

Project title: Lettuce: Screening of existing and new products for weed control

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PRACTICAL SECTION FOR GROWERS

This is the first season of a two-year screening programme and although we can identify novel treatments warranting further assessment, we cannot advise growers to use these treatments without a further year's assessment. Furthermore, the novel treatments may not have suitable approval for use in lettuce crops.

EXPERIMENTAL SECTION

A. GENERAL INFORMATION

This report covers the first season of a two season programme examining the potential of new programmes and herbicides for use in lettuce. Weed control in lettuce is limited by the very restricted range of herbicide products approved for use on the crop. The programme consists of a large herbicide season in 1997 from which a range of novel treatments are selected for potential safety to lettuce. These will be tested on larger scale plots in trials in 1998 to confirm their safety and confirm their value in terms of weed control. From these tests a final decision will be as to which treatments are worth pursuing in terms of developing Off-label Approvals or Full Approvals.

B. SCREENING OF HERBICIDE TREATMENTS ON LETTUCE

Introduction

Weed control in lettuce is limited by the very restricted range of herbicide products approved for use on the crop. The experimental programme of this project is designed to discover novel treatments that could improve the range of products and combinations of products available, and the range of timings that herbicides can be applied to the crop. Currently most products approved are only active before weed emergence. The first season of the project (1997) concentrates on a screening procedure, from which promising treatments are selected to go forward to larger scale grower-based trials in 1998. If such trials confirm the safety of such treatment(s), then this can lead to recommendations for new programmes, or the consideration for development of off-label approvals for new herbicides. The experimental programme has concentrated on transplanted lettuce as this now dominates the market.

Materials and Methods

Site: Balmaalcolm Farm, Kingskettle, Cupar, Fife KY15 7TJ

Grower: Mr A Samson

Soil type: SZL

Design: The experimental design was of two replicate randomised blocks, separated by a guard-bed. The whole trial was separated from the commercial lettuce crop by guard-beds. Plots were 2 m wide across the beds (4 rows of lettuce), allowing 20 plants to be treated with each treatment replicate. There were 50 experimental treatments.

Crop: The trial was undertaken in a transplanted commercial crop of lettuce cultivar: Saladin, planted on 23 May 1997 and harvested on 17 July 1997. The crop received routine fertiliser and pesticide treatments apart from herbicides. There was no irrigation required due to heavy rainfall in late May and throughout June. Temperatures and solar radiation over the period were below normal.

Treatments: Treatments tested are listed in the table below. Product details are given in Table 6. Pre-plant treatments were applied 2 days before the crop was planted. Post-plant/pre-weed emergence treatments were applied 4 days after the crop was planted. The weeds were at cotyledon to two leaf stages at the post-plant/post-weed emergence treatments timing, 12 days after the crop was planted. All treatments planned were applied apart from no. 37 (Ramrod Flo then Debut) due to the failure in getting the novel herbicide Debut in time. A further Ramrod Flo then Fortrol treatment was included as indicated in Table 1.

