FINAL REPORT: 1993

Project Number:	FV/129/93 ADAS No.: C 001/265/93
Project Title:	HERBICIDE MIXTURES FOR ANNUAL WEED CONTROL IN CABBAGE.
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Location of Project:	Wilton Farm, Marlow, Bucks.
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Date Project commenced:	1992
Date completion due:	1993
Key Words:	Brassicas Cabbage Sprouts Annual Weed Control Low dose

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CONTENTS

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Application

The purpose of these trials was to test whether tank mixtures of reduced rate herbicides are safe on seedling summer cabbage, and effective in controlling the weed species commonly found in this crop. Weed species present in the trials included fat-hen, redshank, small nettle, green nightshade, annual mercury, shepherd's purse, groundsel and mayweed.

In 1992 ½ or ¼ rates of Brasoran plus ½ rate Butisan were safe at the 1½-2 true leaf stage of crop and initially effective but did not achieve freedom from weeds through to harvest.

In 1993, however, tank mixed ½ rates of Brasoran plus Butisan at 2½-3 true leaves, followed 10 days later with a further tank mix of ¼ rate Croptex Steel plus $^1/_3$ rate Semeron was safe to the crop and gave excelent weed control through to harvest.

In 1992 very low rates of Fortrol (not currently approved for use on most cabbage types) tank mixed with ½ rate Butisan gave excellent weed control but caused a severe crop check and reduced yield to an unacceptable level. In 1993, however, various treatments incorporating low rate Fortrol were all safe but gave poor weed control

The successful treatments could be used in crops where due to the limitations of, or unavailability of appropriate residual herbicides (including withdrawal of products from the market), weeds have not been adequately controlled. It is not intended at this stage that they should be a substitute for the residual herbicide programme, although in the trials, full weed control was obtained without a residual treatment being applied first.

Summary

Objectives

Safe and effective weed control in vegetable crops relies heavily on successful use of residual herbicides. Sometimes however, residual materials let us down. They may not work properly if the soil surface is too dry, or the application timing is delayed by bad weather, or the seed bed is too cloddy, or resistant weeds are present.

Sometimes crop emergence can be uneven, so that by the time the smallest cabbage are large enough for a contact herbicide, the weeds are too big to be controlled. This is because recommendations for contact weed killers are restricted to a relatively advanced crop stage, typically 3 + true leaves in cabbage.

The purpose of these trials was to test the safety and efficacy of reduced rate mixtures of existing approved contact weed killers in seedling cabbage. Field experience has proved the success of this approach to leeks, and this repeat low dose technique has been widely researched and adopted by sugar beet growers.

Results

Crop safety and weed control

Each treatment was scored for crop safety and weed control on a scale of 0-9, **9 being the equivalent of success** (no crop damage and total weed control) and **0 being the equivalent of failure** (crop loss and no weed control).

Year 1: 1992 (see page 9)

All treatments were applied at the 1½-2 true leaf stage and consisted of single applications of tank mixes of reduced rates of 2 or 3 different herbicides. The mixtures containing Fortrol and Butisan together, even at very low rates, caused severe crop damage and in some cases significantly reduced crop yield, though they gave excellent weed control.

Low rate Fortrol tank mixed with herbicides other than Butisan was safe and gave excelent weed control.

All other treatments were generally ineffective at controlling weeds but none of them caused any crop damage or checked growth to a significant degree.

Year 2. 1993 (see page 17)

All treatments were applied at the 2½-3 true leaf stage and all were safe to the crop. Some of the treatments in 1993 were single applications of tank mixes as in 1992 but many consisted of sequential applications of tank mixes applied 9 days apart.

Fortrol treatments, all applied as single applications were safe to the crop but in general **gave poor weed control.**

All other single application treatments also gave poor weed control and were outperformed in general by the sequential treatments

At first assessment, only treatments 6 and 10 achieved adequate weed control. By the second assessment, weed regrowth was evident where $^1/_3$ rate Semeron + ¼ rate Croptex Steel was repeated (treatment 10), presumably due to the absence of any herbicide with persistent action in this treatment. However, the weed control effect of ½ Brasoran + ½ rate Butisan followed by $^1/_3$ rate Semeron + ¼ rate Croptex Steel persisted until harvest on 24 September 1993, approximately 12 weeks from the date of the first application. This improved persistence was presumably due to the residual properties of Brasoran and Butisan.

Yield

Yield was assessed as numbers and weight of marketable cabbage from a standard area in the centre of each plot.

Year 1 1992

All treatments were significantly better than the unweeded control and Fortrol 1 litre + Butisan S 0.75 litres significantly depressed yield compared with most others

Year 2 1993

Due to the failure of most treatments to control the weed spectrum present and the consequent smothering of the crop, comparable yield information was only possible from treatments 6 and 18 as shown below.

YIELD DATA 1993

Treatment No	Material	Head Nos/plot	Wt/plot	Mean Head Wt
6	Brasoran ½ + Butisan ½ Semeron $^{1}/_{3}$+ Croptex Steel ¼	13.75	13.05	1.13
18	Hand weeded control	8.5	7.725	0.9

Conclusions

In both years the trial sites had received no pre-emergence herbicide treatments so that the degree of weed control achieved was due to the applied treatments only.

A notable feature of the trial in year 2 was the rampant growth of fat-hen, redshank and green nightshade that occurred. The fat-hen in particular reached a height of 2½-3 feet by early August and complete crop smother was recorded in several treatments that had not controlled these weeds. **However, ½ rates Brasoran plus Butisan followed nine days later by ⅓ rate Semeron plus ¼ rate Croptex Steel was safe to the crop and gave excellent weed control which persisted until harvest, twelve weeks after the first spray application.**

Investigations over 2 years into the safety and efficiency of Fortrol mixtures in cabbage have given conflicting results and the potential of this material remains unclear.

Action Points for Growers

The potential for using reduced rate mixtures of approved herbicides safely in cabbage has been demonstrated in these trials. The results are specific to the sites and range of weed species present, but will have application to mineral soil farms growing cabbage where the weed spectrum is similar. Growers should consider making limited scale trial applications of the best treatment on their own farms in 1994.

These trials have also demonstrated safe effective measures that can be applied at an earlier than recommended crop stage, to retrieve situations where residual weed control has been either partially or totally ineffective.

Benefits

Weed control programmes that use less chemical make an important contribution to the environmental objective of using less pesticides overall, as well as reducing growers' costs

Environmental benefits

There is increasing pressure on the whole agricultural and horticultural industry to reduce pesticide input in all forms of crop production. Many of the treatments in this trial make use of greatly reduced rates of herbicide and thus could go a long way towards achieving this aim without losing efficacy of weed control.

Financial benefits.

It seems possible that use of the best of the treatments tested in this trial could reduce the overall cost of herbicides used in the cabbage crop without compromising the success of the weed control programme. Examples of common herbicide programmes are costed in the table below and compared with treatment 6 from the 1993 trial.

COMPARATIVE HERBICIDE COSTS

Costs of programmes.	£/ha
Brasoran 50 WP 2 kg/ha + Butisan S 0.75 l/ha Semeron 25 WP 0.55 kg/ha + Croptex Steel 5 kg/ha	£42/ha
Treflan + Ramrod, Croptex Steel X 2	£88/ha
Sovereign + Ramrod, Croptex Steel X 2	£98/ha
Ramrod + Dacthal, Brasoran + Shield	£220/ha

These prices are for guidance only; many growers may be able to purchase herbicides and other chemicals at advantageous rates. The relative costs will not change greatly however, with the most expensive treatments remaining so, even if at a lower price range overall.

HERBICIDES MIXTURES FOR ANNUAL WEED CONTROL IN CABBAGE

1. Introduction

1.1 Reliability of annual weed control in vegetable crops is vulnerable to a range of practical factors of which the following are considered significant.

a. Reduced performance of residual materials because of dry soil surface, sub optimal timing and uneven seed beds.

b. Uneven crop emergence due to seed, soil or weather factors, delaying application of foliar-acting materials.

c. Presence of resistant weed species.

1.2 Existing recommendations for foliar-acting materials and mixtures are usually restricted to relatively advanced crop stage, typically 3+ true leaves in cabbage by which time complete kill of some weed species is difficult to achieve.

1.3 The lack of new products coming forward together with the loss of established materials emphasises the need to fully develop the potential of existing herbicides, particularly as tank mixes at reduced rates.

1.4 Field experience with arable crops and a limited number of vegetable crops, indicates the potential of using reduced rate mixtures of existing approved materials at earlier than recommended stages without reducing crop safety.

1.5 This approach has been successfully used in sugar beet growing, but only to a limited extent in field vegetables. The opportunity this gives to achieve effective weed control with reduced herbicide input has never been fully exploited.

