Project title:	**Chinese leaf: Screening of existing and new products for weed control**
Report:	**Annual Report (1997)**
Project Number:	**FV 197**
Joint project leader:	**(i) D H K Davies SAC Crop Systems Bush Estate Penicuik Midlothian EH26 0PH** **(ii) A Greenfield Weed Control and Horticulture Consultancy 16 Little Lees Charlbury Oxford OX7 3HB**
Location:	**Year 1: Boghall Farm, nr Edinburgh**
Project co-ordinator:	**Mr Peter Barton**
Date commenced:	**1 February 1997**
Date completed:	**31 January 1999**
Keywords:	**Chinese leaf, weeds, herbicides, crop tolerance, screening**

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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 will not have suitable approval for use in Chinese Leaf crops.

The current OLA for Ramrod Flo appears to be safe to the crop from this trial but should not be used in sequence with a trifluralin product pre-planting.

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 Chinese leaf. Weed control in Chinese leaf is limited by the very lack of herbicide products approved for use on the crop. The programme consists of a large herbicide screen in 1997 from which a range of novel treatments are selected for potential safety to Chinese leaf. 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 CHINESE LEAF

Introduction

Weed control in Chinese leaf is limited to a single approved herbicide use, and that is fluazifop-p-butyl which has a very restricted spectrum of control of grass weeds. There has recently been given Off-label Approval (OLA) for use of Ramrod Flo for broad-leaf weed control. The experimental programme of this project is designed to discover novel herbicide treatments that could be developed as approved treatments, and combinations of treatments, for broad-leaved weed and annual meadow-grass control in Chinese leaf. 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 treatments, then this can lead to recommendations for consideration of label or off-label approvals for these treatments. The experimental programme has concentrated on transplanted Chinese leaf as this is the preferred growing technique, reducing the chance of bolting in this crop.

Materials and Methods

Site: Boghall Farm, Bush Estate, Penicuik, Midlothian EH26 0PH

Grower: SAC Crop Systems

Soil type: SL

Design: Two replicate randomised blocks separated by an untreated guard bed, with guard beds at either side of the trial area. Plots were 2 m wide across the beds of four rows of Chinese leaf, allowing circa 20 plants to be treated within each treatment replicate. There were 50 experimental treatments.

Crop: Plants of Chinese leaf, cultivar Optiko F1 (Elsoms Seeds), were raised by Ravenswood Nursery, Cleghorn, Lanark, hardened, and transplanted into prepared beds on 18 June 1997, and harvested over the period 15 August - 28 August 1997, as marketable heads formed. 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 1997. Temperatures and solar radiation at this time were well below normal, and there was a serious concern that early bolting would occur. This actually occurred at very low levels (2/1000 plants) until the harvest period, when it was probably initiated by a very late attack of cabbage root fly. Harvesting was initiated once the attack was noticed as the crop was considered close to optimum timing.

Treatments: Treatments tested are listed in Table 1 below. Product details are given in Table 9. Pre-plant treatments were applied one day before the crop was planted (17 June 1997). Post-plant/pre-weed emergence were applied six days after the crop was planted (24 June 1997). The

weeds were at cotyledon to two leaf stages at the post-plant/post-weed emergence treatments timing, twenty days after the crop was planted (8 July 1997).

Assessments

Weed control assessments were undertaken about 4 and 8 weeks after treatment, by counts of weed plants by species/m². The data for the final assessment is presented in Table 6. Crop Damage as scorch and necrosis was assessed 2-3 weeks after treatment, and overall vigour reduction before harvest as % effects compared with untreated plots.

Yield data was collected over a two week period as heads become ready. The number of plants/plot harvested, yield per plot and per head were calculated, and a quality score given to surviving plants.

