre-emergence of the crop and with weeds at the cotyledon – 2 true leaf growth stage (T1). A single residual plus contact treatment was applied at 40% crop emergence (T2).

Initially (30DAT1, 20DAT2), no treatments showed any crop phytotoxicity symptoms. A later assessment showed that several treatments had significantly ($P=0.05$) reduced crop vigour compared with the untreated control. Not all of the damaging treatments contained Sencorex. The variety in this trial was Maris piper. Therefore it is not surprising that the T2 post emergence treatment containing Sencorex caused the highest levels of crop damage. However, the final assessment indicated complete recovery of all treatments compared to the untreated control.

Common chickweed was completely controlled by all residual mixtures, Defy and Artist; early-applied Stomp provided over 50% AMG control.

Stomp applied alone at T0 provided low levels of AMG control. Linuron (1.2l) + Sencorex (0.5kg) at T1 showed good control of AMG but the control from this mixture was not significantly ($P=0.05$) improved by an earlier application of Stomp. Three-way residual treatments applied at T1 provided acceptable levels of AMG control.

Small nettle was another weed which was well controlled by most treatments except early Stomp applied alone, Defy (5.0l) and Defy (4.0l) + Linuron (1.2l).

Redshank numbers were low in this trial which led to variation between replicates. However, straight Defy and early Stomp were all significantly ($P=0.05$) less effective than the tank mixed, residual combinations.

Crop Variety	M Piper	M Piper	M Piper
Rating Date	2/Jun/2009	17/Jun/2009	17/Jul/2009
Rating Data Type	Ground cover	Ground cover	Ground cover
Rating Unit	%	%	%
Crop Stage			
Number of Decimals		0	
Treatment	14	15	16
1 Untreated control	25.0 a	83 a	100.0 a
2 T0 Stomp 400SC (2.0l)	25.0 a	82 ab	100.0 a
3 T0 Stomp 400SC (3.3l)	25.0 a	80 ab	100.0 a
4 T0 Stomp 400SC (2.0l) T1 Linuron (1.2l) + Sencorex (0.5kg)	25.0 a	77 b	100.0 a
5 T0 Stomp 400SC (3.3l) T1 Linuron (1.2l) + Sencorex (0.5kg)	25.0 a	82 ab	100.0 a
6 T0 Stomp 400SC (2.0l) T1 Sencorex (0.5kg)	25.0 a	78 ab	100.0 a
7 T0 Stomp 400SC (2.0l) T1 Linuron (1.2l)	25.0 a	77 b	100.0 a
8 T1 Linuron (1.2l) + Sencorex (0.5kg)	25.0 a	78 ab	100.0 a
9 T1 Linuron (1.2l) + Sencorex (0.5kg) + Defy (4.0l)	25.0 a	78 ab	100.0 a
10 T1 Linuron (1.2l) + Sencorex (0.5kg) + Gamit (0.15l)	25.0 a	82 ab	100.0 a
11 T1 Linuron (1.2l) + Artist (2.0kg)	25.0 a	80 ab	100.0 a
12 T1 Artist (2.5kg)	25.0 a	77 b	100.0 a
13 T1 Defy (5.0l)	25.0 a	82 ab	100.0 a
14 T1 Defy (4.0l) + Linuron (1.2l)	25.0 a	77 b	100.0 a
15 T1 Defy (4.0l) + Sencorex (0.5kg)	25.0 a	77 b	100.0 a
16 T2 Linuron (1.2l) + Sencorex (0.5kg) + Retro (2.0l) + Activator 90 (0.2l)	25.0 a	70 c	100.0 a
LSD (P=.05)	0.00	6.5	0.00
Standard Deviation	0.00	3.9	0.00
CV	0.0	4.92	0.0
Replicate F	0.000	3.889	0.000
Replicate Prob(F)	1.0000	0.0315	1.0000
Treatment F	0.000	2.090	0.000
Treatment Prob(F)	1.0000	0.0418	1.0000

TABLE 16. TRIAL C 2009– CROP VIGOUR ASSESSED AS PERCENTAGE GROUND COVER 13.05.2009, 28.05.2009 AND 17.07.2009.

Means followed by same letter do not significantly differ (P=.05, LSD)

Pest Name	Common chickweed	Common chickweed	Annual meadow grass	Annual meadow grass
Crop Variety	M Piper	M Piper	M Piper	M Piper
Rating Date	2/Jun/2009	17/Jun/2009	2/Jun/2009	17/Jun/2009
Rating Data Type	Weed biomass reduction	Weed biomass reduction	Weed biomass reduction	Weed biomass reduction
Rating Unit	%	%	%	%
Treatment	3	10	4	11
1 Untreated control	0 c	0 d	0 d	0 e
2 T0 Stomp 400SC (2.0l)	70 b	53 c	55 c	40 d
3 T0 Stomp 400SC (3.3l)	63 b	80 b	57 c	33 d
4 T0 Stomp 400SC (2.0l) T1 Linuron (1.2l) + Sencorex (0.5kg)	100 a	100 a	100 a	98 ab
5 T0 Stomp 400SC (3.3l) T1 Linuron (1.2l) + Sencorex (0.5kg)	100 a	100 a	98 ab	99 ab
6 T0 Stomp 400SC (2.0l) T1 Sencorex (0.5kg)	100 a	100 a	97 ab	84 bc
7 T0 Stomp 400SC (2.0l) T1 Linuron (1.2l)	97 a	100 a	84 ab	78 c
8 T1 Linuron (1.2l) + Sencorex (0.5kg)	100 a	100 a	98 ab	99 ab
9 T1 Linuron (1.2l) + Sencorex (0.5kg) + Defy (4.0l)	100 a	100 a	97 ab	97 ab
10 T1 Linuron (1.2l) + Sencorex (0.5kg) + Gamit (0.15l)	100 a	100 a	96 ab	97 ab
11 T1 Linuron (1.2l) + Artist (2.0kg)	100 a	100 a	99 ab	99 ab
12 T1 Artist (2.5kg)	100 a	100 a	99 a	97 ab
13 T1 Defy (5.0l)	90 a	100 a	74 bc	87 abc
14 T1 Defy (4.0l) + Linuron (1.2l)	100 a	100 a	98 ab	93 abc
15 T1 Defy (4.0l) + Sencorex (0.5kg)	100 a	100 a	98 ab	100 a
16 T2 Linuron (1.2l) + Sencorex (0.5kg) + Retro (2.0l) + Activator 90 (0.2l)	100 a	100 a	97 ab	97 ab
LSD (P=.05)	15.7	19.4	25.5	15.1
Standard Deviation	9.4	11.6	15.3	9.1
CV	10.58	12.96	18.2	11.17
Replicate F	2.764	0.629	1.671	0.009
Replicate Prob(F)	0.0791	0.5398	0.2051	0.9907
Treatment F	23.427	16.074	9.283	32.555
Treatment Prob(F)	0.0001	0.0001	0.0001	0.0001