1.6 These investigations were carried out in 1992 and 1993 using several low dose treatments plus untreated controls in commercial cabbage crops.

1.7 Single applications of tank mixes only were tested in 1992 but treatments consisting of one tank mix followed by another were included in the 1993 trial.

2.0 Materials and methods: Year 1 1992

2.1 Treatments (as rate per ha of product)

1. Untreated control
2. Brasoran 50WP 2 kg + Butisan S 0.75 litres
3. Brasoran 50WP 1 kg + Butisan S 0.75 litres
4. Brasoran 50WP 1 kg + Semeron 25WP 0.55 kg
5. Brasoran 50WP 2 kg + Croptex Steel 5 kg
6. Brasoran 50WP 1 kg + Croptex Steel 5 kg
7. Semeron 25WP 0.55 kg + Croptex Steel 5 kg
8. Semeron 25WP 0.55 kg + Butisan S 0.75 litres
9. Fortrol 1 litre + Butisan S 0.75 litres
10. Fortrol 0.5 litres + Butisan S 0.75 litres
11. Fortrol 0.5 litres + Croptex Steel 5 kg
12. Fortrol 0.5 litres + Croptex Steel 5 kg + Brasoran 50WP 1 kg
13. Fortrol 0.5 litres + Croptex Steel 5 kg + Butisan S 0.5 litres
14. Fortrol 0.5 litres + Dow Shield 0.5 litres
15. Hand-weeded control

All treatments applied at 1½-2 true leaf stage by Oxford Precision Sprayer on 22 June 1992. Water rate equivalent to 600 l/ha.

2.2 Design

Randomised block design, four replicates. Four row beds, 1.9 m wide, rows 0.4 m apart, plot size 1.9 x 5.3 m (10 m^2).

2.3 Assessments

Weed control score 0-9 scale, 0 = no control, 9 = total control.
Crop damage 0-9 scale, 0 = crop loss, 9 = no crop damage.
Weed number and species recorded from 2 x 1 m^2 area per plot.
Numbers and yield of marketable cabbage.

2.4 Site - Messrs W C Emmett and Sons, Wilton Farm, Little Marlow, Marlow, Bucks SL7 3RR.

2.5 Crop diary

Cultivar - Stonehead
Row arrangement - 4 rows 0.4 m apart, 1.9 m bed
Fertiliser applied - 500 kg/ha 24:0:17 compound
Weed control - none
Previous crop - Parsley
Direct drill on - May 28 1992
Treatments applied 22 June 1992
Crop Safety scoring)
Weed Control scoring) 2 July 1992
Weed counts 10 July 1992
Hand-weeded - 24 July 1992
First yield assessment 1 September 1992
Second yield assessment 10 September 1992

2.6 Statistical analysis

Analysis of variance was carried out using Minitab computer program.

3.0 Results

Each treatment was scored for crop safety and weed control on a scale of 0-9, **9 being the equivalent of success** (no crop damage and total weed control) and **0 being the equivalent of failure** (crop loss and no weed control).

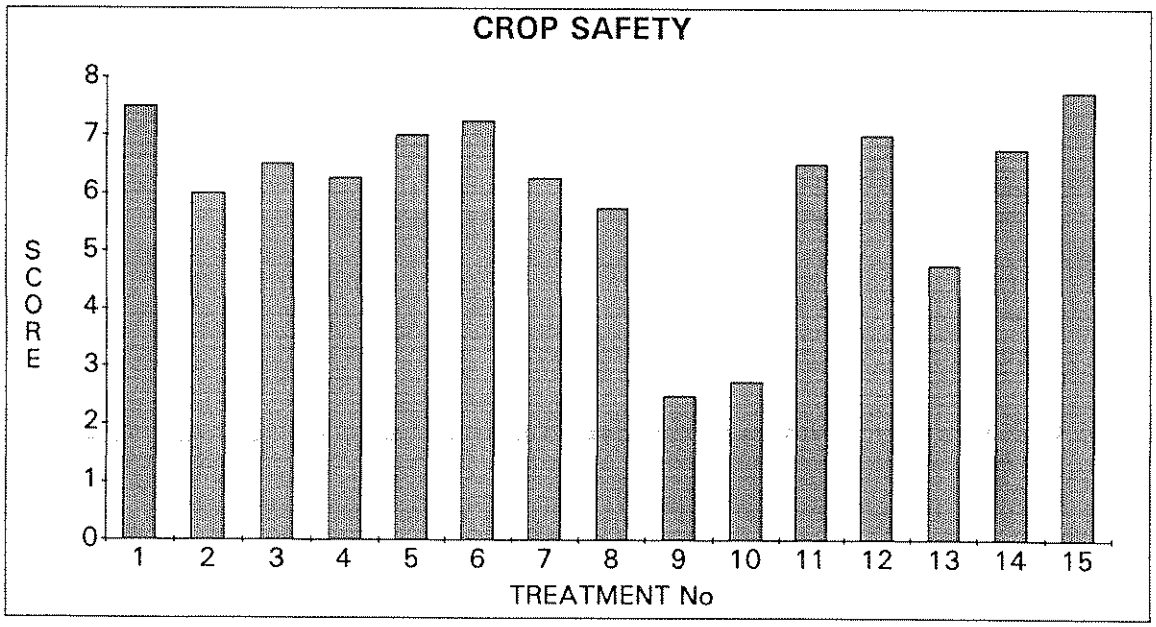
3.1 Crop Safety

Treatments 9 (Fortrol 1 litre + Butisan S 0.75 litres) and 10 (Fortrol 0.5 litres + Butisan S 0.75 litres) seriously scorched the cabbage with a large significant difference from all other treatments. The score for treatment 13 (Fortrol 0.5 litres + Croptex Steel 5 kg + Butisan S 0.5 litres) was also significantly below the controls with a noticeable check to growth.

There were no significant differences between remaining treatments and the untreated controls.

There was a significant difference in mean score value between first and third replicates.

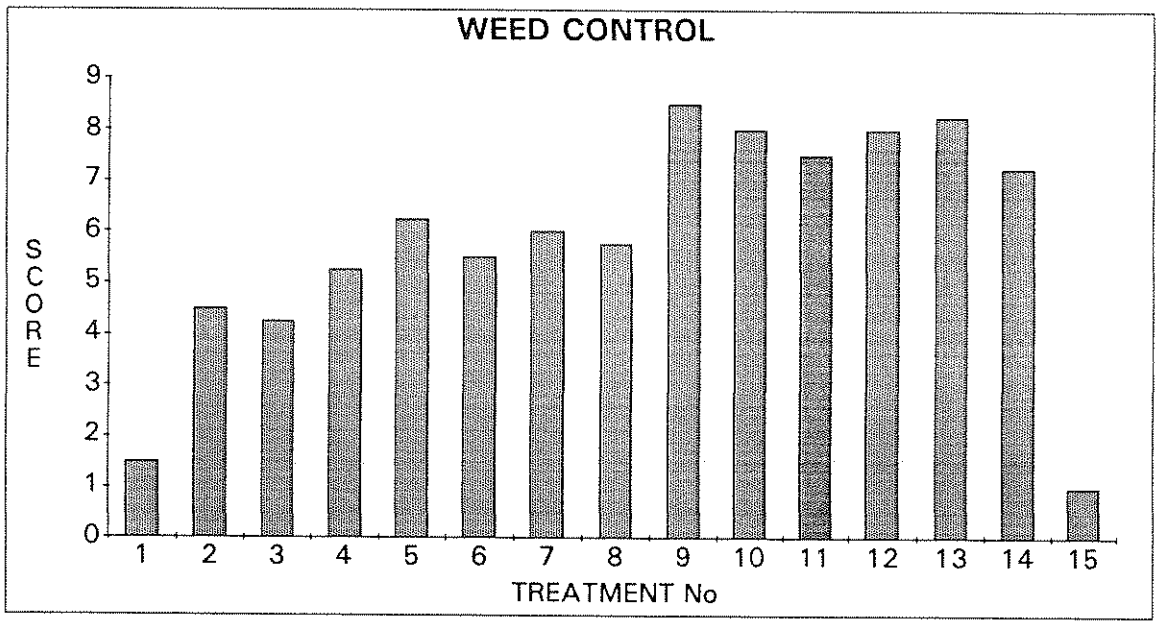
Figure 1 Crop safety



Details at Appendices 1 and 2.

3.2 Weed Control

All herbicide treatments significantly reduced weed cover compared with the controls, but in some cases the differences were small. Treatments 9 (Fortrol 1 litre + Butisan S 0.75 litres), 10 (Fortrol 0.5 litres + Butisan S 0.75 litres), 12 (Fortrol 0.5 litres + Croptex Steel 5 kg + Brasoran 50WP 1 kg) and 13 (Fortrol 0.5 litres + Croptex Steel 5 kg + Butisan S 0.5 litres) were the most effective. Treatments 2, 3, 4, 5, 6, 7, 8 and 11 were less effective.