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

Table 1 HDC Chinese leaves herbicide screen, Boghall Farm, Bush Estate

Treatment list

No.	Pre-planting	Post-planting / pre-weed emergence	Post-weed emergence
1	Untreated	Untreated	Untreated
2	Untreated	Untreated	Untreated
3	Untreated	Ramrod Flo (6)	Untreated
4	Untreated	Untreated	Hand weeding
5	Treflan (1.2)	Ramrod Flo (3)	Untreated
6	Treflan (2.3)	Ramrod Flo (6)	Untreated
7	Treflan (1.2)	Kerb Flo (1.5)	Untreated
8	Treflan (2.3)	Kerb Flo (3)	Untreated
9	Treflan (1.2)	Butisan S (1.25)	Untreated
10	Treflan (2.3)	Butisan S (2.5)	Untreated
11	Treflan (1.2)	Flexidor (0.3)	Untreated
12	Treflan (2.3)	Flexidor (0.3)	Untreated
13	Treflan (1.2)	Sovereign (2)	Untreated
14	Treflan (2.3)	Sovereign (4)	Untreated
15	Treflan (1.2)	Untreated	Butisan S (1.25)
16	Treflan (2.3)	Untreated	Butisan S (2.5)
17	Treflan (1.2)	Untreated	Gesagard + Butisan S (0.9+0.63)
18	Treflan (2.3)	Untreated	Gesagard + Butisan S (1.2+1.25)
19	Treflan (2.3)	Untreated	Semeron (1.1)
20	Treflan (2.3)	Untreated	Cropter Steel + Semeron (5+ 0.55)
21	Treflan (2.3)	Untreated	Benazalox (1)
22	Treflan (2.3)	Untreated	Shield (0.3)
23	Treflan + Comodor (1.2+2)	Untreated	Untreated
24	Treflan + Comodor (2.3+4)	Untreated	Untreated
25	Devrinol + Treflan (2.1+2.3)	Untreated	Untreated
26	Untreated	Ramrod Flo + Comodor (3+2)	Untreated
27	Untreated	Ramrod Flo + Comodor (6+4)	Untreated
28	Untreated	Ramrod Flo + Gesagard (3+1.7)	Untreated
29	Untreated	Ramrod + Gesagard (6+2.3)	Untreated
30	Untreated	Ramrod + Dacthal (3+3)	Untreated
31	Untreated	Ramrod + Dacthal (6+6)	Untreated
32	Untreated	Ramrod Flo (6)	Benazalox (1)
33	Untreated	Ramrod Flo (6)	Galtak (1)
34	Untreated	Ramrod Flo (6)	Fortrol (1)
35	Untreated	Sovereign (2)	Untreated
36	Untreated	Sovereign (4)	Untreated
37	Untreated	Sovereign (2)	Butisan (1.25)
38	Untreated	Sovereign (4)	Butisan (2.5)
39	Untreated	Flexidor (0.3)	Untreated
40	Untreated	Flexidor (0.6)	Untreated
41	Untreated	Flexidor (0.6)	Benazalox (1)
42	Untreated	Ardent (1.5)	Untreated
43	Untreated	Ardent (2.5)	Untreated
44	Untreated	Butisan S (1.25)	SMA + Semeron (5+0.55)
45	Untreated	Untreated	Semeron (1.1)
46	Untreated	Untreated	Semeron (1.7)
47	Untreated	Untreated	Lentagran (2)
48	Untreated	Untreated	Croptex Steel (22.5)
49	Untreated	Untreated	Croptex Steel (33.5)
50	Untreated	Untreated	Fortrol (1)

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.

Results

Weed control

Table 2 gives the assessment of control of the major weeds of the site just before harvest. The patchiness of the weeds in small plot trials makes weed control assessments difficult, but treatments clearly giving good overall weed control include:

Treatment	Dose, kg or ℓ/ha	Treatment number
Hand-weeding	-	-
Treflan/Kerb Flo	1.2/1.5; 2.3/3	7; 8
Treflan/Flexidor	1.2/0.3; 2.3/0.3	11; 12
Treflan/Sovereign	2.3/4	14
Treflan/Gesagard + Butisan S	2.3/1.2 + 1.25	18
Treflan/Benazalox	2.3/1	21
Devrinol + Treflan	2.1 + 2.3	25
Ramrod Flo + Gesagard	3 + 1.7	28
Sovereign	2; 4	35; 36
Sovereign/Butisan S	4/2.5	38
Flexidor	0.3; 0.6	39; 41
Semeron	1.7	46

/denotes sequence; + denotes tank-mix

If oilseed rape control is not counted, then a number of other treatments also look promising, such as Treflan/Butisan S, Treflan/Semeron, Treflan/Shield, Treflan + Comodor, Ramrod Flo + Comodor, Ramrod Flo + Gesagard, Ramrod Flo + Dacthal and Sovereign/Butisan S.

