PROJECT REPORT No. 136

APPROPRIATE HERBICIDE RATES FOR CEREAL CROPS

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APPROPRIATE HERBICIDE RATES FOR CEREAL CROPS

by

D. H. K. DAVIES

SAC Crop Systems Department, Bush Estate, Penicuik EH26 0PH

This is the final report of a three year project which started in July 1991. Project collaborators were: SAC (leader – D. H. K. Davies), ADAS (leader – M. J. Proven) and DANI/The Queen's University of Belfast (leader – A. D. Courtney). The work was funded by a grant of £158,161 from the Home-Grown Cereals Authority (project No. 0049/1/91).

CONTENTS

SUMMARY

This report reviews the results of a project devised to examine whether the approaches developed by SAC and DANI through government and HGCA funded work for optimising herbicide use in cereals could be used on a wider basis, and to examine further the conditions which effect herbicide dose responses. The approach is to develop optimum herbicide rates and programmes consistent with conditions, weed size and crop situations ('appropriate rates'). Earlier trials series were confined to weed flora excluding some of the most competitive weeds, and did not look in detail into the effects of crop/weed relationships, conditions and timing on herbicide activity.

The objectives and conclusions of the two parts of the project are:

A. A series of trials in winter wheat examined whether such approaches have benefits in controlling a difficult weed, using *Galium aparine* (cleavers) as the model, and what are the important components determining the efficacy of such herbicide programmes.

- Using an autumn-residual herbicide, such as diflufenican (DFF) + isoproturon (IPU), pendimethalin + IPU or isoxaben + IBU, improves the activity of the spring cleaver herbicide, fluroxypyr. *The sequential herbicide approach improves weed control allowing dose reductions at least to half-doses.*

- Crop vigour affects the dose response curve. *Use more herbicide in less vigorous crops, and in poorer conditions.*

- Crop density has a clear effect on cleaver growth and the capacity of fluroxypyr to control the weed. This was also confirmed for oilseed rape and perennial ryegrass, used as model weeds in a further trial series at QUB. *Increased crop competition improves herbicide activity.*

- *Fluroxypyr treatment after autumn use of a residual treatment has greatest benefit when used around GS32 of the crop in terms of effect on cleavers and yield benefits.*

B. Futher trial series examined the impact of herbicide timing and weed/crop interaction on dose responses in terms of weed control and crop yield of spring barley:

- Increasing crop density, though competition, reduces weed biomasss, and normally improves herbicide efficacy. *A vigorous crop is the key to good weed control.*
- Crop phytoxicity from herbicide use is most likely at highest crop densities in good growing conditions. *Reduce herbicide doses on vigorous crops in good growing conditions.*
- Sequential pre-/post- herbicide treatments give very variable weed control due to variability in soil moisture required for residual treatments tested. *Use such an approach only when annual meadow-grass is likely to be a problem.*
- Yield response to weed control is very variable in spring barley.
- However, in general, *early post-emergence treatments (2-4 leaves of weeds) give the best weed control.*
- Early treatment gives the greatest possibility of dose reduction, but dose reduction is more effective in competitive and denser crops.

Further trial series have shown the clear impact of crop cultivar in weed suppression and improving herbicide efficacy. *Weed suppression and control is improved by use of cultivars giving relatively high levels of early ground cover.*

The project emphasises the importance of timing and weed size on herbicide activity, and, in winter cereals, the usefulness of the sequential treatment strategy in allowing dose reduction with a high level of security. It emphasises the importance of crop vigour and competition in determining appropriate rates for herbicide programmes. There is a concern regarding crop phytoxicity with herbicides, which is greater in dense, vigorous crops, but it is also in these crops that herbicide dose reduction is most possible.

INTRODUCTION

Weed control accounts for a high proportion of the variable costs of cereal crops, with many winter crops being sprayed two or three times per season, often at close to maximum recommended rates. There was clear evidence from HGCA funded work (Cost-effective Weed Control in Cereal Crops, Cussans and Courtney 1995), and Reduced Cost Approaches to Herbicides and Fungicide use in Cereals (Fisher, 1994)), and government (DAFS/SOAEFD, DANI) core-funded work, that yield responses to weed control do not always give an economic benefit. The use of weed number thresholds could be of assistance in the decision whether to spray or not, but was probably too time-consuming to undertake to be more cost-effective than routine half-recommended rate treatment (Davies *et al*, 1993). Furthermore there was evidence of a potential weed seed build-up in the spray/no-spray threshold approach. It was concluded that thresholds should perhaps be indicators of how much to use rather than whether to use a herbicide. Results from project Fisher, 1994 and DANI and SOAEFD government funded work have indicated that economic rates are often much lower than those recommended, and that low-rate herbicide programmes could be designed with a high level of the necessary insurance of success. However, these trials were limited to cereal weed flora excluding some of the most competitive weeds, and did not look in detail into the effect of crop/weed conditions and timing on herbicide activity.

This project had two basic parts. Using philosophies towards herbicide programmes developed by DANI and SAC in the earlier series, a series of trials in winter wheat highlights whether such approaches have benefits in the control of a more difficult and competitive weed, using Galium aparine (cleavers) as the model. The impact of timing, conditions and crop competition on herbicide activity are also examined. Using oilseed rape and ryegrass as model weeds, a trial at QUB looks in more detail at crop density and timing of treatment interaction in winter wheat.

The second part of the project examines the impact of herbicide timing and conditions and crop and weed interference/competition on herbicide dose responses in spring barley, and crop yield responses.

The winter wheat series, using cleaver control as a model, was undertaken at ADAS, SAC and QUB. the spring barley herbicide timing trials at SAC and QUB, and the weed interference/crop competition small plots trials in winter wheat and spring barley at QUB.

Within this contract, an assessment of weed levels after five growing seasons of routine threshold or full or half-dose herbicide use was evaluated at the four cereal sites in Scotland established under project contract 013/8/88 (Cussans and Courtney, 1995). This was undertaken to obtain further information on the impact of routine use of lower herbicide rates throughout the rotation on weed levels.

PRODUCT LIST AND APPLICATION

The list below includes all products tested in the trials series, with abbreviation used.

a. Diflufenican (DFF) + isoproturon (IPU): 50 g + 500 g a.i./*l* Panther or Cougar (N Ireland only); RP Agriculture.

b. Pendimethalin + isoproturon (IPU): 250 g + 125 g a.i./*l* Encore; Cyanamid

c. Isoxaben + isoproturon (IPU): 19 g + 450 g a.i./*l* Ipso; DowElanco

d. Fluroxypyr: 200 g a.i./*l* Starane 2; DowElanco

e. Mecoprop-P: 600 g a.i./l Duplosan New System CMPP; BASF

f. Ioxynil + bromoxynil (HBN): 380 g a.i./*l* Deloxil; Agrevo

g. Metsulfuron-methyl (metsulfuron): 20% a.i. w/w Ally (DuPont)

h. Pendimethalin: 400 g a.i./*l* Stomp 400; Cyanamid (except N Ireland, Stomp 330)

i. Fluroxypyr + ioxynil + bromoxynil (HBN): 90 + 100 + g a.i./*l* Advance; (DowElanco)

j. MCPA + dichlorprop: 210 + 392 g a.i./*l* Hemoxone; ICI (now Zeneca)

k. MCPA + 2, 4-DP: 150 + 350 g a.i./*l* equivalent

l. Isoproturon (IPU) + bromoxynil + ioxynil (HBN): g a.i./*l* Astrol; Embetec (now RP Agriculture)

m. Isoproturon (IPU) + mecoprop + ioxynil: 250 + 180 + 50 g a.i./Xül Post-Kite; Schering (now (AgrEvo)

n. Linuron: 370 g a.i./l AH as Linuron (Atlas Interlates)

All herbicide treatments were applied by knapsack sprayer calibrated to deliver 200-220 *l*/ha volume at 2-2.4 bars through medium spray (BCPC) nozzles, unless otherwise stated.

WEED SPECIES LIST

Annual meadowgrass (AMG) :	*Poa annua*
Cleavers :	*Galium aparine*
Common chickweed :	*Stellaria media*
Field pansy/pansy :	*Viola arvensis*
Forget-me-not :	*Myosotis arvensis*
Hemp-nettle/Daynettle :	*Galeopsis* spp.
Knotgrass :	*Polygonum aviculare*
Oilseed rape :	*Brassica napus*
Perennial ryegrass :	*Lolium perenne*
Pineappleweed :	*Chamomilla suaveolens*
Red deadnettle :	*Lamium purpureum*
Redshank :	*Polygonum lapathifolium*
Scentless mayweed/mayweed :	*Matricaria perforata*

1. WINTER WHEAT: APPROPRIATE HERBICIDE USE FOR CLEAVER CONTROL

A series of trials was initiated at ADAS, SAC and QUB in season 1991/92 to examine whether approaches developed within earlier HGCA funded work (Fisher 1994), and SOAEFD funded studies at SAC, to reduce herbicide use in winter cereals with a high level of insurance could be extended to a more difficult weed species. Cleavers was chosen as a major weed of wheat, requiring further herbicide treatments for control over the usual background weed flora. The particular approach examined was the use of autumn/spring low-dose sequential treatments, where the use of a low-dose autumn treatment may allow a reduction in the appropriate dose of a specific cleaver herbicide in the spring. A sequence of a diflufenican-based autumn treatment followed by fluroxypyr in the spring was used as a test model for this approach.

Once the relationship had been established, a second trial series at ADAS and SAC examined the appropriate spring dose targetted for cleaver control in response to timing and conditions of treatment.

In a third series, the importance of crop competition was evaluated at all three centres following suggestion from the earlier series that this is an important factor, using varying crop density as a model for competition.

During the three seasons, a further series of trials compared the test sequence with other potential sequences of herbicides, and work at QUB examined in detail the use of multiple low-dose applications of fluroxypyr in the spring. QUB also examined weed competition in wheat more specifically, using oilseed rape as a model weed, and the weed response to crop competition. A further two small trials at SAC had an initial look at the possibility of the use of mecoprop-p/fluroxypyr sequences at low-doses, and the effect of adding ioxynil + bromoxynil (HBN) on the activity of fluroxypyr.

1.1 The testing of a reduced dose sequential herbicide programme on winter wheat crops with weed populations including cleavers, in order to evaluate the interdependence of autumn and spring herbicide activity

1.1.1 *Treatments and design*

Trials were based on a factorial design, with three replicated blocks, based on treatment at crop GS 11/12 with diflufenican (DFF) + isoproturon (IPU) at equivalents of 100, 50, 25, 12.5, and 0 g a.i. DFF/ha, followed by treatment around crop GS 31 with fluroxypyr at equivalent of 200, 100, 50, 25 and 0 g a.i. fluroxypyr/ha, and all combinations of these treatments. Crops otherwise had routine winter wheat treatments for the farm. Plot-sizes were 2.3 - 3.2 m x 20 - 24 m. All sites were sown to winter wheat, cultivar Riband, according to local practice. There was a wide range of weeds over the sites, but all sites were sown with 50 seeds/m² of cleavers from a single source to (reduce variation) incorporated with the drill (then rolled), except for the Haddington site which had a similar native population. See Appendix I (1) for site details.

Site	Agent
Boxworth, Cambridge	ADAS
Drayton, Warwickshire	ADAS
Bridgets, Hampshire	ADAS
Rosemaund, Shropshire	ADAS
Bush, Midlothian	SAC
Luggate, Haddington, East Lothian	SAC
Greenmount, Co Down	QUB

All fields selected had been in cereal dominated rotations.

1.1.2 *Results*

The relationship between the use of DFF/IPU in the autumn and fluroxypyr in the spring in terms of cleaver control is described in Figure 1. This figure presents July cleaver biomass remaining in July as a dry matter assessment, meaned for all sites. Results for individual sites are given in Appendix I(1).

The dose response curves for both autumn and spring treatment are clear, with DFF/IPU also showing moderate cleaver control at full rate. The sequences improved activity, with the best results from the full-dose of both treatments, but at all rates the sequence improved activity over either product alone, with the added benefit of the general broad-leaf weed control from DFF/IPU (Appendix I(1)). There was similar level of activity between the half-dose sequence and the full-dose sequences.

There were major differences between sites, as outlined in Figure 2. At five sites with a mean crop grain yield of about 8 t/ha, the yield dose response curves to herbicide treatment were very similar. However, at Greenmount wet soil conditions led to poor crop vigour (less than 4 t/ha yield) and little crop competition. Herbicide efficacy was greatly reduced, and there was no clear benefit to the fluroxypyr treatment from the autumn use of DFF/IPU. At Haddington, conversely, the crop was very vigorous (c 12 t/ha grain yield) and both DFF/IPU and fluroxypyr were more active. At this site, a quarter dose of DFF/IPU in the autumn allowed fluroxypyr to control cleavers at 12.5% of the recommended dose. This was a dose that had little effect on cleavers when used alone (Figure 1).

Grain yield responses show a net benefit to using the autumn/spring herbicide sequence in comparison with using either treatment alone, even at full dose (Figure 3). There is no general trend accorded to the amount of each product used in the sequence. However, yields are clearly lower if one or other treatments is excluded. At the very high yielding Haddington site there is a tendency for the highest dose sequential treatments to reduce yield. The reverse is true for the low yielding Greenmount site.

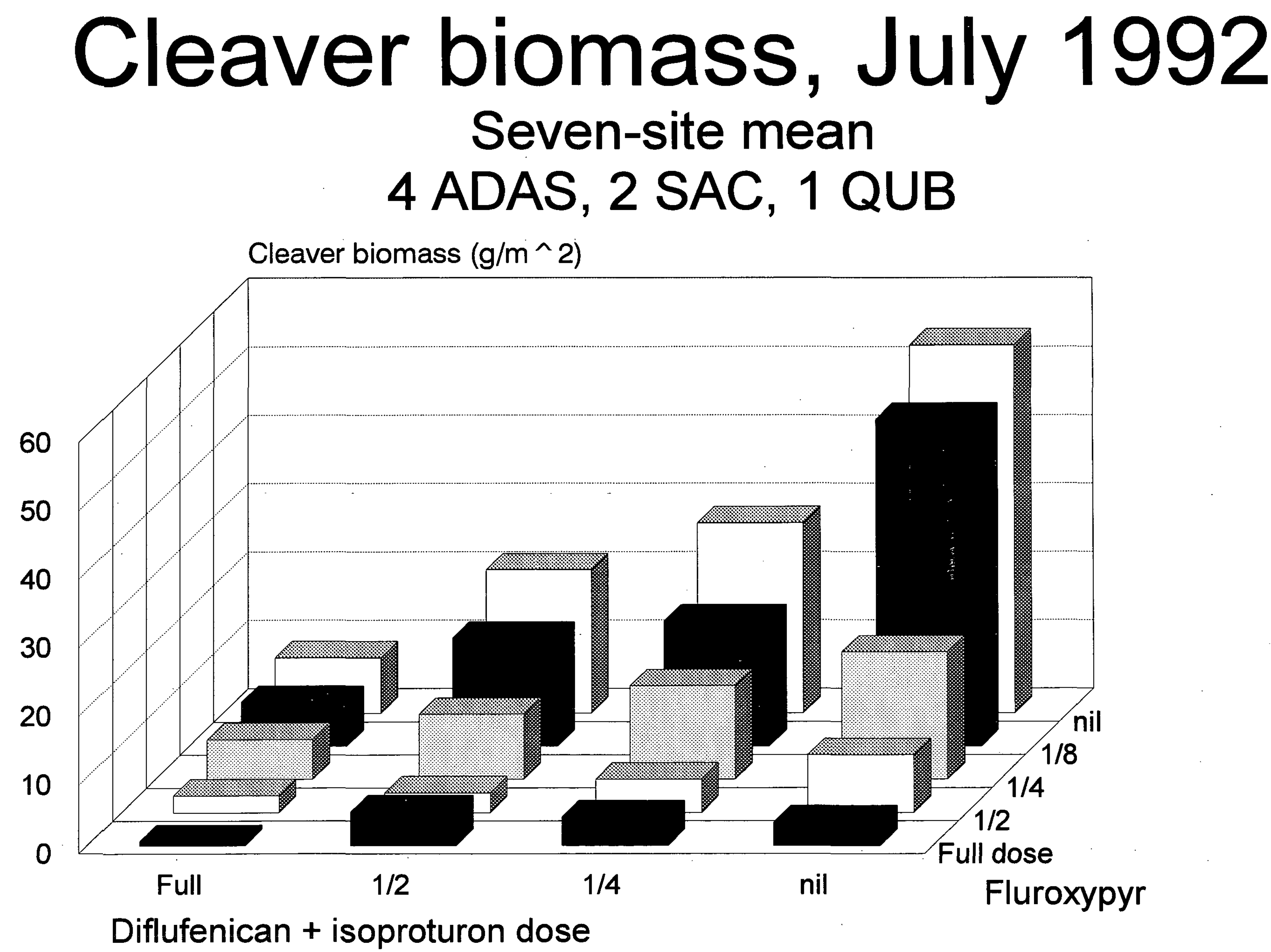
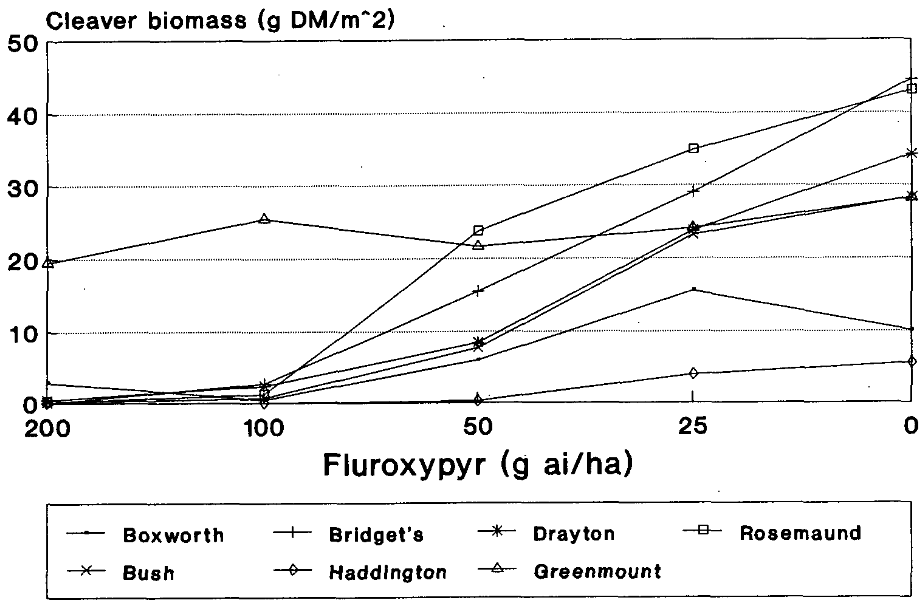


Figure 1 Cleaver dry matter biomass in July following sequential programmes of diflufenican + isoproturon and fluroxypyr (mean of 7 UK sites).

Figure 2 Cleavers dry matter biomass in July following sequential programmes of diflufenican + isoproturon and fluroxypyr at each of 7 UK sites.



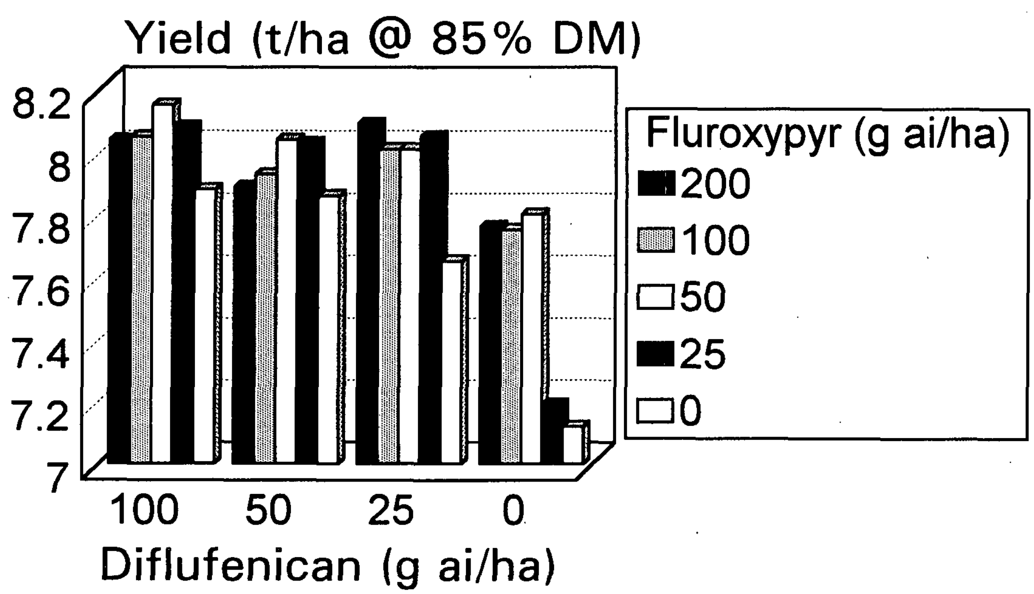


Figure 3 Wheat grain yield following sequential programmes of diflufenican + isoproturon and fluroxypyyr for cleaver control (mean of 7 UK sites).

1.1.3 *Conclusions*

The use of the autumn herbicide treatment benefited the activity of the spring treatment specifically for cleaver control. At most sites this would allow reduction in dose of the spring treatment to around half the dose recommended. It is possible at very high yielding sites that this dose could be reduced further. At low yielding sites there is a possibility of even full doses failing. The added benefit of the sequence approach is in the extra weed control obtained from the autumn treatment, which, at most sites worked well at half the recommended dose on other weeds present at half the recommended dose. The half-dose sequence was generally sufficiently robust to give good general weed control plus cleaver control at a cost similar to or less than that of one of the treatments alone at full-dose. Furthermore, **the sequential low-dose approach clearly had yield benefits over use of either of the products alone.**

This series only looked at one sequence, and other sequences, notably of the autumn treatment, may be more appropriate for certain weed combinations that may occur, and, indeed, did occur at some of the test sites. **However, the principle of use of an initial low dose autumn treatment to benefit the control of surviving weeds by a later treatment is apparently confirmed in this series.**

Recommendations

- Use an autumn residual herbicide for broad-spectrum weed control whenever conditions allow if cleavers are expected to be a problem. This can successfully allow a reduction in herbicide dose to be undertake - both in autumn and spring.

- Crop vigour affects the dose response curve. In less vigorous crops, use more herbicide in the spring for cleaver control.

1.2 The testing of the importance of herbicide timing in the spring following the use of an autumn treatment

1.2.1 *Treatments and design*

Trials were based on a randomised block design with three replicates, based on an overall treatment at crop GS 11/12 with 50 g DFF + 500 g IPU a.i./ha, followed by each of 50, 25 and 12.5 g a.i./ha fluroxypyr, applied at each of four crop timings: February/March (crop GS 24/4), GS 30, GS 31/32, and GS 39. Crops otherwise had routine winter wheat treatments for the farms. Plots were 2.3 - 3.2 m x 20 - 24 m.

All six sites were sown to winter wheat, cultivar Riband, according to local practice. There was a wide range of weeds over the sites, but all sites were sown, incorporated with the drill (then rolled), with 50 seeds/m^2 of cleavers from a single source to reduce variation, except for the Haddington site which had a similar natural population. See Appendix I (2) for site details and assessment and harvest details in 1992/93 season. The same sites were used as for 1991/92 except for Greenmount.

Site	Agent
Boxworth, Cambridge	ADAS
Drayton, Warwickshire	ADAS
Bridgets, Hampshire	ADAS
Rosemaund, Shropshire	ADAS
Bush, Midlothian	SAC
Luggate, Haddington, East Lothian	SAC

1.2.2 *Results*

Activity on weeds

The pattern of fluroxypyr activity (dose response curve) for the different treatment timings is shown in Figure 4. The sites have been grouped into English and Scottish sites to show regional differences in response. In particular, the February treatment was less effective in Scotland, whereas the GS 39 treatments was less effective in England. Site by site data are presented in Appendix I (2), and further variation is evident between sites. For example activity at GS 39 at Rosemaund was better than at the other English sites, and more similar to Scottish results, whereas Haddington in Scotland and Drayton in England had more variable results at the February treatment timing them at other sites.

Work by Orson (1985) showed that fluroxypyr activity is sensitive to soil temperature, and this may have played a part in the activity from February treatments. Soil mean temperatures at 0900 hr at 10 cm in February were lowest at Bush and Boxworth, and this is reflected in differences in the fluroxypyr dose required to give 90 and 50% cleaver control (Table 2). We do not have a complete mean record for the site at Haddington, but soil temperatures would be expected to be marginally higher than Bush.

Table 2 Fluroxypyr dose required in February to give 90 and 50% control of cleaver biomass in July in winter wheat

	Fluroxypyr dose (g a.i./ha)		**Mean soil temperature at 10 cm, °C, at 0900 h**	
Site	**90% control**	**50% control**	**Feb**	**March**
Boxworth	200	100	3.90	5.00
Bridgets	100	50	4.70	5.30
Rosemaund	100	100	4.57	5.00
Drayton	100	25	4.30	5.20
Bush	200	100	3.86	3.83
Haddington	200	200	-	-

The cleaver shoots were about 45 cm long at all sites at the final GS 39 timing. The reduction in herbicide activity may be a reflection of the size of the weed. However, such reduction in activity may also reflect crop canopy shading of the weed to the spring by this stage.

Overall the best timing for most consistent herbicidal effect (the shallowest dose response curve) was at GS 32, when a dose of 100 g a.i./ha fluroxypyr (half the full recommended dose) gave cleaver control similar to that of the full dose. GS 39 timing gave the poorest overall cleaver control, followed by the very early February timing (Figure 4).

Crop Response

Crop yield responses to timing of spring herbicide are given in Table 3. Site differences were evident. In particular, the Haddington site, by far **the highest yielding crop, showed least variation in yield response to timing of herbicide treatments.**

Table 3 Effect of timing of fluroxypyr on grain yield (t/ha at 85% DM), 1992/93

Timing	Box-worth	Bridgets	Drayton	Rose-maund	Bush	Haddington	Mean
February	6.58	8.50	9.23	8.93	6.94	11.15	8.56
GS 30	6.63	8.46	9.02	9.14	7.44	11.25	8.66
GS 32	6.67	8.40	8.79	9.08	7.57	11.19	8.62
GS 39	6.31	8.42	8.56	8.78	7.17	11.20	8.41

Yield reductions due to late timing of treatment were evident at Boxworth, Drayton, Rosemaund and Bush. There was also a reduction in yield due to early (February) treatment at Bush. It is not clear why the early treatment affected yield, but the late treatment may have allowed weed competition to have affected yield.