Details at Appendices 3 and 4.

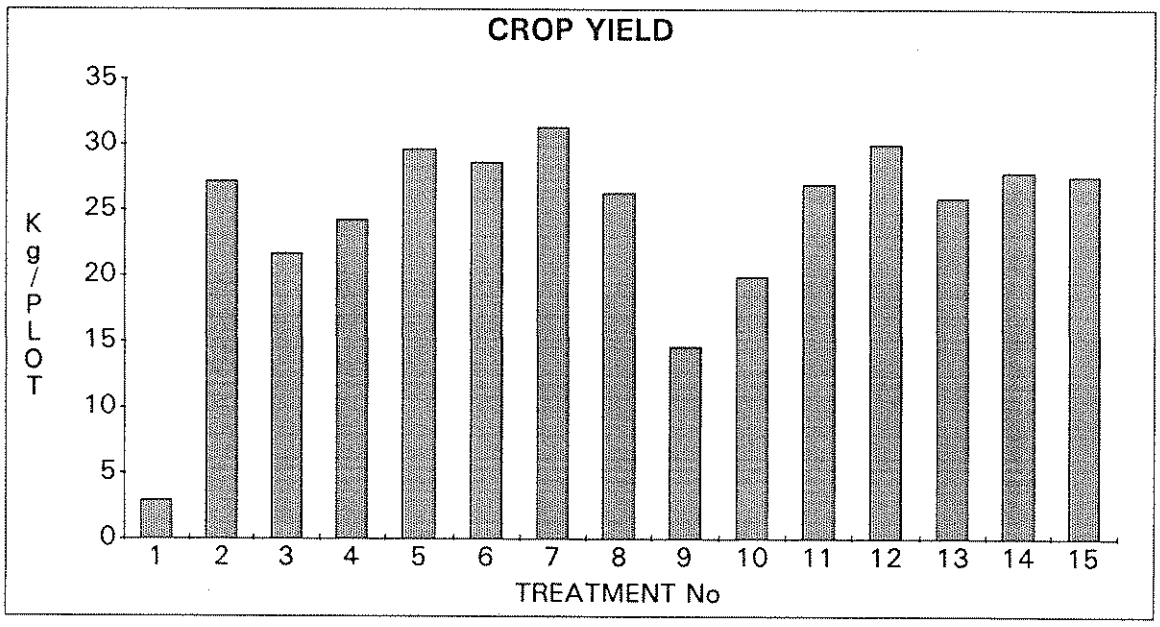
3.3 Weed counts

Weed numbers were lowest in treatments 9-14, but the differences from controls were barely significant. Weed numbers per se are not a meaningful measure of weed competition as weed size is often more important.
Details at Appendices 5 and 6.

3.4 Yield of marketable cabbage

Numbers and weight of marketable cabbage were recorded from a 3 m length of the 2 centre rows of each plot.

All treatments, including the hand-weeded control, gave a significantly increased yield over the unweeded control, but treatment 9 (Fortrol 1 litre + Butisan S 0.75 litres) gave the lowest mean yield of any of the sprayed treatments and was significantly depressed compared with the highest yielding treatments (2, 5, 6, 7, 8, 11, 12, 14 and 15).



Details at Appendices 7 and 8.

The pattern of results in terms of head numbers is very similar to marketable yields, indicating a close relationship between the numbers of heads harvested per plot and the marketable yield.

4.0 Discussion

4.1 Weed spectrum

The site was on a farm that has grown vegetables, including brassicas, intensively for at least 4 decades and the weed spectrum reflects this fact. The cruciferous weeds, shepherd's purse *(Capsella bursa-pastoris)* and field pennycress *(Thlaspi arvensis)* were present in considerable numbers, also annual mercury *(Mercurialis annua)*, small nettle *(Urtica urens)*, groundsel *(Senecio vulgaris)*, redshank *(Polygonum persicaria)*, fathen *(Chenopodium album)*, and mayweed *(Matricaria perforata)* with occasional annual meadowgrass *(Poa annua)* and sow thistle *(Sonchus spp)*.

4.2 Treatment effects

The site received no pre-emergence herbicide treatments so that in some cases effective weed control was achieved with a single application of mixtures of half rate herbicides.

Mixtures of Brasoran 50WP with either Butisan S, Semeron 25WP or Croptex Steel (treatments 2-6) were safe to the crop, had no effect on yield but were only partially effective in controlling weed competition. Semeron 25WP mixed with either Butisan S or Croptex Steel (treatments 7 and 8) achieved very similar results.

Mixtures based on Fortrol, however, showed more promise. Fortrol plus Butisan S (treatments 9, 10 and 13) achieved excellent weed control, but scorched the cabbage and reduced marketable yield to unacceptable levels. Fortrol plus Dow Shield (treatment 14) was safe and effective but the best treatment was the three-way mixture of Fortrol, Croptex Steel and Brasoran 50WP (treatment 12) which was safe to the crop, produced a yield as high as the hand-weeded control, and was effective in controlling weeds, including the Cruciferous species that are traditionally difficult to control in brassica crops.

Treatment 12 consisted of reduced rates of three materials, two of which are relatively low cost. There is potential for repeat applications of such combinations to achieve total weed control at low cost and without crop damage, should single treatments prove inadequate in particular situations.

It should be noted that some of the treatments involved rates of product as low as 25% of the normal recommended rate.

4.3 Weather effects

These results are reported for a single year only and should be treated with caution because weather conditions are known to modify herbicide effects in some circumstances. It should be noted, however, that although 1992 summer is remembered for high rainfall and low sunshine, the treatments were applied and assessments made by early July, while warm weather still prevailed.

5.0 Conclusions

5.1 This investigation demonstrates the potential that exists to develop a range of foliar acting herbicide treatments using mixtures of reduced rates of mainly existing approved brassica herbicides.

5.2 Quarter rate Fortrol plus quarter rate Croptex Steel plus quarter rate Brasoran 50WP appears to be safe, effective and low cost treatment for round summer cabbage, probably also for other cabbage, and for calabrese and sprouts.

5.3 This mixture should be developed further, particularly to investigate the effect of different rates of the constituents and also repeat applications.

5.4 Because Fortrol + Butisan S (treatments 9 and 10) achieved excellent weed control, albeit at the expense of crop safety, even lower rates of these two materials should be investigated further.

5.5 Off-label approval for Fortrol should be sought for use on cabbage and Brussels sprouts as approval only currently exists for calabrese and collards.

6. Materials and Methods: Year 2 1993

6.1 Treatments (rate per ha of commercial product)

1 Untreated Control
2 Brasoran 50 WP 2 kg/ha + Butisan S 0.75 l/ha
3 Brasoran 50 WP 1 kg/ha + Croptex Steel 5 kg/ha
4 Semeron 25 WP 0.55 kg/ha + Croptex Steel 5 kg/ha
5 Brasoran 50 WP 2 kg/ha + Butisan S 0.75 l/ha followed by Brasoran 50 WP 1 kg/ha + Croptex Steel 5 kg/ha
6 Brasoran 50 WP 2 kg/ha + Butisan S 0.75 l/ha followed by Semeron 25 WP 0.55 kg/ha + Croptex Steel 5 kg/ha
7 Brasoran 50 WP 1 kg/ha + Croptex Steel 5 kg/ha followed by Brasoran 50 WP 1 kg/ha + Croptex Steel 5 kg/ha
8 Brasoran 50 WP 1 kg/ha + Croptex Steel 5 kg/ha followed by Semeron 25 WP 0.55 kg/ha + Croptex Steel 5 kg/ha
9 Semeron 25 WP 0.55 kg/ha + Croptex Steel 5 kg/ha followed by Brasoran 50 WP 1 kg/ha + Croptex Steel 5 kg/ha
10 Semeron 25 WP 0.55 kg/ha + Croptex Steel 5 kg/ha followed by Semeron 25 WP 0.55 kg/ha + Croptex Steel 5 kg/ha
11 Fortrol 0.5 l/ha + Croptex Steel 5 kg/ha
12 Fortrol 0.5 l/ha + Croptex Steel 5 kg/ha + Brasoran 50 WP 1 kg/ha
13 Fortrol 0.5 l/ha + Croptex Steel 5 kg/ha + Dow Shield 0.5 l/ha
14 Fortrol 0.5 l/ha + Butisan S 0.4 l/ha
15 Brasoran 50 WP 1 kg/ha + Croptex Steel 10 kg/ha
16 Semeron 25 WP 0.55 kg/ha + Croptex Steel 10 kg/ha
17 Brasoran 50 WP 1 kg/ha + Dow Shield 0.5 l/ha
18 Hand weeded control

All treatments applied at the 2½ true leaf (range 2-3 true leaves) by precision knapsack sprayer on 3 July 1993, with follow up treatments applied 12 July 1993, using a water rate equivalent to 600 l/ha.