Crop Tolerance

Table 3 gives the overall crop damage assessments at a range of timings after treatments. The overall assessments include necrosis and reduction in growth, except for the 11 August assessment which looked at vigour reduction alone. Necrosis or chlorosis symptoms had generally passed by this date, or dying plants had disappeared.

By five weeks after planting (24 July), the following treatments had shown good safety to the crop (<5% crop damage):

Treatment	Dose, kg or ℓ/ha	Treatment number
Untreated plots	-	-
Hand-weeding		
Treflan/Ramrod Flo	1.2/3; 2.3/6	5; 6
Treflan/Kerb Flo	1.2/1.5	7
Treflan/Sovereign	1.2/2	13
Treflan/Shield	2.3/0.3	22
Treflan + Comodor	1.2 + 2	23
Ramrod Flo + Comodor	3 + 2; 6 + 4	26, 27
Sovereign	2	35

Others showing <15% crop damage included:

Treatment	Dose, kg or ℓ/ha	Treatment number
Treflan/Butisan S	1.2/1.25; 2.3/2.5	9/16
Treflan/Benazalox	2.3/1	21
Treflan + Comodor	2.3 + 4	24
Treflan + Devrinol	2.3 + 2.1	25
Ramrod Flo + Dacthal	3 + 3	30
Ramrod Flo/Benazalox	6/1	32
Sovereign	4	36
Sovereign/Butisan S	2/1.25	37

The treatments showing <10% overall vigour reduction just before harvest include:

Treatment	Dose, kg or ℓ/ha	Treatment number
Untreated	-	-
Ramrod Flo	6	3
Treflan/Kerb Flo	1.2/1.5	7
Treflan/Sovereign	1.2/2	13
Treflan/Butisan S (post-weed)	1.2/1.25	16
Treflan/Shield	1.3/0.3	22
Ramrod Flo + Comodor	3 + 2; 6 + 4	26, 27
Ramrod Flo Dacthal	3 + 3	30
Ramrod Flo/Fortrol	6/1	34*
Sovereign	2	35
Sovereign	4	36
Sovereign/Butisan S	2/1.25	37

*Severe early damage seen.

Other treatments showing marginally greater vigour reduction just before harvest (11-15%), but good early safety, include:

Treatment	Dose, kg or ℓ/ha	Treatment number
Treflan/Ramrod Flo	1.2/3; 2.3/6	5; 6
Treflan/Butisan (pre-weed)	1.2/1.25	9
Treflan + Comodor	1.2 + 2; 2.3 + 4	23; 24

Discussion and Conclusions on Crop Yield and Harvest Quality

Table 4 gives the number of marketable Chinese leaf plants per plot; where there were just a few individuals, these were also harvested and weighed to complete the record. The mean yield per plot and per plant are given. A further assessment was made of the general quality of the surviving plants on a 0-9 (good) scale.