TABLE 17. TRIAL C 2009. ASSESSMENT OF CHICKWEED AND AMG CONTROL 02.06.2009, AND 17.06.2009.

Means followed by same letter do not significantly differ (P=.05, LSD)

Pest Name	Small nettle	Small nettle	Redshank	Redshank
Crop Variety	M Piper	M Piper	M Piper	M Piper
Rating Date	2/Jun/2009	17/Jun/2009	2/Jun/2009	17/Jun/2009
Rating Data Type	Weed biomass reduction	Weed biomass reduction	Weed biomass reduction	Weed biomass reduction
Rating Unit	%	%	%	%
Treatment	1	8	2	9
1 Untreated control	0 d	0 d	0 c	0 d
2 T0 Stomp 400SC (2.0l)	77 c	77 c	50 b	18 cd
3 T0 Stomp 400SC (3.3l)	80 c	92 b	45 b	25 cd
4 T0 Stomp 400SC (2.0l) T1 Linuron (1.2l) + Sencorex (0.5kg)	100 a	100 a	100 a	99 a
5 T0 Stomp 400SC (3.3l) T1 Linuron (1.2l) + Sencorex (0.5kg)	100 a	100 a	99 a	98 a
6 T0 Stomp 400SC (2.0l) T1 Sencorex (0.5kg)	100 a	100 a	100 a	85 a
7 T0 Stomp 400SC (2.0l) T1 Linuron (1.2l)	96 ab	100 a	83 a	77 ab
8 T1 Linuron (1.2l) + Sencorex (0.5kg)	100 a	100 a	99 a	92 a
9 T1 Linuron (1.2l) + Sencorex (0.5kg) + Defy (4.0l)	100 a	100 a	100 a	98 a
10 T1 Linuron (1.2l) + Sencorex (0.5kg) + Gamit (0.15l)	100 a	100 a	100 a	100 a
11 T1 Linuron (1.2l) + Artist (2.0kg)	100 a	100 a	100 a	100 a
12 T1 Artist (2.5kg)	100 a	100 a	99 a	70 ab
13 T1 Defy (5.0l)	93 b	95 ab	88 a	48 bc
14 T1 Defy (4.0l) + Linuron (1.2l)	100 a	93 b	100 a	90 a
15 T1 Defy (4.0l) + Sencorex (0.5kg)	100 a	100 a	100 a	100 a
16 T2 Linuron (1.2l) + Sencorex (0.5kg) + Retro (2.0l) + Activator 90 (0.2l)	100 a	100 a	100 a	100 a
LSD (P=.05)	7.2	6.4	22.3	32.2
Standard Deviation	4.3	3.8	13.4	19.3
CV	4.81	4.2	15.68	25.73
Replicate F	2.184	0.451	1.353	2.900
Replicate Prob(F)	0.1301	0.6410	0.2737	0.0706
Treatment F	100.768	128.870	13.956	9.047
Treatment Prob(F)	0.0001	0.0001	0.0001	0.0001

TABLE 18. TRIAL C 2009. ASSESSMENT OF SMALL NETTLE AND REDSHANK CONTROL 02.06.2009, AND 17.06.2009.

Means followed by same letter do not significantly differ (P=.05, LSD)

5. CONCLUSIONS

The project has uniquely identified the strengths and weaknesses of three contact herbicides with the potential to replace PDQ for the control of weeds in potatoes. The properties of the contact herbicides are outlined below:

- Shark is too damaging to the potato crop to be applied post-emergence. It has negligible grassweed activity, but very effective on a range of BLW, although a weakness on mayweeds was observed.
- Basta provided the best grassweed control but was still less effective than PDQ. Crop damage levels were similar to PDQ. BLW control was generally good but a weakness on small nettle was identified.
- Retro caused crop phytotoxicity in potatoes at a similar level to PDQ. The grassweed activity of Retro was between Basta and Shark, which is well below the grassweed activity of PDQ. Increasing the rate of Retro did improve grassweed control but even 4.0l/ha did not match the control levels achievable with PDQ.

The trials found that a “residual-only” approach to weed control was not as effective as applying residual plus contact herbicides just prior to crop emergence. This finding may have been skewed by the two very dry Springs, during which the work was undertaken. The “residual-only” approach was more effective on light soils where a finer tilth could be easily created. Applying Stomp soon after planting did not add to the weed control achieved by a later application of residual herbicides – again, the efficacy of this treatment was probably hindered by dry soil conditions.