Table 1 Lettuce herbicide screen, Balmaalcolm Farm, Kingskettle, Fife

Treatment list

No.	Pre-planting	Post-planting / pre-weed emergence (product dose)*	Post-weed emergence (product dose)*
1	Untreated	Untreated	Untreated
2	Untreated	Untreated	Untreated
3	Untreated	Ramrod Flo (6)	Hand weeding
4	Treflan (1.2)	Kerb Flo (3)	Hand weeding
5	Treflan (1.2)	Ramrod Flo (6)	Untreated
6	Treflan	Ramrod Flo (3) + Kerb (1.8)	Untreated
7	Treflan (1.2)	Sovereign (4) + Ramrod Flo (2)	Untreated
8	Treflan (1.2)	CIPC (4) + Kerb Flo (1.8)	Untreated
9	Treflan (1.2)	Butisan S (1.25)	Untreated
10	Treflan (1.2)	Butisan S (2.5)	Untreated
11	Treflan (1.2)	Untreated	Butisan S (1.5)
12	Treflan (1.2)	Untreated	Butisan S (2.5)
13	Treflan (1.2)	Flexidor (0.3)	Untreated
14	Treflan (1.2)	Flexidor (0.6)	Untreated
15	Untreated	Ramrod Flo (3) + Comodor (2)	Untreated
16	Untreated	Ramrod Flo (3) + Comodor (4)	Untreated
17	Untreated	Flexidor (0.3) + Sovereign (2)	Untreated
18	Untreated	Flexidor (0.6) + Sovereign (4)	Untreated
19	Untreated	Flexidor (0.3) + Ramrod Flo (3)	Untreated
20	Untreated	Flexidor (0.3) + Ramrod Flo (6)	Untreated
21	Untreated	Flexidor (0.6) + Ramrod Flo (6)	Untreated
22	Untreated	Sovereign (3)	Butisan S (1.5)
23	Untreated	Sovereign (4)	Butisan S (2.5)
24	Untreated	Untreated	Gesagard (1.7) + Butisan S (1.25)
25	Treflan (1.2)	Untreated	Gesagard (2.3) + Butisan S (2.5)
26	Untreated	Ramrod Flo (3) + Gesagard (1.7)	Untreated
27	Untreated	Ramrod Flo (6) + Gesagard (2.3)	Untreated
28	Ardent (1.5)	Untreated	Untreated
29	Ardent (2.5)	Untreated	Untreated
30	Untreated	Ardent (1.5)	Untreated
31	Untreated	Ardent (2.5)	Untreated
32	Untreated	Untreated	Capture (0.75)
33	Untreated	Untreated	Capture (1.5)
34	Untreated	Ardent (2.5)	Semeron (1.1)
35	Untreated	Untreated	Semeron (1.1)
36	Untreated	Untreated	Semeron (1.7)
37	Untreated	Ramrod Flo (6)	Fortrol (1)
38	Untreated	Untreated	Fortrol (1)
39	Untreated	Untreated	Betanal E (3.5)
40	Untreated	Untreated	Carbetamex (1.5)
41	Untreated	Untreated	Carbetamex (3)
42	Untreated	Ramrod Flo (6)	Prospect (15)
43	Untreated	CIPC (4)	Butisan S (1.5)
44	Untreated	CIPC (4)	Butisan S (2.5)
45	Untreated	CIPC (4) + Flexidor (0.15)	Untreated
46	Untreated	CIPC (4) + Ramrod Flo (3)	Untreated
47	Untreated	Ramrod Flo (3)	Capture (0.75)
48	Untreated	Ramrod Flo (6)	Capture (1.5)
49	Untreated	Sovereign (2)	Capture (0.75)
50	Untreated	Sovereign (4)	Capture (1.5)

*kg or l/ha

All treatments were applied by Azo propane-pressurised knapsack sprayer calibrated to deliver 200 ℓ/ha at 2.4 bars through medium-spray classification (BCPC) T8003 Nozzles.

Assessments

Crop damage (scorch) was assessed on 13 June and overall scorch/necrosis damage on 25 June and 16 July. A more detailed assessment of foliar necrosis, crop colour and vigour reduction was made on 3 July. A final weed ground cover score was undertaken on 16 July, just prior to the commercial harvest. There was no opportunity for a differential harvest because of the grower's requirements. Smaller lettuce otherwise having recovered from treatments, effectively indicates a delay in harvest, and that has been taken as a factor that precludes the acceptance of that screened treatment from further testing.

The lettuce remaining in the plot centre (nine plants maximum) were cut by hand and sorted into three categories:

- I Dense, and weighing at least 500 g
- II Less dense, poorer shape and weighing at least 500 g
- III Unmarketable

All data was subjected to statistical analysis of variance, and standard errors (SE) and least significant differences (LSD) are given in the tables.

Results

Weed control

Table 2 gives the percent weed ground cover just before harvest on 17 July. The site was not particularly weedy, and weeds were very patchily distributed (note LSDs), so little can be made of this limited experimentation, and detailed analysis would be misleading. The main purpose of the trial was to evaluate crop tolerance, and the weed spectrum of the established and experimental products is well known. However, the most active treatments in this experiment were those containing Capture, Flexidor and Gesagard + Butisan S or Butisan post-weed emergence, along with some individual treatments, eg Ramrod/Fortrol sequences. Sovereign/Capture and Sovereign/Butisan S sequences were also very active. Amongst less active sequences may be included standards such as Treflan/Kerb Flo and Treflan/Sovereign + Ramrod Flo plus, for example, low dose Ardent treatments alone, Flexidor + Ramrod Flo, CIPC + Ramrod Flo, low dose Semeron, Trifluralin/Flexidor, Ramrod Flo + Comodor. In some cases variation in weed cover between replicates is very high.

Crop Tolerance

Table 3 gives the crop scorch visible by 13 June (12 days after final treatments) and chlorosis on 25 June, and an overall assessment of damage in terms of growth reduction within the plot just before harvest. Table 4 gives the more detailed assessment of leaf necrosis colour and vigour reduction on 3 July.