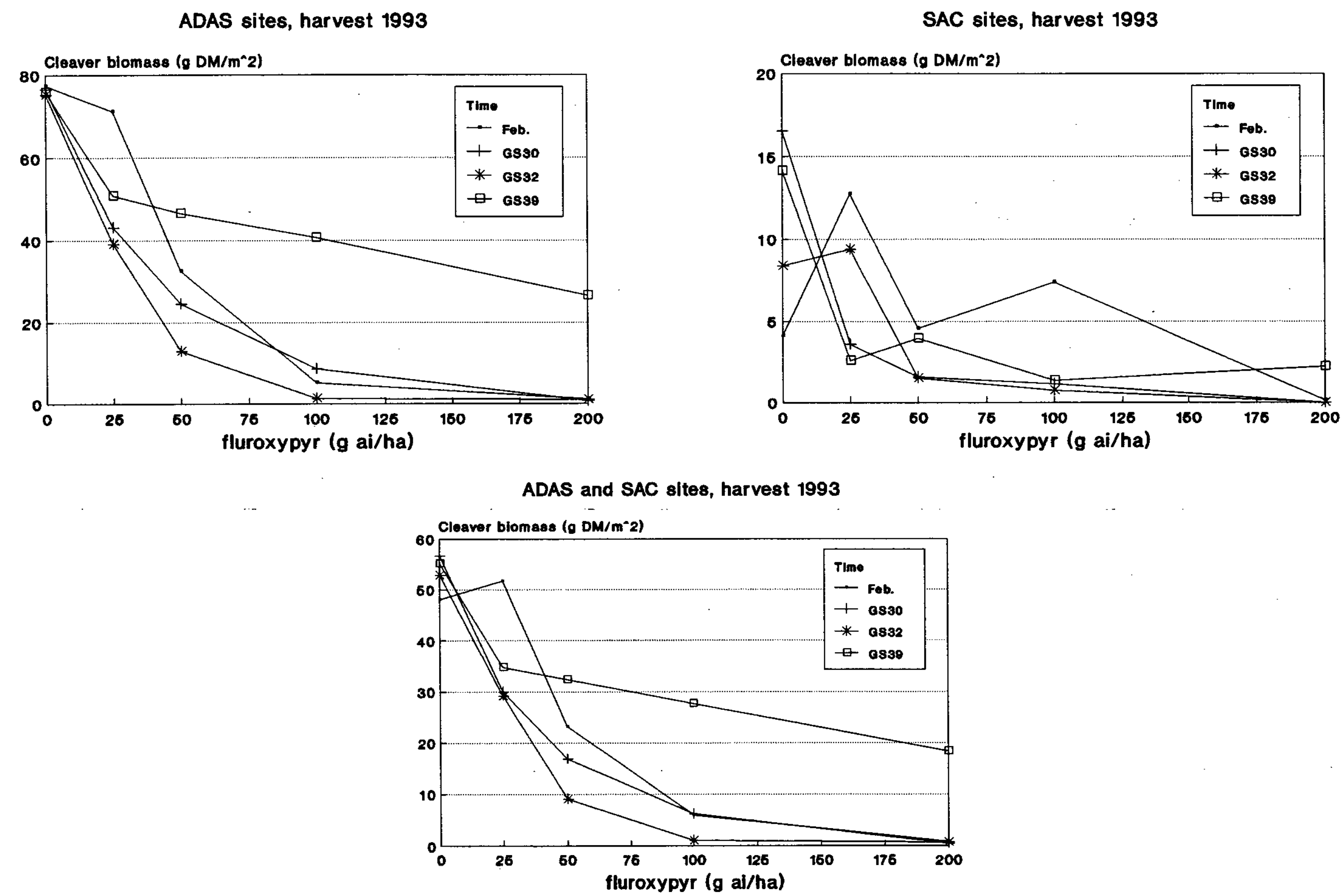


Figure 4 Dose response curves for fluroxypyr activity on cleavers from different treatment timings: (a) 4 ADAS and (b) 2 SAC sites).

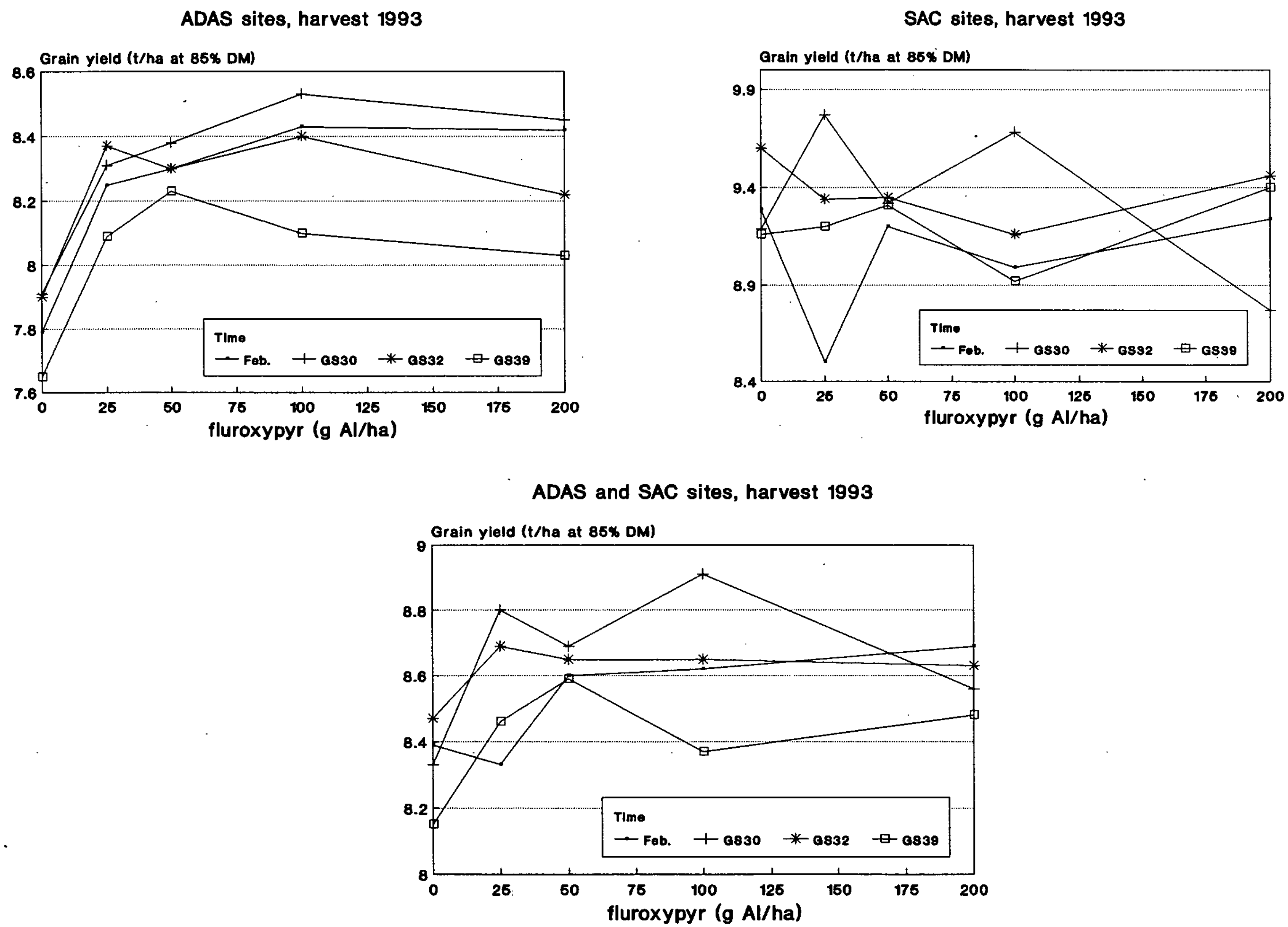


Figure 5 The effect of application timing and dose on the mean cost benefit margin over hericide cost (MOHC) of flurosypyr treatment, given a wheat grain value of £100/t (4 ADAS and 2 SAC sites).

Response to fluroxypyr dose (Table 4) also showed variation, with a yield reduction in response to the top dose evident at Rosemaund, but to no fluroxypyr treatment at Drayton and Boxworth. At Bush, all treatment doses seem to have reduced yield. This suggests a herbicidal effect on the crop under some circumstances. It is not clear what has contributed to this effect.

Table 4 Effect of dose of fluroxypyr on grain yield (t/ha at 85% DM), 1992/3

g a.i./ha Fluroxypyr	Boxworth	Bridget's	Drayton	Rosemaund	Bush	Haddington	Mean
0	5.95	8.30	8.21	8.89	7.55	11.06	8.33
25	6.45	8.43	8.95	9.19	7.20	11.10	8.57
50	6.67	8.56	9.01	8.98	7.35	11.24	8.64
100	6.84	8.46	9.00	9.15	7.09	11.28	8.64
200	6.85	8.47	9.08	8.72		11.22	8.59

Overall, the best timings for optimising crop yield are from GS 30-32 of the crop, with GS32 timing having the shallowest and least variable response curve (Figure 5). The poorest response comes from delaying treatment to GS 39. **Yields were also optimised by using 50-100 g a.i./ha fluroxypyr (25-50% of the full recommended dose).**

1.2.3 *Economic Analysis*

Figure 6 gives the mean cost benefit margin over herbicide cost (MOHC) for each timing and dose of fluroxypyr in the 1992/3 trial series, given a wheat grain value of £100/t, cf MOHC for full rate fluroxypyr at a GS 32 timing.

The response curves reflect the slight yield drop noted at some sites from the highest herbicide dose used, but the slopes generally indicate the **lack of yield benefit from using a full dose over lower doses of fluroxypyr**. This is particularly noticeable at the English sites, but there is site variation (Appendix I (2)). The Scottish data are strongly influenced by the poor yield response to fluroxypyr use at Bush. The higher yielding Haddington site, however, clearly showed the benefit of reducing dose to below that of full dose.

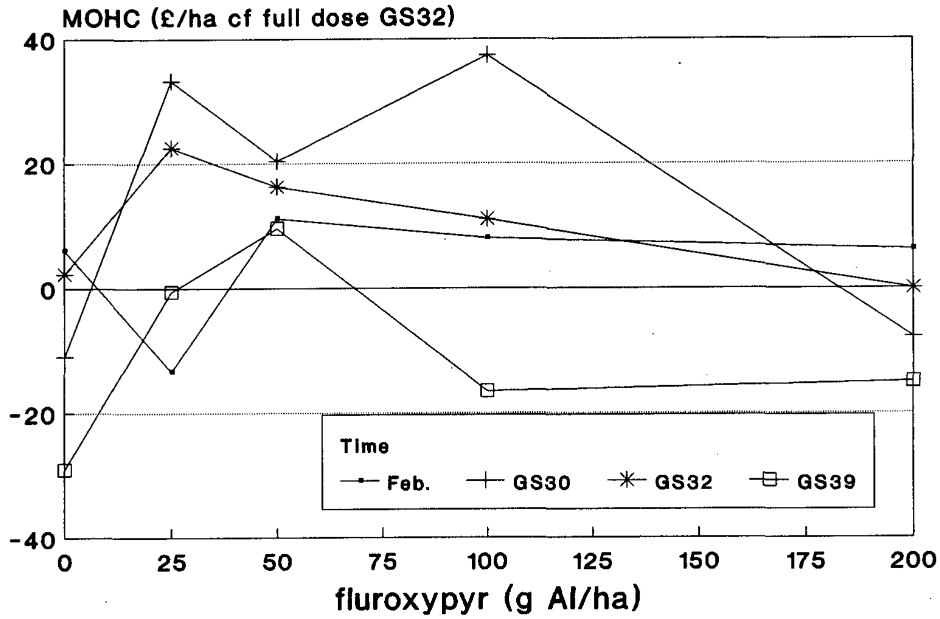


Figure 6 Effect of application time on margin over herbicide cost (MOHC) at 6 sites in 1993.

GS 39 timing clearly comes out as the worst option because of no yield benefits. At this timing no more than 50 g a.i./ha fluroxypyr should have been used to optimise cost benefit, but this dose would have led to insufficiently high levels of weed control except at the very high yielding Haddington site.

Particularly at Bush, but also at Drayton, there was a general trend to spring cleaver control not showing a cost benefit (Table 5) and this is not clearly reflected in cleaver biomass differences, but is due to a lack of benefit in crop yield terms. This was also true at Boxworth at the GS39 timing.

Table 5 Effect of fluroxypyr treatment timing (mean of all 4 doses) on cost benefit margin/ha over herbicide cost (MOHC) at six sites

Timing	Boxworth	Bridget's	Drayton	Rosemaund	Bush	Haddington	Mean
February	-2.1	+34.1	+13.7	+47.3	-81.2	+6.3	+3.0
GS30	+11.3	+29.9	+6.8	+71.0	-12.7	+18.6	+20.6
GS32	+14.4	+21.3	-15.3	+55.2	-23.4	+17.3	+11.6
GS39	-27.9	+22.1	-38.2	+40.9	-24.4	+14.8	-4.5

1.2.4 *Conclusions and Recommendations*

- The overall results indicate that use of fluroxypyr after the autumn use of DFF/IPU has greatest benefit from being timed around GS 32 of the crop in terms of consistency of effect on cleavers and crop yield response.

- The very early timing should be avoided where possible because of inconsistency in effect; probably related to soil temperatures - the late, GS 39, timings showed reduced fluroxypyr activity on cleavers and poorer yield responses, and treatments should not be delayed to this timing.

- With treatment around GS 32, the dose reduction of fluroxypyr to 100 g a.i./ha (50% of the full recommended dose) gave the most consistent economic benefit, and indeed higher doses would seem to be unsuitable economically.

There are occasions where the high doses, and all doses at one site, reduced yield over no spring herbicide use. There are no clear reasons for these effects, which warrant further evaluation.

1.3 The importance of crop competition on herbicide activity on cleavers

1.3.1 *Treatments and Design*

A block design trial with three replicates at five sites, based on full randomisation of wheat sowing density x dose of fluroxypyr at GS 31/2 of the crop:

Wheat Seed Rate:			Fluroxypyr Dose:		
	A	No wheat		(i)	100 g a.i./ha
	B	50 seeds/m^2		(ii)	50 g a.i./ha
	C	200 seeds/m^2		(iii)	25 g a.i./ha
	D	400 seeds/m^2		(iv)	12.5 g a.i./ha
				(v)	0

The whole trial area was treated with 50 g DFF + 500 g IPU a.i./ha at crop GS 11/12. Crops otherwise had routine winter wheat treatments for the farm. Plots were 2.3 - 3.2 m x 20 - 24 m. All five sites were sown to cultivar Riband, according to local practice. There was a wide range of weeds over the sites, but all sites were sown, incorporated with the drill (then rolled), with 50 seeds/m^2 of cleavers from a single source to reduce variation. See Appendix I (3) for site details and assessment and harvest details in 1993/94 season. The same sites were used as for 1991/2 except for Haddington and Greenmount (see 1.1.1).

1.3.2 *Results*

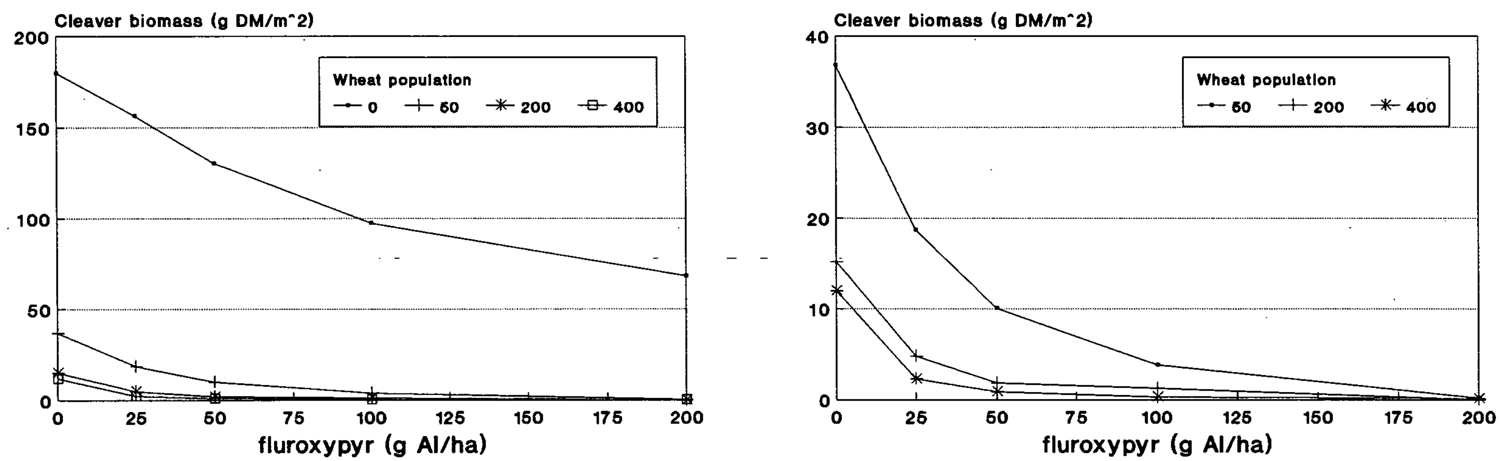
Figure 7 gives the mean response in terms of cleaver biomass in July to varying fluroxypyr dose for different crop populations. Figure 7a includes the response curve where there was no crop, whereas Figure 7b looks in more detail at the response curves where a crop is present.

It is evident that the presence of the crop had a major effect on the cleaver growth, and the capacity of fluroxypyr to control the weed. The crop density also had an effect when lower than the recommended herbicide dose was used, but the difference between the two highest crop populations tested was small.

There was some variation between sites, with the surviving cleaver population being noticeably reduced at the Scottish site at Bush, where the autumn DFF/IPU treatment may have had more effect in a particularly long wet/cold winter (Appendix I (4)). At this site the weed population was also much more patchy than at the other sites; probably for the same reason. Nevertheless, a similar trend in response to crop density was seen at Bush as seen at the English sites.

A similar pattern of response to crop density was also noted on other weeds present, but there was less difference between crop plant densities of 200 and 400 crop seeds/m^2 in their effect on other weeds than for cleavers (Appendix I (4)).

The mean yield response to fluroxypyr dose is given in Figure 8. Grain yield clearly reflected crop density. There was little evidence of the level of cleaver control by lower doses of fluroxypyr reducing yield except, possibly, at the highest crop population (400 seeds/m^2), where no fluroxypyr use may have reduced yield. There is a trend to a reduction in yield at both 400 and 50 crop seeds/m^2 by the highest dose of fluroxypyr. Such an effect from the highest fluroxypyr dose has been noted earlier in this series (see 1.2.2). But site to site variation was high, with all fluroxypyr doses reducing yield at Rosemaund at a crop density of 200 seeds/m^2 (Table 5).



(a) (b)

Figure 7 The effect of winter wheat plant population density on the activity of fluroxypyr on cleaver dry matter biomass in July (4 ADAS and 1 SAC site). 7a includes no wheat plants for comparison.

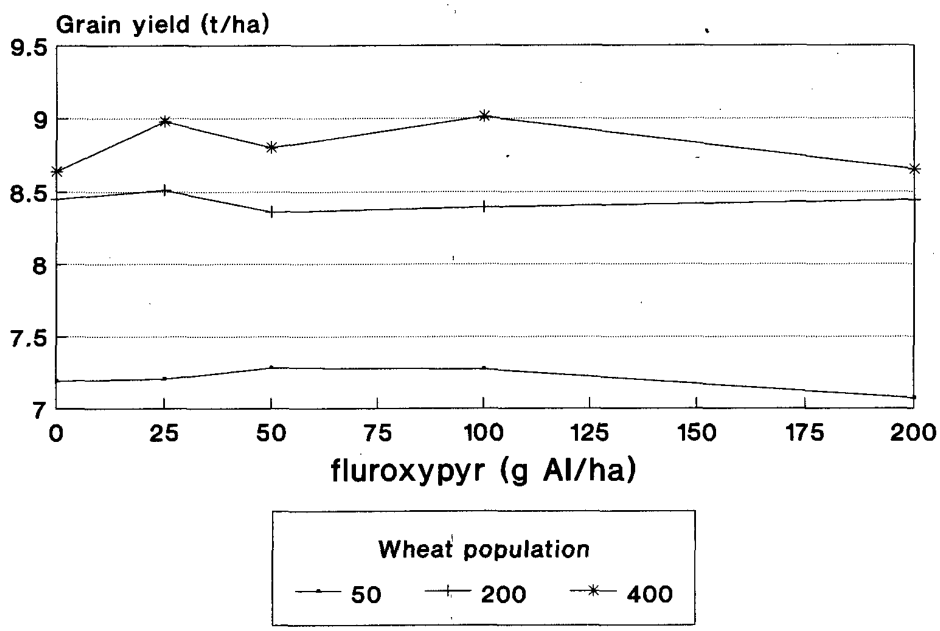


Figure 8 The effect of fluroxypyr dose for cleavers control on the grain yield of wheat at varying crop plant population densities (4 ADAS and 1 SAC site).

Table 5 **Mean effect of fluroxypyr dose on cleaver control (% of untreated) and crop yield (for 200 seeds/m² density, % of untreated), for each site.**

Fluroxypyr g a.i./ha	Boxworth		Bridgets		Drayton		Rosemaund		Bush	
	Cleavers	Yield	Cleavers	Yield	Cleavers	Yield	Cleavers	Yield	Cleavers	Yield
0	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0
25	76.6	100.4	25.0	101.2	65.1	88.3	84.8	99.0	0.0	123.9
50	92.8	101.9	100.0	101.6	99.6	100.2	26.7	95.9	0.0	91.7
100	99.9	100.4	100.0	98.8	100.0	101.4	84.3	96.1	100.0	100.7
200	100.0	100.2	100.0	97.7	100.0	101.4	100.0	96.1	100.0	107.4

This level of variation may reflect the very difficult growing conditions of 1993/4, with a long cool/wet winter, cold/dry spring and a warm/dry summer. Variation tended to be lowest at the 400 seeds/m² crop population (Appendix I (4)).

1.3.3 *Economic analysis*

Figure 9 gives the margin over herbicide cost (MOHC) for each dose of fluroxypyr at each density of wheat sown, compared with a crop density of 200 seeds/m² treated with the full dose of fluroxypyr (200 g a.i./ha), as represented by the zero line. The pattern of response follows the yield pattern from which it is calculated, and clearly shows the benefit of the higher crop population. The top dose of fluroxypyr reduces the MOHC because of the lack of yield response to varying levels of cleaver control by fluroxypyr seen at most sites, as well as the impact of the yield reduction seen at some sites to herbicide use.

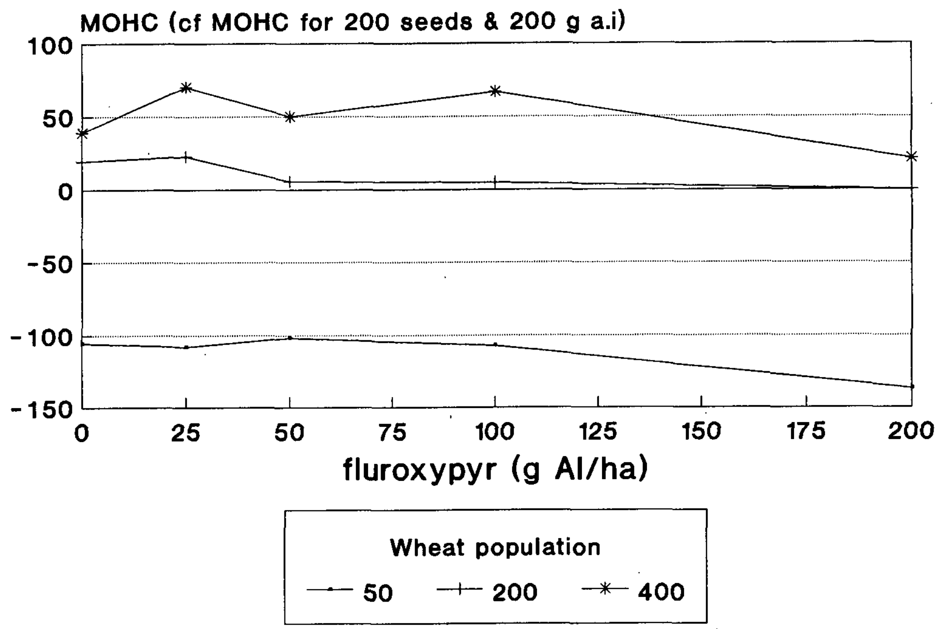


Figure 9 The effect of wheat population density on the mean cost benefit margin over herbicide cost (MOHC) of fluroxypyr treatment, given a wheat grain value of £100/t (4 ADAS and 1 SAC site).

1.3.4 *Conclusions*

- Crop density has a clear effect on cleaver growth, confirming studies on other weeds and, hence, an effect on the capacity of fluroxypyr to control the weed.

It is evident in this trial series in a difficult season with variable crop growth that clear trends are difficult to find. Nevertheless the cleaver biomass was sufficient by controlled at most sites with 100-200 g a.i./ha fluroxypyr if crop plant populations all boxes on 200-400/m² sown population. The lower end of this range of doses is within the range of the better MOHC returns.

1.4 The testing of alternative autumn /spring sequential herbicide programmes for cleaver control in wheat (A)

1.4.1 *Treatments and Design*

A single replicate randomised screen with treatments applied at crop GS 11/12: DFF + IPU at 100 + 1000, 50 + 500, 25 + 250 and 0 g a.i./ha, pendimethalin + IPU at 1000 + 500, 500 + 250, 250 + 125 and 0 g a.i./ha and isoxaben + IPU at 76 + 1800, 38 + 900, 19 + 450 and 0 g a.i./ha. The top rate was a label recommended rate. These were followed by the following treatments at crop GS 30/31: 200, 100, 50, 25, and 0 g a.i./ha fluroxypyr or 1200, 600, 300, 150, and 0 g a.i./ha mecoprop-p. The crop otherwise had routine winter wheat treatments for the farm. Plots were 2 m x 6 m. Winter wheat cultivar Riband, with a natural cleaver population, 1991/92 at Balgarrock, Aberlemno, Angus (Appendix I (4)).