The usefulness of residual-based programmes and early applied Stomp should be re-evaluated in a more typically wet season.

Low rates of Linuron did not provide sufficient residual weed control in any trial except for one trial where a late planted crop provided very early crop competition to weeds. All the other residual herbicides available in the UK were evaluated in mixture with Linuron to extend residual weed control. Sencorex was shown to be the most effective partner herbicide. Unfortunately, Sencorex can cause crop phytotoxicity on light soil textures which could limit the adoption of the findings of this report. However, damage has been caused where rates of Sencorex 1kg/ha and above were used and heavy rainfall occurred soon after application. This project attempted to find a rate of Sencorex which could be safely used on light soils. No crop damage resulted from Sencorex applied to a loamy sand in the range of 0.25kg – 1.5kg/ha. The dry conditions probably accounted for the safety of high rates of Sencorex. The Sencorex crop safety data reported here cannot be extrapolated to a wetter spring. More, specific Sencorex crop safety trials on light soils are urgently required. The design of trials should include irrigation at various times after application to provide more confidence in the use of Sencorex and indicate safe application rates.

Defy generally showed a more narrow weed spectrum than Sencorex and was less long-lasting. However, Defy plus Linuron provides a very crop safe option on light soils. Artist applied alone and in mix with Linuron gave good results but this combination contains Sencorex which may limit use on lighter soils. Gamit extends the weed spectrum of Linuron but does not help with many common weeds of potatoes. Artist, Gamit and Defy all provided useful and similar Cleaver control.

Three way residual mixtures e.g. Linuron + Sencorex + Defy provided good weed control levels but the cost of these treatments may be prohibitive. It was clear that no combination of herbicides matched the levels of polygonum (especially Redshank and Black bindweed) control previously achieved with Linuron (2.0 - 3.7l/ha).

6. KNOWLEDGE TRANSFER ACTIVITIES

- CUPGRA - Potato conference Workshop 18.12.2008
- ChemSpec (East Anglia) Limited - Potato Agronomy Workshop 26.01.2009
- Bayer Potato Consultants Day 28.01.2009
- Greenvale growers meeting 02.02.2009
- QV Foods Potato Event 04.02.2009
- North Norfolk Potato Agronomy Group 05.02.2009
- Greenvale Agronomists Training Day 02.03.2009

7. PROJECT DELIVERABLES

- New independent information on the crop safety of contact herbicides with the potential to replace paraquat.
- New independent information on the efficacy of contact herbicides capable of replacing paraquat.
- New independent information on the limitations of low rates of Linuron.
- New independent information on how to bolster the performance of low rates of Linuron.
- Basic information required to assist the re-build of potato herbicide programmes in light of regulatory changes to paraquat and Linuron.
- This information can be made available to levy payers through the Potato Council website, agricultural press articles and grower / agronomist meetings.

8. APPENDICES

8.1. Appendix 1

Background information for 2008 trials:

8.1.1. Trial A: Thetford, Norfolk.

8.1.1.1. *Experimental Details*

Co-operator:	WO & PO Jolly Roudham Farm Roudham Norwich Norfolk
Site:	Thetford Norfolk
Grid reference:	TL 948874
Soil type:	Sandy loam
Previous crop (2007):	Winter wheat
Crop & Cultivar:	Maincrop potatoes var. Maris piper.
Planting Date:	10.04.2008
Field Preparation:	Over-wintered ploughing. Ridge De-stone Plant
Plot Maintenance Treatments:	Potato blight and insect pest control consistent with good local practise.
Previous treatments:	Nil
Plot size:	3m X 8m
Design:	RCB – first block unreplicated. X3 replication

	Treatment	Rate / ha	Timing
1	Untreated control		T1
2	Alpha Linuron	1.3l	T1
3	Alpha Linuron + Sencorex	1.3l + 0.5kg	T1
4	Alpha Linuron + Sencorex	2.0l + 0.5kg	T1
5	Alpha Linuron + Sencorex + Gamit	1.3l + 0.5kg + 0.15l	T1
6	Artist	2.5kg	T1
7	Alpha Linuron + Artist	1.3l + 1.5kg	T1
8	Alpha Linuron + Artist	1.3l + 2.0kg	T1
9	Alpha Linuron + Defy	1.3l + 4.0l	T1
10	Sencorex + Defy	0.5kg + 4.0l	T1
11	Sencorex + Gamit	0.5kg + 0.15l	T1
12	Alpha Linuron + PDQ	2.0l + 2.0l	T2
13	Alpha Linuron + PDQ	1.3l + 2.0l	T2
14	Alpha Linuron + Retro + Activator 90	1.3l + 2.0l + 0.2l	T2
15	Alpha Linuron + Basta	1.3l + 2.0l	T2
16	Alpha Linuron + Shark	1.3l + 0.33l	T2

TABLE 19. TREATMENT LIST: TRIAL A THETFORD, NORFOLK

T1 = soon after planting, once soil has settled but before any weeds beyond cotyledon stage.