Of the treatments showing some safety to individual plants (see Crop Tolerance above) the following appeared to reduce plant numbers:

Treatment	Dose, kg or ℓ/ha	Treatment number
Treflan + Comodor	1 + 2; 2.3 + 4	23; 24
Treflan + Butisan S (post-plant)	1.2/1.25; 2.3/2.5	9; 10
Treflan + Devrinol	2.1 + 2.3	25
Treflan/Kerb Flo	2.3/3	8
Ramrod Flo/Fortrol	6/1	36
Treflan/Ramrod Flo	1.3/6	6

The remainder did not reduce plant numbers significantly:

Treatment	Dose, kg or ℓ/ha	Treatment number
Untreated	-	1; 2; 4
Ramrod Flo	6	3
Treflan/Ramrod Flo	1.2/3	5
Treflan/Kerb Flo	1.2/1.5	7
Treflan/Sovereign	1.2/2; 2.3/4	13; 14
Treflan/Butisan S (post-weed)	2.3/2.5	16
Treflan/Shield	2.3/0.3	22
Ramrod Flo + Comodor	3 + 2; 6 + 4	26/27
Ramrod Flo + Dacthal	6 + 6	31
Ramrod Flo/Galtak	6 + 1	33
Sovereign	2; 4	35; 36
Sovereign/Butisan S	2/1.25; 4/2.5	37; 38

Of these treatments listed, the Treflan/Ramrod Flo sequences probably reduced individual plant yield more than marginally.

Of the remaining treatments, which did not significantly effect plant yield the following gave an acceptable head quality.

Treatment	Dose, kg or ℓ/ha	Treatment number
Untreated	-	1; 2; 4
Ramrod Flo*	6	3
Treflan/Kerb Flo	1.2/1.5	7
Treflan/Sovereign	1.2/2; 2.3/4	13; 14
Treflan/Butisan S (post-weed)	2.3/2.5	16
Treflan Shield	2.3/0.3	22
Ramrod + Comodor	3 + 2; 6 + 4	26; 27
Ramrod + Dacthal	6 + 6	31
Ramrod Flo/Galtak*	6 + 1	33
Sovereign	2; 4	35; 36
Sovereign/Butisan S	2/1.5; 4/2.5	37; 38

*marginal

Treflan/Ramrod Flo produced a less acceptable head quality.

C. OVERALL DISCUSSION

This trial was principally designed to look for novel alternative herbicide programmes for use in Chinese leaves, and in particular resolve the safety to the crop. As such the small plots used to screen the large number of treatments is not the optimum approach for weed control trials. Some evidence on weed control in the conditions pertaining was obtained; however, none of the products tested were novel, and their weed control potential is understood from their commercial labels and previous research and use in other crops. For that reason we list in the Appendix the weed spectra for the products selected for further testing for crop tolerance. It should be noted that a wide range of the treatments tested, which also had some crop tolerance, gave good weed control in this trial; especially those with Treflan starting a sequence of treatments, Sovereign and Ramrod Flo. A number of the treatments also controlled volunteer oilseed rape; notably amongst safer products, those with Sovereign, Kerb Flo and Dacthal.

The crop tolerance data indicates a list of herbicide products and programmes worth further examination, and this has been refined by harvest assessments. Yield data from small plots is open to variation, but we have selected treatments with clear levels of safety similar to untreated plots and the standard Ramrod Flo, which was less safe than some experimental treatments.

The step-by-step assessment presented in the Results section above suggests the following novel treatments (excluding Ramrod Flo alone) require further evaluation:

1. Treflan pre-planting/Kerb Flo post-planting (low doses)
2. Treflan pre-planting/Sovereign post-planting
3. Treflan pre-planting/Butisan S post-weed emergence
4. Ramrod Flo + Comodor post-planting
5. Ramrod Flo + Dacthal post-planting
6. Sovereign post-planting
7. Sovereign post-planting/Butisan S post-weed-emergence (low dose)
8. Shield post-weed-emergence, after use of a residual eg Treflan or Ramrod Flo or Kerb Flo.
9. Galtak post-weed-emergence, after use of residual, eg Treflan or Ramrod Flo. This is a more marginal treatment.

Other treatments of which we are more uncertain as to their selectivity includes.

1. Treflan pre-planting/Ramrod Flo post-planting
2. Use of Butisan S soon after planting
3. Treflan pre-planting/Kerb Flo higher doses

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 include early treatment damage, mid-season discolouration, vigour reduction, quality of survivors, number of marketable plants, plot yield and yield per plant. On that basis the best scores cut of a potential of 21 are given in the table below.