1.4.3 *Results*

Table 6 shows that sequences with mecoprop-p may be at least as active as these with fluroxypyr but mecoprop-p was particularly active in this trial. Pendimethalin/IPU and isoxaben/IPU sequences gave similar results to DFF/IPU sequences with mecoprop-p and fluroxypyr.

1.4.4 *Conclusions*

This was only a single replicate screen, but it indicated that further testing of alternative sequences was required.

Table 6 **Herbicide sequences screen for cleaver control in winter wheat, 1991/92; percent control, cf untreated plots**

		Mecoprop-p						Fluroxypyr		
Sequence	**g a.i/ha**	**1200**	**600**	**300**	**150**	**0**	**200**	**100**	**50**	**25**
DFF/IPU	1100	99	100	94	97	26	100	100	100	94
	550	97	98	85	86	63	100	100	91	72
	275	99	99	94	99	55	100	98	100	29
Pendimethalin /	1500	100	100	96	97	97	100	100	100	96
IPU	750	100	100	96	94	84	96	100	98	94
	375	97	97	100	91	77	100	96	92	88
Isoxaben/IPU	1876	98	100	94	88	81	100	98	87	98
	938	99	100	95	81	0	99	100	61	98
	469	98	99	76	100	10	100	96	89	62
Nil		100	100	98	-	0	96	95	91	-

1.5 The testing of alternative autumn/spring sequential herbicide programmes for cleaver control in wheat (B)

1.5.1 *Treatments and design*

A randomised block design with two replicates. Treatments applied at crop GS 11/12: 50 g DFF + 500 g IPU a.i./ha, 500 g pendimethalin + 250 g IPU a.i./ha, 38 g isoxaben + 900 g IPU a.i./ha. These were followed up with 50, 25 or 12.5 g a.i./ha fluroxypyr at crop GS 30/31. The crop otherwise had routine winter wheat treatment for the farm. Plots were 2.3 m x 6 m. The site was sown to winter wheat, cultivar Riband, and the cleavers were sown, incorporated with the drill (then rolled), at 50 seeds/m^2. The site was at Bush, Midlothian in 1992/3 season. See Appendix I (5) for site and assessment details.

1.5.2 *Results*

There was considerable variation in this small plot trial, but there is some indication that isoxaben/IPU sequences with fluroxypyr may show promise (Table 7). No cleavers remained following the use of 50 g a.i./ha fluroxypyr in the spring, after half the recommended dose of isoxaben/IPU had been used in the autumn. Pendmethalin/IPU was also an effective sequence partner at these low doses. There were no untreated plots in this trial, but in the adjoining trial treated in the same manner, plots with 550 g a.i./ha DDF/IPU in the autumn, and not treated in the spring, had 11.3 g DM cleavers/m^2 remaining in June.

Table 7 **Cleaver dry weight biomass assessment; alternate herbicide sequence strategies (June 1993, Bush)**

Herbicide Sequence	**Dose of fluroxypyr**	**Cleavers g/plot**
DFF/IPU[1]/fluroxypyr	0.25 l/ha	0.60
DFF/IPU[1]/fluroxypyr	0.125 l/ha	0.80
DFF/IPU[1]/fluroxypyr	0.63 l/ha	0.70
Pendimethalin/IPU[2]/fluroxypyr	0.25 l/ha	0.35
Pendimethalin/IPU[2]/fluroxypyr	0.125 l/ha	0.45
Pendimethalin/IPU[2]/fluroxypyr	0.63 l/ha	1.30
Isoxaben/IPU[3]/fluroxypyr	0.25 l/ha	0.00
Isoxaben/IPU[3]/fluroxypyr	0.125 l/ha	0.95
Isoxaben/IPU[3]/fluroxypyr	0.63 l/ha	1.30

[1]550 g a.i./ha, [2]375 g a.i./ha, [3]938 g a.i./ha

1.5.4 *Conclusion and Recommendation*

It is apparent that a range of options for such autumn/spring sequences are possible, and although more work needs doing on their dose response relationships with fluroxypyr, both pendimethalin/IPU and isoxaben/IPU provide a good basis for a sequential programme when used at half their recommended dose.

1.6 The testing of alternative autumn/spring sequential herbicide programmes for cleaver control in wheat (C)

1.6.1 *Treatment and Design*

A randomised block design with three replicates. Treatments applied at crop GS 11/12: DFF + IPU at 100 + 1000, 50 + 500, 25 + 250 and 0 g a.i./ha or pendimethalin + IPU at 1000 + 500, 500 + 250, 250 + 125 and 0 g a.i./ha, followed by fluroxypyr at 200, 100, 50 and g a.i./ha. The crop otherwise had routine winter wheat treatments for the farm. Plots were 3 m x 12 m. Winter wheat, cultivar Riband, was sown by the farmer. The site was at Haddington, East Lothian in 1993/94 season and had a indigenous cleaver population of c 9 plants/m^2. See Appendix I (6) for site details and assessment details.

1.6.2 *Results*

Table 8 gives the mean cleaver numbers in late winter after autumn treatments.

Table 8 Cleaver numbers in February after autumn residual herbicide use

Herbicide (g a.i./ha)	Cleaver No/m^2
DFF/IPU (100 + 1000)	2.8
DFF/IPU (50 + 500)	1.9
DFF/IPU (25 + 250)	1.7
Pendimethalin/IPU (100 + 500)	3.0
Pendimethalin/IPU (500 + 250)	3.0
Pendimethalin/IPU (250 + 125)	5.5
Untreated	4.4
SED	0.84

The DFF/IPU treatments tended to be slightly more active than the pendimethalin/IPU treatments in this test; particularly at the lowest dose treatments. No treatment gave adequate cleaver control.

Table 9 gives the cleaver shoot numbers prior to harvest. Cleaver numbers were low in 1993/94 following a prolonged cool winter and spring droughting, so biomass data were poor and variable. The activity of fluroxypyr was high on the remaining low cleaver numbers, and few treatment differences are discernible DFF/IPU treatments again may have been slightly more active than the pendimethalin/IPU treatments.

Table 9 Effect of herbicide sequences on cleaver shoot number (15 July 1994)

		Cleaver shoot No/m²		
Fluroxypyr g a.i./ha	0	50	100	200
DFF/IPU g a.i./ha				
100 + 1000	0.0	0.0	0.0	0.0
50 + 500	0.7	0.0	0.0	0.0
25 + 250	2.3	0.0	0.0	0.0
Pendimethalin/IPU g a.i./ha				
1000 + 500	0.0	0.0	0.0	0.0
500 +250	2.7	0.0	0.1	0.0
250 + 125	3.7	0.7	0.0	0.3
No treatment	8.7	0.3	0.3	0.3
SED autumn treatment		0.53		
SED spring treatment		0.40		

1.6.3 *Conclusions*

Few conclusions can be derived from this trial where herbicide activity was very high and cleaver growth relatively poor and patchy in the cool winter and very dry spring and summer of 1993/94. There was a tendency for cleavers to be more dose sensitive to pendimethalin/IPU than DFF/IPU.

1.7 The effect of sequential use of reduced doses of mecoprop-p and fluroxypyr in the spring on cleaver control

1.7.1 *Treatments and Design*

A randomised block design with two replicates. This screen had an overall treatment of 50 + 500 g a.i./ha DFF + IPU at crop GS 11/12. The following treatments were applied in the spring; 300 g a.i./ha mecoprop-p at crop GS 25 followed or not by 50 g a.i./ha fluroxypyr, the same rate of fluroxypyr at GS 25 then 300 g a.i./ha mecoprop-p at GS 32; and 50 g a.i./ha fluroxypyr at GS 32 alone. The crop otherwise had routine winter wheat treatments for the farm. Plots were 3 m x 12 m. Winter wheat, cultivar Riband, sown by the farmer. The site was at Haddington, East Lothian with a natural cleaver population in 1993/94 season. See Appendix I (7) for site details and assessment details.

1.7.2 *Results*

Neither of these products can be used more than once in any season on cereal crops. However, they can both be used once. This trial examined the potential of using very low rates of those products (25% recommended dose, rate of herbicide) in sequence for cleaver control, compared with those treatments alone.

Table 10 indicates that the sequences may have a benefit over mecoprop-P applied alone, with mecoprop-P/fluroxypyr being possibly more active than the reverse sequence. However, there was no benefit in the sequence over the use of fluroxypyr alone at GS 32.

Table 10 Effect of sequences of low rates of mecoprop-P and fluroxypyr on cleaver control, 1993/4

Herbicide sequence and crop GS ( )	**No/m² 8.7.93**	**Dry wt-harvest (g/plot)**
Mecoprop-P (300 g a.i./ha) (25)	3.3	1.53
Mecoprop-P (300 g a.i./ha) (25) / fluroxypyr (50 g a.i./ha) (32)	T	0.17
Fluroxypyr (50 g a.i./ha) (25) / mecoprop-P (300 g a.i./ha) (32)	1.3	0.17
Fluroxypyr (50 g a.i./ha) (32)	T	0.03
Untreated	12.0	2.60
SED	2.76	1.13

T = trace

1.7.3 *Conclusions and Recommendations*

There is no benefit evident from this trial in using mecoprop-P/fluroxypyr sequences over the use of fluroxypyr at optimum timing (see Section 1.2) of around crop GS 32. The only benefit noted in the trial is that if a low rate is used early in the season, and proves inadequate, there is no major detriment to activity on cleavers in a follow-up with the other product, also at a low dose.

1.8 The impact of ioxynil + bromoxynil (HBN) addition to the dose response curve of fluroxypyr on cleavers

1.8.1 *Treatments and Design*

A randomised block design with three replicates. The site had an overall treatment of 50 + 500 g a.i./ha DFF + IPU at crop GS 11/12. The following treatments were applied in the spring at GS 30/31: fluroxypyr alone at 100, 50 and 25 g a.i./ha, and tank-mixed with HBN at 100, 150, 50 and 25 g a.i. fluroxypyr/ha + 190 g a.i. HBN/ha. The crop otherwise had routine winter wheat treatments for the farm. Plots were 3 m x 12 m. Winter wheat, cultivar Riband, was sown by the farmer. The site was at Haddington, East Lothian with a natural cleaver population in 1992/93 season. See Appendix I (8) for site details and assessment details.

1.8.2 *Results*

The activity of fluroxypyr was clearly enhanced in this trial by the addition of ioxynil + bromoxynil (HBN) once doses of fluroxypyr dropped below half the recommended rate (1 l/ha) (Table 11).

Table 11 Effect of ioxynil + bromoxynil (HBN) on fluroxypyr activity on cleavers; dry weight of cleavers biomass before harvest (Haddington)

Herbicide Treatment (g a.i./ha)	**Cleaver dry wt. (g/plot)**
Fluroxypyr 25	4.33
Fluroxypyr 50	2.67
Fluroxypyr 100	0.57
Fluroxypyr 25 + HBN 190	2.33
Fluroxypyr 50 + HBN 190	0.67
Fluroxypyr 100 + HBN 190	0.67
SED ±	1.69

1.8.3 *Conclusions and Recommendations*

This trial tends to confirm benefits in fluroxypyr activity from the addition of ioxynil + bromoxynil (HBN) suggested by Davies & Hinchcliffe (1988). Further work would be needed to evaluate the impact of the mixture on the timing of the herbicide.

1.9 Section Conclusions and Recommendations

This series of trials has shown that cleaver control in winter wheat can be optimised, both in terms of the best timing for weed control and crop yield benefit, and that this is assisted by crop competition.

The main herbicide product used for cleaver control in these trials (fluroxypyr) is the current market leader with excellent activity on this weed. However, it has been shown that the insurance of good control can be improved. In particular, the adoption of a programmed sequential approach with another product with some, but generally inadequate, cleaver control activity, has proven a robust approach to cleaver control with a greater degree of insurance than the single treatment. The additional benefit of the programmed sequence is that control of a wide range of other weeds can be taken into consideration.

Most of the work in this study used DFF/IPU as a model for the early residual-based part of the sequence, but other trials indicated that pendmethalin/IPU or isoxaben/IPU could also be effective, and that possibly such sequences could also enhance mecoprop-P activity on cleavers in the spring. The main sequence used (DFF/IPU followed by fluroxypyr) clearly suggested that **the use of such a sequence could allow with more confidence a reduction of dose of both parts of the sequence with still a high insurance of obtaining good cleaver control. This confirms earlier studies that the low-dose sequential approach to broad-leaved weed/annual meadowgrass control in winter cereals is a robust, high insurance approach to weed control,** with the possibility that, given good conditions, the follow-up low-dose may occasionally not be required with further economies to the spray programme.

That any such programme is affected by conditions is clear. **The optimal timing in the spring in terms of weed control and crop yield appears to be around crop GS 30-32**, with both earlier and later timings much more variable in response. There is evidence that earlier timing may be less successful in the cooler north than south of Britain. Crop yields were reduced by waiting until crop GS39 before treatment, presumably due to competition from the cleavers earlier in the season.

The degree of success of the treatment is linked with the potential yield of the crop - **the more vigorous the crop, the greater the herbicide activity and the lower the doses that could be used**. This is also the case with crop density - increasing density improved weed control. More dense and vigorous crops may also be more sensitive to herbicide effects, so lower doses are favoured in such situations.

A limited range of additional trials indicated that cleaver activity with fluroxypyr could be enhanced further with the addition of HBN, but that sequences of mecoprop-P/fluroxypyr in the spring have limited benefit over use of fluroxypyr alone at a higher dose.

A suggested approach to sequential herbicide use for improved cleaver control with lower dose of herbicide, but maintaining good control of other broad-leaf weeds present would, therefore, be:

- Use of an autumn treatment, at crop GS11/12 based on DFF/IPU, pendimethalin/IPU or isoxaben/IPU, at a low dose - about half the recommended dose.
- Follow-up with the cleaver herbicide in the spring at crop GS32.
- The dose of the spring treatment, if it is fluroxypyr, can be halved unless the crop is a poor one. In very vigorous crops, lower doses may be possible.

Note that such programmes would have to be modified to cope with other weeds present, and that sequences other than these tested may be equally, more or less effective.

2. WINTER WHEAT: WEED AND CROP COMPETITION AND EFFECTS ON HERBICIDE ACTIVITY

The trial investigated the interaction of herbicide rate, timing and crop density on herbicide efficacy and crop yield response, using oilseed rape and perennial ryegrass as model weeds.

2.1 *Treatments and Design*

Winter wheat cv Riband was sown on 20/10/92 at densities of 0, 50, 100 and 200 seeds/m^2. Oilseed rape and perennial ryegrass was sown on 20/10/92 at a density of 100 seeds/m^2. The trial was set out to a randomised block design with four replicates giving 256 plots of 2m x 5m, a total experimental area of 2560 m^2, incorporating four crop densities. A single herbicide, isoproturon + mecoprop + ioxynil, was applied at four different timings based on crop growth stage, at a range of four rates, 0, 0.5, 1, and 2 x normal rate (N).

Herbicide treatments

Isoproturon + mecoprop + ioxynil.[250:180:50 g a.i./l.]

Application Rates

Rate X Normal	Product l/Ha.
0.0 N	0.0 l/ha.
0.5 N	2.5 l/Ha
1.0 N	5 l/Ha
2.0 N	10 l/Ha

Application Dates

Timing	Crop Growth Stage
1.	GS (12)
2.	GS (15)(22)
3.	GS (23)(31)
4.	GS (32)

See Appendix II for assessment, biomass and harvest details.

2.2 Results

2.2.1 *Herbicide Efficacy*

From the weed biomass assessments in July (total weed biomass) the main factors to influence weed control were crop density ($P<0.001$) and herbicide rate ($P<0.001$). Spray date, although early application tended to give the better control, was not significant due to a significant interaction between herbicide rate and spray timing, and the relative control of broadleaved weeds and perennial ryegrass.

As can be seen Figure 10, in the absence of herbicide, the main weed component was the perennial ryegrass. The oilseed rape contributed little biomass and the main broadleaved component was spring germinating knotgrass.

The significance of spray timing and the interaction with herbicide rate (Figure 11, Figure 12, Figure 13.) shows how the herbicide application in December (Date 1.) reduced the ryegrass and, particularly at the 2x normal rate, increased the broadleaved (knotgrass) component.

This indicates the potential benefits of sequential applications to prevent such a species replacement. The overall effect of crop competition and spray timing for the mean herbicide response versus the unsprayed on weed control is shown in Figure 14 and Figure 15. At all the timings, **the effects of increasing crop competition are clearly shown with weed biomass decreasing with increasing crop density, both with and without herbicide application**. That crop competition complements herbicide activity is also shown by the herbicide treatments resulting in less weed than the corresponding untreated plots at each density. However, when these differences are considered on a % change versus untreated basis, the interaction of crop density and timing becomes apparent. At the first three timings, the % change v untreated declines with increasing crop density, indicating an increased benefit from herbicide treatment with increasing crop density. But at the last timing (May, GS 32) the % change increases, indicating a reduction in herbicide efficacy with increasing crop density.

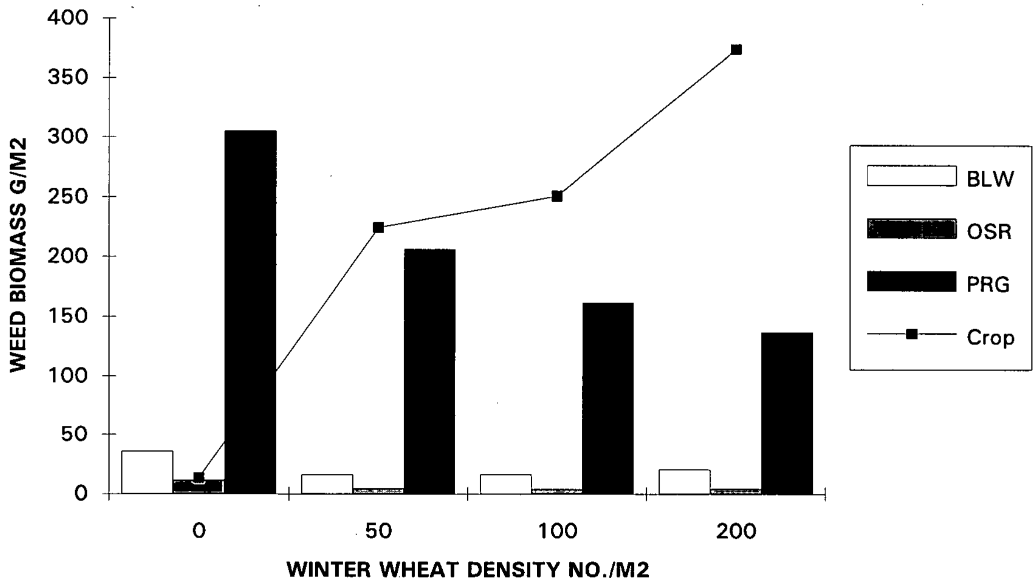


Figure 10 Weed species biomass and wheat biomass in relationship in July in untreated plots.

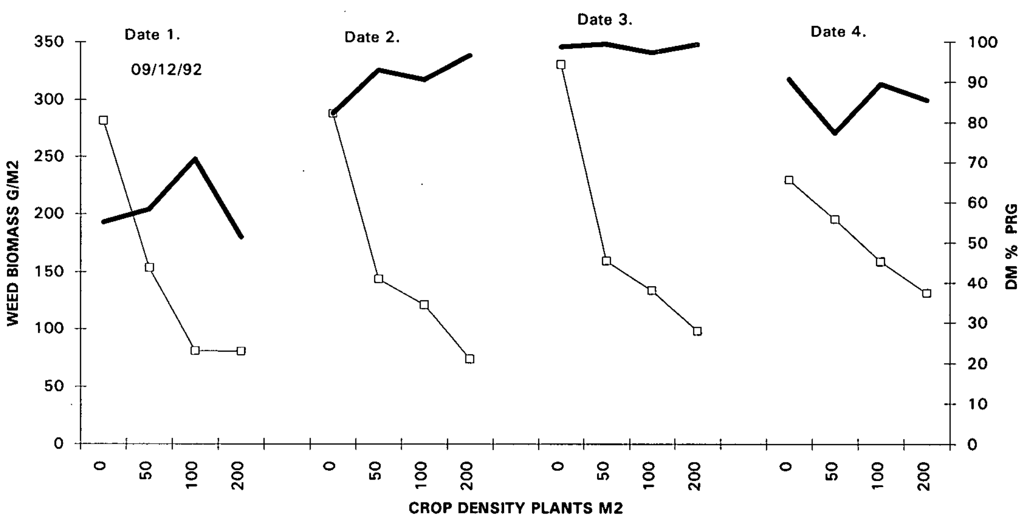


Figure 11 Effect of herbicide treatment timing on total weed biomass and % dry matter (DM) of perennial ryegrass (PRG) at varying wheat populations.

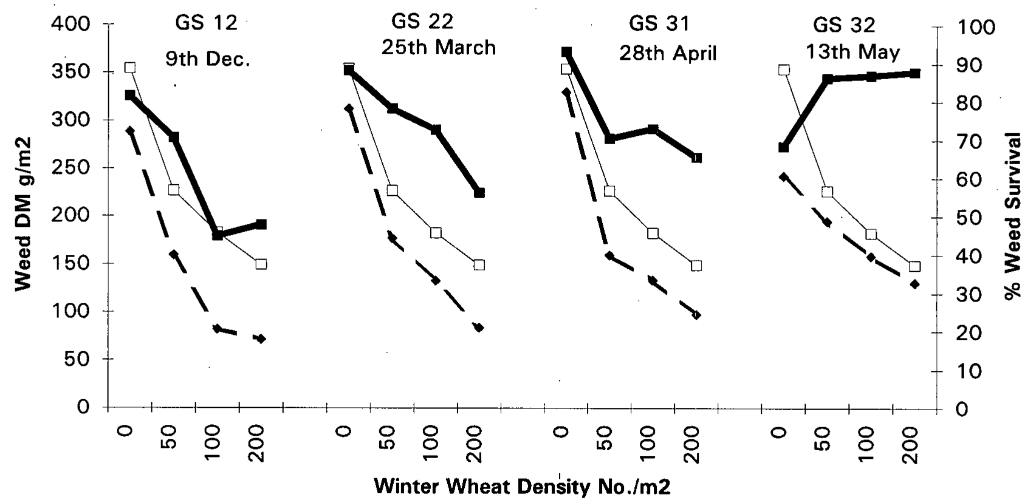


Figure 12 Weed dry matter (DM) and herbicide efficacy in realtion to wheat plant density and timing of application.

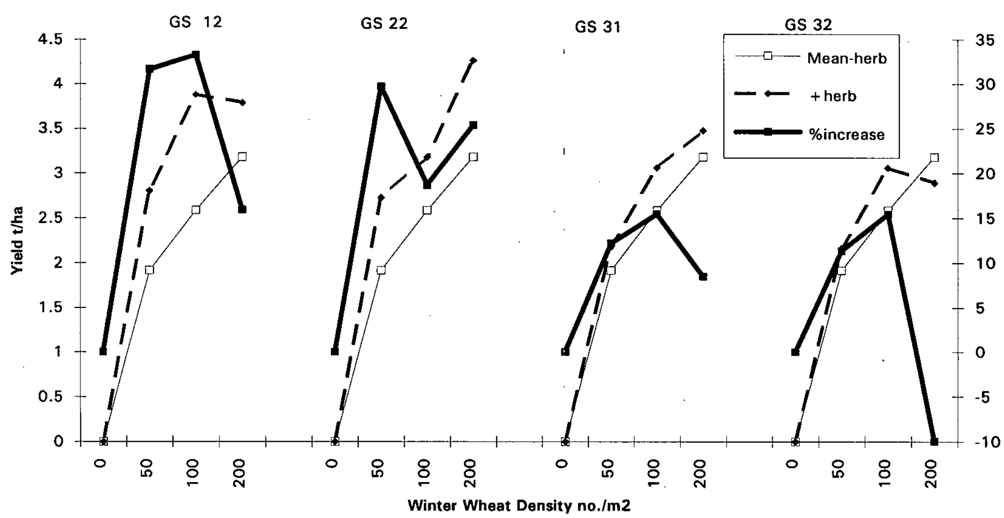


Figure 13 Wheat yield response to herbicide treatment in relation to crop density and timing of treatment.

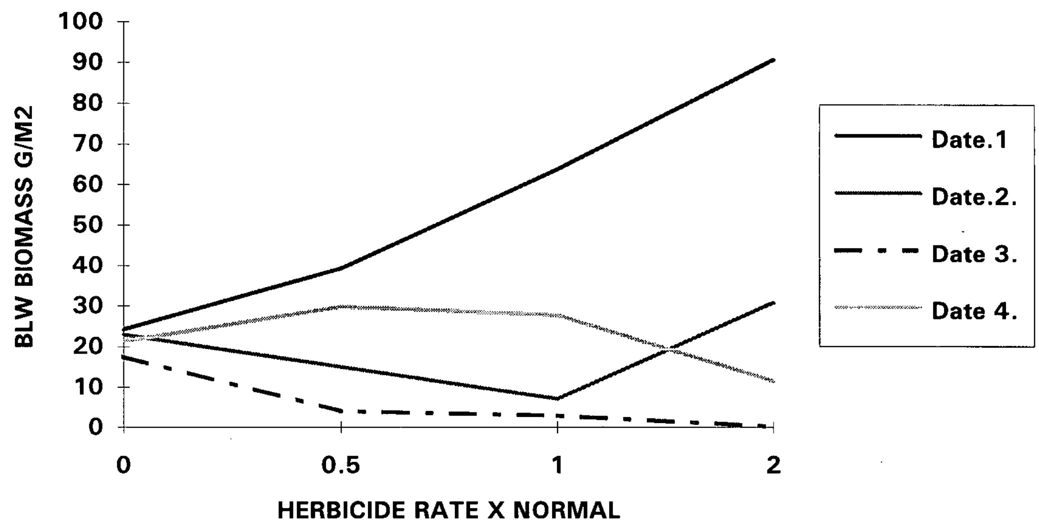


Figure 14 The impact of spray date on herbicide activity in terms of broad-leaf weed (BLW) biomass in July.