Early crop scorch: Severe crop scorch was seen with all Capture, Gesagard + Butisan treatments and high doses of Ramrod + Gesagard, Ardent/Semeron, Ramrod/Fortrol and Ramrod/Prospect. Fortrol alone gave a marginally unacceptable level of scorch.

Necrosis and Discolouration: General foliar necrosis was particularly severe amongst the same range of treatments listed above as giving severe scorch, plus Sovereign/Butisan sequence and Semeron, both at high dose. The standard, Treflan/Butisan sequences also gave unsatisfactory levels of necrosis at the higher dose tested.

Amongst these showing little or no discolouration (>8.5 colour assessment) or necrosis (<5% necrosis) were:

Treatment	Dose, kg or l/ha	Treatment number
<u>Standard</u>		
Standard treatments	-	4-8
<u>New Approaches</u>		
Ramrod Flo + Comodor	3 + 2	15
Flexidor + Sovereign	0.3 + 2; 0.6 + 4	17; 18
Flexidor + Ramrod Flo	0.3 + 3; 0.3 + 6; 0.6 + 6	19; 20; 21
Ardent (pre-planting)	1.5; 2.5	28; 29
Ardent (post-planting)	1.5; 2.5	30; 31
Semeron	1.1	35
Betanal E	3.5	39
Carbetamex	1.5; 3	40; 41
CIPC + Ramrod Flo	4 + 3	46
CIPC/Butisan S	4; 1.5	43
More marginal treatments included:		
Treflan/CIPC + Kerb Flo	1.2; 4 + 1.8	8
Treflan/Flexidor	1.2; 0.3; 1.2; 0.6	13; 14
Ramrod Flo + Comodor	3 + 4	16
Ramrod Flo + Gesagard	3 + 1.7	26
CIPC/Butisan S	4/2.5	44

Vigour Reduction: Vigour reduction assessments on 3 July are a combination of poor growth and of a slowing of growth, although crop colour may be satisfactory. Of

the treatments listed above as showing satisfactory appearance, the following showed unacceptable vigour reduction (>15%):

Treatment	Dose, kg or ℓ/ha	Treatment number
Treflan/Flexidor	1.2; 0.6	14
Ramrod Flo + Gesagard	3 + 1.7	26
CIPC/Butisan S	4/2.5	44

Marginal (>10% vigour reduction) were:

Treatment	Dose, kg or ℓ/ha	Treatment number
Flexidor + Sovereign	0.3 + 2/0.6 + 4	17/18
Semeron	1.1	35
Betanal E	3.5	39
Treflan/Flexidor	1.2/0.3	13
Ramrod Flo + Comodor	4 + 4	16

Of these products, only the CIPC/Butisan S (44) sequence seem to show increasing vigour reduction before harvest (16 July assessment), whilst amongst the standards, increased vigour reduction was noted for Treflan/Kerb Flo (4), Treflan/Ramrod Flo (5) and Treflan/Ramrod Flo + Kerb Flo (6) - although not to unacceptable levels.

Harvest assessments (Table 5): The yield assessment of small plot screening trials is by its nature subject to high levels of variation. Missing plants have a big impact on total yield, but may be missing due to factors other than that of herbicide treatment. Nevertheless in some cases missing plants are clearly due to herbicide effects. Ignoring treatments with more than three missing plants, the following treatments gave yields similar to untreated plots and standards, and well within significance.

Treatment	Dose, kg or ℓ/ha	Treatment number
<u>Standards (5-8)</u>		
Treflan/Ramrod Flo/Kerb Flo	1.2/3/1.8	6
Treflan/Sovereign + Ramrod Flo	1.2/4 + 2	7
Treflan/CIPC + Kerb Flo	1.2/4 + 1.8	8

Treflan/Kerb Flo (4)* and Treflan/Ramrod Flo (5)* gave indications of increased plant numbers in Category III, and some increases in missing plants.

New Approaches

Amongst the new treatments tested, the highest yields, equivalent to standards, excluding Treflan/Kerb Flo (4⁺) and Treflan/Ramrod Flo (5⁺) treatments, were from the Ardent treatments (28, 29, 30, 31).