T2 = just prior to crop emergence – weeds probably cotyledon – 4 true leaves

8.1.1.2. Application Details

Applicator: GS plot sprayer - CO₂ pressurised (Pulvexpur - 3m)
Nozzles: 015 F110 Lo Drift
Pressure: 3.2 bar
Speed: 1.0 m/s
Water Volume: 200 l/ha

T1

Date: 25.04.2008
Crop Stage: pre-emergence (eyes open – no chit development))
Leaf Moisture: n/a
Soil Moisture (Surface): dry
Soil Moisture (Sub-surface): moist
Soil Condition: loose
Soil Tilth: fine
Weather at application: Overcast
Air temperature (Deg. C): 19
Soil temperature (Deg. C): 11
Wind (kph): 5 - southwest
Cloud cover (%): 100
Comment: Good spraying conditions

T2

Date: 09.05.2008
Crop Stage: pre emergence – chits 2cm from soil surface
Leaf Moisture: dry (weed)
Soil Moisture (Surface): dry
Soil Moisture (Sub-surface): moist
Soil Condition: loose
Soil Tilth: fine
Weather at application: Sunny
Air temperature (Deg. C): 20
Soil temperature (Deg. C): 16
Wind (kph): 5
Cloud cover (%): 0
Comment: Very dry soil conditions

8.1.1.3. Weed levels in the untreated control.

The T1 application (25.04.2008) was made before weed emergence. Some large, transplanted AMG (2-4 tillers) were observed but these weeds were excluded from all subsequent weed control assessments.

Weed species	Weeds / sq. m	Weed size
<i>Poa annua</i> (Annual meadow grass)	45	1 leaf – 1 tiller
<i>Chenopodium album</i> (Fat hen)	<1	cotyledon
<i>Polygonum aviculare</i> (Knotgrass)	<1	cotyledon
<i>Senecio vulgaris</i> (Groundsel)	<1	cotyledon

TABLE 20. WEED LEVELS IN UNTREATED CONTROLS AT T2 APPLICATION – 09.05.2008. TRIAL A THETFORD, NORFOLK

The trial contained excellent high levels of AMG (grassweeds were specifically targeted), distributed very evenly over the trial area. BLW numbers were very low. Efficacy data regarding BLW control must be interpreted very cautiously.

Weed species	Weeds / sq. m	Weed size
<i>Poa annua</i> (Annual meadow grass)	70	1 leaf – 4 tillers
<i>Chenopodium album</i> (Fat hen)	<1	2-4 true leaf
<i>Polygonum aviculare</i> (Knotgrass)	<1	6-8 true leaf
<i>Senecio vulgaris</i> (Groundsel)	<1	2-4 true leaf

TABLE 21. WEED LEVELS IN UNTREATED CONTROLS AT FIRST ASSESSMENT - 22.05.2008 (28DAT1 AND 13DAT2). TRIAL A THETFORD, NORFOLK

Weed species	Weed - % ground cover
<i>Poa annua</i> (Annual meadow grass)	10
<i>Chenopodium album</i> (Fat hen)	1
<i>Polygonum aviculare</i> (Knotgrass)	<1
<i>Senecio vulgaris</i> (Groundsel)	1

TABLE 22. WEED LEVELS IN UNTREATED CONTROLS AT ASSESSMENT – 05.06.2008 (42DAT1 AND 27DAT2) TRIAL A THETFORD, NORFOLK

8.1.2. Trial B: Lutton, South Lincolnshire

8.1.2.1. *Experimental Details*

Co-operator:	George Thompson Farms Ltd. Holbeach Hurn Spalding Lincolnshire
Site:	Lutton Marsh Spalding Lincs.
Grid reference:	TF 455269
Soil type:	Silt loam
Previous crop (2007):	Winter wheat
Crop & Cultivar:	Maincrop potatoes var. Maris piper.
Planting Date:	18.04.2008
Field Preparation:	Over-wintered ploughing. Power harrow X2 Plant.
Plot Maintenance Treatments:	Potato blight and insect pest control consistent with good local practise.
Previous treatments:	Nil
Plot size:	3m X 8m
Design:	RCB – first block unreplicated. X3 replication

	Treatment	Rate / ha	Timing
1	Untreated control		T1
2	Alpha Linuron	1.3l	T1
3	Alpha Linuron + Sencorex	1.3l + 0.5kg	T1
4	Alpha Linuron + Sencorex	2.0l + 0.5kg	T1
5	Alpha Linuron + Sencorex + Gamit	1.3l + 0.5kg + 0.15l	T1
6	Artist	2.5kg	T1
7	Alpha Linuron + Artist	1.3l + 1.5kg	T1
8	Alpha Linuron + Artist	1.3l + 2.0kg	T1
9	Alpha Linuron + Defy	1.3l + 4.0l	T1
10	Sencorex + Defy	0.5kg + 4.0l	T1
11	Sencorex + Gamit	0.5kg + 0.15l	T1
12	Alpha Linuron + PDQ	2.0l + 2.0l	T2
13	Alpha Linuron + PDQ	1.3l + 2.0l	T2
14	Alpha Linuron + Retro + Activator 90	1.3l + 2.0l + 0.2l	T2
15	Alpha Linuron + Basta	1.3l + 2.0l	T2
16	Alpha Linuron + Shark	1.3l + 0.33l	T2

TABLE 23. TREATMENT LIST: TRIAL B: LUTTON, SOUTH LINCOLNSHIRE

T1 = soon after planting, once soil has settled but before any weeds beyond cotyledon stage.

T2 = 40% crop emergence – weeds cotyledon – 4 true leaves (T2 was later than protocol timing, to allow weed size to increase).

8.1.2.2. Application Details

Applicator: GS plot sprayer - CO₂ pressurised (Pulvexpur - 3m)
Nozzles: 015 F110 Lo Drift
Pressure: 3.2 bar
Speed: 1.0 m/s
Water Volume: 200 l/ha

T1

Date: 02.05.2008
Crop Stage: pre-emergence (chits 1cm long and root development)
Leaf Moisture: n/a
Soil Moisture (Surface): moist
Soil Moisture (Sub-surface): moist
Soil Condition: loose
Soil Tilth: small clods
Weather at application: Sunny
Air temperature (Deg. C): 15
Soil temperature (Deg. C): 9
Wind (kph): 3 - southwest
Cloud cover (%): 25
Comment: Soil "settled" by heavy showers since planting.