6.2 Design

Randomised block, 4 replicates. Four row beds, 1.9 m wide, rows 0.4 m apart, plot size 1.9 x 5.3 m. (10 m^2)

6.3 Assessments

Weed control score, 0-9 scale, made 21 July and 5 August 1993.

Crop safety score, 0-9 scale, made 21 July 1993.
Numbers and yield of marketable cabbage, limited treatments only.

6.4 Site

Messrs W C Emmett & Sons Ltd, Wilton Farm, Little Marlow, Marlow, Bucks SL7 3RR.

6.5 Crop Diary

Cultivar - Stonehead

Row arrangement - 1.9 m bed system, 4 rows 0.4 m apart.

Fertiliser - Base; 115 kg/ha N, 82 kg/ha K plus 97 kg/ha N top dressing

Weed control prior to treatments - none.

Previous crop - marrows

Direct drilled on - 18 June 1993

Treatments applied - initial application 3 July 1993
follow up application 12 July 1993

Crop safety scoring	- 21 July 1993
Weed control scoring	- 21 July 1993 5 August 1993
Yield assessment	- 24 September 1993
Control plots handweeded	- 21 July 1993
Plots thinned	- 5 August 1993

6.6 Statistical analysis

Analysis of variance was carried out using Minitab computer programme.

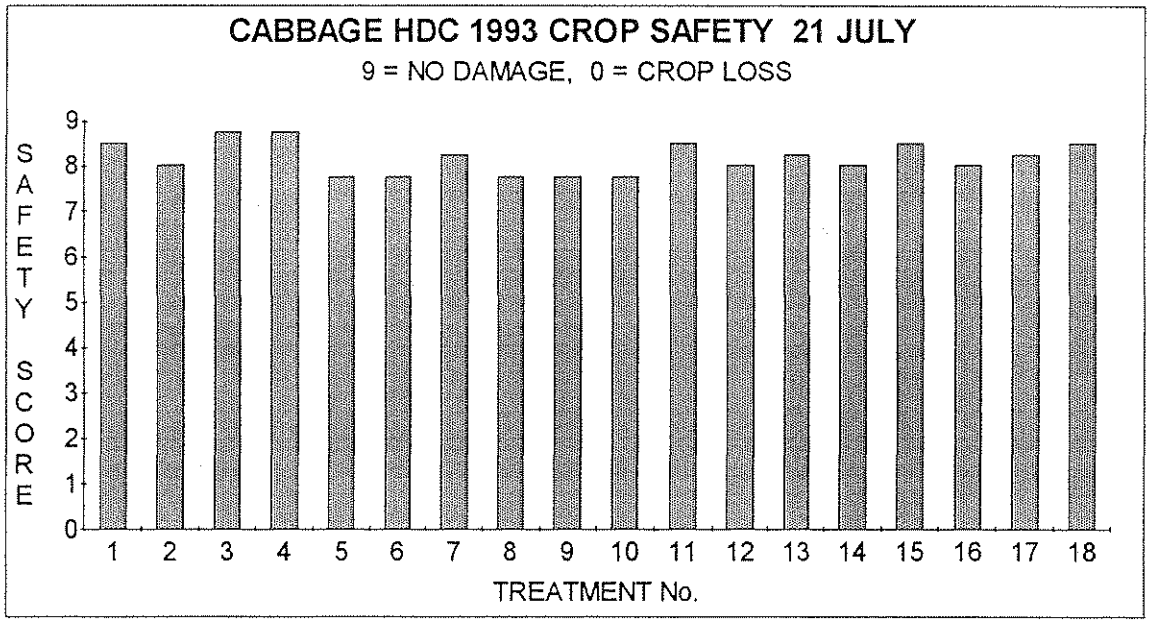
7. Results

7.1 Crop Safety

Each treatment was scored on a 0-9 scale, 9 equivalent to no crop damage, 0 equivalent to complete crop loss.

None of the treatments caused any adverse effect to the crop, and no checks to growth were observed. The lowest mean score recorded was 7.75, (5 treatments) with 8.50 for the untreated control, and there were no significant differences between any treatments, nor between replicates.

FIGURE 1



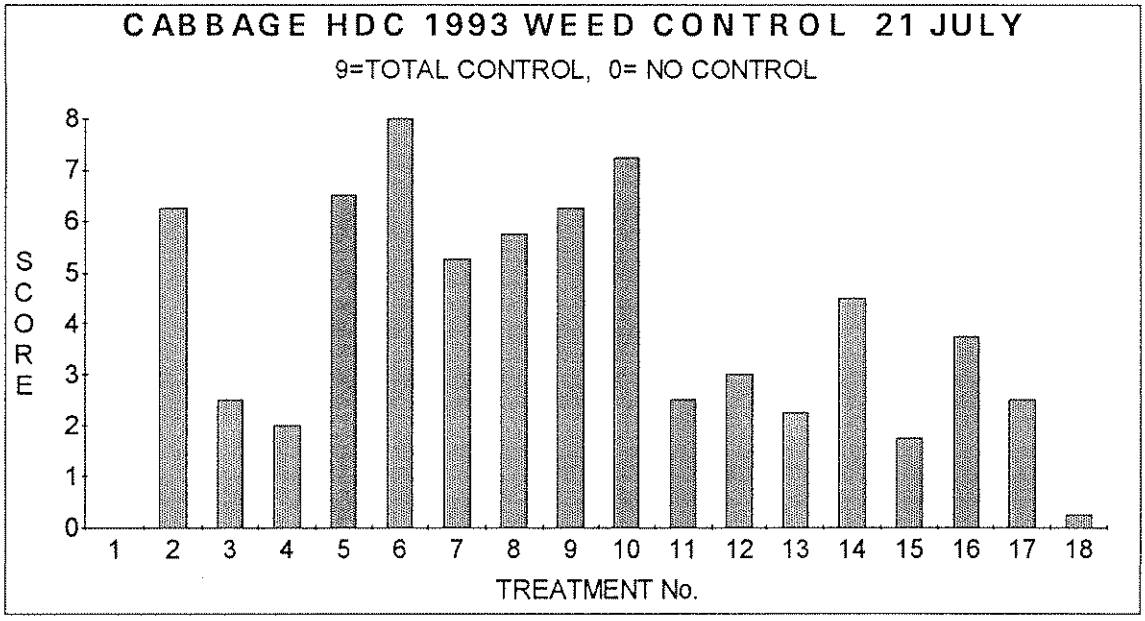
Details at appendices 9 and 10.

7.2 Effect on Weeds

Each treatment was scored twice for efficacy of weed control on a 0-9 scale, 9 equivalent to total weed control, 0 equivalent to no weed control.

At the first assessment date (21-7-1993) 10 treatments had significantly reduced weed numbers and size compared with the controls, but in some cases, differences were small, and only treatments 6 and 10 achieved a mean score above 7.0.

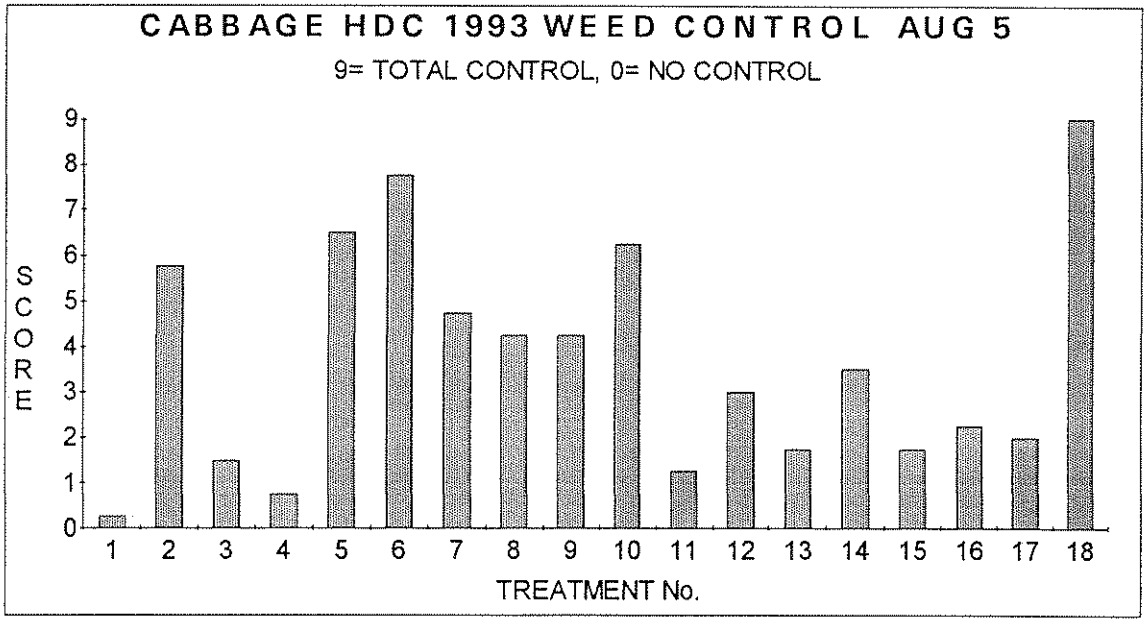
FIGURE 2



Details at appendix 11 and 12.