If the means of standard treatment 4⁺ and 5⁺ are included, then the following new treatments gave as good yields:

Treatment	Dose, kg or ℓ/ha	Treatment number
Treflan/Butisan S	1.2/1.25	9
Treflan/Flexidor	1.2/0.3	13
Treflan/Flexidor	1.2/0.6	14
Ramrod Flo + Comodor	3 + 2	15
Ramrod Flo + Comodor	3 + 4	16
Flexidor + Sovereign	0.6 + 4	18
Flexidor + Ramrod Flo	0.2 + 6	20
Flexidor + Ramrod Flo	0.6 + 6	21
Ramrod Flo + Gesagard*	3 + 1.7	26
Betanal E	3.5	39
Carbetamex	1.5	40
Carbetamex	3	41
CIPC + Ramrod Flo	4 + 3	46

*higher dose very damaging

Of these, CIPC + Ramrod Flo had one or more plants in Category III per plot.

Selecting on the basis of ratios of Category I and II plants has not proven helpful because of the variation between the standard treatments. However, the products listed above tended to have similar ratios to the standards.

Delayed Maturity: Other products that gave overall lower yields than the standards, but had a low level of losses or discards, and a similar category ratio, were affected by the requirements to harvest on a given date. These treatments could be considered to have delayed an otherwise acceptable harvest; eg Sovereign/Butisan S (3/1.5) (22).

Marketable Head Weights

The treatments that gave lettuce head weights in Categories I and II similar to those of untreated and standard treatments, and amongst these giving highest overall plot yields, were:

Treatment	Dose, kg or ℓ/ha	Treatment number
Ramrod Flo + Comodor	3 + 4	16
Flexidor + Sovereign	0.3 + 2	17
Flexidor + Ramrod Flo	0.3 + 3/0.6 + 6	19/20
Ramrod Flo + Gesagard	3 + 1.7	26
Ardent treatments	all doses	28-31

C. DISCUSSION

The interpretation of data collected in small plot screening experiments is difficult because of the variation that can occur within a site, and in particular the interpretation of the weed control data in this case. The trial was principally designed, however, to look for novel alternative herbicide treatments and programmes, and crop tolerance was the unknown factor. None of the herbicides tested were completely novel, and their weed control potential is understood from their commercial labels and previous research and use in other crops. This site did not have a high weed population this year, and species distribution was so patchy as to make species by species control assessment impossible. So an overall assessment is given, and the variation within that makes interpretation difficult. As a consequence we list the label weed control recommendations of the herbicides we have selected for further testing as Appendix 1 rather than to discuss in detail the weed control results here.

The crop tolerance data indicates a list of herbicide products and programmes worth further examination, and this has been refined by the harvest assessment. Once again the validity of yield data on such small plots is open to debate, but we have selected treatments with clearly levels of safety similar to that of the standards.

The step-by-step assessment presented in the Results section above suggests the following treatments require further evaluation:

1. Ardent pre-planting and post-planting
2. Ramrod Flo + Comodor post-planting
3. Flexidor + Sovereign post-planting
4. Flexidor + Ramrod Flo post-planting
5. Ramrod Flo + Gesagard post-planting, low dose

of these treatments, Ramrod Flo + Gesagard was very severe on the crop at the higher dose treated, and perhaps has not got a great enough safety margin.

Other treatments of which we are slightly more uncertain as to their selectivity include:

1. Carbetamex post-planting
2. CIPC + Ramrod Flo post-planting
3. Treflan/Butisan S sequence (low dose)
4. Trifluralin/Flexidor sequence
5. Betanal E post-planting

of these Carbetamex, Butisan S and, especially, Betanal E are of interest because of their post-emergence weed activity.

A further exercise undertaken was to give a point score to each of several beneficial features, with a total indicating the overall safest treatments. The features included early scorching, necrosis, vigour reduction, yield assessments and number of marketable plants. On that basis the best treatments with scores out of a potential of 14 are given in Table below:

Treatment	Dose, kg or ℓ/ha	Treatment number
<u>13/14 Score</u>		
1. Untreated		
2. Treflan/Sovereign + Ramrod Flo	1.2/4 + 2	7
3. Treflan/CIPC + Kerb Flo	1.2/4 + 1.8	8
4. Ardent pre-planting	1.5	28
5. Ardent pre-planting	2.5	29
6. Ardent post-planting	1.5	30
7. Ardent post-planting	2.5	31
8. CIPC + Ramrod	4 + 3	46
<u>11/12 Score</u>		
9. Hand-weeded	-	3
10. Treflan/Ramrod Flo	1.2/6	5
11. Treflan/Ramrod Flo + Kerb Flo	3 + 1.8	6
12. Flexidor + Sovereign	0.6 + 4	18
13. Ramrod + Comodor	3 + 2	15
14. Flexidor + Ramrod Flo	0.2 + 6	20
15. Flexidor + Ramrod Flo	0.6 + 6	21
16. Carbetamex	1.5	40
17. Carbetamex	3	43
<u>9/10 Score</u>		
18. Treflan/Kerb Flo	1.2/3	4
19. Treflan/Flexidor	1.2/0.3	13
20. Ramrod Flo + Comodor	3 + 4	16
21. Betanal E	3.5	39