T2

Date: 20.05.2008
Crop Stage: 20% emergence
Leaf Moisture: dry
Soil Moisture (Surface): dry
Soil Moisture (Sub-surface): moist
Soil Condition: loose
Soil Tilth: small clods
Weather at application: Sunny
Air temperature (Deg. C): 9
Soil temperature (Deg. C): 11
Wind (kph): 0
Cloud cover (%): 0
Comment: Ideal spraying conditions

8.1.2.3. Weed levels in the untreated control.

The T1 application (02.05.2008) was made before weed emergence.

Weed species	Weeds / sq. m	Weed size
<i>Senecio vulgaris</i> (Groundsel)	2	2-4 true leaf
<i>Polygonum convolvulus</i> (Black bindweed)	3	2 true leaf

TABLE 24. WEED LEVELS IN UNTREATED CONTROLS AT T2 APPLICATION – 16.05.2008. TRIAL B: LUTTON, SOUTH LINCOLNSHIRE

A very dry early May resulted in low numbers of emerged weeds on silt soils. Low weed levels and their sporadic distribution reduces the reliability of weed control efficacy data.

Weed species	Weed - % ground cover
<i>Polygonum convolvulus</i> (Black bindweed)	5
<i>Senecio vulgaris</i> (Groundsel)	5
<i>Matricaria spp.</i> (Mayweeds)	<1
<i>Veronica hederifolia</i> (Ivy leaved speedwell)	<1
<i>Veronica agrestis</i> (Field speedwell)	<1

TABLE 25. WEED LEVELS IN UNTREATED CONTROLS AT ASSESSMENT – 09.06.2008. TRIAL B: LUTTON, SOUTH LINCOLNSHIRE

Typically, untreated plots on silt soils will contain weed growth of 100% ground cover whereas the mean weed ground cover here was 10%.

8.1.3. Trial C Holbeach Hurn, South Lincolnshire.

8.1.3.1. *Experimental Details*

Co-operator:	Worth Farms Holbeach Hurn Spalding Lincolnshire
Site:	Holbeach Hurn Spalding Lincs.
Grid reference:	TF 400284
Soil type:	Silt loam
Previous crop (2007):	Winter wheat
Crop & Cultivar:	Second early potatoes var. Marfona
Planting Date:	02.04.2008 –45-55 mm seed
Field Preparation:	Over-wintered ploughing. Power harrow X2 Plant.
Plot Maintenance Treatments:	Potato blight and insect pest control consistent with good local practise.
Previous treatments:	Nil
Plot size:	3m X 6m
Design:	RCB – first block unreplicated. X4 replication

	Treatment	Rate / ha	Timing
1	Untreated control		T1
2	Alpha Linuron + Sencorex	1.3l + 0.5kg	T1
3	Alpha Linuron + Sencorex	2.0l +0.5kg	T1
4	Basta	2.0l	T2
5	PDQ	2.0l	T2
6	Retro + Activator 90	2.0l + 0.2l	T2
7	Shark	0.33l	T2
8	Basta	2.0l	T3
9	Basta	3.0l	T3
10	PDQ	2.0l	T3
11	Retro + Activator 90	2.0l + 0.2l	T3
12	Shark	0.33l	T3
13	Alpha Linuron + PDQ	1.3l + 2.0l	T2
14	Alpha Linuron + Retro	1.3l + 2.0l	T2
15	Alpha Linuron + Basta	1.3l + 2.0l	T2
16	Alpha Linuron + Shark	1.3l + 0.33l	T2

TABLE 26. TREATMENT LIST. TRIAL C HOLBEACH HURN, SOUTH LINCOLNSHIRE

T1 = soon after planting, once soil has settled but before any weeds beyond cotyledon stage.

T2 = 40% crop emergence.

T3 = 100% crop emergence

8.1.3.2. Application Details

Applicator: GS plot sprayer - CO₂ pressurised (Pulvexpur - 3m)

Nozzles: 015 F110 Lo Drift

Pressure: 3.2 bar

Speed: 1.0 m/s

Water Volume: 200 l/ha

T1

Date: 06.05.2008
Crop Stage: pre-emergence (chits 2cm from soil surface)
Leaf Moisture: n/a
Soil Moisture (Surface): dry
Soil Moisture (Sub-surface): moist
Soil Condition: loose
Soil Tilth: small clods
Weather at application: Sunny
Air temperature (Deg. C): 18
Soil temperature (Deg. C): 13
Wind (kph): 2 - east
Cloud cover (%): 0
Comment: Good spraying conditions.

T2

Date: 16.05.2008
Crop Stage: 40% emergence
Leaf Moisture: dry
Soil Moisture (Surface): dry
Soil Moisture (Sub-surface): moist
Soil Condition: loose
Soil Tilth: small clods
Weather at application: Overcast
Air temperature (Deg. C): 14
Soil temperature (Deg. C): 14
Wind (kph): 3 - east
Cloud cover (%): 100
Comment: T2 timing delayed to allow development of weeds.

T3

Date: 22.05.2008
Crop Stage: 100% emergence
Leaf Moisture: damp (drying dew)
Soil Moisture (Surface): dry
Soil Moisture (Sub-surface): moist
Soil Condition: loose
Soil Tilth: small clods
Weather at application: Sunny
Air temperature (Deg. C): 13
Soil temperature (Deg. C): 14
Wind (kph): 2 - east
Cloud cover (%): 0
Comment:

8.1.3.3. Weed levels in the untreated control.

The T1 application (06.05.2008) was made before any major weed emergence – occasional (<<1/sq m) cotyledon small nettle and black bindweed were observed.