By the second assessment date (5-8-1993) only treatment 6 recorded a mean score above 7.0 (7.75), except for treatment 18, the hand weeded control which was hand weeded on 21 July 1993 after the first assessment and was weed free at the time of the second assessment. This treatment (7) remained virtually clear of weeds until harvest, with only a few stunted Shepherds Purse surviving.

FIGURE 3



Details at appendix 13 and 14.

7.3 Yield of Marketable Cabbage

Due to the failure of most treatments to control the weed spectrum present, and the consequent smothering of the crop, only very limited yield data could be obtained. Information was possible only from treatments 6 and 18 with the following comparable data.

TABLE 1

Treatment No	Material	Head Nos/plot	Wt/plot	Mean Head Wt
6	Brasoran ½+ Butisan ½ Semeron $^1/_3$+ Croptex Steel ¼	13.75	13.05	1.13
18	Hand weeded control	8.5	7.725	0.9

8.0 Discussion

8.1 Weed spectrum

The site was again on a farm that has grown vegetable crops intensively, including brassicas, for at least 4 decades. The following weed species were recorded on 3 July 1993 at the time of the first treatment.

TABLE 2

COMMON NAME	SPECIES	STAGE No of true leaves	APPROXIMATE HEIGHT inches	APPROXIMATE SPREAD inches
Fat-hen	Chenopodium album	4-6	2	2
Small Nettle	Urtica urens	4	1	1½
Annual Mercury	Mercurialis annua	4-6	1½	2
Redshank	Polygonum persicaria	5-6	1-2	3-4
Green Nightshade	Solanum physalifolium	4-5	1	2
Shepherds Purse	Capsella bursa-pastoris	4	1-2	1-2

Small numbers of Groundsel (Senecio vulgaris) and Mayweed (Matricaria spp) were recorded subsequently.

8.2 Treatment Effects

The site had received no pre-emergence herbicide treatment so that the degree of weed control achieved was due to the applied treatments only.

A notable feature of the trial was the rampant growth of Fat-hen and Red Shank that occurred. The Fat-hen in particular reached a height of 2½-3 feet by early August.

Complete smothering of the crop was recorded in several treatments that had failed to control Fat-hen, Red Shank and Green Nightshade. Because of this, it was decided to eliminate by rotavation 30 of the 72 plots, accounting for 9 treatments including the untreated control. It was clear by this stage that the treatments had failed, and the action was taken to reduce the amount of weed seed being returned to the soil. Treatments 1, 3, 4, 11, 12, 13, 15, 16 and 17 were all terminated in this way.

The mixture of half rate each of Brasoran and Butisan formed the basis of three safe and promising treatments (2, 5 and 6). However, as found in 1992, a single application did not achieve freedom from weeds until harvest, (Treatment 2). A sequential application of ¼ rate Brasoran + ¼ rate Croptex Steel (treatment 5) further checked weed growth, but subsequent regrowth of Fat-hen and Red Shank in particular occurred, with crop smother in one replicate.

Where the follow up treatment consisted of $^1/_3$ rate Semeron + ¼ rate Croptex Steel, (Treatment 6), however, excellent weed control was achieved, persisting until harvest.

Where $^1/_3$ rate Semeron + ¼ rate Croptex Steel formed both initial and sequential applications (treatment 10), good weed control was achieved to begin with, but later deteriorated as Red Shank, Fat-hen and Green Nightshade tended to recover.

In 1992, promising results were obtained with treatments that included low rate Fortrol, particularly the 3 way mixture of approximately quarter rate each of Fortrol, Croptex Steel and Brasoran. In 1993, however, this combination (treatment 12) gave poor results, being one of the treatments that was rotavated in. Similarly, the combination of Fortrol and Butisan which was very effective, but too damaging in 1992, was tested again in 1993 at ¼ rate Butisan. (treatment 14). Although this year the mixture was safe to the crop, weed control was poor. The treatments this year were applied to larger cabbage (2½ true leaves as against 1½ true leaves in 1992), and the weeds were also larger, the Fat-hen being beyond the stage that it is likely to be controlled by Fortrol. The ¼ rate Fortrol + ½ rate Butisan treatment was not repeated in 1993 so its effect on cabbage at 2½-3 true leaves has not been tested.

The active ingredient of Croptex Steel (sodium monochloroacetate [SMA]) is an inorganic salt formulated without wetter. The presence of wetter would be expected to cause crop scorch, but no evidence of this has been found in the two years work where Croptex Steel was mixed with other materials containing wetter. Most Croptex Steel treatments were at the 5 kg/ha rate, but in two this year (treatments 15 and 16), the rate was increased to 10 kg/ha. Even at this rate there was no evidence of crop damage of any sort.

9.0 Conclusions

9.1 Half rates of Brasoran and Butisan tank mixed have been tested on seedling cabbage for two years, and appear safe, as no significant reduction to growth of cabbage has been observed.

9.2 This mixture is unlikely to give control of weeds through to harvest.

9.3 A follow up treatment 7-10 days later appears necessary to achieve full weed control. The choice should be made according to the weed spectrum present, but in this trial $^1/_3$ rate Semeron + ¼ rate Croptex Steel was safe and effective.

9.4 Investigations over 2 years into the safety and efficiency of Fortrol mixtures in cabbage have given conflicting results and the potential of this material remains unclear.

10.0 Acknowledgements

Thanks is due to Mr P W Emmett for his assistance with this trial and for supplying some of the herbicides used.

Appendix 1

Crop safety: Means of treatment and replicate scores. 1992

ROWS: rep COLUMNS: treat

	1	2	3	4	5	6	7	8
1	8.0000	7.0000	8.0000	8.0000	7.0000	9.0000	7.0000	6.0000
2	8.0000	5.0000	7.0000	6.0000	7.0000	6.0000	5.0000	6.0000
3	6.0000	6.0000	5.0000	5.0000	7.0000	7.0000	7.0000	5.0000
4	8.0000	6.0000	6.0000	6.0000	7.0000	7.0000	6.0000	6.0000
ALL	7.5000	6.0000	6.5000	6.2500	7.0000	7.2500	6.2500	5.7500

	9	10	11	12	13	14	15	ALL
1	2.0000	3.0000	7.0000	7.0000	6.0000	7.0000	8.0000	6.6667
2	3.0000	2.0000	7.0000	7.0000	5.0000	6.0000	9.0000	5.9333
3	2.0000	2.0000	6.0000	7.0000	5.0000	7.0000	6.0000	5.5333
4	3.0000	4.0000	6.0000	7.0000	3.0000	7.0000	8.0000	6.0000
ALL	2.5000	2.7500	6.5000	7.0000	4.7500	6.7500	7.7500	6.0333