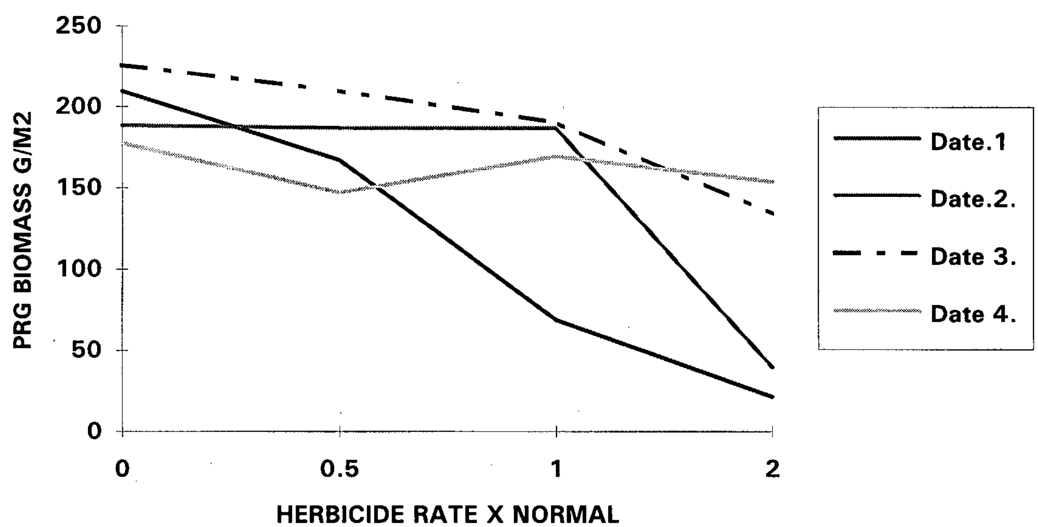


Figure 15 The impact of spray date on herbicide activity in terms of perennial ryegrass (PRC) biomass in July.

2.2.2 *Yield Response*

Yield showed significant increases with crop density ($P<0.1$), herbicide rate ($P<0.001$) (with the highest yield from the 2x normal rate reflecting the severity of the weed competition) and time of application ($P<0.001$) with the highest yields from the earliest two dates of spraying.

2.2.3 *% Yield Response to Herbicide.*

A similar interaction of crop density and timing is also evident in the yield response (Figure 11). At each timing, the % change v untreated increases with increasing crop density except at the highest density where the % change decreases. At the first three timings this decrease still represents a benefit from herbicide use. However, at the last timing, the % change at the highest density falls into the negative, representing a detrimental effect from herbicide use, probably due to greater herbicide interception by the crop resulting in crop phytotoxicity.

2.3 *Conclusions and Recommendations*

- Crop density in the absence of herbicide significantly reduces weed biomass.
- Increased crop competition normally complements herbicide activity (% weed control)
- In extreme circumstances, as in this experiment at the latest growth stage, it did appear that spray interception by the weed may have become the limiting factor.
- Crop yield increased with crop density and was favoured by early herbicide application.
- % yield increase from herbicide application became less at the highest crop density and the latest application date

3. EVALUATION OF APPROPRIATE HERBICIDE APPROACHES IN SPRING BARLEY

Work under SOAEFD and DANI funding, and from HGCA project 0036/2/88, has shown the potential for a wide range of herbicide treatments, particularly broad-spectrum tank-mixtures, to be effective at lower than recommended doses. However, it is also evident that there is a higher failure rate in lowering dose in spring barley than in winter crop programmes in terms of weed levels remaining in crops. From H-GCA project 0036/2/88 it can be shown that greater than 5% ground cover of weeds remained in summer after use of the full dose on 27% of occasions in spring barley, 9% in wheat and about 1% in winter barley (Davies, *et al*, 1994).

A number of factors related to conditions at the time of application, and to crop and weed vigour and density may play a part in this failure rate. **This series of trials examines some of these aspects of weed control in order to ensure better use of herbicides in spring barley.**

A further trial series also examines the broadening of weed control spectra by the use of pre-emergence/post-emergence sequences of herbicides. It was felt that this may allow very low doses for a broader spectrum of control, including the control of annual meadowgrass (Poa annua), which is not generally controlled by spring barley treatments, and can be a major problem in wet seasons in the north and west of the UK.

3.1 Efficiency of reduced rates in spring barley: a range of treatments and dose responses compared

3.1.1 *Treatments and Design*

A trial based on four fully randomised replicate blocks. The following treatments were applied at full 0, 0.33, 0.11 and full (N) rates: metsulfuron (N = 6 g a.i./ha), mecoprop-P (N = 1200 g a.i./ha), fluroxypyr + HBN (N = 580 g a.i./ha) and MCPA + dichlorprop (N = 3010 g a.i./ha). The crop otherwise had routine treatments for spring barley. Plots were 2.5 x 10 m. Spring barley, cultivar Prisma, was sown at Hillsborough, Northern Ireland in 1992. There was a natural weed population. See Appendix III (1) for site details and assessment and harvest details.

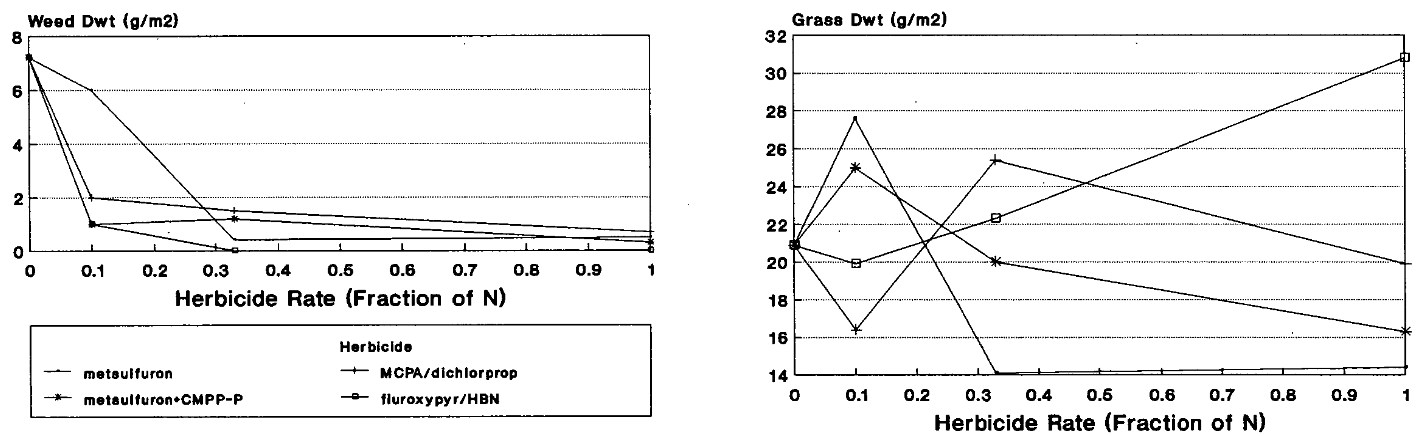
3.1.2 *Results*

Of the four treatments tested, fluroxypyr + HBN gave the best weed control dose response, with metsulfuron/mecoprop-P close, and significantly better than MCPA/dichlorporp or metsulfuron alone (Figure 16a). However, fluroxypyr + HBN allowed more compensatory grass weed survival and growth in the absence of other weeds than the other products (Figure 16b).

There was some indication of crop phytoxicity at the top doses of the two most active treatments in terms of crop biomass, but this was not reflected in yield responses (Appendix III (1)).

3.1.3 *Conclusions*

The robust dose-response curves of many modern herbicide products are emphasised in this spring barley trial. However, the trial also shows that **control of broad-leaf weeds may lead to an increase in the biomass of any grasses remaining uncontrolled**. The yield responses were surprisingly small, with some indication of crop suppression from the highest rates of treatment.



(a)

(b)

Figure 16 The effect of dose of a range of herbicide treatments on (a) broad-leaf weed biomass and (b) grass weed biomass in July in spring barley.

3.2 Effect of crop density on herbicide efficacy in spring barley

3.2.1 *Treatments and Design*

This trial was conducted at Newforge lane, with Spring barley cv Prisma sown on 4/5/92 at densities of 0, 50, 100, 200 and 400 seeds/m². It was marked out to a randomised block design with four replicates giving 400 plots of 2.5m x 5m, a total experimental area of 5000 m², incorporating five crop densities and two weed densities

Two herbicides, metsulfuron-methyl and isoproturon + HBN were applied at a range of five rates 0, 0.25 0.5, N and 2 x Normal rate. Further details are given in Appendix III (2).

3.2.2 *Results*

The main effects of the herbicide treatments on weed biomass and subsequent yield are shown in Figure 17. These are the data meaned for the two herbicides.

The interaction between weed and crop for the zero herbicide rate shows a steady decrease in weed biomass with increasing crop density emphasising crop competition as the main factor in controlling weed growth. The effect of crop density in the absence of herbicide is also illustrated in Figure 18 which shows weed biomass with and without herbicide decreasing with spring barley density (meaned over all rates of herbicide).

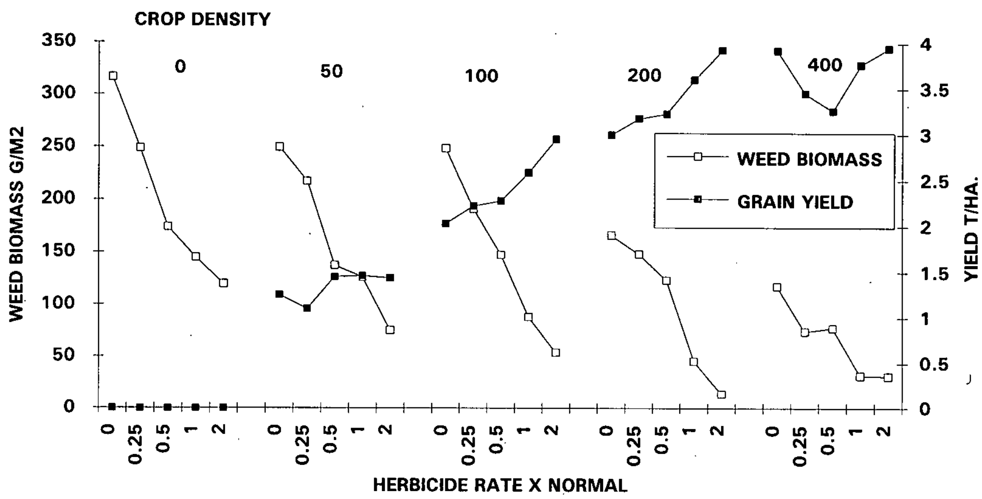


Figure 17 The effect of spring barley plant density on herbicide efficacy and yield response.

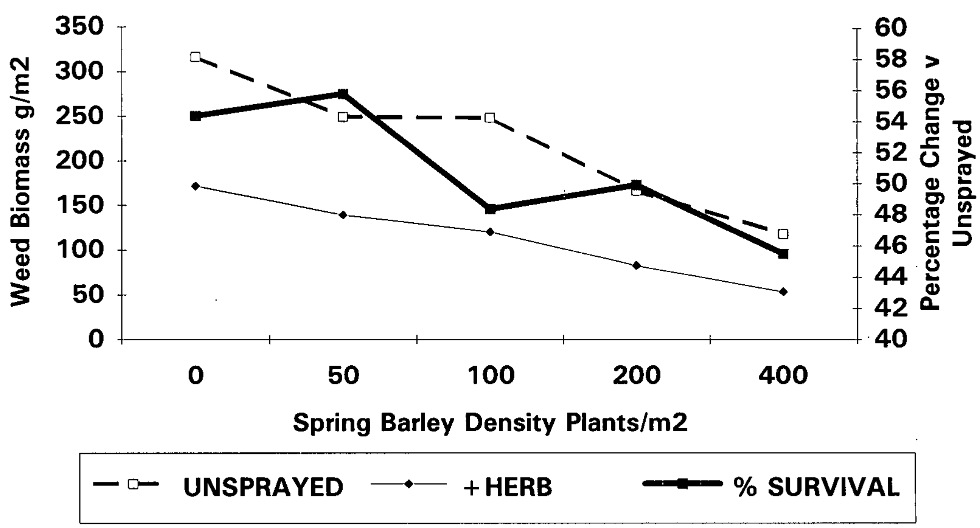


Figure 18 The effect of spring barley plant density on weed biomass in July, with or without herbicide, and precent survival relative to the untreated control.

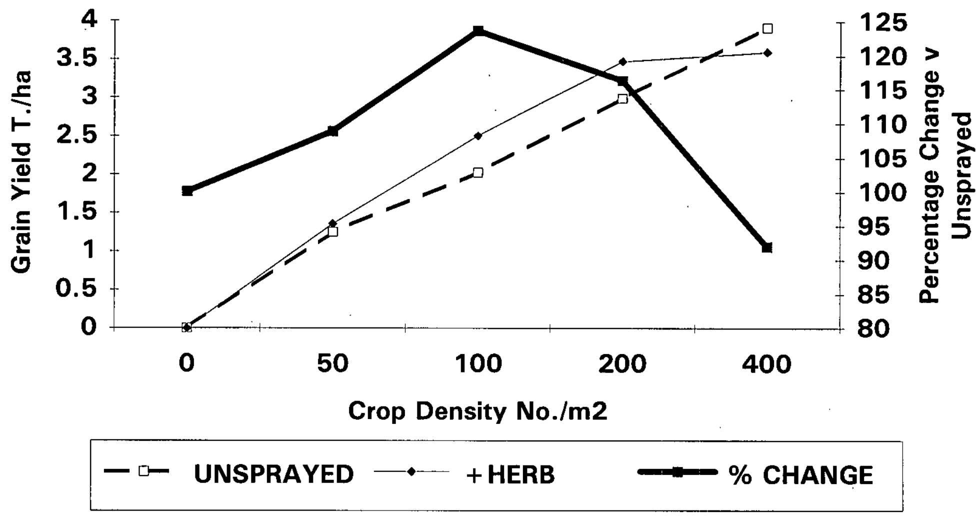


Figure 19 The effect of spring barley plant density on crop yield response, and percent change relative to the untreated control.

Figure 17 shows the significant effect of sowing density on yield.There was a significant (P<0.01) dose response to herbicide rate with increased yields up to the highest (2x normal) rates of herbicide.

There was however at the highest (400) plants/m² an indication of reduced yield response at the 0.25 and 0.5 N rates of herbicide. Whilst not significant, this occured for both herbicides A possible explanation of this effect is that an inadequate level of weed control from low rates of herbicide occured due to the crop restricting herbicide interception by the weed, and this allowed crop phytotoxicity to be expressed.

The significance of crop density and the yield response to herbicide is summarised in Figure 19. As yields increased with crop density the % response to herbicide was initially low and then increased for crop densities up to 100 plants/m² and then reduced at stands of 200/m² and 400/m². This suggests that where there is a dense vigorous crop then the response to herbicide will be less and crop phytotoxicity is more likely to occur.

3.2.2 *Conclusions and Recommendations*

This trial simulating weed competition and assessing the basic nature of the interaction of crop density on herbicide efficacy and yield response demonstrates a number of effects of crop density:

- Normally, crop density through competition reduces weed biomass.

- That crop density also normally improves herbicide efficacy, (% weed control).

- The yield response relative to the unsprayed crop increased initially up to median crop densities (100 plants/m^2) and then declined, with crop phytotoxicity evident at the highest plant density.

- This illustrates the ever present balance of the benefits of removing weed competition with the potential expression of herbicide phytotoxicity.

3.3 Comparison of the use of pre-emergence treatments, as part of a sequence of treatments, with single treatments in spring barley (A)

3.3.1 *Treatment and Design*

Trials with three fully randomised incomplete replicate block design was layed out at 2 sites in 1993 (Crosshall and Sunnybraw) and 1994 (New Downie and Mungoswalls). Pendimethalin was applied pre-emergence of the crop at the following doses: 0, 250, 500 and 1000 g.a.i./ha in 1993 season, and 0, 188 (New Downie only), 375, 750 and 1500 g.a.i./ha in 1994 season.

This was followed by mecoprop-P at crop GS30-31 at 0, 300 and 600 g.a.i./ha at Crosshall in 1993, and both sites in 1994, and by 0, 125 and 250 g.a.i./ha MCPA/2, 4-DP at GS15 at Sunnybrae in 1993. For comparison, in 1994, metsulfuron + mecoprop-P was applied at 0.75 + 150 (Mungoswells only), 1.5 + 300, 3 + 600 and 6 + 1200 g.a.i./ha at GS30-31. The crops otherwise had routine farm treatments for spring barley. Plots were 2.3 x 20 m.

The trials sites were at Crosshall, Berwickshire and Sunnybrae, Aberdeen, in 1993, in spring barley cultivar Camargue. In 1994, the sites were at New Downie, Angus, and Mungoswalls, Roxburghshire, in cultivar Derkado. There was a natural weed population at both sites; unfortunately weed populations were low at all southern Scottish sites in the very dry springs of these two seasons. This particularly affected the expected annual meadowgrass infesttions. For full site, assessment and harvest details see Appendix III (3).

3.3.2 1993 *Results*

Dry, cold conditions in April-June 1993 reduced weed germination and residual herbicide activity in spring barley in Scotland. This is evident from the relatively low activity of pendimethalin pre-emergence on a low population of chickweed and annual meadowgrass at Sunnybrae, and on annual meadowgrass at Crosshall. Full details are in Appendix III (3), but Table 12 gives the total weed control figures from the sites for the pendimethalin sequences examined.

The clearest benefit from the sequential approach was seen at Sunnybrae on broad-leaf weeds where the use of MCPA/2, 4-DP at 125 g a.i./ha brought the level of activity of 250 g a.i./ha pendimethalin to that of 1000 g a.i./ha pendimethalin alone, and was far more effective than use of the post-emergence herbicide alone.

Table 12 Spring barley - sequential herbicide use, 1993, Scottish sites; % gound cover (% control of untreated)

Treatment	Sunnybrae % ground cover (27.7.93)		Crosshall % ground cover (1.7.93)	
	BLW	AMG	BLW	AMG
Pendimethalin/mecoprop-P sequence				
1000/0	-	-	0.0 (100)	0.0 (100)
1000/300	-	-	0.0 (100)	0.2 (97)
1000/600	-	-	0.0 (100)	0.7 (90)
500/0	-	-	0.0 (100)	0.2 (97)
500/300	-	-	0.0 (100)	0.5 (93)
500/600	-	-	0.0 (100)	0.2 (97)
250/0	-	-	0.2 (90)	0.7 (90)
250/300	-	-	0.0 (100)	2.8 (60)
250/600	-	-	0.0 (100)	0.6 (91)
Mecoprop-P alone				
300	-	-	0.2 (92)	5.0 (29)
600	-	-	0.2 (92)	5.3 (24)
Pendimethalin/MCPA/24-DP, Sequence				
1000/0	8.3 (86)	2.0 (33)	-	-
1000/125	5.3 (91)	0.7 (77)	-	-
1000/250	2.3 (96)	2.0 (33)	-	-
500/0	13.4 (78)	2.7 (10)	-	-
500/125	7.0 (88)	2.0 (33)	-	-
500/250	5.0 (92)	1.6 (47)	-	-
250/0	17.0 (72)	1.7 (43)	-	-
250/125	8.7 (86)	2.3 (23)	-	-
250/250	7.7 (8.7)	2.7 (10)	-	-
MCPA/2, 4-DP alone				
125	21.7 (64)	2.7 (10)	-	-
250	16.0 (74)	2.7 (10)	-	-
500	5.7 (91)	1.7 (43)	-	-
Untreated	60.9 (0)	3.0 (0)	2.6 (0)	7.0 (0)

The sequence at Sunnybrae showed some advantage over MCPA/2, 4-DP alone in improved control of knotgrass (Appendix III (3)).

Yield responses were variable with no significant differences at Crosshall or Sunnybrae, except that reducing MCPA/2, 4-DP dose usually improved yield; particularly when used alone.

3.3.3 1994 *Results*

Weed levels at the two sites were very low reflecting generally poor weed emergence in cold dry conditions of spring 1994, then warm dry conditions in the summer. Levels of annual meadowgrass were particularly low, and variation in response could not be recorded with sufficient accuracy. Table 13 gives the overall weed control data from the two sites; individual weed data are available in Appendix III (4).

Table 13 Effect of pre-/post-emergence herbicide sequential treatment on weed control at two Scottish spring barley sites, 1994

Treatment	**Total weed % weed control**	
(g a.i.)	New Downie	Mungoswalls
Pendimethalin/mecoprop-P sequence		
150/600	99	100
1500/300	96	97
1500/0	89	39
750/600	98	99
750/300	90	87
750/0	60	61
375/600	98	99
375/300	95	84
375/0	43	26
188/600	97	-
188/300	87	-
188/0	43	-
Mecoprop-P alone		
600	97	55
300	95	26
0 (untreated)	0+	0++

Metsulfuron + Mecoprop-P		
6 + 1200	99	45
3 + 600	99	90
1.5 + 300	97	0
0.75 + 150	-	6

+20.4% ground cover (10% chickweed, 3.7 oilseed rape, 5.0% scentless mayweed and 0.7% forget-me-not. ++3.1% ground cover (1.7 charlock, 0.7% black-bindweed, 0.7% knotgrass)

Pendimethalin gave very little weed control at the particularly dry site at Mungoswalls despite very low levels of weeds, but the sequential combination with mecoprop-P was much more active than either pendimethalin or mecoprop-P alone. For example, 1500 g a.i./ha pendimethalin gave 39% weed control, and 300 g a.i./ha mecoprop-P gave 26% weed control, but the sequence gave 97% weed control. The sequence particularly improved control of charlock at this stage.

New Downie was a little weedier, and herbicide activity was higher than at Mungoswalls. Sequences, however, were no more active than using mecoprop-P alone, and only on the low level of forget-me-knot was there an indication that pendimethalin improved activity. Conversely the addition of mecoprop-P improved activity on the other weeds.

With the low levels of weeds, little or no yield response to weed control was expected. In fact there was a general tendency for herbicide use to reduce yield. The mean herbicide treated yield was 4.84 t/ha at Mungoswalls compared with 5.04 t/ha for untreated plots, and 5.63 t/ha at New Downie compared with 5.79 t/ha for the untreated plots (Table 14). There is no clear yield pattern related to herbicide dose at Mungoswalls. At new Downie there is perhaps evidence that post-emergence treatments gave lower crop yield.

Table 14 Yield responses to herbicide ingredients used at two Scottish spring barley sites, 1994

Herbicide Treatment	g a.i./ha	Grain yield t/ha @ 85% DM New Downie	Mungoswalls
Pendimethalin	1500	5.60	4.82
	750	5.64	4.83
	375	5.68	4.83
	188	5.71	-
Mecoprop-P	600	5.65	4.82
	300	5.57	4.77
Metsulfuron + Mecoprop-P	All doses	5.56	4.89
Untreated	0	5.79	5.04
	SED	0.21	0.21

3.3.4 *Conclusions and Recommendations*

- The major benefit of using a pre-emergence sequence of this kind, was considered to be the addition of annual meadowgrass control. The dry conditions greatly reduced the activity of pendimethalin on annual meadowgrass, despite populations being lower than expected. This would be a problem in drier areas of the country. Further trials are warranted to confirm activity under a wider range of conditions.

- There is a suggestion from one trial that knotgrass activity was improved by use of pendimethalin/MCPA/2, 4-DP sequence over that of the standard, metsulfuron + mecoprop-P treatment, and that of MCPA/2, 4-DP alone. It is evident, therefore, that, apart from meadowgrass control, there may be specific situations where such programmes could prove beneficial.

- There is some evidence, especially in the 1994 trials, that, at low weed levels, there may be some yield loss due to herbicide use, and particularly to post-emergence treatments. There is no evidence in these trials as to the factors that are most important in such losses, but they have been seen in other spring barley trial series, and warrants further research.

3.4 Comparison of the use of pre-emergence treatments,as part of a sequence of treatments with single treatments in spring barley (B)

Trials in N Ireland to examine the potential benefits of a sequential approach in spring barley were commenced in 1993 with both linuron and pendimethalin, and in 1994 with pendimethalin only, as the pre-emergence treatment, followed in 1993 by dichlorprop/MCPA and in 1994 by mecoprop.

3.4.1 *Treatments and design*

Pendimethalin and linuron were applied pre-emergence(26/3/93) at normal (N), 0.5, 0.25, and 0 dose rates. followed by dichlorprop/MCPA applied post-emergence (GS 30) at half, quarter and zero rates. Metsulfuron + mecoprop was applied post-emergence on its own at 0.25, 0.125 and 0 normal (N) dose rates. There were three replicates giving a total of 78 plots. Plot Size was 2 m x 10 m. See Appendix III (3) for details of assessments and harvest.

Trial Location - Hillsborough. Soil Type - Medium Loam. Previous Crop - Spring Barley. Crop - Spring barley cv Chad sown at 178 Kg/ha on 19/3/93.

3.4.1 *Results*

The main weed species were redshank, hempnettle and knotgrass together with annual meadow grass.

Single Treatment

Comparing the main treatments applied alone (not in sequence), all the herbicides except the linuron gave effective control of the broad-leaved weeds (Figure 20).

Crop yield was highest from the pre-emergence applied pendimethalin and lower from the post-emergence treatments indicating the potential benefits of early weed removal. There was also an indication of crop phytotoxicity from even the half rates of metsulfuron + mecoprop and dichlorprop/MCPA.

Herbicide Sequences

In the case of the linuron sequence (Figure 21) good weed control of both grass and broad-leaved species was only achieved from the full rate linuron and half rate dichlorprop/MCPA, where as this level of control was obtained by pendimethalin at 0.25 and 0.5 dose rates in sequence 0.5 dose with the 0.5 dose rate dichlorprop/MCPA. However, with pendimethalin (Figure 22) there was a yield penalty from the less than half rate pre-emergence treatments. Again confirming the benefits of an effective early pre-emergence removal of weed competition in spring barley.

3.4.1.2 Conclusions and Recommendations

- Early weed removal with pendimethalin optimised crop yield response.
- Linuron did not give adequate pre-emergence weed control.
- The post-emergence applications gave a reduced yield response and showed crop phytotoxicity even at half rates.