It is to be noted on this scale that the standard Treflan/Kerb Flo had a relatively low score due to reduced yield, and Ramrod Flo + Gesagard has a good yield, but was marked down on early symptoms and the severe effect of higher doses and so does not appear on the list above. Trifluralin/Butisan S sequences do not appear, even at low doses, due to early discolouration.

D. CONCLUSIONS

We suggest, therefore, that future research should concentrate on novel programmes based on:

Ardent
Ramrod Flo + Comodor
Flexidor + Sovereign
Flexidor + Ramrod
Treflan/Flexidor

with further evaluation of:

Carbetamex
Betanal E

These two have been included because of potential post-emergence activity.

The following products are considered too damaging: Capture, Fortrol and Prospect.

Semeron and Butisan S at low doses may be selective in certain sequences - and of these the post-emergence activity of Semeron would be the more interesting, but some discolouration was seen in this trial.

E. RECOMMENDED PROGRAMME OF TREATMENTS FOR 1998

The following herbicide programmes are recommended for testing in the 1998 trials:

1.	Ardent + Ramrod Flo post-planting	2.5 + 6 l/ha
2.	Ardent pre-planting	2.5 l/ha
3.	Ramrod Flo + Comodor post-planting	3 + 2 l/ha
4.	Flexidor + Sovereign post-planting	0.6 + 4 l/ha
5.	Flexidor + Ramrod post-planting	0.6 + 6 l/ha
6.	Treflan/Flexidor pre-planting/post-planting	1.2 + 0.6 l/ha
7.	Ramrod Flo/Kerb Flo post-planting followed by Betanal E early post-weed emergence	3 + 1.8 l/ha 3.5 l/ha
8.	Carbetamex post-planting	3 kg/ha
9.	Ramrod Flo/Kerb Flo post-planting standard	3 + 1.8 l/ha 1.2/2.5 l/ha
10.	Untreated	

Trials will be undertaken on a high organic matter (peaty) and a low organic matter site.

F. ACKNOWLEDGEMENTS

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Table 2 HDC lettuce herbicide trial, Balmalcolm, Kingskettle, Fife

Weed control assessment

Treatment No.	% Ground cover Weeds 16/07/97	% Weed Control 16/07/97
1	21.00	55.0
2	12.50	42.5
3	12.50	85.0
4	11.00	82.0
5	6.50	97.0
6	9.00	82.5
7	20.00	50.0
8	7.50	90.0
9	10.50	92.5
10	7.50	99.0
11	5.00	95.0
12	3.50	99.0
13	15.00	40.0
14	4.50	100.0
15	10.00	92.5
16	12.50	69.0
17	11.00	84.5
18	9.00	76.0
19	3.50	95.5
20	12.50	96.0
21	11.00	90.0
22	2.00	98.5
23	1.55	100.0
24	2.00	99.0
25	1.05	100.0
26	4.00	99.5
27	6.00	94.5
28	20.00	62.5
29	19.00	7.5
30	15.00	45.0
31	16.00	32.5
32	2.50	100.0
33	1.50	99.5
34	8.50	92.5
35	13.50	80.0
36	9.00	75.0
37	0.50	100.0
38	2.50	100.0
39	7.50	75.0
40	12.50	87.5
41	7.50	77.5
42	11.50	85.0
43	7.50	99.5
44	3.50	99.0
45	5.00	92.5
46	12.50	87.5
47	4.00	98.0
48	3.50	99.0
49	3.50	100.0
50	1.00	100.0
Mean	8.39	84.0
SE	3.60	10.1
LSD	10.22	28.7