CELL CONTENTS --
crop:MEAN

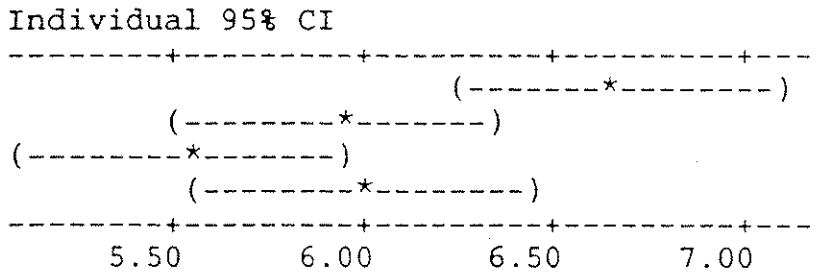
Appendix 2

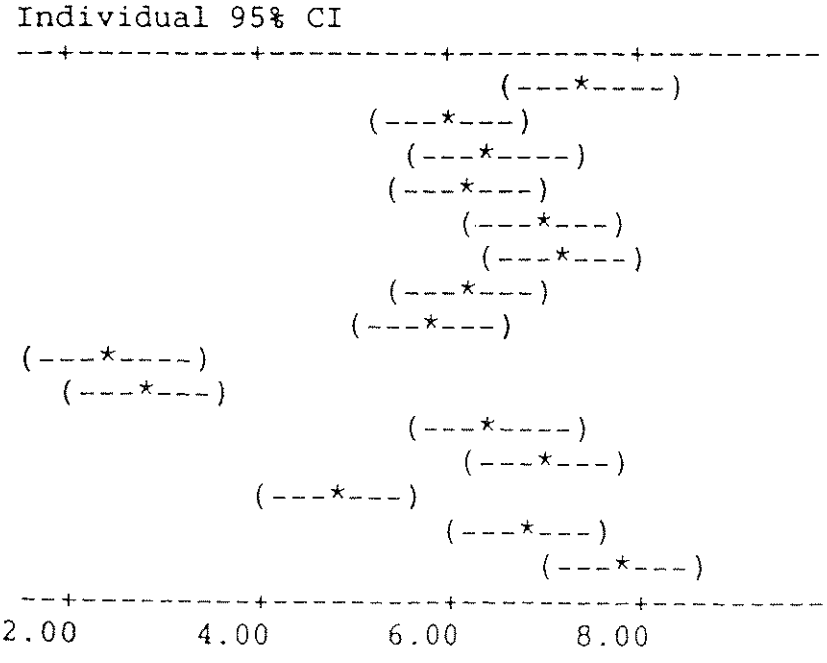
Crop safety: Analysis of variance. 1992

SOURCE	DF	SS	MS
Rep	3	9.933	3.311
treat	14	137.933	9.852
ERROR	42	28.067	0.668
TOTAL	59	175.933	

ANALYSIS OF VARIANCE crop

SOURCE	DF	SS	MS
Rep	3	9.933	3.311
treat	14	137.933	9.852
ERROR	42	28.067	0.668
TOTAL	59	175.933	





ADAS

Appendix 3

Weed control: Means of treatment and replicate scores. 1992

ROWS: rep COLUMNS: treat

	1	2	3	4	5	6	7	8
1	2.0000	4.0000	4.0000	5.0000	6.0000	5.0000	4.0000	6.0000
2	0.0000	6.0000	6.0000	7.0000	7.0000	7.0000	6.0000	3.0000
3	3.0000	3.0000	2.0000	3.0000	6.0000	4.0000	7.0000	7.0000
4	1.0000	5.0000	5.0000	6.0000	6.0000	6.0000	7.0000	7.0000
ALL	1.5000	4.5000	4.2500	5.2500	6.2500	5.5000	6.0000	5.7500

	9	10	11	12	13	14	15	ALL
1	9.0000	8.0000	7.0000	8.0000	8.0000	7.0000	1.0000	5.6000
2	8.0000	8.0000	8.0000	8.0000	8.0000	7.0000	0.0000	5.9333
3	9.0000	8.0000	7.0000	7.0000	8.0000	7.0000	3.0000	5.6000
4	8.0000	8.0000	8.0000	9.0000	9.0000	8.0000	0.0000	6.2000
ALL	8.5000	8.0000	7.5000	8.0000	8.2500	7.2500	1.0000	5.8333

CELL CONTENTS --
weed:MEAN

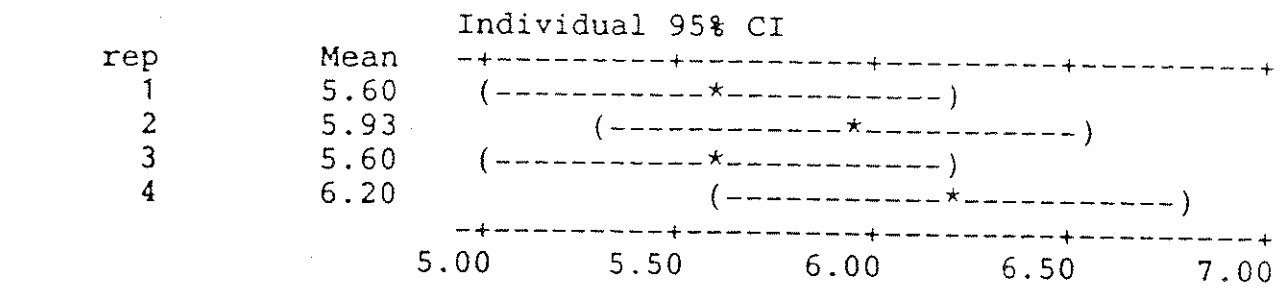
TB > paper

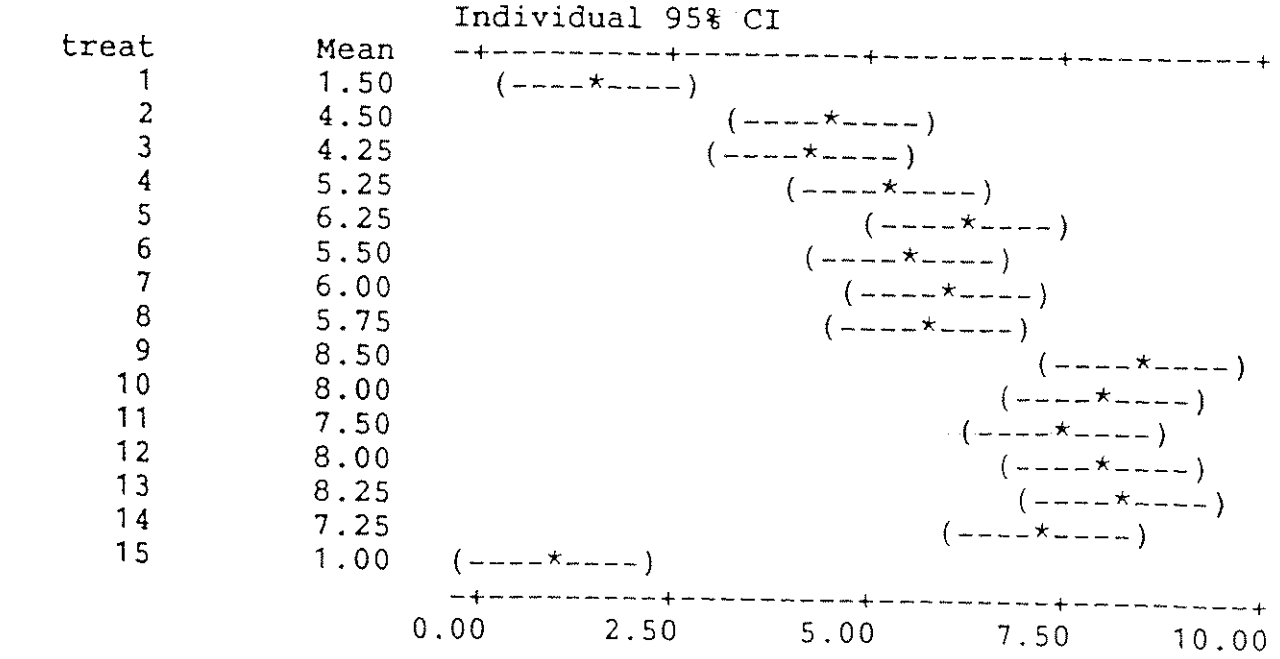
Appendix 4

Weed control: Analysis of variance. 1992

ANALYSIS OF VARIANCE weed

SOURCE	DF	SS	MS
Rep	3	3.80	1.27
Treat	14	296.83	21.20
ERROR	42	57.70	1.37
TOTAL	59	358.33	





ADAS

Appencix 5

Weed counts: Means of treatment and replicate scores. 1992

ROWS: rep COLUMNS: treat

	1	2	3	4	5	6	7	8
1	67.000	70.000	96.000	68.000	32.000	61.000	72.000	47.000
2	123.000	25.000	45.000	20.000	19.000	21.000	45.000	147.000
3	45.000	36.000	119.000	251.000	48.000	128.000	34.000	23.000
4	118.000	48.000	64.000	22.000	39.000	23.000	31.000	29.000
ALL	88.250	44.750	81.000	90.250	34.500	58.250	45.500	61.500

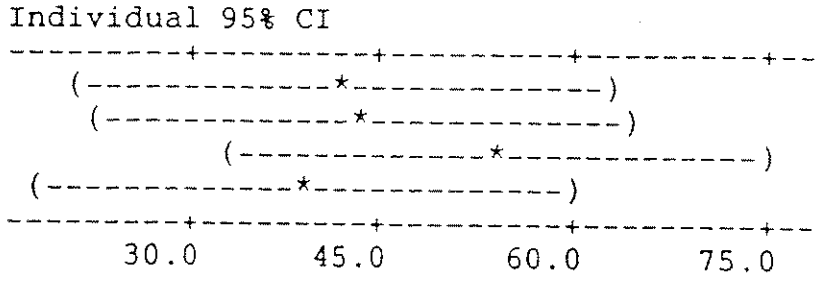
	9	10	11	12	13	14	15	ALL
1	0.000	12.000	15.000	7.000	11.000	15.000	62.000	42.333
2	4.000	10.000	10.000	10.000	8.000	33.000	135.000	43.667
3	3.000	12.000	6.000	10.000	5.000	34.000	54.000	53.867
4	4.000	2.000	6.000	6.000	3.000	28.000	160.000	38.867
ALL	2.750	9.000	9.250	8.250	6.750	27.500	102.750	44.683