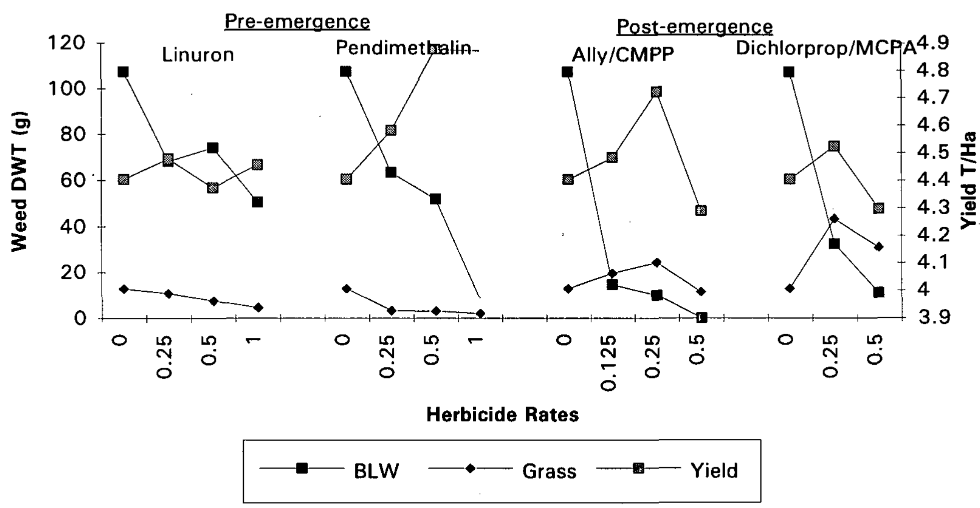


Figure 20 Effects of pre- and post-emergence herbicide treatments on weed control and yield response

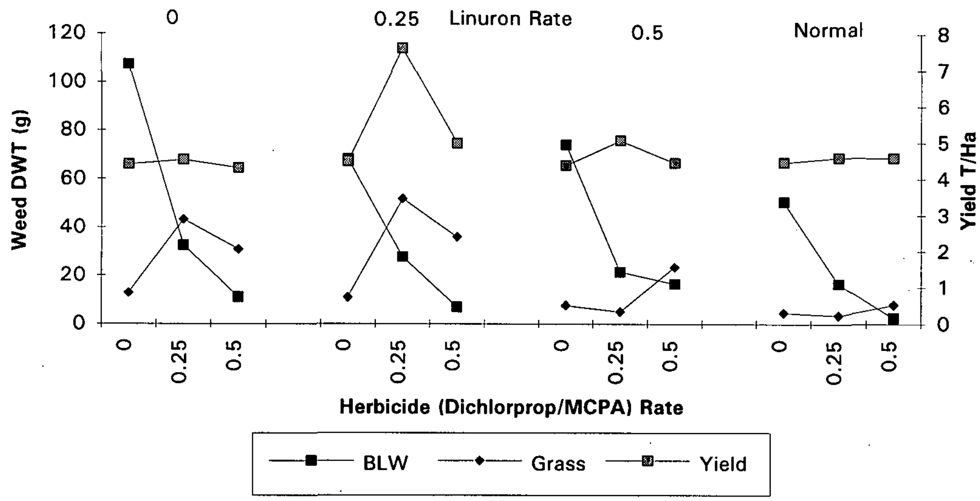


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Figure 21 Effect of pre-emergence linuron and sequential dichlorprop/MCPA on Weed Control and crop yield

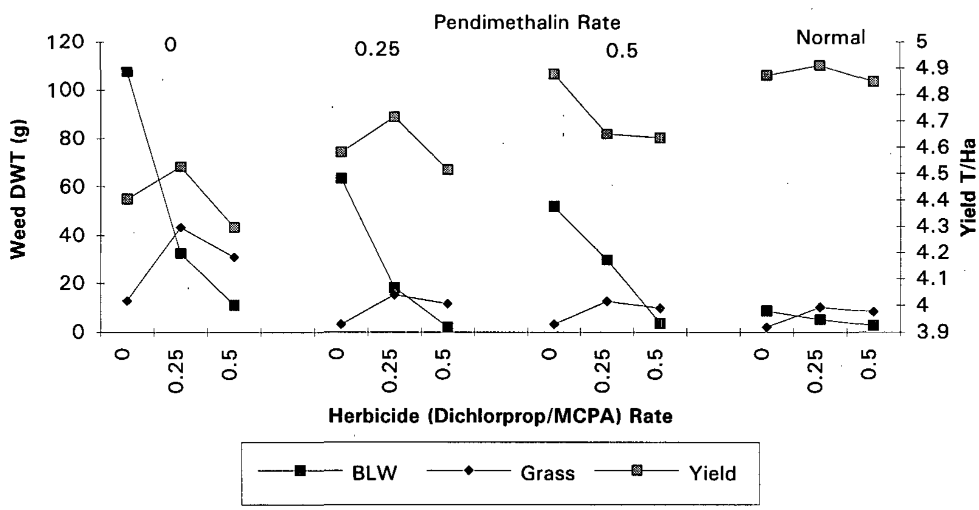


Figure 22 Effect of pre-emergence pendimethalin and sequential dichlorprop/MCPA on weed control and crop yield

N. Ireland

3.4.2 *Treatment and design for 1994 trials*

Trial Location-Strangford (Ballycoulter), Co. Down. Crop-Spring Barley cv Chad was sown at 300 seeds/m^2 (178Kg/Ha) drilled on 1/4/94. Dates of application: pre-emergence 22/4/94, post-emergence 10/6/94 (crop GS 1.4 - 2.3 - 3.1 and weed growth stage 4-8 leaf. The main weed species were being groundsel, shepherds purse and redshank. Prior to post-emergence treatments 2 x (25 x 25)cm quadrats were sampled for crop and weed numbers and fresh weights. Pre-harvest (0.5 m^2) biomass samples were taken on 2/9/94. The trial was combined on 14/9/94.

Trial Location-Crossnacreevy Plant Testing Station, Co.Down Crop-Spring Barley cv Chad was sown at 300 seeds/m^2 on 27/4/94. Dates of application pre-emergence 27/4/94, post-emergence 25/6/94 (crop GS -(1.6.) - (2.2.) - (3.2.) and weed growth stage 6-8 leaf). The main species being hempnettle, redshank, knotgrass and creeping buttercup. Prior to post-emergence treatments 2 x (25x25)cm quadrats were sampled for crop and weed numbers and fresh weights and pre-harvest (0.5 m^2) biomass samples were taken on 15/9/94. The trial was combined 15/9/94. Both trials was set out using a randomised block design with 3 replicates giving 51 plots of 2 x 10 m.

Herbicide Treatments-(applied at both sites)

Pre-emergence: pendamethalin @ 0, 0.25, 0.5, 1.0 x normal dose (4 l/ha)

Post-emergence: mecoprop-P @ 0, 0.25, 0.5,1.0 x normal dose (1 l/ha)

Post-emergence only metsulfuron-methyl + mecoprop-P @ 0, 0.125, 0.25, 0.5 x normal.

3.4.4 *Results*

Single Treatment

The comparison of pre-versus post-emergent weed control at the two sites did not indicate the advantage to pre-emergent, early weed removal observed from the pendimethalin treatments in 1993. At the Crossnacreevy site (Figure 23.) the apparent depression of yield by the 0.25 and 0.5 rates of pendimethalin is unusual but has been observed on other occasions and reflects the expression of crop phytotoxicity where weed control is poor; in this case increasing the development of the grass weed component. At the Crossnacreevy site the mecoprop-P metsulfuron + mecoprop-P treatments and mecoprop-P showed phytotoxicity at less than normal rates of application. At the Strangford site (Figure 24) the 0.5 N rate of mecoprop-P also indicated phytopoxic effects.

Herbicide Sequences (Figure 25)

The broadleaved weed control was good even without a pre-emergence treatment, but control of the grass component increased up to the full rate of pendimethalin. The post-emergence mecoprop-P treatment complemented control of the grass at the half rate.

With the exception of the odd response from 0.25 N mecoprop-P alone, optimum yield was acheived by 0.5 N pendimethalin with 0.5 N mecoprop-P or 1.0 N pendimethalin with 0.25 N mecoprop-P sequences.

3.4.5 *Conclusions and Recommendations*

- The main benefit of the pendimethalin was in relation to grassweed control although early removal did not appear critical with the post-emergence alone treatments giving as good a yield response.

- As in 1993 there was evidence of crop phytotoxicity at less than normal rates of some treatments.

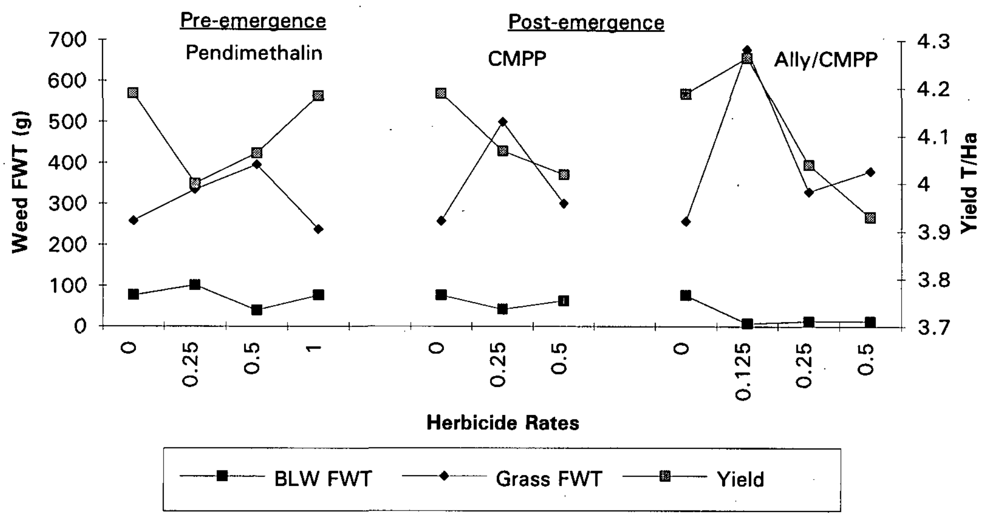


Figure 23 Summary of effects of pre and post emergence herbicide treatments on weed control and yield response (Crossnacreevy 1994).

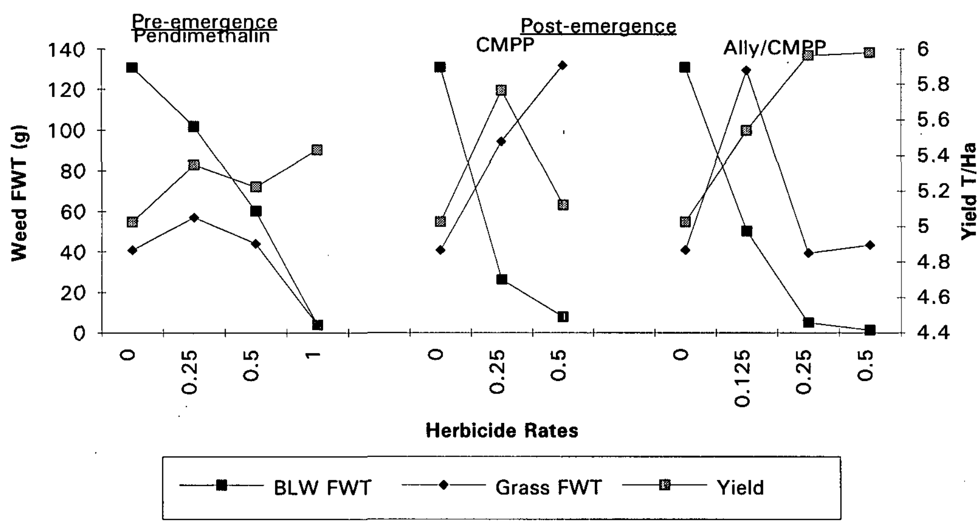


Figure 24 Summary of effects of pre and post emergence herbicide treatments on weed control and yield response (Strangford 1994).

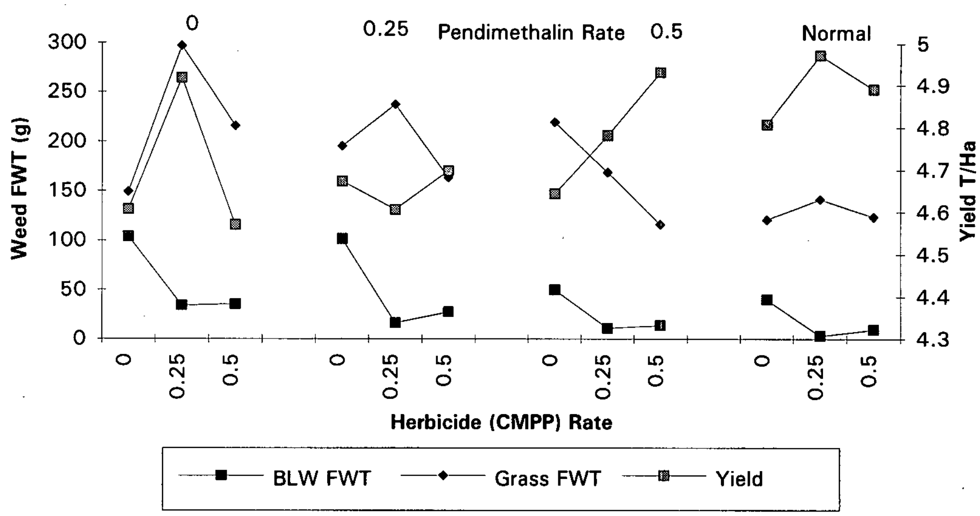


Figure 25 Effect of pre-emergence pendimethalin and sequential mecoprop-P on weed control and crop yield. (mean of 2 sites)

3.5 The impact of timing on the dose-response curves of spring barley herbicide treatments

Although there is now a lot of infomration on the dose response curves of herbicide treatments in spring barley, there is relatively little information on the impact of timing of treatment on the dose response curves. This section describes trials examining this important feature of herbicide activity (also see Whytock and Davies, 1996).

3.5.1 *Treatments and Design*

A series of trials in spring barley in seasons 1993/94 assessing the impact of timing of application on the dose response curve of herbicides, using as a model a major and typical spring herbicide treatment based on metsulfuron + mecoprop-P. The herbicide treatments were applied at three weed growth stages, 2-4 leaves, 4-6 leaves and 6-8 leaves, at a range of doses 0, 6.25*, 12.5, 25, 50 and 100% of their full dose of 6 g + 1200 g a.i./ha. There were three replicates per treatment. Plots otherwise had routine treatment for spring barley. Plots were 2.5 x 20-24 m. Spring barley cultivar Camargue was sown at Nether Finlarg, Angus, and cultivar Tyne at Hillbrae, Aberdeenshire, in the 1993 season. Camargue was sown at Hoprig, East Lothian and Chariot at Sunnybrae, Aberdeen, and Blackiemuir, Kincardineshire, in 1994. The natural weed species lists are given in Appendix III (5). Weed ground cover in July was about 67% at Nether Finlarg, 49% at Hillbrae, 20% at Hoprig, 58% at Sunnybrae and 43% at Blackiemuir. Droughting in 1994 reduced weed development, and weeds were desiccating naturally in July. For full site, assessment and harvest details see Appendix III (5). Both 1993 sites, and particularly the northern site at Hillbrae, suffered from delayed sowing and slow early growth in a very cold spring. Neither crop could be considered highly competitive, and this is reflected in yields of about 5 t/ha. In 1994, the crop and weed growth was delayed again by unusually cold conditions in May, but in this season droughty conditions prevailed. However, sowing was earlier, and yields ended slightly higher at 6 t/ha at Hoprig, and 6.5 t/ha at Blackiemuir, but remained low at about 5 t/ha at Sunnybrae.

3.5.2 *Results*

In these conditions of low to moderate crop competition, and to some extent, poorer than preferred conditions (from label recommendations) for herbicide activity, it is clear that **treatment at the earliest weed growth stages generally gave the best activity** and shallowest dose response curves (Figure 20). The poorest dose response and steepest response curves were evident at the weediest site, Nether Finlarg (Table 15), which was also the lowest yielding site in 1993. However, at Hoprig, with a higher yield and a lower weed population, there was little difference in response curves between timings. The response of different weed species varied between sites and clear patterns are not discernible.

Grain yield responses to treatment varied between sites (Table 15), and did not fully reflect the level of weed control. At Hillbrae, the earliest timing gave a poor yield, similar to that of the untreated plots. At Nether Finlarg, in the same season, the earliest timing gave marginally the best yield, and overall the relationship between yield response and dose was clearer than at Hillbrae; especially at the second timing. The differences are not statistically significant.

In 1994, overall yield did not vary significantly at Hoprig between treated and untreated plots. At Sunnybrae, however, at this relatively weedy site higher doses gave the best yields at the earlier timings; there was no significant overall yield differences between timings. The lack of yield differences between timings was also true at Blackiemuir, but at this site there were significant differences between treated and untreated plots. Responses to dose varied greatly within timings, with a tendency for higher doses at the earlier timings to reduce yield compared with other treatments, and for lower doses to reduce yield at the later timing.

It is therefore very difficult to discern trends (Table 15), but there is an overall mean yield benefit response of about 4% over the untreated crops from herbicide treatments, with no difference dependent on timing, but a trend towards yield responses reflecting weed ground cover.

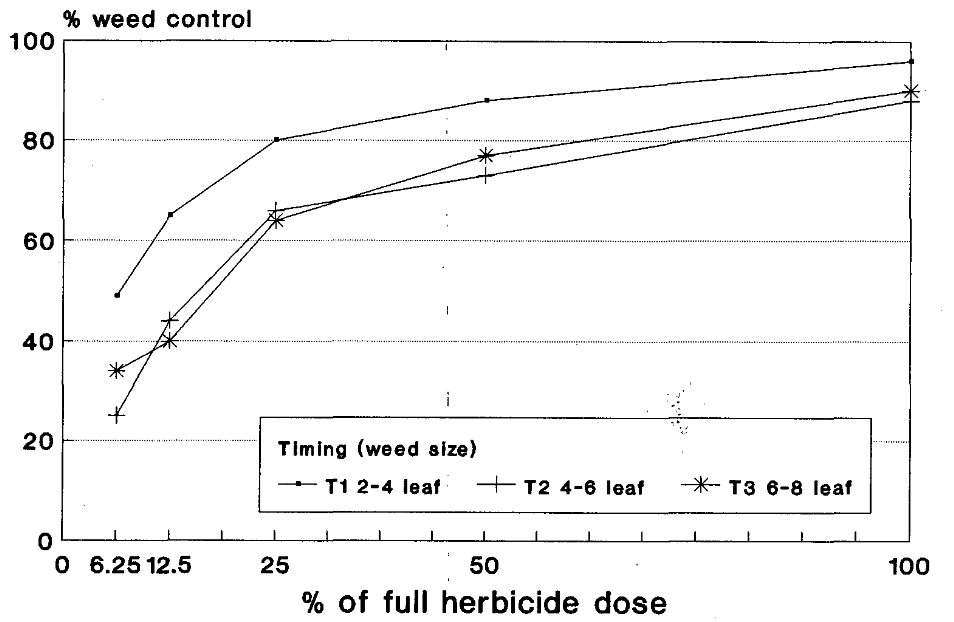


Figure 26 Mean effect of timing of metsulfuron + mecoprop-P treatments on the weed control dose response curve at 5 spring barley sites. T1 = 2-4 leaf; T2 = 4-6 leaf; T3 = 6-8 leaf stage of weeds.

Table 15 **Mean spring barley yield responses to herbicide use at six Scottish sites, and their relative weed densities**

Site	Mean grain yield @ 85% DM (t/ha)	Mean % ground cover of weed
Nether Finlarg	103.5	67
Hillbrae	104.6	49
Hoprig	100.1	20
Sunnybrae	109.1	58
Blackiemuir	103.7	43
All sites	104.2	47

Table 16 **Yield response to treatment* dose and timing at Scottish spring barley sites, 1993/4**

Dose % of full dose, and timing	Nether Finlarg	Hillbrae	Hoprig	Sunnybrae	Blackiemuir	Mean
Timing 1						
6.25	106.3	-	105.0	103.6	104.4	104.8
12.50	103.6	99.0	100.3	101.9	105.1	102.0
25.00	105.3	99.6	102.7	108.6	106.3	104.5
50.00	102.8	99.2	99.0	113.1	101.1	103.0
100.00	103.6	100.2	98.7	116.7	104.0	104.5
Mean	104.3	99.5	101.1	108.7	104.2	103.8
Timing 2						
6.25	100.6	-	95.4	101.7	106.1	101.0
12.50	102.8	106.5	103.6	109.5	103.2	105.1
25.00	100.8	109.8	95.0	109.5	105.7	104.2
50.00	108.3	104.3	101.0	109.5	101.4	104.9
100.00	109.1	110.0	102.2	112.0	98.3	106.3
Mean	104.3	107.7	99.4	108.4	102.9	104.3
Timing 3						
6.25	104.1	-	103.6	109.7	100.6	104.5
12.50	98.0	111.2	92.9	11.6	101.7	103.1
25.00	103.7	105.5	102.2	107.2	106.7	105.1
50.00	103.2	104.5	99.8	109.1	106.0	104.5
100.00	101.0	104.7	100.0	114.1	104.6	104.4
Mean	102.0	106.5	99.7	110.3	103.9	104.4
Untreated	100.0	100.0	100.0	100.0	100.0	
(t/ha)	(5.07)	(4.89)	(6.03)	(4.75)	(6.53)	
SED	9.28	7.98	3.98	2.97	3.89	

*metsulfuron + mecoprop-P

3.5.3 *Conclusions*

- There is evidence that early treatment in spring barley gives the best weed control response, with a greater possiblity of reducing herbicide dose at this timing.

- Yield response to treatement these and timing is much less clear, with variation between sites. Overall, weed control gave a c 4% yield benefit, but this varied from c 100-110% between sites, with a slight tendency to reflect weed density.

3.6 The significance of timing of herbicide application in relation to weed control and crop response in spring barley

Basic studies using oilseed rape as a simulated weed.

3.6.1 *Treatments and Design*

In 1992 and 1993 spring barley trials were established at Newforge Lane, Belfast to compare weed control and yield response to the two herbicides, metsulfuron and dichlorprop MCPA, applied at a range of crop growth stages. The herbicides were applied at doses equivalent to 0,0.25,0.5,1.0 and 2.0 normal (N) recommended rates. Oilseed rape was sown at about 250 seeds/m² to supplement background weed competition. Weed control was assessed by biomass sampling prior to harvest and the plots were combine harvested to assess yield response. (For details see Appendix III (6))

3.6.2 *Results*

In both years there were highly significant responses to herbicide and timing of application with the dichlorprop/MCPA treatment giving better weed control but not significantly better yield response.

<u>Timing</u>

The mean data for the two years (Figure 27a) illustrate some of the main relationships of herbicide rate and timing on weed control and yield response.

<u>Herbicide Efficacy</u>

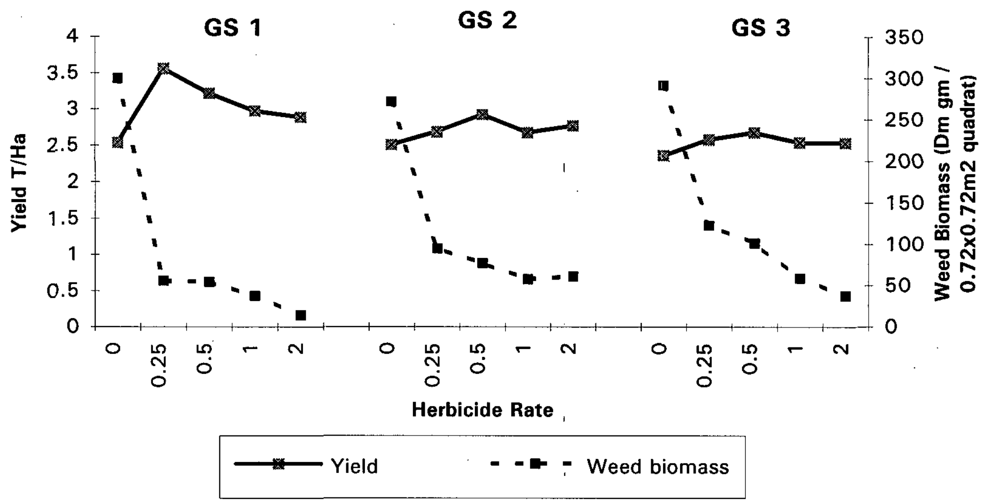
The earliest applications gave the highest levels of weed control, particularly from the 0.25 N rate but even up to the 2.0 N rate. The response to herbicide was always highly significant, but not the differences between dose rate.

Yield Response

As anticipated the earlier the application and the quicker **the removal of the weed competition the greater the yield response**.

The dose response relationship also appears to change with timing of application with the optimum dose for yield at the earliest application being the 0.25 N rate and the 0.5 N rate at the later dates of spraying

a)



b)

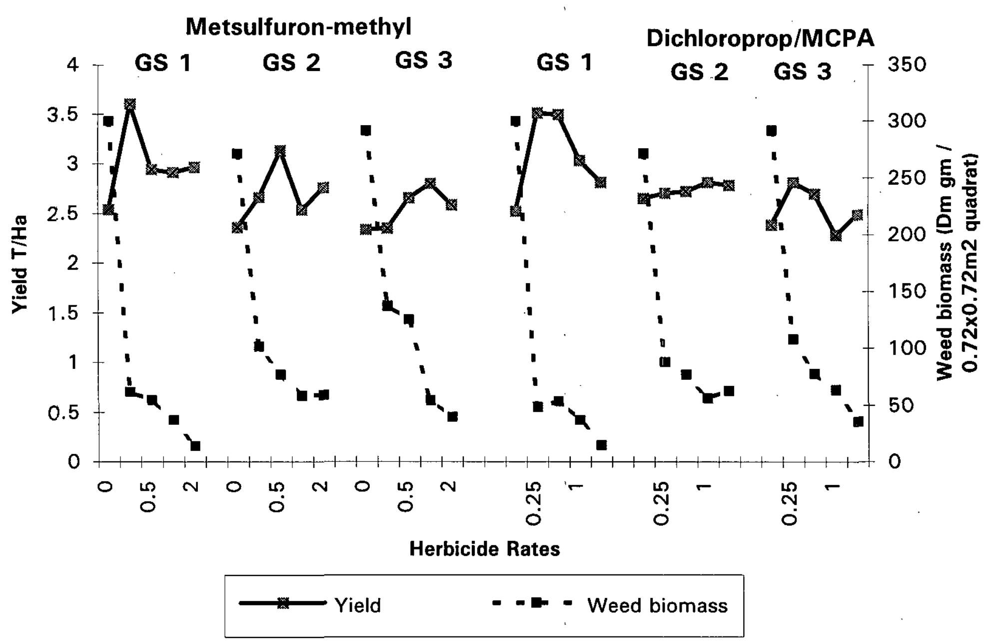


Figure 27 Effect of weed growth stage (timing) on herbicide activity and crop response.