Table 3 HDC lettuce herbicide screen, Balmalcolm Farm, Kingskettle, Fife

Crop tolerance

Treatment No.	% Crop damage 13/06/97	% Crop damage 25/06/97	% Crop damage 16/07/97
1	0.0	0.0	0.00
2	0.0	0.0	1.50
3	0.0	2.5	1.00
4	5.0	2.5	9.00
5	5.0	12.5	9.00
6	0.0	0.0	10.00
7	0.0	0.0	0.00
8	0.0	0.0	0.00
9	0.0	0.0	7.50
10	0.0	12.5	50.00
11	0.0	0.0	7.50
12	0.0	20.0	17.50
13	4.0	0.0	0.00
14	0.0	2.5	14.00
15	0.0	0.0	3.50
16	0.0	0.0	0.00
17	0.0	10.0	11.00
18	0.0	0.0	4.00
19	0.0	0.0	7.50
20	0.0	2.5	2.50
21	0.0	0.0	0.00
22	0.0	5.5	4.05
23	4.0	25.0	24.00
24	32.5	77.5	70.00
25	50.0	80.0	65.00
26	0.0	0.0	9.00
27	60.0	79.5	65.00
28	0.0	0.0	0.00
29	0.0	0.0	0.00
30	0.0	0.0	0.00
31	0.0	0.0	0.00
32	45.0	80.0	40.00
33	52.5	80.0	52.50
34	32.5	65.0	50.00
35	0.0	5.0	1.50
36	7.5	10.0	19.00
37	20.0	52.5	45.00
38	13.5	42.5	40.00
39	1.0	0.0	7.50
40	0.0	0.0	0.00
41	0.0	0.0	16.00
42	51.5	82.5	80.00
43	40.0	40.0	35.00
44	0.0	2.5	20.00
45	9.0	15.0	7.50
46	0.0	5.0	5.50
47	65.0	80.0	70.00
48	42.5	47.5	41.50
49	55.0	67.5	50.00
50	80.0	87.5	80.00
Mean	13.5	21.9	21.07
SE	11.4	10.9	10.72
LSD	32.5	30.9	30.47

Table 4

Lettuce herbicide screen, Balmaicolm Farm, Kingskettle, Fife

Crop Tolerance 03/07/97

Treatment No.	% Foliar Necrosis	Colour 0-9 (9 = Good)	% Vigour Reduction
1	1.5	8.50	2.5
2	0.0	9.00	0.0
3	1.5	8.75	5.0
4	2.5	8.50	6.5
5	20.0	8.50	10.0
6	1.0	8.50	2.5
7	0.0	8.75	0.0
8	0.0	8.00	8.0
9	1.0	7.75	13.5
10	12.5	7.25	37.5
11	4.0	7.50	20.5
12	6.0	7.25	26.5
13	0.0	8.25	14.0
14	2.5	8.00	17.5
15	1.5	8.50	4.0
16	1.5	8.00	10.5
17	4.0	7.00	21.5
18	0.0	8.50	12.5
19	1.0	8.50	9.5
20	4.0	8.50	8.5
21	0.0	8.75	3.5
22	2.5	7.50	21.5
23	35.0	7.00	30.0
24	80.0	5.00	50.0
25	84.0	6.00	50.0
26	0.0	8.25	16.5
27	82.5	5.00	46.5
28	0.0	8.75	1.0
29	0.0	9.00	0.0
30	0.0	9.00	8.5
31	0.0	8.50	6.5
32	74.0	5.00	34.0
33	76.5	5.00	49.0
34	79.0	4.50	42.5
35	1.0	8.50	10.0
36	36.5	7.75	25.0
37	77.5	5.50	35.0
38	57.5	6.50	29.0
39	1.5	9.00	15.0
40	0.0	8.75	4.0
41	0.0	8.50	5.5
42	80.0	4.00	70.0
43	42.5	7.00	22.5
44	5.0	8.00	19.0
45	4.0	7.75	24.0
46	0.0	8.75	4.0
47	71.5	5.50	50.0
48	47.5	6.00	46.5
49	76.5	5.50	37.5
50	82.5	4.00	55.0
Mean	23.2	7.43	20.8
SE	11.0	0.58	7.2
LSD	31.2	1.66	20.4

Table 5 HDC lettuce herbicide screen, Balmaicolm Farm, Kingskettle, Fife

Yield Assessments by Categories 16/07/97 (kg/plot)