Weed species	Weeds / sq. m	Weed size
<i>Urtica urens</i> (Small nettle)	3	coty.-4 true leaf
<i>Stellaria media</i> (Chickweed)	1	4-6 true leaf
<i>Polygonum aviculare</i> (Knotgrass)	1	2 true leaf
<i>Polygonum persicaria</i> (Redshank)	4	2-4 true leaf
<i>Senecio vulgaris</i> (Groundsel)	2	2-4 true leaf
<i>Matricaria spp.</i> (Mayweeds)	1	4 true leaf
<i>Polygonum convolvulus</i> (Black bindweed)	<1	2 true leaf

TABLE 27. WEED LEVELS IN UNTREATED CONTROLS AT T2 APPLICATION – 16.05.2008. . TRIAL C HOLBEACH HURN, SOUTH LINCOLNSHIRE

A very dry early May resulted in low numbers of emerged weeds on silt soils. Low weed levels and their sporadic distribution reduces the reliability of efficacy data.

Weed species	Weeds / sq. m	Weed size
<i>Urtica urens</i> (Small nettle)	3	6-8 true leaf
<i>Stellaria media</i> (Chickweed)	1	4-6 cm across
<i>Polygonum aviculare</i> (Knotgrass)	1	4-6 cm across
<i>Polygonum persicaria</i> (Redshank)	5	4-6 true leaf
<i>Senecio vulgaris</i> (Groundsel)	2	8-10 true leaf
<i>Matricaria spp.</i> (Mayweeds)	1	6-10 true leaf

TABLE 28. WEED LEVELS IN UNTREATED CONTROLS AT T3 – 22.05.2008. . TRIAL C HOLBEACH HURN, SOUTH LINCOLNSHIRE

Weed species	Weed - % ground cover
<i>Urtica urens</i> (Small nettle)	3
<i>Polygonum persicaria</i> (Redshank)	2
<i>Senecio vulgaris</i> (Groundsel)	2
<i>Matricaria spp.</i> (Mayweeds)	5

TABLE 29. WEED LEVELS IN UNTREATED CONTROLS AT ASSESSMENT 09.06.2008 (40DAT2 AND 33DAT3). . TRIAL C HOLBEACH HURN, SOUTH LINCOLNSHIRE

Typically, untreated plots on silt soils will contain weed growth of 100% ground cover whereas the mean weed ground cover here was 12%.

8.2. Appendix 2

Background information for 2009 trials:

8.2.1. Trial A: Holbeach, South Lincolnshire

8.2.1.1. *Experimental Details*

Co-operator:	Taylor's Bulbs Ltd. Washway House Farm Holbeach Spalding Lincolnshire
Site:	Saracens Head Lincolnshire
Grid reference:	TF 345269
Soil type:	Silt loam
Previous crop (2007):	Cauliflower
Crop & Cultivar:	Maincrop potatoes var. Cara
Planting Date:	18.03.2009
Field Preparation:	Over-wintered ploughing. Ridge Bed tiller Plant
Plot Maintenance Treatments:	Potato blight and insect pest control consistent with good local practise.
Previous treatments:	Nil
Plot size:	3m X 8m
Design:	RCB – first block unreplicated. X3 replication

	Treatment	Rate / ha	Timing
1	Untreated control		
2	Stomp 400SC	2.0l	T0
3	Stomp 400SC	3.3l	T0
4	Stomp 400SC fb Linuron+Sencorex	2.0l fb 1.2l + 0.5kg	T0+T1
5	Stomp 400SC fb Linuron+Sencorex	3.3l fb 1.2l + 0.5kg	T0+T1
6	Stomp 400SC fb Sencorex	2.0l fb + 0.75kg	T0+T1
7	Stomp 400SC fb Linuron	2.0l fb 1.2l + 0.75kg	T0+T1
8	Linuron + Sencorex	1.2l + 0.5kg	T1
9	Linuron + Sencorex + Defy	1.2l + 0.5kg + 4.0l	T1
10	Linuron + Sencorex + Gamit	1.2l + 0.5kg + 0.15l	T1
11	Linuron + Artist	1.2l + 2.0kg	T1
12	Artist	2.5kg	T1
13	Artist + Sencorex	2.0kg + 0.25kg	T1
14	Defy + Linuron	4.0l + 1.2l	T1
15	Defy + Sencorex	4.0l + 0.5kg	T1
16	Linuron + Sencorex + Retro + Acitivor 90	1.2l + 0.5kg + 2.0l + 0.2l	T2

TABLE 30. TREATMENT LIST. TRIAL A: HOLBEACH, SOUTH LINCOLNSHIRE

T0 = Soon after planting - once soil settled and moist.

T1 = Pre crop emergence – weeds cotyledon maximum.

T2 = Up to 5% emergence.

8.2.1.2. Application Details

Applicator: GS plot sprayer - CO₂ pressurised (Pulvexpur - 3m)

Nozzles: 015 F110 Lo Drift

Pressure: 3.2 bar

Speed: 1.0 m/s

Water Volume: 200 l/ha

T0

Date: 10.04.2009
Crop Stage: pre emergence – chits 1cm long
Leaf Moisture:
Soil Moisture (Surface): dry
Soil Moisture (Sub-surface):moist
Soil Condition: loose
Soil Tilth: small clods
Weather at application: Overcast
Air temperature (Deg. C): 14
Soil temperature (Deg. C): 10
Wind (kph): 5 - northeast
Cloud cover (%): 100
Comment: Very dry soil conditions

T1

Date: 21.04.2008
Crop Stage: pre-emergence (chit 5cm from surface)
Leaf Moisture: n/a
Soil Moisture (Surface): dry
Soil Moisture (Sub-surface):damp
Soil Condition: loose
Soil Tilth: small clods
Weather at application: Sunny
Air temperature (Deg. C): 17
Soil temperature (Deg. C): 12
Wind (kph): 1 - northeast
Cloud cover (%): 0
Comment: Very dry soil conditions

T2

Date: 26.04.2009
Crop Stage: crop 10% emerged
Leaf Moisture: dry (weed)
Soil Moisture (Surface): dry
Soil Moisture (Sub-surface):moist
Soil Condition: loose
Soil Tilth: small clods
Weather at application: Sunny
Air temperature (Deg. C): 18
Soil temperature (Deg. C): 11
Wind (kph): 2 - southwest
Cloud cover (%): 10
Comment: Very dry soil conditions

8.2.1.3. Weed levels in the untreated control.

The T0 application (10.04.2009) was made before weed emergence.