This is illustrated particularly well by the metsulfuron response (Figure 27b.) where the optimum rate increases from 0.25N at GS1 to 0.5N at GS2 and to the full rate at the latest date of application.

Early application consequently appears to offer the benefit of better weed control a better yield response and the greater prospect of optimising control at a lower rate of herbicide. The full data set for the two herbicides at each date of application in the two seasons are presented in the appendix.

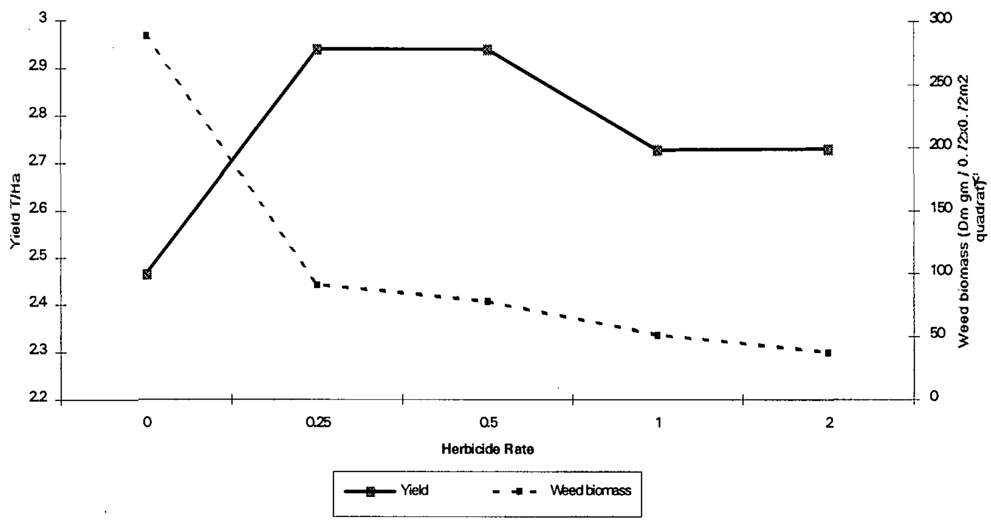


Figure 28 The basic dose response relationship between weed control and spring barley yield (mean of 2 herbicides and 3 growth stages over 2 seasons).

These data also illustrate that the dose response curve for weed control and yield shows a fairly rapid transition from yield increase to indicate crop phytotoxity. This general relationship is illustrated in Figure 28. where the data for weed biomass and crop yield are summarised for the two herbicides and the three dates of application in 1992 and 1993. Weed control is optimised up to the 0.5 N rate and further increases in herbicide result in a yield penalty. The full range of these dose response relationships all tend to show this basic relationship, and is evident in Figure 21 and the full data set.

In 1994 the implications and interactions of timing and dose response were examined at in relation to broadleaved weed control in spring barley for metsulfuron-methyl + mecoprop. For details see Appendix III (6). The relationships between weed control and yield response are shown in Figure 28.

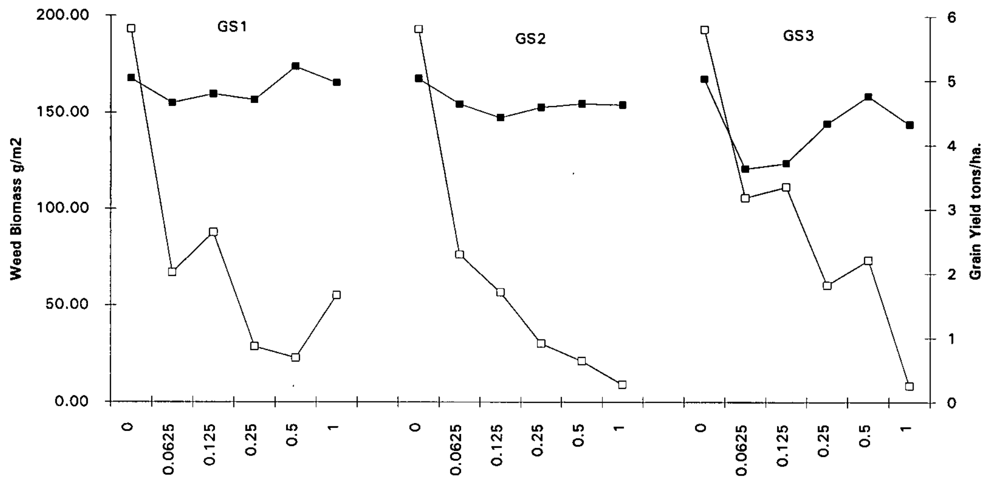


Figure 29 The effect of herbicide dose and timing on weed biomass in July and spring barley grain yield in 1994 trial.

These data indicate a further element in the relationship of yield response to weed control. This is that crop phytotoxicity is evident from low rates of herbicide in advance of adequate weed control. This is most clear at the latest timing of application but is indicated at all three dates and suggests again that there is a very critical relationship between the removal of weed competition and the expression of phytotoxicity.

Discussion

Herbicide rate can be reduced in response to weed size with a lower rate where weeds are small, confirming trial results reported in section 3.5.

These two sets of data illustrate this potential with **the highest yields from early weed removal.** This, however, has to be reconciled with the possibility of later flushes of weeds being inadequately controlled. In spring barley it is likely that these later emerging weeds will be suppressed by crop competition. However, these results show more positive yield responses to timing than the Scottish field sites (section 3.5).

The other feature of these data,which is also evident in the trials for control of *Galium aparine,* is that the **optimum yield response appears to occur slightly in advance of total weed control.** This appears to be a relationship common to a wide range of herbicides i.e. fluroxypyr and these experiments with metsulfuron and dichlorprop/MCPA .

Conclusions

- Early weed control improves control and yield response.
- It is indicated that optimum yield response occurs at progressively lower rates the earlier the herbicide application.
- These data confirm that there is in spring barley a quite critical balance between weed removal (competition) and the expression of crop phytotoxicity.
- This relationship is such that crop phytotoxicity occurs even at very low rates of herbicide if this is not matched by weed control and reduced competition.

3.7 Section Conclusions and Recommendations

The importance of herbicide timing and crop competition in the efficacy of herbicides and dose reduction is confirmed. The use of pre-/post-emergence sequences of herbicides is not fully confirmed because of dry conditions effecting pre-emergence treatments, but one trial series showed that it may be of use in some circumstances, such as meadowgrass control. Higher doses of herbicides, and even lower doses in dense crops where weed levels are low, appear to commonly produce crop phytoxicity in spring barley.

General recommendations:

- Treat crops early; when weeds are about 2-4 leaf stage, for best weed control, and greater chance of reducing dose.
- Optimum yield response tends to occur at progressively lower rates the earlier the herbicide application.
- Dose reduction is more effective in competitive and denser crops.
- Particularly in denser, vigorous crops, dose reduction may improve yield but crop phytotoxicity may occur at lower rates if there is insufficient weed control.

4. THE EFFECTS OF CROP CULTIVAR ON WEED GROWTH AND THE IMPACT ON REDUCED HERBICIDE DOSES

4.1 Winter wheat

4.1.1 *Treatments and Design*

Four wheat cultivars were sown in four randomised replicate blocks in 1992. Metsulfuron + mecoprop-P was applied at crop GS 26 at 0, 0.6 + 120 and 3 + 600 g a.i./ha. The low dose was included to clarify differences between cultivars. Plots were 2.3 m x 20 m. The cultivars sown were Apollo, Riband, Hereward and Estica. The trial was established at Bush, Midlothian. For full details see Appendix IV (1).

4.1.2 *Results*

Spring 1992 at Bush, Midlothian, was dry, causing crop stress and poor weed emergence and early desiccation. This led to less difference between treatments than expected from earlier trials (Richards and Davies, 1992). The cultivars with the lowest early ground cover, Estica and Apollo, had the highest weed covers remaining in untreated plots (Table 17) and after herbicide treatment with 0.1 or 0.5 N rate of metsulfuron/mecoprop-P. The cultivar with highest early ground cover (Riband) also gave the lowest variation in yield response to weed control (Table 18). However, weed ground cover variation was high in this trial.

Table 17 Crop ground cover (1-9 good) and weed cover (%) at GS 30 in untreated plots

	Crop	**Weed**
Apollo	4.7	18.1
Riband	6.0	9.7
Hereward	5.0	14.3
Estica	3.0	18.9

Table 18 Effect of herbicide on % weed cover in different cultivars at GS 32

% weed cover	48.3	21.7	2.0	45.3	11.7	0.3	49.3	7.7	0.3	33.0	15.3	2.3
Herbicide dose	0	1/10	½	0	1/10	½	0	1/10	½	0	1/10	½
	Apollo			Riband			Hereward			Estica		

Table 19 Yield of grain t/ha

t/ha	7.8	8.2	8.1	9.8	9.9	9.8	7.9	8.1	8.2	7.6	8.1	7.3
Herbicide dose	0	1/10	½	0	1/10	½	0	1/10	½	0	1/10	½
	Apollo			Riband			Hereward			Estica		

4.1.3 *Conclusions*

Variation was very high at this site, but there was an indication that Riband, **the cultivar with the highest early ground cover, also showed the lowest variation in yield response to weed control,** confirming suggestions from earlier work (Richards & Davies, 1991), **and, with Hereward, assisted in improving weed control by herbicide treatment**. This compared with Apollo and Estica, which had low early ground cover.

4.2 **Spring Barley**

4.2.1 *Treatments and Design*

Five spring barley cultivars were sown in four randomised replicate blocks. Metsulfuron + mecoprop-P was applied at crop GS 26 at 0, 0.6 + 120 and 3 + 600 g a.i./ha. A very low dose was included to clarify differences between cultivars. The cultivars sown were Shirley, Osprey, Derkado, Blenheim and Tyne. Weed species present included common chickweed, field pansy and field forget-me-knot. The trial was established at Bush, Midlothian in 1992. For full details see Appendix IV (2).

4.2.3 *Results*

The site at Bush experienced a severe early dry spell, limiting weed emergence and causing early senescence and crop stress. This had a severe effect on the competitive interaction. The five cultivars compared showed a range of ground covers, with Shirley the most competitive (Table 19). In other such trials, high early ground cover had led to reduced susceptibility to weed competition, and a consequent impact in terms of improved weed control from reduced herbicide dose (Richards and Davies, 1991). However, in these conditions there was no significant response to herbicide treatment Appendix IV (2).

Table 19 Crop ground cover (1-9 good) and weed cover (%) at GS 59 in untreated plots

	Crop	Weed
Shirley	9.0	2.0
Osprey	9.0	10.7
Derkado	7.0	8.6
Blenheim	7.7	16.6
Tyne	7.0	8.6

4.2.3 *Conclusions*

Droughting led to excessive variation in this trial, and there is only a trend towards Shirley, **the cultivar giving the best early ground cover, also having the lowest weed level**. This trend confirms better results seen at other sites (Richards & Davies, 1991).

4.3 **Section Conclusions**

There are clear benefits in terms of weed growth reduction and herbicide activity in selecting crop cultivars with higher levels of eraly ground cover. Such selection is confounded by the need to select cultivars for other purposes such as end-use and disease resistance. However, where other factors are equal, such selection would proved a cost-benefit.

There is a need to provide a data-base for farmers to be able to select cultivars on the basis of early ground cover.

5. LONG-TERM REDUCED HERBICIDE USE SITES

Four sites in south-east Scotland on arable farms dominated by cereal rotations have plots which have been treated with half-doses of appropriate herbicides on all spray occasions in the cereal crops since 1989. Comparison has been made with plots treated with full doses of herbicides, and with plots initially treated once weeds had achieved threshold levels determined by models developed by Cousens, Cousens (1985) and Cussans, Cousens, Wilson (1986) at Long Ashton Research Station. The sites were initiated with funding from H-GCA grant 9143/013 (Cussans and Courtney, 1995).

The data from the trials is used to assist in determining the risks of continued use of reduced doses, without consideration of the crop and weed situation. This report follows that reporting the results in detail, extending the data or weed leads for four further seasons.

5.1 Effect of long-term herbicide use at reduced doses on weed levels and grain qualities

5.1.1 *Treatments and Design*

Three replicate blocks of five treatments ± pre-harvest glyphosate treatment. The pre-harvest treatment assessments were meaned for this season's evaluations. The herbicide treatments varied between the four sites, depending on the crop and weed flora. For this assessment they are termed Insurance (prophylactic) treatments, at half-or full- recommended dose over the five seasons of the trial, and threshold (treated once weeds obtained threshold levels) treatments at half- or full-recommended dose if treatment is needed. In practice, the threshold plots have needed treatment in each of the last 3-4 seasons. Plots were 18-27 m x 4 m. For full details of the original trial series see HGCA project 013/8/88 report, and Proven *et al*, (1993). The main herbicide treatments used were DFF/IPU in the autumn at crop GS11, where required, followed by mecoprop-P or fluroxypyr in the spring, and metsulfuron-methyl + mecoprop-P in spring barley, or where no autumn treatment was used in winter cereals.

The four farm sites are:

1. Niddrie Mains, West Lothian
2. Smith's Holding, Midlothian
3. Remote, Midlothian
4. Gleghornie, East Lothian

In 1992/3, the crops were winter wheat at Niddrie Mains and Gleghornie, and spring barley at Smith's Holding and Remote. See weed tables in Appendix V for species list. Trials were harvested at Niddrie Mains, Smith's Holding and Remote.

5.1.2 *Results*

Table 20 gives the weed levels at three of the sites in spring 1993. The untreated plots had the highest weed levels, as would be expected. The half-dose treatment after threshold evaluation at Smith's, and both threshold treatments at Remote, had higher weed levels than continually Insurance treated plots. There were no treatment differences at Gelghornie. The insurance half-dose treatment may have overall led to increased weed levels over full-dose treatment plots.

Table 20 Weed levels by % ground cover at three Scottish sites after five seasons of full and half-dose herbicide treatments

	% Ground cover			
Treatment	**Niddrie Mains**	**Smith's Holding**	**Remote**	**Gleghornie**
Untreated		40.6	33.4	14.8
Threshold - full dose		2.2	24.6	0.2
Threshold - half dose		11.7	19.8	1.3
Insurance - full dose		2.2	10.9	0.2
Insurance - half dose		6.8	15.0	1.5

Table 21 Yields from three Scottish sites after five seasons of full and half-dose herbicide treatment

Treatment	Niddrie Mains	Smith's Holding	Remote
Untreated	8.78	4.63	7.39
Threshold - full dose	9.48	4.56	7.63
Threshold - half dose	9.55	4.62	7.32
Insurance - full dose	10.72	4.40	7.02
Insurance - half dose	11.06	4.44	7.46
SED	0.553	0.271	0.509

Only at Niddrie Mains was there evidence of yields being affected by weed levels developed over five seasons in untreated plots. There was no significant differences at the other two sites between herbicide treatments, but yield levels from originally threshold treated plots were lower than from insurance-treated plots.

There was no evidence of specific weight being affected by treatment, although this has been noted elsewhere (Davies, *et al*, 1994), and no consistent pattern in grain dry matter content - although at Niddrie mains full dose treatment tended to reduce grain dry matter - or 1000-grain weights (Appendix 5). The good harvesting conditions may have been reduced differences noted in other seasons in this trial series.

5.1.4 *Conclusions*

This finalises the results from a series started in 1989 under the auspices of HGCA grant 013/8/88 **There is clear evidence of a weed build-up in untreated plots, with some evidence of a weed build-up where half-dose herbicides has been used routinely through the cereal rotation. The initial use of a threshold approach has increased weed levels at some sites.**

Yield responses are variable, and may be related to weed levels as at Niddrie Mains, or possibly herbicide effects on the crop, as at Remote, but these inconsistencies have been typical of the series. This is in part because the sites selected were chosen on the basis of not having high levels of weeds, otherwise weed build-up may have been faster, and yield responses consequently changed.

Grain qualities were largely unaffected in 1993, although there have been occasions in earlier years where there have been effects (Davies & Whiting, 1990; Davies et al, 1994). This may have been due to the good, drying harvest conditions.

Recommendation

The main feature of this series has been the slow build-up of weed populations in the half-dose plots, which indicate, that over time, the appropriate dose may have to be increased to control populations. Particularly if there are crops in the rotation with specific or high weed control requirements.

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APPROPRIATE HERBICIDE RATES FOR CEREAL CROPS

PART II
APPENDICES

CONTENTS

LIST OF APPENDICES

APPENDIX I: WINTER WHEAT: APPROPRIATE HERBICIDES FOR CLEAVER CONTROL

APPENDIX I (1)

The testing of a reduced dose sequential herbicide programme on winter wheat crops with weed populations including cleavers, in order to evaluate the interdependence of autumn and spring herbicide activity

1. **ADAS**

1.1 Boxworth, Cambridge

Crop:	Winter wheat, cultivar Riband
Sowing date:	10.10.91
Cleaver populationL	5.5 m² (Feb)
Other major weeds present:	None
Soil type:	Clay
Soil series	Hanslope

1.2 Drayton, Warwickshire

Crop:	Winter wheat, cultivar Riband
Sowing date:	8.10.91
Cleaver population:	12.2/m² (March)
Other major weeds present:	Fool's parsley, field speedwell, forget-me-knot, wild oat
Soil type:	Clay
Soil series:	Gresham

1.3 Bridget's Hampshire

Crop:	Winter wheat, cultivar Riband
Sowing date:	21.10.91
Cleaver population:	14/m² (March)
Other major weeds present:	Pansy, groundsel, chickweed, field speedwell
Soil type:	Silty-loam
Soil series:	Andover

1.4 Rosemaund, Shropshire

Crop:	Winter wheat, cultivar Riband
Sowing date:	15.10.91
Cleaver population:	12.2/m²
Other major weeds present:	Mayweed, chickweed, field speedwell
Soil type:	Silty clay loam
Soil series:	Bromyard

All harvested mid-August; biomass mid-end June '92, and mid-late March '92.

SAC

1.5 Bush, Midlothian

Crop:	Winter wheat, cultivar Riband	
Sowing date:	10.10.92	
Cleaver population:	17.9/m² (March)	
Other major weeds present:	Chickweed, ivy-leaved speedwell	
Soil type:	Sandy clay loam	
Soil series:	Macmerry	
Biomass:	7.8.92	Combine harvest: 10.9.92

1.6 Luggate, Haddington, E Lothian

Crop:	Winter wheat, cultivar Riband	
Sowing date:	1.10.92	
Cleaver population:	18.2/m² (December)	
Other major weeds present:	Chickweed, ivy-leaved speedwell	
Soil type:	Sandy clay loam	
Soil series:	Biel	
Biomass harvests:	6.4.92; 7.8.92	Combine harvest: 29.8.92

QUB

1.7 Greenmount, Co Down

Crop:	Winter wheat, cultivar Riband	
Sowing date:	9.10.91	
Cleaver population:	Poa spp, chickweed	
Soil type:	Clay loam	
Biomass harvests:	7.4.92; 6.8.92	Combine harvest: 17.9.92

2. **Herbicide treatments**

	Sequences (g a.i./ha)			
Autumn* applied isoproturon+ diflufenican as Panther or Cougar	1100	550	275	0
Spring** applied fluroxypyr as Starane 2	200	200	200	200
	100	100	100	100
	50	50	50	50
	25	25	25	25
	0	0	0	0

Untreated: Two additional untreated control plots per replicate:
* Crop growth stage GS11
** Crop growth stage GS30 (before GS31)

Herbicide treatments applied in 200 l/ha water with a medium quality (BCPC) spray at a minimum pressure of 2 bars. Minimum of 3 replicates per treatment.

3. Meteorological data and further site details are on file, and will be published as relevent in conference and other papers.

4. Full trial results are on file. Not all are published here to reduce the volume of the report.

APPENDIX I (1)

1. Cleaver Biomass (g DM/m^{-2}) - spring assessment (post-DFF, pre-fluroxypyr)

DFF (g ai/ha)	fluroxypyr (g ai/ha)	Boxworth	Bridgets	Drayton	Rosemaund	Bush	Haddington	Greenmount	MEAN
100	200	0.53	0.43	0.41	0.36	0.60	0.07	0.63	0.43
100	100	0.13	0.43	0.53	0.31	1.07	0.00	0.21	0.38
100	50	0.07	0.43	0.34	0.49	0.23	0.03	0.23	0.26
100	25	0.07	0.43	0.62	0.40	0.17	0.03	0.56	0.33
100	0	0.03	0.43	0.53	0.53	0.50	0.10	0.24	0.34
50	200	0.50	0.51	0.80	0.44	1.27	0.10	0.52	0.59
50	100	0.03	0.51	1.73	0.89	0.57	0.53	0.59	0.69
50	50	0.97	0.51	1.72	2.62	1.20	0.20	0.53	1.11
50	25	1.67	0.51	1.46	0.62	0.87	0.27	1.92	1.05
50	0	0.53	0.51	1.27	1.82	1.50	0.33	0.96	0.99
25	200	0.43	0.89	1.38	2.49	1.47	0.00	0.75	1.06
25	100	0.37	0.89	1.75	2.93	1.00	0.97	1.33	1.32
25	50	1.10	0.89	1.72	1.96	2.03	0.20	1.06	1.28
25	25	1.00	0.89	1.09	2.67	1.63	1.67	1.43	1.48
25	0	1.51	2.81	0.92	4.49	1.50	0.33	7.34	1.46
0	200	1.51	2.81	1.95	7.38	3.17	1.40	1.29	2.79
0	100	1.51	2.81	0.98	6.49	2.33	1.13	0.88	2.30
0	50	1.51	2.81	2.70	4.27	3.23	1.57	1.77	2.55
0	25	1.51	2.81	0.97	8.89	2.07	1.83	2.65	2.96
0	0	1.51	2.81	1.83	5.79	3.53	1.23	1.98	2.67
DFF Mean	100	0.17	0.43	0.49	0.42	0.51	0.05	0.37	0.35
	50	0.74	0.51	1.40	1.28	1.08	0.29	0.90	0.89
	25	0.73	0.89	1.37	2.91	1.53	0.63	1.18	1.32
	0	1.51	2.81	1.69	6.56	2.87	1.43	1.71	2.65
Fluroxypyr Mean	200	0.74	1.16	1.14	2.67	1.63	0.39	0.80	1.22
	100	0.51	1.16	1.25	2.66	1.24	0.66	0.75	1.18
	50	0.91	1.16	1.62	2.34	1.67	0.50	0.90	1.30
	25	1.06	1.16	1.04	3.15	1.19	0.95	1.64	1.45
	0	0.71	1.16	1.14	3.16	1.76	0.50	1.13	1.36

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APPENDIX 1 (1)

2. **Cleaver Biomass /g DM/M-² 2) - summer assessment (post-DFF, pre-fluroxypyr)**

DFF (g ai/ha)	fluroxypyr (g ai/ha)	Boxworth	Bridgets	Drayton	Rosemaund	Bush	Haddington	Greenmount	MEAN	MEAN (excl Greemount and Haddington)
100	200	0.33	0.00	1.07	0.00	0.20	0.00	2.66	0.61	0.32
100	100	0.03	0.10	0.62	0.60	0.00	0.00	16.02	2.48	0.27
100	50	3.43	5.70	3.96	6.70	0.90	0.00	20.15	5.83	4.14
100	25	3.73	5.70	5.20	8.50	14.73	0.00	7.17	6.43	7.57
100	0	4.87	12.10	21.64	5.30	4.60	0.00	8.26	8.11	9.70
50	200	0.07	0.00	0.62	0.50	0.00	0.00	33.10	4.90	0.24
50	100	0.00	0.00	1.07	2.70	0.20	0.00	16.26	2.89	0.79
50	50	5.33	6.40	7.38	32.30	3.57	0.00	11.27	9.46	11.00
50	25	7.93	5.80	17.55	19.90	13.47	0.00	45.69	15.76	12.93
50	0	5.40	21.70	13.11	30.60	23.70	6.47	45.62	20.94	18.90
25	200	10.80	0.00	0.00	0.00	0.00	0.00	18.31	4.16	2.10
25	100	1.03	2.10	7.20	1.10	0.23	0.00	22.21	4.84	2.33
25	50	2.97	3.20	5.51	31.40	12.37	0.00	39.91	13.62	11.09
25	25	11.47	16.30	38.08	16.00	25.40	0.00	18.29	18.22	21.85
25	0	13.63	16.40	52.65	52.50	33.50	4.13	21.91	27.82	33.74
0	200	0.00	0.00	0.00	0.00	0.00	0.00	23.83	3.40	0.00
0	100	0.60	8.30	0.31	0.00	2.00	0.00	47.27	8.35	2.24
0	50	11.97	46.60	16.93	24.40	13.67	1.03	15.18	18.54	22.71
0	25	39.33	88.20	34.12	93.00	39.10	15.33	25.32	47.77	58.75
0	0	16.27	127.90	49.22	83.80	51.02	11.51	36.86	53.80	65.64
DFF Mean	100	2.48	4.72	6.50	4.22	4.09	0.00	10.85	4.69	4.40
	50	3.75	6.78	7.94	17.20	8.19	1.29	30.39	10.79	8.77
	25	7.98	7.60	20.69	20.60	14.30	0.83	24.13	13.73	14.23
	0	13.63	54.20	20.12	40.24	21.16	5.57	29.69	26.37	29.87
Fluroxypyr Mean	200	2.80	0.00	0.42	0.13	0.05	0.00	19.48	3.27	0.68
	100	0.42	2.63	2.30	1.10	0.61	0.00	25.44	4.64	1.41
	50	5.93	15.48	8.44	23.70	7.63	0.26	21.63	11.87	12.23
	25	15.62	29.00	23.74	34.85	23.18	3.83	24.12	22.05	25.28
	0	10.04	44.53	34.16	43.05	28.21	5.53	28.16	27.67	32.00