Treatment No.	Weight Cat I	Weight Cat II	Weight Cat III	Total Weight	No. Cat I	No. Cat II	No. Cat III	Total No.
1	3.375	4.050	0.000	7.4250	4.0	5.0	0.0	9.0
2	3.725	4.400	0.000	8.1250	4.5	5.0	0.0	9.5
3	2.700	3.600	0.000	6.3000	3.5	5.5	0.0	9.0
4	2.000	3.500	0.950	6.4500	2.5	4.5	2.0	9.0
5	2.050	5.025	0.000	7.0750	2.5	5.5	0.0	8.0
6	3.025	4.100	0.000	7.1250	3.5	5.0	0.0	8.5
7	1.625	5.800	0.900	8.3250	2.0	6.5	1.0	9.5
8	3.800	4.625	0.000	8.4250	4.5	5.5	0.0	10.0
9	1.975	4.350	0.000	6.3250	3.0	6.5	0.0	9.5
10	1.375	2.125	1.300	4.8000	2.0	3.0	4.0	9.0
11	1.125	2.350	2.300	5.7750	1.5	3.5	4.5	9.5
12	0.000	1.700	2.675	4.3750	0.0	2.5	7.5	10.0
13	1.800	4.650	0.000	6.4500	2.5	6.5	0.0	9.0
14	2.600	3.900	0.100	6.6000	3.5	6.0	0.5	10.0
15	3.850	2.450	0.000	6.3000	5.5	3.5	0.0	9.0
16	2.900	3.725	0.000	6.6250	3.5	5.5	0.0	9.0
17	1.150	2.150	1.975	5.2750	1.5	3.5	4.5	9.5
18	2.075	4.300	0.000	6.3750	2.5	5.5	0.0	8.0
19	2.050	3.850	0.075	5.9750	2.5	5.5	0.5	8.5
20	2.325	4.025	0.125	6.4750	3.0	6.0	0.5	9.5
21	0.800	5.775	0.000	6.5750	1.0	7.0	0.0	8.0
22	3.275	0.800	0.850	4.9250	5.5	1.5	3.0	10.0
23	1.450	1.125	0.850	3.4250	2.0	2.0	4.0	8.0
24	0.000	0.275	1.300	1.5750	0.0	0.5	6.0	6.5
25	0.000	1.050	0.950	2.000	0.0	3.5	3.5	7.0
26	3.400	3.125	0.500	7.0250	4.0	4.5	1.0	9.5
27	0.000	2.350	0.000	2.3500	0.0	3.0	0.0	3.0
28	3.025	4.875	0.500	8.4000	3.5	5.5	0.5	9.5
29	3.175	4.575	0.000	7.7500	3.5	5.5	0.0	9.0
30	2.850	4.675	0.125	7.6500	3.5	5.5	0.5	9.5
31	3.200	3.275	0.000	6.4750	4.5	5.0	0.0	9.5
32	0.000	0.825	2.125	2.9500	0.0	1.0	6.5	7.5
33	0.000	0.000	1.675	1.6750	0.0	0.0	5.5	5.5
34	0.000	0.800	1.600	2.4000	0.0	1.5	6.0	7.5
35	0.775	3.950	0.550	5.2750	1.0	6.5	1.5	9.0
36	0.750	2.300	2.125	5.1750	1.0	3.5	5.0	9.5
37	0.000	1.600	0.975	2.5750	0.0	2.0	3.0	5.0
38	0.400	1.250	1.775	3.4250	0.5	1.5	4.5	6.5
39	1.350	4.700	0.150	6.2000	2.0	7.5	0.5	10.0
40	2.725	3.450	0.300	6.4750	4.0	5.0	0.5	9.5
41	3.675	2.500	0.200	6.3750	5.0	3.5	0.5	9.0
42	0.000	0.000	1.025	1.0250	0.0	0.0	5.5	5.5
43	1.150	3.050	0.375	4.5750	1.5	5.0	1.5	8.0
44	1.050	0.850	1.175	3.0750	2.0	1.5	4.0	7.5
45	0.900	4.175	0.750	5.8250	1.0	6.0	2.0	9.0
46	3.075	2.650	0.550	6.2750	4.5	3.5	1.0	9.0
47	0.000	0.000	1.450	1.4500	0.0	0.0	4.5	4.5
48	1.400	1.875	0.600	3.8750	1.5	3.0	2.0	6.5
49	0.000	0.950	1.675	2.6250	0.0	1.5	6.0	7.5
50	0.000	0.000	1.075	1.0750	0.0	0.0	5.5	5.5
Mean	1.679	2.830	0.713	5.2215	2.2	3.9	2.2	8.3
SE	0.789	0.899	0.452	0.8730	1.1	1.3	1.1	1.0
LSD	2.241	2.554	1.286	2.4809	3.1	3.7	3.2	2.7