Treatment	Dose, kg or ℓ/ha	Treatment number
20/21 Score		
1. Hand-weeding	-	4
2. Treflan/Kerb Flo[+]	1.2/1.5	7
3. Treflan/Sovereign[++]	1.2/2	13
17/18/19 Score		
4. Untreated	-	1
5. Ramrod Flo	6	3
6. Ramrod Flo + Comodor	6 + 4	27
7. Ramrod Flo + Dacthal	6 + 6	31
8. Sovereign	2	35
9. Sovereign	4	36
10. Sovereign/Butisan S (post-weed)	2/1.25	37
14/15/16 Score		
11. Untreated	-	2
12. Treflan/Butisan S (post-weed)	2.3/2.5	16
13. Treflan/Shield	2.3/0.3	22

[+]High dose scored 8, [++]high dose scored 13

On this scale, Treflan/Ramrod Flo again scored poorly due to reduced yield. Treflan/Kerb Flo and Treflan/Sovereign at higher doses affected early crop appearance, and reduced plant numbers in the case of Treflan/Kerb Flo. Ramrod Flo/Galtak, which gave a good plant yield, showed some early and intermediate crop vigour effects, which reduced the score on this scales.

D. OVERALL CONCLUSIONS

A number of potential treatments for further evaluation have been discovered by this screen. Most of the treatments are used in other brassica crops. It is evident that many of the treatments are only safe to the crop at lower doses, and even the standard, Ramrod Flo, shows some crop effects. This suggests that weed control in Chinese leaves may become very reliant on careful selection of sequential low-dose programmes of products.

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

Treflan sequences with Kerb Flo and Sovereign
Ramrod Flo combinations with Comodor and Dacthal
Sovereign alone and in sequence with Butisan S*

There should be further evaluation of Butisan S*, Shield and Galtak as post-weed emergence treatment because of this important activity timing, in sequence with the products listed above.

The following are considered too damaging:

Treflan/Ramrod Flo sequences
Flexidor
Gesagard
Semeron
Fortrol
Benazalox
Croptex Steel
SMA
Ardent
Treflan + Comodor or Devrinol

E. RECOMMENDED PROGRAMME OF TREATMENTS FOR 1998

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

1.	Treflan/Kerb Flo pre-planting/post planting	1.2/1.5 ℓ/ha
2.	Treflan/Sovereign pre-planting/post planting	1.2/2 ℓ ha
3.	Treflan/Sovereign pre-planting/post-planting	1.2/4 ℓ ha
4.	Ramrod Flo + Comodor post-planting	6 + 4 ℓ/ha
5.	Ramrod Flo + Dacthal post-planting	6 + 6 ℓ/ha
6.	Sovereign post-planting	4 ℓ/ha
7.	Sovereign/Butisan S post-planting/early post-weed emergence	2/1.25 ℓ/ha
8.	Ramrod Flo/Butisan S post-planting/early post-weed emergence	6 + 1.25 ℓ/ha
9.	Treflan/Butisan S pre-planting/early post-weed emergence	1.2/2.5 ℓ/ha
10.	Ramrod Flo/Sovereign + Butisan S post-planting/early post-weed emergence	6/2 + 1.25 ℓ/ha
11.	Ramrod Flo/Shield post-planting/post-weed emergence	6/0.3 ℓ/ha
12.	Ramrod Flo/Galtak post-planting/post-weed emergence	6/1.5 ℓ/ha
13.	Untreated	

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

F. ACKNOWLEDGEMENTS

Mr R Fisher, Ravenswood Nursery, Lanark for an excellent suppy of plants. A Cleland and his staff particularly Gordon Wilson who ran the trial, at SAC.