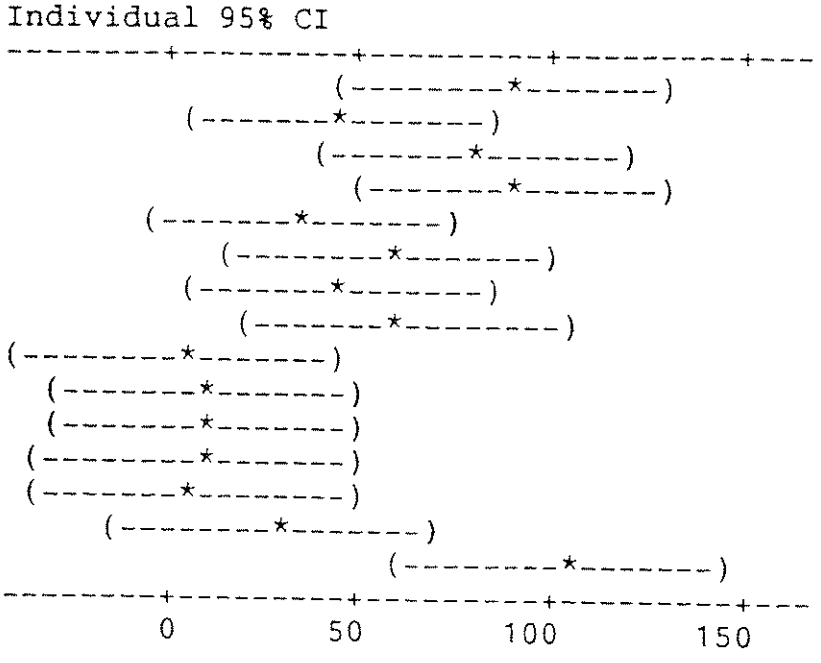
CELL CONTENTS --
count:MEAN

Appendix 6

Weed counts: Analysis of variance. 1992

SOURCE	DF	SS	MS
Rep	3	1871	624
Treat	14	66340	4739
ERROR	42	70664	1682
TOTAL	59	138875	





ADAS

Appendix 7

Crop yield: Means of treatment and replicate scores. 1992

ROWS: rep COLUMNS: treat

	1	2	3	4	5	6	7	8
1	1.900	28.600	25.700	29.700	34.500	29.000	33.600	28.100
2	0.000	25.500	34.500	19.500	25.200	29.800	43.300	33.500
3	7.500	27.000	24.100	27.300	30.000	33.800	27.300	21.200
4	2.200	27.700	2.700	20.300	28.600	21.700	21.100	22.500
ALL	2.900	27.200	21.750	24.200	29.575	28.575	31.325	26.325

	9	10	11	12	13	14	15	ALL
1	6.500	26.800	25.100	33.100	30.600	31.200	28.900	26.220
2	24.600	18.600	33.500	34.800	31.900	32.700	23.800	27.413
3	10.500	12.600	26.900	29.400	25.600	25.100	32.300	24.040
4	16.600	21.400	22.400	22.900	15.400	22.300	25.100	19.527
ALL	14.550	19.850	26.975	30.050	25.875	27.825	27.525	24.300

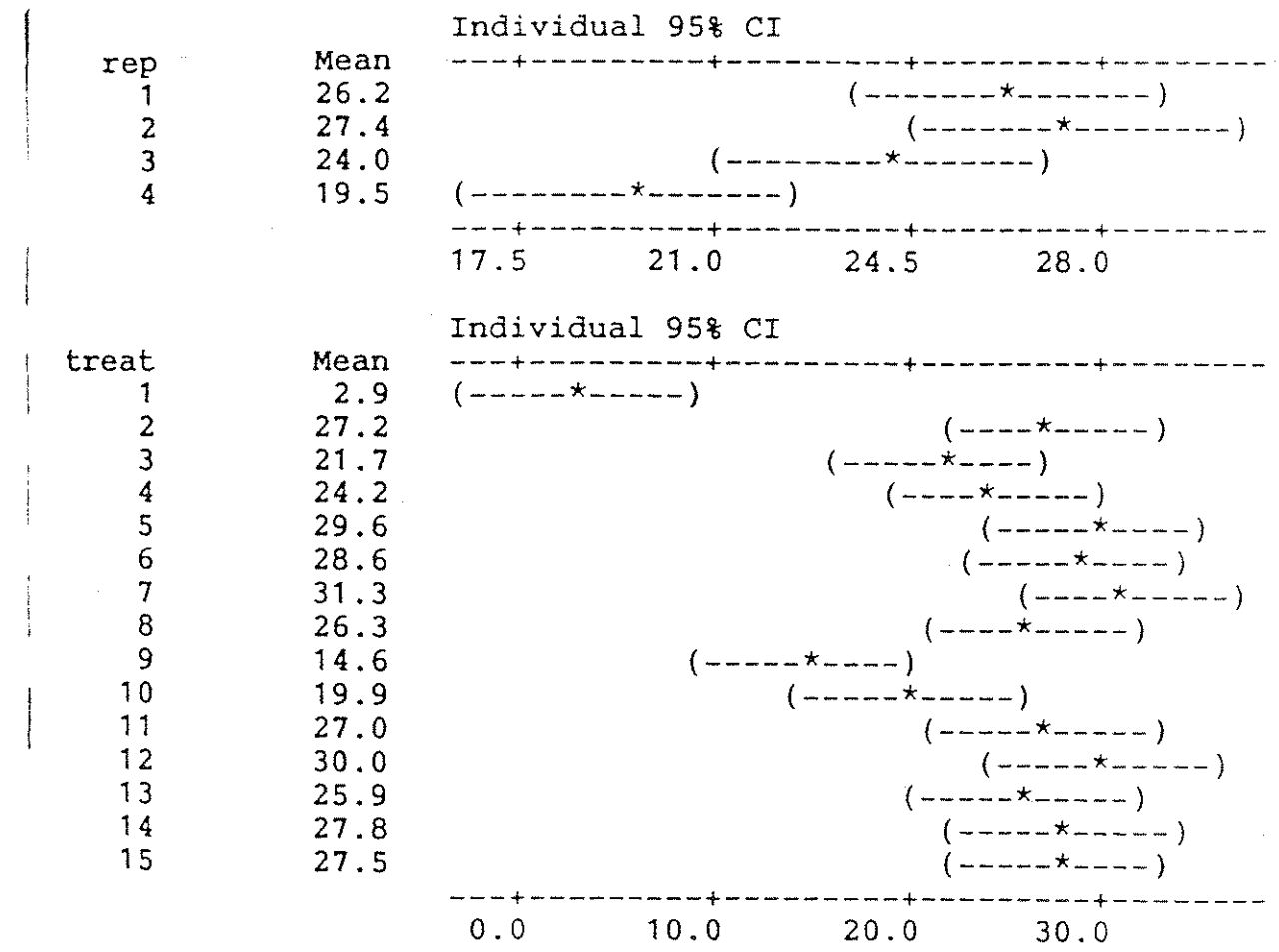
CELL CONTENTS --
yield:MEAN

Appendix 8

Crop yield: Analysis of variance. 1992

ANALYSIS OF VARIANCE yield

SOURCE	DF	SS	MS
Rep	3	543.5	181.2
Treat	14	3011.3	215.1
ERROR	42	1329.8	31.7
TOTAL	59	4884.5	



ADAS

Appendix 9

Crop safety: Means of treatment and replicate scores. 1993

ROWS: TRT COLUMNS: REP

	1	2	3	4	ALL
1	9.0000	9.0000	9.0000	7.0000	8.5000
2	8.0000	8.0000	8.0000	8.0000	8.0000
3	8.0000	9.0000	9.0000	9.0000	8.7500
4	9.0000	9.0000	9.0000	8.0000	8.7500
5	7.0000	8.0000	8.0000	8.0000	7.7500
6	7.0000	7.0000	9.0000	8.0000	7.7500
7	9.0000	7.0000	8.0000	9.0000	8.2500
8	7.0000	8.0000	8.0000	8.0000	7.7500
9	8.0000	8.0000	7.0000	8.0000	7.7500
10	8.0000	7.0000	8.0000	8.0000	7.7500
11	9.0000	8.0000	9.0000	8.0000	8.5000
12	8.0000	9.0000	8.0000	7.0000	8.0000
13	9.0000	9.0000	7.0000	8.0000	8.2500
14	9.0000	8.0000	8.0000	7.0000	8.0000
	1	2	3	4	ALL
15	9.0000	9.0000	8.0000	8.0000	8.5000
16	9.0000	8.0000	7.0000	8.0000	8.0000
17	8.0000	9.0000	8.0000	8.0000	8.2500
18	9.0000	8.0000	8.0000	9.0000	8.5000
ALL	8.3333	8.2222	8.1111	8.0000	8.1667