Weed species	Weeds / sq. m	Weed size
<i>Galium aparine</i> (Cleaver)	15	cotyledon
<i>Polygonum persicaria</i> (Redshank)	5	cotyledon
<i>Polygonum convolvulus</i> (Black bindweed)	41	cotyledon

TABLE 31. WEED LEVELS IN UNTREATED CONTROLS AT T1 APPLICATION – 21.04.2009. TRIAL A: HOLBEACH, SOUTH LINCOLNSHIRE

The trial contained good levels of cleavers distributed very evenly over the trial area. Other BLW numbers were low due to dry conditions

Weed numbers at T2 (26.04.2009) were the same as at T1. Soil conditions were too dry for further weed seed germination.

Weed species	Weed - % ground cover
<i>Galium aparine</i> (Cleaver)	30
<i>Polygonum persicaria</i> (Redshank)	4
<i>Polygonum convolvulus</i> (Black bindweed)	3

TABLE 32. WEED LEVELS IN UNTREATED CONTROLS AT ASSESSMENT – 03.06.2009. TRIAL A: HOLBEACH, SOUTH LINCOLNSHIRE

8.2.2. Trial B Larling. Norfolk

8.2.2.1. *Experimental Details*

Co-operator:	T Jolly Roudham Farm Roudham Thetford Norfolk
Site:	Larling Norfolk
Grid reference:	TL 975895
Soil type:	Loamy sand
Previous crop (2007):	Winter barley
Crop & Cultivar:	Maincrop potatoes var. Lady Rosetta
Planting Date:	30.03.2009
Field Preparation:	Over-wintered ploughing. Ridge De-stone Plant
Plot Maintenance Treatments:	Potato blight and insect pest control consistent with good local practise.
Previous treatments:	Nil
Plot size:	3m X 8m
Design:	RCB – first block unreplicated. X3 replication

	Treatment	Rate / ha	Timing
1	Untreated control		
2	Alpha Linuron	1.2l	T1
3	Sencorex	0.25kg	T1
4	Sencorex	0.5kg	T1
5	Sencorex	1.0kg	T1
6	Sencorex	1.5kg	T1
7	Artist	2.0kg (= 0.5kg Sencorex)	T1
8	Defy	4.0l	T1
9	Retro + Activator 90	2.0l + 0.2l	T1
10	Retro + Activator 90	3.0l + 0.2l	T1
11	Retro + Activator 90	4.0l + 0.2l	T1
12	Basta	2.0l	T1
13	Shark	0.33l	T1
14	Linuron + Sencorex + Retro + Acitivator 90	1.2l + 0.5kg + 2.0l + 0.2l	T1
15	Linuron + Sencorex + Defy + Retro	1.2l + 0.5kg + 4.0l + 2.0l	T1
16	Linuron + Sencorex + Gamit + Retro + Activator 90	1.2l + 0.5kg + 0.15l + 2.0l + 0.2l	T1

TABLE 33. TREATMENT LIST. TRIAL B LARLING. NORFOLK

T1 = just prior to crop emergence – weeds cotyledon – 4 true leaves

8.2.2.2. Application Details

Applicator: GS plot sprayer - CO₂ pressurised (Pulvexpur - 3m)
Nozzles: 015 F110 Lo Drift
Pressure: 3.2 bar
Speed: 1.0 m/s
Water Volume: 200 l/ha

T1

Date: 26.04.2009
Crop Stage: pre emergence – chits 2.5cm from surface
Leaf Moisture:
Soil Moisture (Surface): dry
Soil Moisture (Sub-surface): moist
Soil Condition: loose
Soil Tilth: fine
Weather at application: Sunny
Air temperature (Deg. C): 15
Soil temperature (Deg. C): 11
Wind (kph): 1 - southeast
Cloud cover (%): 0
Comment: Very dry soil conditions

8.2.2.3. Weed levels in the untreated control.

Weed species	Weeds / sq. m	Weed size
<i>Poa annua</i> (Annual meadow grass)	70	1 leaf – 3 tillers

TABLE 34. WEED LEVELS IN UNTREATED CONTROLS AT T1 APPLICATION – 26.04.2009. TRIAL B LARLING. NORFOLK

The trial contained good levels of AMG distributed very evenly over the trial area. Other BLW numbers were too low to assess herbicide performance.