Table 2 Chinese leaf herbicide screen, Boghall Farm trial : weed numbers/m^2 11/8/97

Treatment	Mayweed	Groundsel	Knotgrass	Vol. O.S.R.	Chickweed	Total Weeds
1	1.5	0.5	2.0	6.5	11.0	21.5
2	0.0	0.0	4.5	8.5	2.0	15.0
3	0.0	0.0	4.0	6.0	0.0	10.0
4	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.5	2.5	0.0	3.0
6	1.5	0.0	0.5	11.5	0.0	13.5
7	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	1.5	0.0	1.5
9	0.0	0.0	0.0	2.5	0.0	2.5
10	0.0	0.0	0.0	6.5	0.0	6.5
11	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.5	0.0	0.5
13	0.0	0.5	0.0	1.5	0.0	2.0
14	0.0	0.0	0.0	0.0	0.0	0.0
15	0.5	0.0	0.0	1.0	0.0	1.5
16	0.0	0.0	0.0	2.5	0.0	2.5
17	1.0	0.0	0.0	0.0	0.0	1.0
18	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	4.5	0.0	4.5
20	0.0	0.0	0.0	2.0	0.0	2.0
21	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	5.0	0.0	5.0
23	0.0	0.0	0.0	11.0	0.0	11.0
24	0.0	0.0	0.0	6.0	0.0	6.0
25	0.0	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	2.0	4.0	0.0	6.0
27	0.0	0.0	0.0	7.0	0.0	7.0
28	0.0	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	2.0	0.0	2.0
30	0.0	0.0	1.0	0.5	0.0	1.5
31	0.0	0.0	0.0	4.5	0.5	5.0
32	0.0	0.0	1.5	4.0	0.5	6.0
33	0.0	0.5	0.0	6.0	0.0	6.5
34	0.0	0.0	2.0	2.0	0.0	4.0
35	0.0	0.0	0.0	0.0	0.0	0.0
36	0.0	0.5	0.0	0.0	0.0	0.5
37	0.0	0.0	0.0	2.0	0.0	2.0
38	0.0	0.0	0.0	0.5	0.0	0.5
39	0.0	0.0	0.5	0.0	0.0	0.5
40	0.0	0.0	1.0	0.0	0.0	1.0
41	0.0	0.0	0.5	0.0	0.0	0.5
42	0.0	0.0	1.0	0.5	0.5	2.0
43	0.0	0.0	0.5	0.5	0.0	1.0
44	0.0	0.0	0.5	0.5	0.0	1.0
45	0.0	0.0	1.5	2.0	0.5	4.0
46	0.0	0.0	0.0	0.5	0.0	0.5
47	0.0	0.0	1.5	0.5	0.0	2.0
48	0.0	0.0	7.5	2.0	0.0	9.5
49	0.0	0.0	1.0	0.0	0.0	1.0
50	0.0	0.0	8.5	10.0	0.0	18.5
SE	0.3	0.1	1.3	3.3	0.8	3.8
LSD	1.0	0.4	3.8	9.4	2.2	10.8

Table 3 HDC Chinese leaf herbicide screen, Boghall Farm, Bush Estate: Crop tolerance

Treatment	% damage 04/07	% damage 07/07	% damage 15/07	% damage 24/07	% vigour reduction 11/08
1	0	0	0	0	0
2	14	10	10	3	13
3	5	0	8	5	9
4	0	0	0	0	8
5	0	0	0	0	15
6	3	0	1	5	14
7	0	0	0	1	4
8	20	23	23	39	32
9	1	0	0	15	15
10	35	15	46	45	23
11	15	75	95	93	90
12	60	80	99	100	100
13	3	0	0	0	7
14	10	13	20	16	11
15	1	0	8	23	14
16	0	0	3	4	8
17	3	0	53	45	11
18	4	0	78	68	23
19	21	25	50	50	23
20	46	0	70	55	25
21	4	0	4	8	14
22	0	0	1	0	9
23	0	0	0	1	13
24	4	15	1	8	12
25	10	15	10	13	14
26	0	0	0	1	10
27	1	0	0	3	7
28	60	70	75	60	34
29	80	75	75	75	43
30	11	0	5	5	9
31	50	50	38	33	15
32	3	0	1	10	18
33	4	5	3	28	18
34	5	0	55	40	8
35	1	0	0	0	5
36	8	0	0	2	8
37	10	5	8	10	4
38	11	5	33	28	12
39	55	85	95	95	95
40	45	78	100	100	100
41	75	75	99	99	98
42	70	80	95	83	55
43	55	80	90	80	72
44	5	0	55	48	16
45	33	13	53	30	12
46	3	0	60	43	11
47	25	8	30	24	11
48	0	0	88	78	35
49	0	0	80	73	24
50	3	0	45	45	14
SE	10.4	7.7	12.6	8.2	6.7
LSD	29.5	21.9	35.8	23.2	18.9