Table 6 Product Details

Product	Active ingredients	Manufacture	Formulation	MAFF Number
ATLAS CIPC 40	chlorpropham	Atlas	400 g/l EC	7710
ARDENT	diflufenican + trifluralin	RP Agric	40 + 400 g/l EC	4248
BETANALE	phenmedipham	AgrEvo	114 g/l EC	7248
BUTISAN S	metazachlor	BASF	500 g/l SC	0357
CAPTURE	diflufenican + bromoxynil + ioxynil	RP Agric	50 + 300 + 200 g/l EC	6881
CARBETAMEX	carbetamide	RP Agric	70% w/w WP	6186
COMODOR 600	tebutam	Agrichem	600 g/l EC	6808
FLEXIDOR 125	isoxaben	DowElanco	125 g/l SC	5104
FORTROL	cyanazine	Cyanamid	500 g/l SC	7009
GESAGARD 50 WP	prometryn	Novartis	50% w/w WP	0981
KERB 50 W	propyzamide	PBI	50% w/w WP	1133
PROSPECT	thifensulfuron-methyl	DuPont	75% w/w WB	6541
RAMROD FLO	propachlor	Monsanto	480 g/l SC	1688
SEMERON 25 WP	desmetryn	Novartis	25% w/w WP	1916
SOVEREIGN	pendimethalin	Novartis	400 h/l SC	8152
TREFLAN	trifluralin	DowElanco	480 g/l EC	5817

APPENDIX Weed control label recommendations for candidate lettuce herbicide programmes

Weed	Residuals (Pre-em weeds)				Residual + Post-em Weeds			Contact	
	Flexidor + Sovereign	Ramrod + Comodor	Ramrod + Flexidor	Treflan/ Flexidor	Ardent* S/MS	Carbetamex	Betanal E	Semeron	
Annual Meadow-grass	S	S	S	S	S/MS	S	-	-	
Annual Mercury	-	MS	-	S	-	-	-	-	
Black-bind-weed	(S)	MS	-	S	-	-	S	-	
Black-grass	-	S	S	(MS)	(MS)	S	-	S	
Black nightshade	(MS)	MS	MS	-	-	-	S	S	
Bugloss	-	-	-	-	-	-	S	MS	
Charlock	S	-	S	S	-	-	S	-	
Cleaver	(MS)	S	S	(MS)	MS	[S]	-	-	
Common chickweed	S	S	S	S	S	S	S	S	
Common field speed well	S	S	S	S	S	S	S	MS	
Common fumitory	S	-	S	S	MS	[S]	S	S	
Common hemp-nettle	S	S	S	S	-	-	S	S	
Common orache	S	-	-	MS	-	-	S	S	
Common poppy	S	S	S	S	S	-	S	S	
Corn marigold	S	S	S	S	-	[S]	S	S	
Corn spurrey	S	S	S	S	-	[S]	S	S	
Fat-hen	S	-	-	S	-	-	-	-	
Field forget-me-not	S	S	S	S	S	-	S	-	
Field pansy	S	-	-	S	S	-	S	-	
Field penny-cross	-	-	-	-	S	-	MS	-	
Gallant soldier	-	S	S	-	S	-	-	-	
Groundsel	S	S	S	S	-	-	S	MS	
Henbit deadnettle	S	(MS)	MS	S	-	-	-	(MS)	
Ivy-leaved speedwell	S	-	S	S	-	S	MS	-	
Knotgrass	S	S	S	S	-	[S]	MS	S	
Pale persicaria	-	-	-	S	-	-	MS	-	
Pineapple weed	S	S	S	S	MS	-	S	-	
Red deadnettle	S	S	S	S	-	-	MS	S	
Redshank	S	-	S	S	-	-	MS	S	
Scarlet pimpernel	S	S	S	S	MS	-	-	-	
Scentless mayweed	S	S	S	S	-	-	-	-	
Sheep's sorrel	-	-	-	-	-	-	-	-	
Shepherd's purse	S	S	S	S	S	-	MS	-	
Small nettle	S	S	S	S	-	[S]	S	S	
Smooth sow-thistle	S	S	MS	-	-	-	-	-	
Sun spurge	-	-	-	-	-	-	-	-	
Volunteer rape	S	-	S	S	MS	-	-	-	
Wild-oat	-	MS	-	MS	-	S	-	-	
Wild radish	S	-	S	S	S	-	S	MS	

S = susceptible; MS = moderately susceptible; () = susceptibility expected by author; * = has only been tested as an autumn treatment; [] = pre-emergence only