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APPENDIX 1 (1)

3. 'Other' BLW biomass (g DM/m^{-2}) - summer assessment (post DFF, post fluroxypyr)

DFF (g ai/ha)	fluroxypyr (g ai/ha)	Boxworth	Bridgets	Drayton	Rosemaund	Bush	Haddington	Greenmount	MEAN	MEAN (excl Greemount and Haddington)
100	200		0.00	382	0.00	4.47	0.00	11.93	3.37	2.07
100	100		0.20	6.62	0.00	5.50	0.00	19.11	5.24	3.08
100	50		0.00	9.24	0.00	0.70	0.00	12.74	3.78	2.49
100	25		0.10	6.71	0.00	2.70	0.00	33.83	7.22	2.38
100	0		0.10	26.93	0.00	4.63	0.00	18.07	24.96	7.92
50	200		0.10	0.98	0.00	0.00	1.40	98.29	16.79	0.27
50	100		0.20	4.58	0.00	0.93	1.93	71.43	13.16	1.43
50	50		0.10	12.17	0.21	0.30	0.00	49.99	10.48	3.20
50	25		0.40	8.40	0.00	3.47	0.00	44.34	9.43	3.07
50	0		0.10	9.82	0.00	16.83	0.00	15.35	7.35	7.19
25	200		0.00	5.91	0.25	2.10	2.10	27.40	6.30	7.01
25	100		0.00	12.31	0.96	0.00	0.00	72.92	14.37	3.32
25	50		0.00	10.04	0.00	1.60	0.00	42.13	8.98	2.94
25	25		0.10	4.58	0.00	8.20	0.70	75.61	14.86	3.22
25	0		0.70	13.02	0.00	2.83	0.00	97.47	19.00	4.14
0	200		5.40	1.29	8.58	7.33	0.27	65.32	14.70	5.65
0	100		5.10	9.29	28.87	0.77	2.67	165.24	35.32	11.01
0	50		1.90	10.66	14.21	2.13	0.40	43.41	12.12	7.23
0	25		5.00	35.59	20.42	27.50	2.80	74.03	27.56	22.13
0	0		4.20	19.49	16.73	27.24	3.51	82.57	25.62	16.92
DFF Mean	100		0.08	10.66	0.00	3.60	0.00	39.14	8.91	3.59
	50		0.18	7.19	0.04	4.71	0.67	55.88	11.44	3.03
	25		0.18	9.17	0.24	2.95	0.56	63.12	12.70	3.13
	0		4.32	15.26	17.70	12.99	1.93	86.11	23.06	12.58
Fluroxypyr Mean	200		1.38	3.00	2.21	3.46	0.94	50.75	10.29	2.51
	100		1.38	8.20	7.46	1.80	1.15	82.18	17.03	4.71
	50		0.53	10.53	3.61	1.16	0.10	37.07	8.83	3.96
	25		1.40	13.82	5.11	10.47	0.88	56.95	14.77	7.70
	0		1.28	17.32	4.18	13.38	0.88	78.37	19.23	9.04

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APPENDIX 1 (1)

4. **Grain yield (t/ha at 85% DM)**

DFF (g ai/ha)	fluroxypyr (g ai/ha)	Boxworth	Bridgets	Drayton	Rosemaund	Bush	Haddington	Greenmount	MEAN	MEAN (excl Greemount and Haddington)
100	200	7.38	9.49	6.81	7.31	9.86	12.09	3.33	8.04	8.37
100	100	7.36	9.59	7.20	7.57	9.55	12.26	2.84	8.05	8.48
100	50	7.38	9.72	6.59	7.51	9.74	12.57	3.53	8.15	8.39
100	25	7.31	9.46	6.61	7.76	9.16	12.51	3.78	8.08	8.25
100	0	7.00	9.43	8.71	7.44	10.05	12.62	1.91	7.88	8.41
50	200	7.48	9.59	6.64	7.69	9.96	11.97	1.90	7.89	8.47
50	100	7.22	9.60	6.82	7.74	9.39	12.11	2.60	7.93	8.39
50	50	7.20	9.58	7.00	7.81	9.39	12.30	3.03	8.04	8.44
50	25	7.22	9.42	7.01	7.35	9.59	12.11	3.54	8.03	8.34
50	0	6.99	9.48	6.92	7.25	8.71	12.32	3.34	7.86	8.09
25	200	7.13	9.65	7.01	8.30	9.77	12.14	2.61	8.05	8.60
25	100	7.35	9.60	6.72	7.58	9.72	12.28	2.85	8.01	8.40
25	50	7.27	9.88	7.32	7.52	9.78	12.57	1.72	8.01	8.62
25	25	6.92	9.69	6.80	7.12	9.71	12.37	3.73	8.05	8.33
25	0	6.79	9.28	6.48	6.91	9.69	12.43	1.97	7.65	8.09
0	200	7.01	9.47	6.73	7.44	9.35	11.78	2.55	7.76	8.25
0	100	7.43	9.43	7.14	7.02	9.14	11.57	2.49	7.75	8.18
0	50	6.89	9.49	6.71	7.61	9.44	12.26	2.18	7.80	8.31
0	25	6.67	9.20	6.58	6.24	8.85	11.13	1.65	7.19	7.72
0	0	6.31	9.04	6.63	6.07	8.66	10.89	2.24	7.12	7.60
DFF Mean	100	7.29	9.54	6.78	7.52	9.67	12.41	3.08	8.04	8.36
	50	7.22	9.53	6.88	7.57	9.41	12.16	2.88	7.95	8.35
	25	7.09	9.62	6.87	7.48	9.73	12.36	2.58	7.96	8.43
	0	6.86	9.33	6.76	6.86	9.09	11.53	2.22	7.52	8.01
Fluroxypyr Mean	200	7.25	9.55	6.80	7.96	9.74	12.00	2.60	7.94	8.44
	100	7.34	9.56	6.97	7.48	9.45	12.06	2.69	7.93	8.36
	50	7.19	9.67	6.90	7.61	9.59	12.43	2.62	8.00	8.44
	25	7.03	9.44	6.75	7.12	9.33	12.03	3.18	7.84	8.16
	0	6.77	9.31	6.68	6.92	9.28	12.07	2.37	7.63	8.05

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APPENDIX I (2)

The testing of the importance of herbicide timing in the spring for cleaver control following the use of an autumn treatment.

1. **Details of sites with cleavers**

ADAS

1.1 Boxworth, Cambridge

Crop:	Winter wheat, cultivar Riband
Sowing date:	10.10.92
Cleaver population:	c 10 m^2
Soil type:	Clay
Soil series	Hanslope
Biomass harvest:	end July

1.2 Drayton, Warwickshire

Crop:	Winter wheat, cultivar Riband
Sowing date:	10.10.92
Cleaver population:	c 10 m^2
Soil type:	Clay
Soil series:	Gresham
Biomass harvest:	end July

1.3 Bridget's Hampshire

Crop:	Winter wheat, cultivar Riband
Sowing date:	15.10.92
Cleaver population:	c 10 m^2
Soil type:	Silty-loam
Soil series:	Andover
Biomass harvest:	end July

1.4 Rosemaund, Shropshire

Crop:	Winter wheat, cultivar Riband
Sowing date:	10.10.92
Cleaver population:	c 10 m^2
Soil type:	Silty clay loam
Soil series:	Bromyard
Biomass harvest:	end July

All harvested mid-August

SAC

1.5 Bush, Midlothian

Crop:	Winter wheat, cultivar Riband
Sowing date:	15.10.96
Cleaver population:	c 8 m^2
Soil type:	Sandy clay loam

Soil series:	Macmerry	
Biomass harvest:	5.7.93	10.9.92

1.6 Ormiston (Luggate) Haddington, East Lothian

Crop:	Winter wheat, cultivar Riband	
Sowing date:	12.10.92	
Cleaver population:	c 12 m²	
Soil type:	Sandy loam	
Soil series:	Darvel	
Biomass harvests:	8.7.93	15.8.93

2. **Herbicide treatments**

	Sequences
Autumn* applied isoproturon + diflufenican	50 + 500
Spring** applied fluroxypyr	200
	100
	50
	25
	0

Untreated: Two additional untreated control plots per replicate:

* Crop growth stage: GS11

** Crop growth stage: Feb/March
GS30
GS31/32
GS39

Herbicide treatments applied in 20 l/ha water with a medium quality (BCPC) spray at a minimum pressure of 2 bars. Minimum of 3 replicates per treatment.

Full metrorological data, and results, are on file. Not included here to reduce the volume of the report.

APPENDIX 1 (2)

1. Grain yield (t/ha at 85% DM)

Timing	flurozypyr (g ai/ha)	Boxworth	Bridgets	Drayton	Rosemaun d	Bush	Haddington	ADAS mean	SAC mean	Overall mean
February	0	6.15	8.29		8.94	7.49	11.08	7.79	9.29	8.39
February	25	6.28	8.43	9.18	9.11	5.79	11.20	8.25	8.50	8.33
February	50	6.39	8.60	9.17	9.04	7.41	10.99	8.30	9.20	8.60
February	100	6.97	8.61	9.23	8.91	6.69	11.29	8.43	8.99	8.62
February	200	7.12	8.56	9.34	8.67	7.30	11.17	8.42	9.24	8.69
GS30	0	5.87	8.26	8.46	9.03	7.27	11.10	7.91	9.19	8.33
GS30	25	6.45	8.32	9.16	9.32	8.22	11.32	8.31	9.77	8.80
GS30	50	6.72	8.62	9.31	8.88	7.39	11.24	8.38	9.32	8.69
GS30	100	7.11	8.44	8.98	9.58	7.93	11.43	8.53	9.68	8.91
GS30	200	7.02	8.65	9.19	8.93	6.39	11.15	8.44	8.77	8.55
GS32	0	5.93	8.30	8.22	9.14	8.34	10.86	7.90	9.60	8.46
GS32	25	6.72	8.52	8.78	9.44	7.49	11.19	8.37	9.34	8.69
GS32	50	6.95	8.56	8.79	8.91	7.46	11.23	8.30	9.35	8.65
GS32	100	6.94	8.30	9.00	9.34	6.84	11.47	8.39	9.16	8.65
GS32	200	6.81	8.31	9.19	8.57	7.71	11.20	8.22	9.46	8.63
GS39	0	5.83	8.36	7.95	8.45	7.11	11.21	7.65	9.16	8.15
GS39	25	6.34	8.44	8.68	8.90	7.29	11.10	8.09	9.20	8.46
GS39	50	6.60	8.46	8.76	9.08	7.13	11.48	8.23	9.31	8.59
GS39	100	6.34	8.48	8.80	8.77	6.90	10.94	8.10	8.92	8.37
GS39	200	6.45	8.34	8.60	8.71	7.42	11.37	8.02	9.40	8.48
Timing Mean	February	6.58	8.50	9.23	8.93	6.94	11.15	8.31	9.04	8.55
	GS30	6.63	8.46	9.02	9.14	7.44	11.25	8.31	9.34	8.66
	GS32	6.67	8.40	8.79	9.08	7.57	11.19	8.24	9.38	8.62
	GS39	6.31	8.42	8.56	8.78	7.17	11.22	8.02	9.20	8.41
Fluroxypyr Mean	0	5.95	8.30	8.21	8.89	7.55	11.06	7.84	9.31	8.33
	25	6.45	8.43	8.95	9.19	7.20	11.20	8.25	9.20	8.57
	50	6.67	8.56	9.01	8.98	7.35	11.24	8.30	9.29	8.63
	100	6.84	8.46	9.00	9.15	7.09	11.28	8.36	9.19	8.64
	200	6.85	8.47	9.08	8.72	7.21	11.22	8.28	9.21	8.59

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APPENDIX I (2)

2. Herbicide price (£/ha, approx)

Timing		fluroxypyr (g ai/ha)	Overall mean
February		0	0.00
February		25	2.38
February		50	4.75
February		100	9.50
February		200	19.00
GS30		0	0.00
GS30		25	2.38
GS30		50	4.75
GS30		100	9.50
GS30		200	19.00
GS32		0	0.00
GS32		25	2.38
GS32		50	4.75
GS32		100	9.50
GS32		200	19.00
GS39		0	0.00
GS39		25	2.38
GS39		50	4.75
GS39		100	9.50
GS39		200	19.00
Timing Mean		February	7.13
	GS30		7.13
	GS32		7.13
	GS39		7.13
Fluroxypyr Mean		0	0.00
		25	2.38
		50	4.75
		100	9.50
		200	19.00

APPENDIX I (2)

3. Margin over herbicide cost (£/ha cf. MOHC for fluroxypur at GS32, wheat = £100/t)

Timing	fluroxypyr (g ai/ha)	Boxworth	Bridgets	Drayton	Rosemaund	Bush	Haddington	ADAS mean	SAC mean	Overall mean
		622.30	812.00	900.10	837.50	752.00	1101.00	802.95	926.50	844.13
February	0	-46.80	17.00		56.20	-3.00	7.00	8.80	2.00	6.08
February	25	-36.78	28.62	15.22	71.25	-175.38	16.62	19.58	-79.38	-13.41
February	50	-27.65	43.25	12.25	61.55	-15.75	-6.75	22.35	-11.25	11.15
February	100	25.07	39.50	13.00	44.40	-92.50	18.50	30.49	-37.00	8.00
February	200	30.88	25.00	14.40	10.90	-41.00	-3.00	20.30	-22.00	6.20
GS30	0	-75.00	14.00	-53.80	65.00	-25.00	9.00	-12.45	-8.00	-10.97
GS30	25	-19.28	17.62	13.22	91.72	67.62	28.62	25.82	48.12	33.25
GS30	50	4.85	45.25	26.05	46.65	-17.75	18.25	30.45	0.25	20.38
GS30	100	39.27	22.50	-11.80	110.50	31.50	32.50	40.12	32.00	37.41
GS30	200	20.40	34.00	-0.40	36.00	-132.00	-5.00	22.50	-68.50	-7.38
GS32	0	-68.94	18.00	-78.40	76.10	82.00	-15.00	-13.13	33.50	2.29
GS32	25	7.42	37.62	-24.88	104.52	-5.38	15.62	31.17	5.12	22.49
GS32	50	28.51	29.25	-26.35	49.15	-10.75	17.25	22.64	3.25	16.18
GS32	100	21.84	8.50	-10.10	87.00	-77.50	36.50	26.81	-20.50	11.04
GS32	200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GS39	0	-79.70	24.00	-105.00	7.40	-41.00	20.00	-38.33	-10.50	-29.05
GS39	25	-30.38	29.62	-34.78	50.32	-25.38	6.62	3.69	-9.38	-0.66
GS39	50	-6.88	29.25	29.25	66.15	-43.75	42.25	14.82	-0.75	9.63
GS39	100	-37.74	26.50	-30.00	29.90	-71.50	-16.50	-2.84	-44.00	-16.56
GS39	200	-36.39	3.00	58.80	14.00	-29.00	17.00	-19.55	-6.00	15.03
Timing	February	-11.06	30.67	13.72	48.86	-65.53	6.47	20.55	-29.53	3.86
	GS30	-5.95	26.67	-5.32	69.77	-15.13	16.67	21.29	0.77	14.45
	GS32	-2.23	20.67	-27.95	63.35	-2.33	10.87	13.46	4.27	10.40
	GS39	-38.22	22.47	-51.57	33.55	-42.13	13.87	-8.44	-14.13	-10.33
Fluroxypyr Mean	0	-67.61	18.25	-59.30	51.17	3.25	5.25	-14.37	4.25	-8.16
	25	-19.76	28.37	-7.81	79.45	-34.63	16.87	20.07	-8.88	10.42
	50	-0.29	39.25	-4.33	55.63	-22.00	17.75	22.56	-2.13	14.33
	100	12.11	24.25	-9.73	67.95	-52.50	17.75	23.65	-17.28	9.97
	200	3.72	15.00	-11.20	15.23	-50.50	2.25	5.81	-24.13	-4.17

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APPENDIX I (2)

4. Cleaver biomass (g DM/m^2) - summer assessment

Timing	fluroxypyr (g ai/ha)	Boxworth	Bridgets	Drayton	Rosemaund	Bush	Haddington	ADAS mean	SAC mean	Overall mean
February	0	144.90	73.50		13.95	3.92	4.35	77.45	4.14	48.12
February	25	200.10	67.40	1.24	16.02	14.67	10.85	71.19	12.76	51.71
February	50	79.50	27.50	15.42	7.90	2.21	6.93	32.58	4.57	23.24
February	100	15.88	3.20	1.64	0.37	0.88	13.87	5.27	7.38	5.97
February	200	1.22	0.00	3.29	0.00	0.27	0.00	1.13	0.14	0.80
GS30	0	162.10	73.30	60.22	10.68	8.61	24.53	76.58	16.57	56.57
GS30	25	85.20	58.60	12.93	15.90	0.08	7.12	43.16	3.60	29.97
GS30	50	41.34	38.80	5.20	12.81	0.88	2.32	24.54	1.60	16.89
GS30	100	11.80	21.60	0.13	1.02	1.33	0.99	8.64	1.16	6.15
GS30	200	0.00	2.50	0.00	0.37	0.00	0.00	0.72	0.00	0.48
GS32	0	127.90	86.20	71.91	14.69	5.07	11.73	75.18	8.40	52.92
GS32	25	84.70	45.30	19.24	7.44	5.15	13.60	39.17	9.38	29.24
GS32	50	18.54	17.20	12.04	4.04	1.95	1.07	12.96	1.51	9.14
GS32	100	0.00	1.80	2.62	0.65	1.52	0.00	1.27	0.76	1.10
GS32	200	1.29	0.30	2.40	0.00	0.00	0.00	1.00	0.00	0.67
GS39	0	125.10	118.40	45.91	13.70	11.28	16.99	75.78	14.13	55.23
GS39	25	75.55	63.30	43.73	20.99	1.68	3.47	50.89	2.58	34.79
GS39	50	95.10	38.00	41.69	11.67	4.45	3.47	46.62	3.96	32.40
GS39	100	125.70	18.00	16.62	2.84	1.95	0.80	40.79	1.38	27.65
GS39	200	48.49	15.00	40.93	1.73	1.15	3.28	26.54	2.22	18.43
Timing	February	88.32	34.32	5.40	7.65	4.39	7.20	33.92	5.80	24.55
	GS30	60.09	38.96	15.70	8.16	2.18	6.99	30.73	4.59	22.01
	GS32	46.49	30.16	21.64	5.36	2.74	5.28	25.91	4.01	18.61
	GS39	93.99	50.54	37.78	10.19	4.10	5.60	48.12	4.85	33.70
Fluroxypyr Mean	0	140.00	87.85	59.35	13.26	7.22	14.40	75.11	10.81	53.68
	25	111.39	58.65	19.29	15.09	5.40	8.76	51.10	7.08	36.43
	50	58.62	30.38	18.59	9.11	2.37	3.45	29.17	2.91	20.42
	100	38.35	11.15	5.25	1.22	1.42	3.92	13.99	2.76	10.22
	200	12.75	4.45	11.65	0.52	0.36	0.82	7.34	0.59	5.09

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APPENDIX I (3)

The importance of crop competition on herbicide activity on cleavers.

1. **Details of sites with cleavers**

ADAS

1.1 Boxworth, Cambridge

Crop:	Winter wheat, cultivar Riband
Sowing date:	15 October 1992
Cleaver population:	c 10 m^1
Soil type:	Clay
Soil series	Hanslope

1.2 Drayton, Warwickshire

Crop:	Winter wheat, cultivar Riband
Sowing date:	12 October 1992
Cleaver population:	c 12 m^1
Soil type:	Clay
Soil series:	Gresham

1.3 Bridget's Hampshire

Crop:	Winter wheat, cultivar Riband
Sowing date:	c 20 October 1992
Cleaver population:	c 10 m^1
Soil type:	Silty-loam
Soil series:	Andover

1.4 Rosemaund, Shropshire

Crop:	Winter wheat, cultivar Riband
Sowing date:	15 October 1992
Cleaver population:	c 10 m^1
Soil type:	Silty clay loam
Soil series:	Bromyard

All harvested mid-August; biomass end June 1993

SAC

1.5 Bush, Midlothian

Crop:	Winter wheat, cultivar Riband
Sowing date:	30 August 1993
Cleaver population:	11.25 m^2
Soil type:	SCL
Soil series:	Macmerry
Biomass harvest:	22 August 1994 Combine harvest: 27 September 1994

2. **Herbicide treatments**

Three replicate randomised blocks.
Winter wheat saving rates: 0, 50, 200, 400 seeds/m^2
Herbicide sequence (rate g a.i./ha):

DFF + IPU*	50 + 500
Fluroxypyr	200, 100, 50, 25 0

* Crop growth stage: GS11
** Crop growth stage: GS31/32

Herbicide treatments applied in 200 l/ha water with a medium quality (BCPC) spray at a minimum pressure of 2 bars. Minimum of 3 replicates per treatment.

3. Metrorological data and full trial results are on file, Not all are published here to reduce the volume of the report.

APPENDIX I (3)

1. Cleaver biomass (g DM/m^2) - summer assessment

Crop pop.	fluroxypyr (g ai/ha)	Boxworth	Bridgets	Drayton	Rosemaund	Bush	ADAS mean	SAC mean	Overall mean
0	0	520.27	276.00	65.20	39.90	0.17	224.67	0.17	179.77
0	25	541.96	110.00	72.70	26.60	30.53	187.62	20.53	156.36
0	50	365.56	172.00	61.60	27.20	6.63	161.59	6.63	130.60
0	100	392.44	23.00	62.20	7.62	1.97	121.32	1.97	97.45
0	200	319.78	10.00	0.20	1.80	0.00	82.95	0.00	68.36
50	0	104.71	8.00	30.40	20.17	20.77	40.82	20.77	36.81
50	25	70.00	1.00	5.50	13.11	3.33	22.40	3.33	18.59
50	50	29.78	1.00	0.90	18.03	0.47	12.43	0.47	10.04
50	100	5.11	0.00	0.10	12.80	1.13	4.50	1.13	3.83
50	200	0.80	0.00	0.00	0.00	0.00	0.20	0.00	0.16
200	0	52.84	4.00	12.60	6.37	0.00	18.95	0.00	15.16
200	25	12.38	3.00	4.40	0.97	3.20	5.18	3.20	4.79
200	50	3.82	0.00	0.50	4.67	0.27	2.25	0.27	1.85
200	100	5.33	0.00	0.00	1.00	0.00	1.58	0.00	1.27
200	200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
400	0	46.58	7.00	2.00	3.65	0.50	14.81	0.50	11.95
400	25	11.33	0.00	0.00	0.28	0.00	2.90	0.00	2.32
400	50	3.16	0.00	0.10	1.26	0.00	1.13	0.00	0.90
400	100	1.31	0.00	0.00	0.16	0.00	0.37	0.00	0.29
400	200	0.58	0.00	0.00	0.00	0.00	0.15	0.00	0.12
Crop mean	0	428.00	116.20	55.84	20.62	7.86	155.67	7.86	126.11
	50	42.08	2.00	7.38	12.82	5.14	16.07	5.14	13.88
	200	14.87	1.40	3.50	2.60	0.69	5.59	0.69	4.61
	400	12.59	1.40	0.42	1.07	0.10	3.87	0.10	3.12
Fluroxypyr	0	181.10	73.75	15.00	17.52	5.36	71.84	5.36	68.55
	25	158.91	28.50	20.65	10.24	9.27	54.58	9.27	45.51
	50	100.58	43.25	20.78	12.79	1.84	44.35	1.84	36.85
	100	101.05	5.75	15.58	5.40	0.78	31.94	0.78	26.71
	200	80.29	2.50	0.05	0.45	0.00	20.82	0.00	16.66

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APPENDIX I (3)

2. Other BLW biomass (g DM/m^2) - summer assessment

Crop pop.	fluroxypyr (g ai/ha)	Boxworth	Bridgets	Drayton	Rosemaund	Bush	ADAS mean	SAC mean	Overall mean
0	0	67.73	80.00	399.60	113.20	169.83	165.13	169.83	166.07
0	25	86.89	72.00	360.80	127.80	197.03	161.87	197.03	168.90
0	50	51.16	63.00	352.10	167.60	94.87	158.46	94.87	145.75
0	100	100.36	32.00	385.50	69.30	95.77	142.54	95.77	133.19
0	200	36.36	30.00	190.90	63.40	126.80	80.16	126.80	89.49
50	0	1.33	2.00	41.50	35.40	37.93	20.06	37.93	23.63
50	25	3.24	1.00	25.40	31.13	30.50	15.19	30.50	18.25
50	50	3.64	1.00	9.10	47.40	13.17	14.29	13.17	15.86
50	100	8.44	0.00	9.40	12.50	1.80	7.59	1.80	6.43
50	200	3.51	0.00	3.50	24.30	23.03	7.83	23.03	10.87
200	0	4.13	1.00	8.40	1.47	7.78	3.75	7.87	4.57
200	25	0.09	0.00	3.80	1.43	3.60	1.33	3.60	1.78
200	50	1.47	0.00	2.80	4.90	1.53	2.29	1.53	2.14
200	100	3.82	0.00	0.70	1.02	10.87	1.39	10.87	3.28
200	200	0.00	0.00	0.30	1.87	2.27	0.54	2.27	0.89
400	0	2.71	0.00	3.50	1.34	0.87	1.89	0.87	1.69
400	25	3.96	0.00	2.00	1.36	1.80	1.83	1.80	1.82
400	50	1.33	0.00	0.80	2.10	0.00	1.06	0.00	0.85
400	100	1.16	0.00	0.30	1.50	5.97	0.74	5.97	1.79
400	200	1.51	0.00	0.30	5.80	0.33	1.90	0.33	1.69
Crop mean	0	68.50	55.40	334.38	108.26	138.66	141.63	136.85	140.88
	50	4.04	0.80	17.76	30.15	21.29	13.19	21.29	14.81
	200	1.90	0.20	3.20	2.14	5.23	1.66	5.23	2.63
	400	2.13	0.00	1.38	2.42	1.79	1.48	1.79	1.55
Fluroxypyr	0	18.98	20.75	17.80	37.85	54.13	23.85	54.13	29.90
	25	23.54	18.25	98.00	40.43	58.23	45.06	58.23	47.89
	50	14.40	16.00	91.20	55.50	27.39	44.28	27.39	40.90
	100	28.44	8.00	94.73	21.08	28.60	38.06	28.60	36.17
	200	10.34	7.50	48.75	23.84	38.11	22.61	38.11	25.71