Table 7 HDC Chinese leaves herbicide screen, Boghall Farm, Bush Estate: harvest data

Treatment	No plot/harvested	Yield/plot kg	Yield plant g	Quality of surviving plants (0-9)
1	7.0	6.08	869	8.7
2	8.5	6.90	812	8.2
3	8.5	7.15	841	7.9
4	8.0	7.33	916	8.7
5	7.0	5.15	736	7.6
6	5.0	3.75	750	7.8
7	8.0	7.35	919	8.7
8	5.0	4.78	956	6.7
9	5.0	5.00	1000	6.9
10	3.5	2.80	800	6.8
11	0.0	0.00	0	0.8
12	0.0	0.00	0	0.0
13	8.0	6.95	869	8.3
14	7.0	6.23	890	8.2
15	5.5	4.55	827	7.7
16	8.0	6.35	794	8.4
17	7.0	5.58	797	7.6
18	3.0	2.50	833	6.1
19	3.0	2.23	743	6.9
20	4.5	3.53	784	6.8
21	4.5	3.60	800	8.1
22	7.0	5.55	793	8.1
23	5.5	3.53	642	7.8
24	4.0	2.90	725	7.5
25	5.0	3.78	756	7.8
26	8.0	6.43	804	8.1
27	7.5	6.55	873	8.5
28	6.5	5.83	897	5.9
29	4.0	3.48	870	5.5
30	8.0	8.00	1000	8.4
31	5.0	4.23	846	7.3
32	6.0	4.93	822	6.9
33	8.0	6.28	785	7.8
34	5.5	4.33	787	8.4
35	8.0	6.25	781	8.8
36	8.5	6.83	804	8.4
37	7.0	6.38	911	8.8
38	7.0	5.65	807	8.1
39	0.0	0.00	0	0.5
40	0.0	0.00	0	0.0
41	0.0	0.00	0	0.3
42	0.5	0.35	700	3.8
43	0.5	0.35	700	2.8
44	5.0	4.25	850	7.3
45	6.5	5.13	789	7.6
46	7.5	6.05	807	8.3
47	8.0	6.03	754	8.4
48	2.0	2.03	102	5.6
49	4.5	3.55	789	7.1
50	7.5	5.60	747	7.8
SE	1.4	1.185		
LSD	3.9	3.367		
SE+	1.5	1.269	112.9	
LSD+	4.2	3.621	322.2	

+excluding plots with no marketable plants remaining

Table 8 Product Details

Product	Active ingredients	Manufacture	Formulation	MAFF Number
Ardent	diflufenican + trifluralin	RP Agric	40/400 g/ℓ EC	4248
Benazalox	benazolin + clopyralid	AgrEvo	30 : 5% w/w WP	7246
Butisan S	metazachlor	BASF	500 g/ℓ SC	0357
Comodor 600	tebutam	Agrichem	600 g/ℓ EC	6808
Croptex Steel	sodium monochloroacetate	Hortichem	95% w/w SP	2418
Dacthal W-75	chlorthal-dimethyl	Hortichem	75% w/w WP	5500
Devrinol	napropamide	RP Agric	450 g/ℓ SC	6195
Flexidor 125	isoxaben	DowElanco	125 g/ℓ SC	5104
Fortrol	cyanazine	Cyanamid	500 g/ℓ SC	7009
Galtak	benazolin	AgrEvo	330 g/ℓ EC	?
Gesagard 50 WP	prometryn	Novartis	50% w/w WP	0981
Kerb Flo	propyzamide	PBI	400 g/ℓ SC	4521
Lentagran WP	pyridate	Sandoz	45% w/w	7556
Ramrod Flo	propachlor	Monsanto	480 g/ℓ 5C	1688
Semeron 25 WP	desmetryn	Novatris	25% w/w WP	1916
Shield (Dow Shield)	clopyralid	DowElanco	200 g/ℓ SL	5578
Sovereign	pendimethalin	Novartis	400 g/ℓ SC	8152
Treflan	trifluralin	DowElanco	480 g/ℓ EC	5817