Weed species	Weed - % ground cover
<i>Poa annua</i> (Annual meadow grass)	25

TABLE 35. WEED LEVELS IN UNTREATED CONTROLS AT ASSESSMENT – 28.05.2009. TRIAL B LARLING. NORFOLK

Weed species	Weed - % ground cover
<i>Poa annua</i> (Annual meadow grass)	80

TABLE 36. WEED LEVELS IN UNTREATED CONTROLS AT ASSESSMENT – 17.06.2009 TRIAL B LARLING. NORFOLK

8.2.3. Trial C East Wretham. Norfolk

8.2.3.1. *Experimental Details*

Co-operator:	R G Abrey Larkshall Farm East Wretham Thetford Norfolk
Site:	East Wretham Norfolk
Grid reference:	TL 913914
Soil type:	Loamy sand
Previous crop (2007):	Carrot
Crop & Cultivar:	Maincrop potatoes var. Maris Piper
Planting Date:	14.04.2009
Field Preparation:	Over-wintered ploughing. Ridge De-stone Plant
Plot Maintenance Treatments:	Potato blight and insect pest control consistent with good local practise.
Previous treatments:	Nil
Plot size:	3m X 8m
Design:	RCB – first block unreplicated. X3 replication

	Treatment	Rate / ha	Timing
1	Untreated control		
2	Stomp 400SC	2.0l	T0
3	Stomp 400SC	3.3l	T0
4	Stomp 400SC fb Linuron+Sencorex	2.0l fb 1.2l+0.5kg	T0+T1
5	Stomp 400SC fb Linuron+Sencorex	3.3l fb 1.2l+0.5kg	T0+T1
6	Stomp 400SC fb Sencorex	2.0l fb 0.5kg	T0+T1
7	Stomp 400SC fb Linuron	2.0l fb 1.2l	T0+T1
8	Linuron + Sencorex	1.2l + 0.5kg	T1
9	Linuron + Sencorex + Defy	1.2l + 0.5kg + 4.0l	T1
10	Linuron + Sencorex + Gamit	1.2l + 0.5kg + 0.15l	T1
11	Linuron + Artist	1.2l + 2.0kg	T1
12	Artist	2.5kg	T1
13	Defy	5.0l	T1
14	Defy + Linuron	4.0l + 1.2l	T1
15	Defy + Sencorex	4.0l + 0.5kg	T1
16	Linuron + Sencorex + Retro + Acitivator 90	1.2l + 0.5kg + 2.0l + 0.2l	T2

TABLE 37. TREATMENT LIST. TRIAL C EAST WRETHAM, NORFOLK

T0 = Soon after planting - once soil settled and moist.

T1 = Pre crop emergence – weeds cotyledon maximum.

T2 = Up to 5% emergence.

8.2.3.2. Application Details

Applicator: GS plot sprayer - CO₂ pressurised (Pulvexpur - 3m)

Nozzles: 015 F110 Lo Drift

Pressure: 3.2 bar

Speed: 1.0 m/s

Water Volume: 200 l/ha

T0

Date: 24.04.2009
Crop Stage: pre emergence – chits 4 mm long
Leaf Moisture:
Soil Moisture (Surface): dry
Soil Moisture (Sub-surface): moist
Soil Condition: loose
Soil Tilth: fine
Weather at application: Sunny
Air temperature (Deg. C): 15
Soil temperature (Deg. C): 12
Wind (kph): 5 - southeast
Cloud cover (%): 0
Comment: Very dry soil conditions

T1

Date: 03.05.2008
Crop Stage: pre-emergence (chit 3 cm from surface)
Leaf Moisture: n/a
Soil Moisture (Surface): dry
Soil Moisture (Sub-surface): damp
Soil Condition: loose
Soil Tilth: fine
Weather at application: Overcast
Air temperature (Deg. C): 13
Soil temperature (Deg. C): 13
Wind (kph): 5 - northwest
Cloud cover (%): 50
Comment: Very dry soil conditions

T2

Date: 13.05.2009
Crop Stage: crop 40% emerged
Leaf Moisture: dry (weed)
Soil Moisture (Surface): dry
Soil Moisture (Sub-surface): damp
Soil Condition: loose
Soil Tilth: fine
Weather at application: Overcast
Air temperature (Deg. C): 15
Soil temperature (Deg. C): 13
Wind (kph): 3 - east
Cloud cover (%): 100
Comment: Very dry soil conditions – T2 delayed by windy conditions.

8.2.3.3. Weed levels in the untreated control.

The T0 application (24.04.2009) was made before weed emergence.

Weed species	Weeds / sq. m	Weed size
<i>Poa annua</i> (Annual meadow grass)	8	1 leaf
<i>Urtica urens</i> (Small nettle)	38	Cotyledon – 2 true leaf
<i>Stellaria media</i> (Chickweed)	15	Cotyledon – 2 true leaf
<i>Polygonum persicaria</i> (Redshank)	4	2 true leaf

TABLE 38. WEED LEVELS IN UNTREATED CONTROLS AT T1 APPLICATION – 03.05.2009. TRIAL C EAST WRETHAM, NORFOLK

The trial contained good levels of Small nettle and Chickweed, distributed very evenly over the trial area. Redshank and AMG levels were lower. Other BLW numbers were too low to compare herbicides, due to dry conditions.

Weed species	Weeds / sq. m	Weed size
<i>Poa annua</i> (Annual meadow grass)	10	2 tillers
<i>Urtica urens</i> (Small nettle)	38	4 true leaf
<i>Stellaria media</i> (Chickweed)	25	Cotyledon – 1cm across
<i>Polygonum persicaria</i> (Redshank)	4	3 true leaf

TABLE 39. WEED LEVELS IN UNTREATED CONTROLS AT T2 APPLICATION – 13.05.2009. TRIAL C EAST WRETHAM, NORFOLK

Weed species	Weed - % ground cover
<i>Poa annua</i> (Annual meadow grass)	5
<i>Urtica urens</i> (Small nettle)	15
<i>Stellaria media</i> (Chickweed)	3
<i>Polygonum persicaria</i> (Redshank)	5

TABLE 40. WEED LEVELS IN UNTREATED CONTROLS AT ASSESSMENT – 02.06.2009. TRIAL C EAST WRETHAM, NORFOLK