CELL CONTENTS --
CROP:MEAN

Appendix 10

Crop safety: Analysis of variance. 1993

ANALYSIS OF VARIANCE CROP

SOURCE	DF	SS	MS
TRT	17	8.500	0.500
REP	3	1.111	0.370
ERROR	51	24.389	0.478
TOTAL	71	34.000	

TRT	Mean	Individual 95% CI
1	8.50	
2	8.00	
3	8.75	
4	8.75	
5	7.75	
6	7.75	
7	8.25	
8	7.75	
9	7.75	
10	7.75	
11	8.50	
12	8.00	
13	8.25	
14	8.00	
15	8.50	
16	8.00	
17	8.25	
18	8.50	

7.20 7.80 8.40 9.00

REP	Mean	Individual 95% CI
1	8.33	
2	8.22	
3	8.11	
4	8.00	

7.75 8.00 8.25 8.50

ADAS

Appendix 11

Weed control July 21: Means of treatment and replicate scores. 1993

ROWS: TRT COLUMNS: REP

	1	2	3	4	ALL
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	5.0000	6.0000	7.0000	7.0000	6.2500
3	3.0000	1.0000	2.0000	4.0000	2.5000
4	3.0000	2.0000	1.0000	2.0000	2.0000
5	7.0000	7.0000	4.0000	8.0000	6.5000
6	8.0000	8.0000	7.0000	9.0000	8.0000
7	5.0000	5.0000	5.0000	6.0000	5.2500
8	6.0000	5.0000	5.0000	7.0000	5.7500
9	6.0000	6.0000	7.0000	6.0000	6.2500
10	7.0000	8.0000	6.0000	8.0000	7.2500
11	3.0000	0.0000	6.0000	1.0000	2.5000
12	4.0000	6.0000	1.0000	1.0000	3.0000
13	2.0000	6.0000	0.0000	1.0000	2.2500
14	5.0000	5.0000	1.0000	7.0000	4.5000
	1	2	3	4	ALL
15	3.0000	4.0000	0.0000	0.0000	1.7500
16	3.0000	2.0000	6.0000	4.0000	3.7500
17	4.0000	1.0000	4.0000	1.0000	2.5000
18	0.0000	0.0000	0.0000	1.0000	0.2500
ALL	4.1111	4.0000	3.4444	4.0556	3.9028

CELL CONTENTS --
WEED1:MEAN

Appendix 12

Weed control July 21: Analysis of variance. 1993

ANALYSIS OF VARIANCE WEED1

SOURCE	DF	SS	MS
TRT	17	390.57	22.97
REP	3	5.15	1.72
ERROR	51	132.60	2.60
TOTAL	71	528.32	

TRT	Mean	Individual 95% CI
1	0.00	(----*----)
2	6.25	(-----*----)
3	2.50	(----*-----)
4	2.00	(-----*----)
5	6.50	(-----*----)
6	8.00	(-----*----)
7	5.25	(----*-----)
8	5.75	(----*-----)
9	6.25	(-----*----)
10	7.25	(----*-----)
11	2.50	(----*-----)
12	3.00	(----*----)
13	2.25	(----*-----)
14	4.50	(----*----)
15	1.75	(-----*----)
16	3.75	(----*-----)
17	2.50	(----*-----)
18	0.25	(-----*----)

0.00 3.00 6.00 9.00

REP	Mean	Individual 95% CI
1	4.11	(----------*----------)
2	4.00	(----------*----------)
3	3.44	(----------*----------)
4	4.06	(----------*----------)

3.00 3.60 4.20 4.80

ADAS

Appendix 13

Weed control Aug 5: Means of treatment and replicate scores. 1993

ROWS: TRT COLUMNS: REP

	1	2	3	4	ALL
1	1.0000	0.0000	0.0000	0.0000	0.2500
2	4.0000	6.0000	6.0000	7.0000	5.7500
3	2.0000	1.0000	0.0000	3.0000	1.5000
4	2.0000	0.0000	0.0000	1.0000	0.7500
5	7.0000	7.0000	4.0000	8.0000	6.5000
6	8.0000	8.0000	7.0000	8.0000	7.7500
7	5.0000	4.0000	6.0000	4.0000	4.7500
8	5.0000	3.0000	3.0000	6.0000	4.2500
9	7.0000	2.0000	5.0000	3.0000	4.2500
10	7.0000	7.0000	4.0000	7.0000	6.2500
11	1.0000	0.0000	4.0000	0.0000	1.2500
12	4.0000	6.0000	1.0000	1.0000	3.0000
13	1.0000	6.0000	0.0000	0.0000	1.7500
14	6.0000	4.0000	0.0000	4.0000	3.5000
	1	2	3	4	ALL
15	3.0000	4.0000	0.0000	0.0000	1.7500
16	2.0000	1.0000	6.0000	0.0000	2.2500
17	4.0000	1.0000	2.0000	1.0000	2.0000
18	9.0000	9.0000	9.0000	9.0000	9.0000
ALL	4.3333	3.8333	3.1667	3.4444	3.6944

CELL CONTENTS --
WEED2:MEAN

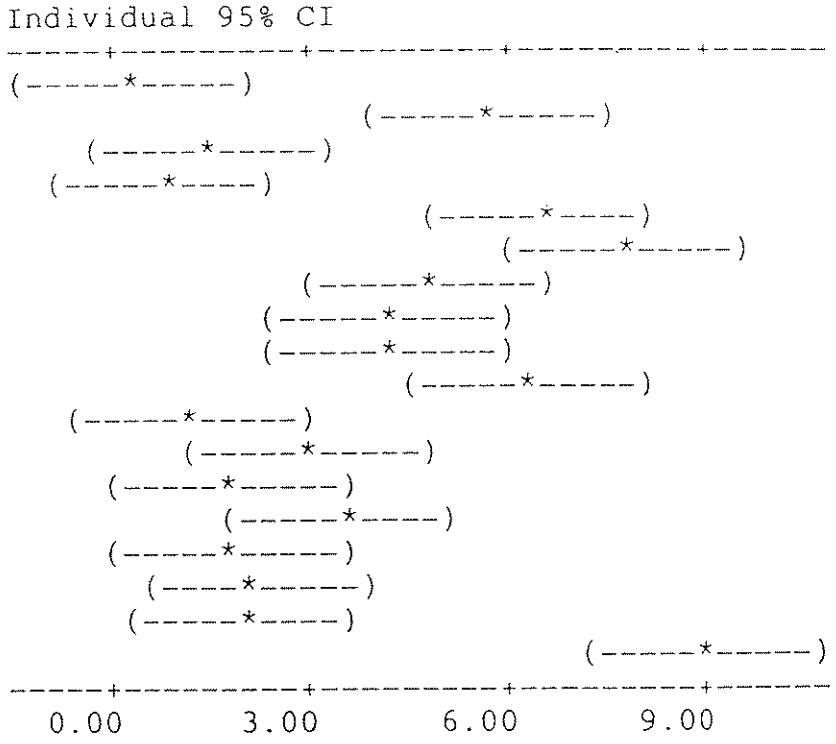
Appendix 14

Weed control Aug 5: Analysis of variance. 1993

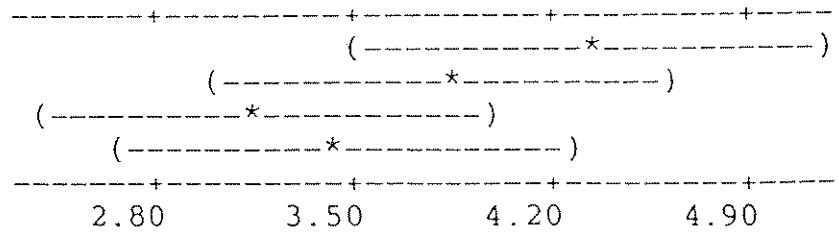
ANALYSIS OF VARIANCE WEED2

SOURCE	DF	SS	MS
TRT	17	437.28	25.72
REP	3	13.83	4.61
ERROR	51	152.17	2.98
TOTAL	71	603.28	

TRT	Mean
1	0.25
2	5.75
3	1.50
4	0.75
5	6.50
6	7.75
7	4.75
8	4.25
9	4.25
10	6.25
11	1.25
12	3.00
13	1.75
14	3.50
15	1.75
16	2.25
17	2.00
18	9.00



REP	Mean
1	4.33
2	3.83
3	3.17
4	3.44



ADAS