APPENDIX Weed control label recommendations for candidate Chinese leaf herbicide programmes

	Residuals (pre-weed emergence)				Residual/early post-em			Contact		
Weed	Ramrod + Comodor	Ramrod + Dacthal	Sovereign	Sovereign/ Butisan	Treflan/ Kerb	Treflan/ Sovereign	Sovereign/ Butisan	Butisan	Galtak*	Shield
Annual Meadow-grass	S	S	S	S	S	S	S	S	-	-
Annual Mercury	MS	MS	-	-	-	-	-	-	-	-
Black-bind-weed	MS	MS	-	MS	S	S	MS	MS	-	MS
Black-grass	S	S	(MS)	S	S	S	S	S	-	-
Black nightshade	MS	S	-	-	S	-	-	-	-	-
Bugloss	-	-	-	-	-	-	-	-	-	-
Charlock	-	-	-	-	-	-	-	-	MS	-
Cleaver	S	S	-	MS	MS	-	[MS]	[MS]	S	-
Common chickweed	S	S	S	S	S	S	S	S	S	-
Common field speed well	S	S	S	S	S	S	S	S	-	-
Common fumitory	-	-	MS	MS	MS	MS	[MS]	-	(S)	-
Common hemp-nettle	S	S	S	S	[S]	S	[S]	-	-	-
Common orache	-	MS	S	S	[MS]	S	[S]	-	-	-
Common poppy	S	S	S	S	-	S	[S]	[MS]	-	-
Corn marigold	S	S	S	S	-	S	S	MS	-	S
Corn spurrey	S	S	-	MS	S	MS	MS	MS	-	-
Fat-hen	S	S	S	S	S	S	[S]	[S]	MS	-
Field forget-me-not	-	-	S	S	-	S	S	S	-	-
Field pansy	S	S	S	S	[S]	S	[S]	-	-	-
Field penny-cress	-	-	-	-	-	-	-	-	-	-
Gallant soldier	S	S	-	-	-	-	-	-	-	-
Groundsel	S	S	-	S	-	-	S	S	-	S
Henbit deadnettle	-	MS	S	S	[S]	S	[S]	-	-	-
Ivy-leaved speedwell	-	-	S	S	S	S	S	S	-	-
Knotgrass	S	S	S	S	S	S	[S]	-	(MS)	-
Pale persicaria	-	-	-	-	[S]	S	-	-	-	S
Pineapple weed	S	S	-	S	-	-	S	S	-	-
Red deadnettle	S	S	S	S	-	S	S	S	(MS)	-
Redshank	-	MS	(MS)	MS	S	S	MS	MS	(MS)	-
Scarlet pimpernel	S	S	S	S	[S]	S	-	-	-	-
Scentless mayweed	S	S	(MS)	S	-	(MS)	S	S	-	S
Sheep's sorrel	-	S	-	-	-	-	-	-	-	-
Shepherd's purse	S	S	MS	S	MS	MS	[S]	[S]	-	-
Small nettle	S	S	S	S	S	S	[S]	[S]	-	-
Smooth sow-thistle	S	MS	S	S	-	S	-	-	-	S
Sun spurge	-	-	-	-	-	-	-	-	-	-
Volunteer rape	-	-	(MS)	(MS)	-	(MS)	(MS)	-	-	-
Wild-oat	MS	-	-	-	S	MS	-	-	-	-
Wild radish	-	-	-	-	-	-	-	-	-	-
Thistles	-	-	-	-	-	-	-	-	-	S

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