APPENDIX I (3)

3. Grain yield (l/ha at 85% DM)

Crop pop.	fluroxypyr (g ai/ha)	Boxworth	Bridgets	Drayton	Rosemaund	Bush	ADAS mean	SAC mean	Overall mean
0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	0	6.97	9.85	8.26	6.29	4.61	7.84	4.61	7.19
50	25	7.12	10.10	8.08	6.34	4.34	7.91	4.34	7.20
50	50	7.41	10.13	7.94	6.16	4.76	7.91	4.76	7.28
50	100	7.50	10.15	7.92	6.34	4.48	7.98	4.46	7.27
50	200	7.25	9.83	8.14	5.96	4.15	7.60	4.14	7.07
200	0	8.32	10.57	9.14	8.82	5.39	9.21	5.39	8.45
200	25	8.35	10.70	8.07	8.73	6.68	8.95	6.68	8.51
200	50	8.48	10.74	9.16	8.46	4.94	9.21	4.94	8.38
200	100	8.35	10.44	9.27	8.48	5.43	9.14	5.43	8.39
200	200	8.34	10.33	9.27	8.48	5.79	9.10	5.79	8.44
400	0	8.36	10.48	9.68	8.53	6.16	9.28	6.16	8.64
400	25	8.66	10.95	9.55	9.15	6.56	9.58	6.56	8.98
400	50	8.56	10.75	9.24	8.96	6.48	9.38	6.48	8.80
400	100	8.60	10.72	10.13	9.32	6.30	9.69	6.30	9.01
400	200	8.69	10.55	9.65	8.97	5.41	9.45	5.41	8.65
Crop mean	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	50	7.25	10.01	8.07	6.22	4.46	7.89	4.46	7.20
	200	8.37	10.58	8.98	8.59	5.65	9.12	5.65	8.43
	400	8.58	10.69	9.65	8.99	6.16	9.48	6.18	8.82
Fluroxypyr	0	7.65	7.73	6.77	5.91	4.04	7.58	4.04	6.42
	25	7.81	7.94	6.42	6.06	4.40	7.06	4.40	6.63
	50	7.97	7.91	6.58	5.90	4.05	7.09	4.05	6.48
	100	7.99	7.83	6.83	6.04	4.05	7.17	4.05	8.55
	200	7.88	7.66	8.76	5.85	3.84	7.04	3.84	6.40

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APPENDIX I (3)

4. Margin over herbicide cost (£/ha cf. MOHC for full rate fluroxypyr and 200 plants/m, wheat = £100/t)

Crop pop.	fluroxypyr (g ai/ha)	Boxworth	Bridgets	Drayton	Rosemaund	Bush	ADAS mean	SAC mean	Overall mean
		614.71	1014.00	907.70	829.00	560.00	891.35	580.00	825.08
0	0	-614.71	-1014.00	-907.70	-829.00	-560.00	-891.35	-580.00	-825.08
0	25	-817.09	-1016.38	-910.08	-831.38	-562.38	-893.73	-552.00	-827.48
0	50	-819.46	-1018.75	-912.45	-833.75	-564.75	-896.10	-564.75	-829.83
0	100	-824.21	-1023.50	-917.20	-838.50	-569.50	-900.85	-569.50	-834.58
0	200	-833.71	-1033.00	-926.70	-848.00	-579.00	-910.35	-579.00	-844.08
50	0	-117.99	-29.00	-82.10	-200.00	-99.00	-107.27	-99.00	-105.62
50	25	-104.83	-6.38	-102.38	-197.38	-128.38	-102.74	-128.38	-107.97
50	50	-78.16	-5.75	-118.15	-217.75	-88.75	-104.95	-88.75	-101.71
50	100	-74.33	-8.50	-125.00	-204.50	-123.50	-103.08	-123.50	107.17
50	200	-108.62	-50.00	-112.70	-252.00	-164.00	-130.83	-164.00	-137.48
200	0	16.97	43.00	6.40	53.00	-21.00	29.84	-21.00	19.67
200	25	17.72	53.62	-103.28	41.62	105.62	2.42	105.62	23.06
200	50	28.71	55.25	3.05	12.25	-70.75	24.82	-70.75	6.70
200	100	10.76	20.50	9.90	9.60	-26.50	12.57	-26.50	4.85
200	200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
400	0	21.41	34.00	60.50	24.00	56.00	34.96	56.00	39.18
400	25	49.11	78.62	45.32	83.62	93.62	64.17	93.62	70.08
400	50	36.65	56.25	11.25	62.25	83.25	41.60	83.25	49.93
400	100	35.51	48.50	95.50	93.50	60.50	68.25	60.50	66.70
400	200	35.84	22.00	37.50	37.50	-38.00	38.11	-38.00	21.29
Crop mean	0	-621.64	-1021.13	-914.83	-836.13	-567.13	-898.48	-567.13	-832.21
	50	-96.79	-19.93	-108.07	-214.33	-120.73	-109.78	-120.73	-111.97
	200	14.83	34.47	-16.79	23.27	-2.53	13.95	-2.53	10.66
	400	35.66	47.87	50.07	62.47	51.07	49.02	51.07	49.43
Fluroxypyr	0	-233.58	-241.50	-230.72	-238.00	-156.00	-233.45	-156.00	-217.96
	25	-213.77	-222.83	-267.60	-255.88	-122.88	-232.47	-122.88	-210.88
	50	-208.06	-228.25	-254.07	-244.25	-160.25	-233.68	-160.25	-218.98
	100	-213.07	-240.75	-234.20	-235.00	-164.75	230.75	-164.75	-217.55
	200	-226.67	-265.25	-250.40	-262.75	-195.25	-251.27	-195.25	-240.08

APPENDIX I (4)

The testing of alternative autumn/spring sequential herbicide programmes for cleaver control in wheat (A).

1. **Site details**

Site:	Balgarrock, Aberlemno, Angus No. 552 574
Farmer:	R Tingle
Crop:	Winter wheat, cultivar Riband
Sowing date:	5 October 1992
Cleaver population:	8/m²

2. **Herbicide treatments**

	Sequences (rate g a.i./ha)			
Autumn* applied isoproturon + diflufenican	1100	550	275	0
OR				
Autumn applied isoproturon + pendimethalin	1500	750	375	0
OR				
Autumn applied isoproturon + isoxaben	1642	821	411	0
		followed by		
Spring** applied fluroxypyr	200	200	200	200
	100	100	100	100
	50	50	50	50
	25	25	25	25
	0	0	0	0
OR				
Spring** applied mecoprop-P	1200	1200	1200	1200
	600	600	600	600
	300	300	300	300
	150	150	150	150
	0	0	0	0

* Treatments applied at crop GS11, cleavers at pre-emergence, on 3.12.91.
** Treatments applied at crop GS30/31, cleavers at , on 22.4.92.

Herbicide treatments applied in 200 l/ha water with medium quality (BCPC) spray at a minimum pressure of 2 bars.

APPENDIX I (4)

4.3 **Results (one Replicate)**

		% Reduction in cleavers								
		Duplosan CMPP					Starane 2			
		F	½	¼	1/8	0	F	½	¼	1/8
Panther	F	99	100	94	97	26	100	100	100	94
	½	97	98	85	86	63	100	100	91	72
	¼	99	99	94	99	55	100	98	100	29
Encore	F	100	100	96	97	97	100	100	100	96
	½	100	100	96	94	84	96	100	98	94
	¼	97	97	100	91	77	100	96	92	88
Ipso	F	98	100	94	88	81	100	98	87	98
	½	99	100	95	81	0	99	100	61	98
	¼	99	99	76	100	10	100	96	89	62
Nil		100	100	98	-	0	96	95	91	-

APPENDIX I (5)

The testing of alternative autumn/spring sequential herbicide programmes for cleaver control in wheat (B), 1992/3.

1. **Site details**

Site:	Bush, Midlothian
Crop:	Winter wheat cv Riband
Sowing date:	10 October 1992
Cleaver population:	11.3/m²
Soil type:	SCL
Soil series	Macmerry
Biomass harvest:	7 August 1992

2. **Herbicide treatments**

A randomised block design with two replicates.

Sequence combinations	GS30/31 fluroxypyr treatemtent (g a.i.)		
DFF + UPU	225	112.5	56.3
Penedimethalin + IPU	375	187.5	93.8
Isoxaben + IPU	469	234.5	117.3

3. **Results**

Table 1 Cleaver control: Herbicide sequence Bush, June 1993

Assessment Treatment sequence		Cleaver No/m²
g a.i./ha		1.6.93
DFF + IPU/fluroxypyr		
225/50		2.0
112.5/25		0
56.3/12.5		1.0
Pendimethalin + IPU/fluroxypyr		
375/50		0
187.5/25		1.0
93.8/12.5		1.0
Isoxaben + IPU/fluroxypyr		
375/50		0
187.5/25		1.0
93.8/12.5		1.0
Isoxaben + IPU/fluroxypyr		
469/50		0
234.5/25		0
117.3/12.5		1.0
	SED	1.00

Table 2 Cleaver control: Herbicide Sequences, Bush, June 1993 Biomass assessment: (dry weight g/plot)

Treatment sequence g a.i./ha	Cleavers	Other weeds	Wheat
DFF + IPU/fluroxypr			
225/50	0.60	10.50	422.1
112.5/25	0.80	5.25	432.9
56.3/12.5	0.70	1.25	365.5
Pendimethalin + IPU/fluroxypyr			
375/50	0.35	4.20	353.6
187.5/25	0.45	2.50	413.5
93.8/12.5	1.30	2.50	425.5
Isoxaben + IPU/fluroxypyr			
469/50	0	2.55	417.8
234.5/25	0.95	0.40	426.5
117.3/12.5	1.15	7.60	350.2
Isoxaben + IPU/fluroxypyr			
469/50	0	2.55	417.8
234.5/25	0.95	0.40	426.5
117.3/12.5	1.15	7.60	350.2
SED	0.89	3.62	43.00

APPENDIX I (6)

The testing of alternative autumn/spring sequential herbicide programmes for cleaver control in wheat (C), 1993/4.

1. **Site details**

Site:	Luggate, Haddington, East Lothian
Crop:	Winter wheat, cultivar Riband
Sowing date:	10 October 1992
Cleaver population:	$87/m^2$
Soil type:	SCL
Soil series	Macmerry
Biomass harvest:	17 August 1994 Combine Harvest: 25 August 1994

2. **Treatments**

As per table. Diflufenican + isoproturon and pendimethalin + isoprotoron applied at GS11 of the crop, and fluroxypyr at GS30/31 (cleavers about 15 cm tall).

Table Control of cleavers by sequential herbicide treatments, Luggate, 1994.

Autumn treatment and dose (% of cf. untreated)	Fluroxypyr dose (% of untreated)	Cleavers (No/m²) 1.6.94	15.7.94	Cleaver Biomass (kg/m²) 7.8.94 Fresh	Dry
Diflufenican + isoproturon					
100	100	0	0	0	0
100	50	0	0	0	0
100	25	0	0	0	0
100	0	0.7	0	0	0
50	100	0	0	0	0
50	50	2.0	0	0	0
50	25	0	0	0	0
50	0	2.0	0.7	0.3	0.01
25	100	0.7	0	0	0
25	50	1.3	0	0	0
25	25	-	0	0	0
25	0	1.3	2.3	0.33	0.1
Pendimethalin + isoproturon					
100	100	0.7	0	0.07	0.03
100	50	0.7	0	0	0
100	25	0	0	0.03	0.01
100	0	0	0	0	0
50	100	0.7	0	0	0
50	50	0	0	1.77	0.67
50	25	0	0	0	0
50	0	1.3	2.7	1.30	0.37
25	100	4.3	0.3	0	0
25	50	2.0	0	0	0
25	25	0.7	0.7	0	0
25	0	2.7	3.7	0.33	0.07
0	100	7.3	0.3		
0	50	7.3	0.3		
0	25	2.0	0.3		
0	0	4.3	8.7		
	SED	1.34	1.19		

APPENDIX I (7)

The effect of sequential use of reduced doses of mecoprop-P and fluroxypyr in the spring on control of cleavers.

1. **Site details**

Site:	Luggage, Haddington, East Lothian
Crop:	Winter wheat, cv. Riband
Sowing date:	15 October 1993
Cleaver population:	8.7/m^2
Soil type:	Sandy clay loam
Soil series	Macmerry
Biomass harvest:	17 August 1994

2. **Herbicide Treatments**

		g a.i./ha	Crop Growth Stage
a.	Mecoprop-P	300	25
b.	Fluroxypyr	300	25
	Mecoprop-P	50	32
c.	Fluroxypyr	50	25
	Mecoprop-P	300	32
d.	Fluroxypyr	50	32

Untreated plots were included. There were two replicates per treatment in a randomised block design, with 2 m x 6 m plotsl

Herbicide treatments applied in 200 l/ha water with a medium quality (BCPC) spray at a minimum pressure of 2 bars.

Table 1 Cleaver control: Herbicide sequences, Haddington 1993

Treatment (g a.i./ha) and timing		Cleavers No/m² 31.5.93	Cleavers No/tillers/m² 8.7.93
Mecoprop-P (300) (I)		1.3	3.3
Mecoprop-P (300) (I)/ fluroxypyr (50) (II)		0	0
Fluroxypyr (50) (II)		0.7	7.3
Fluroxypyr (50) (I)/ Mecoprop (50) (II)		0	1.3
Fluroxypyr (50) (II)		0	0
No spring treatment		11.3	12.0
	SED	1.18	2.76

*After DFF + IPU at 550 g a.i./ha at crop GS11.

Table 2 Cleaver control: Herbicide sequences Biomass assessments: (dry weights g/plot), Haddington 1993

Treatment (g a.i./ha) and timing	Cleavers	Other weeds	Wheat
Mecoprop-P (300) (I)	1.53	0	531.1
Mecoprop-P (300) (I)/ fluroxypyr (50) (I)	0.17	0	482.9
Fluroxypr (50) (II)	2.37	0.7	497.1
Fluroxypr (50) (I)/ Mecoprop-P (300) (II)	0.17	0	557.0
Fluroxypyr (50) (II)	0.03	0	529.9
No spring treatment	2.60	0	507.9
SED	1.13	0.38	47.83

APPENDIX I (8)

Impact of the addition of ioxynil + bromoxynil (HBN) on the dose response curve of fluroxypyr on cleavers.

1. **Site details**

Site:	Marketgate (Luggate), Haddington
Farmer:	J Clarke
Crop:	Winter wheat, cv. Riband
Sowing date:	10 October 1992
Cleaver population:	17.9/m²
Soil type:	SCL
Soil series	Macmerry
Biomass assessment:	23 June 1993

2. **Herbicide Treatments**

	Dose rate (g a.i.)
Autumn (GS11/12) treatment Diflufenican + isoproturan	550
Spring (GS30) treatment	
Fluroxypyr	25, 50, 100
Fluroxypyr + ioxynil/bromoxynil	25 + 250, 50 + 250, 100 + 250

Herbicide treatments applied in 200 l/ha water with a medium quality (BCPC standard) spray at a minimum pressure of 2.4 bars.

Three fully randomised replicte blocks of 2 m x 6 m plots.

APPENDIX II

WINTER WHEAT: WEED AND CROP COMPETITION AND EFFECTS ON HERBICIDE ACTIVITY

1. Site details

Site:	Hillsborough, N Ireland	
Farmer:	DANI	
Crop:	Winter wheat, cv Riband	
Sowing date:	20 October 1992	
Soil type:	Medium loam	
Biomass harvest:	25-29 July 1993	Combine harvest: 28 August 1993

2. Herbicide treatments

	Dose (Xül/ha)
250 + 180 + 50 g/l LI IPU + Mecoprop + ioxynil	
0.0 N	0
0.5 N	2.5
1.0 N	5
2.0 N	10

Applied by knapsack sprayers in 200 l/ha with a medium quality spray (BCPC) at a minimum pressure of 2 bar at four application timings:

1	16 December 1992	GS12
2	25 March 1993	GS15/22
3	28 April 1993	GS23/31
4	13 May 1993	GS32

APPENDIX III

EVALUATION OF APPROPRIATE HERBICIDE APPROACHES IN SPRING BARLEY

APPENDIX III (I)

Efficiency of reduced rates in spring barley: a range of treatments and dose responses compared

1. **Site details**

Site:	Hillsborough, N Ireland	
Farmer:	DANI	
Crop:	Spring barley, cv Prisma	
Sowing date:	4.5.92	
Soil type:	Medium loam	
Biomass harvest:	8.7.92	Combine harvest: 21.9.97

2. **Herbicide Treatments**

	Full dose (product/ha)
20% WG metsulfuron-methyl (Ally)	30 g
600/l LI SL mecoprop-P (Duplosan CMPP)	2 l
110 + 90 +100g/l LI bromoxynil + fluroxypyr + ioxynil (Advance)	2 l
392 + 210 g/l SL dichlorprop + MCPA (Hemoxone)	4 l

Treatments applied at full (N), 1/3, 1/9 and 0 rates on 5.6.92. Herbicide treatments applied in 200 l /ha water with a medium quality spray (BCPC) at a minimum pressure of 2 bars. There were four replicate fully randomised blocks; plots 2.5 x 10 m.

APPENDIX III (2)

The impact of crop and weed density on herbicide efficacy in spring barley

1. **Site details**

Site:	Newforge, N Ireland	
Farmer:	QUB	
Crop/density:	Spring barley, cv Prisma 0, 50, 100, 200, 400 seeds/m²	
Sowing date:	4.5.92	
Weed sown/density:	Oilseed rape	100 and 500 seeds/m²
	Perennial ryegrass	100 and 500 seeds/m²
Soil type:	Medium loam	
Biomass harvest:	10.7.92	Combine harvest: 2.10.92

2. **Herbicide Treatments**

Metsulfuron-methyl @ 0, 7.5, 15, 30 (N) and 60 (2N) g product/ha.

Isoproturon + bromoxynil + ioxynil @ 0, 0.61, 1.21, 2.42 (N) and 4.84 (2N) kg product/ha.

Treatments applied on 9.6.92. Herbicide treatments applied in 200 l/ha water with a medium sprayer (BCPC) at a minimum pressure of 2 bars. Design: 5 crop densities x 2 densities x 2 herbicides x 5 rates x 4 replicate blocks. Plot size 2.5 x 5 m.

APPENDIX III (3)

Comparison of the use of low dose pre-emergence treatments as part of a sequence of treatments with single treatments in spring barley (Scotland).

1. **Site details**

a.	Site:	Sunnybrae, Craibstone, Aberdeen
	Farmer:	SAC
	Crop:	Spring barley, cv Tyne
	Sowing date:	21.4.93
	Soil type:	Sandy loam
	Combine harvester:	8.10.93
b.	Site:	Crosshall, Eccles, Berwickshire
	Farmer:	J Cavers
	Crop:	Spring barley, cv Camergue
	Sowing date:	10.3.93
	Soil type:	Sandy clay loam
	Combine harvester:	31.8.93
c.	Site:	New Downie, Carnoustie, Angus
	Farmer:	Mr G Booth
	Crop:	Spring barley, cv Derkado
	Sowing date:	18 March 1994
	Soil type:	Balrownie, SL
	Combine harvester:	18 August 1994
d.	Site:	Mungoswalls, Kelso, Roxburghshire
	Farmer:	J R Thomson
	Crop:	Spring barley cv Derkado
	Sowing date:	29 March 1994
	Soil type:	SCL, Whitsome
	Combine harvester:	21 August 1994

2. **Herbicide Treatments**

a. **Sunnybrae**

Pendimethalin: 1000, 500 and 250 g a.i./ha pre-emergence followed by MCPA/2, 4 DP: 0, 125 and 250 g a.i./ha at 2-4 leaves of weeds.

MCPA/2, 4DP: 62.5, 125, 250 and 500 g a.i./ha at 2-4 leaves of weeds.

Metsulfuron + mecoprop-P at 6 + 1200, 3 + 600, 1.5 + 300 and 0.75 + 75 g a.i./ha at 2-4 leaves of weeds.

Randomised block design with 3 replicates and 3 spaced controls per replicate.

APPENDIX 111 (3)

b. **Crosshall**

Pendimethalin: 1000, 500 and 250 g a.i./ha pre-emergence followed by mecoprop-P at 0, 300 and 600 g a.i./ha at 2-4 leaves of weeds.

Mecoprop-P: 300, 600 g a.i./ha at 2-4 leaves of weeds.

Metsulfuron + mecoprop-P: 3 + 600, 1.5 + 300 and 0.75 + 150 g a.i./ha at 2-4 leaves of weeds.

Randomised block design with 3 replicates and one control per block.

c. **New Downie**

Pendimethalin at 1500, 750, 375 and 188 g a.i./ha pre-emergence followed by mecoprop-P at 0, 300 and 600 g a.i./ha at 2-4 leaves of weeds.

mecoprop-P: 300, 600 g a.i./ha at 2-4 leaves of weeds.

Metsulfuron + mecoprop-P: 6 + 1200, 3 + 600, 1.5 + 300 g a.i./ha at 2-4 leaves of weeds.

Randomised block design with 3 replicates and one untreated control per block.

d. **Mungoswalls**

Pendimethalin at 1500, 750 and 375 g a.i./ha pre-emergence followed by mecoprop-P at 0, 300 and 600 g a.i./ha at 2-4 leaves of weeds.

Mecoprop-P: 300, 600 g a.i./ha at 2-4 leaves of weeds.

Metsulfuron + mecoprop-P: 6 + 1200, 3 + 600, 1.5 + 300 and 0.75 + 150 g a.i./ha at 2-4 leaves of weeds.

Randomised block design with 3 replicates and one untreated control per block.

All treatments applied by Azo pressurised knapsack sprayers calibrated to deliver 200 l/ha volume at 2.4 bar pressure through medium spray (BCPC classification) nozzles. Plots were 2 m x 2.3 m x 18-24 m.

APPENDIX 111 (3)

Table 1 **Spring barley - timing of herbicide**
Weed % ground cover; Sunnybrae 27.7.93

Treatment (g a.i./ha)	Chickweed	Hempnettle	Knotgrass	Mayweed	AMG
Pendimethalin/MCPA + 2, 4-DP sequence					
1000/0	7.3	0	0	1.0	2.0
1000/250	2.0	0	0	0.3	2.0
1000/125	2.3	0	2.3	0.7	0.7
500/0	10.0	0	2.7	0.7	2.7
500/250	3.3	0.3	0.7	0.7	1.6
500/125	5.0	1.0	0.3	0.7	2.0
250/0	12.0	1.3	2.0	1.7	1.7
250/250	5.7	1.7	0.3	0	2.7
250/125	4.7	1.7	1.0	1.3	2.3
MCPA + 2, d-DP alone					
500	0.3	1.0	3.7	0.7	1.7
250	5.0	4.0	5.7	1.3	2.7
125	8.7	2.7	7.0	1.3	2.7
62.5	7.0	3.3	11.3	1.7	3.0
Metsulfuron + mecoprop-P					
6 + 1200	0	0	1.3	0	2.0
3 + 600	0	0	6.0	0	2.3
1.5 + 300	1.3	0	9.7	0	2.7
0.75 + 150	2.3	0.7	10.3	0	2.3
Untreated	20.6	7.2	28.9	4.2	3.0
SED	2.12	1.62	2.32	0.76	0.63

APPENDIX III (3)

Table 2 Spring barley - Timing of herbicide grain yield: Sunnybrae 1993

Treatment (g a.i./ha)		Grain yield t/ha (85% DM)
Pendimethalin/MCPA + 2, 4-DP sequence		
1000/0		4.17
1000/250		4.29
1000/125		4.37
500/0		4.19
500/250		4.18
500/125		4.33
250/0		4.70
250/250		4.31
250/125		3.82
MCPA + 2, d-DP alone		
500		3.95
250		3.97
125		4.22
62.5		4.33
Metsulfuron + mecoprop-P		
6 + 1200		4.18
3 + 600		4.56
1.5 + 300		4.35
0.75 + 150		4.17
Untreated		4.42
	SED	0.357

APPENDIX III (3)

Table 3 **Spring barley - Timing of herbicide**
Weed % ground cover; Crosshall, 1.7.93

Treatment (g a.i./ha)	AMG	Red deadnettle	Chickweed
Pendimethalin/mecprop-P sequence			
1000/0	0	0	0
1000/300	0.2	0	0
1000/600	0.7	0	0
500/0	0.2	0	0
500/300	0.5	0	0
500/600	0.2	0	0
250/0	0.7	T	0.2
250/300	2.8	0	0
250/600	0.6	0	0
Untreated	5.3	0.3	0.5
Mecoprop-P			
300	5.0	0.2	0
600	5.3	0.2	0
Metsulfuron + mecoprop-P			
3 + 600	3.3	0	0
1.5 + 300	5.3	0.1	0
0.75 + 150	5.0	0.1	0
Untreated	7.0	0.6	2.0
SED	1.22	0.2	0.4

APPENDIX III (3)

Table 4 **Spring barley - Timing of herbicide**
Harvest data; Crosshall 1993

Treatment (g a.i./ha)	Grain yield t/ha (85% DM)	DMC %	1000 grain weight (g)
Pendimethalin/mecoprop-P sequence			
1000/0	8.89	84.6	52.3
1000/300	8.82	84.1	52.2
1000/600	8.64	84.1	52.3
500/0	8.77	84.9	51.4
500/300	8.72	84.8	52.1
500/600	8.72	84.1	52.3
250/0	8.70	84.3	52.4
250/300	8.58	84.5	51.6
250/600	8.69	84.5	50.6
Untreated 1	8.73	84.3	51.7
Mecoprop-P			
300	8.78	84.8	51.9
500	8.65	84.4	51.5
Metsulfuron + mecoprop-P			
3 + 500	8.79	84.6	51.1
1.5 + 200	8.76	84.5	51.5
0.75 + 150	8.90	84.0	50.6
Untreated 2	8.70	84.3	51.9
SED	0.14	0.47	0.67

APPENDIX III (3)

Table 5 **Spring barley - timing of herbicide; weed % ground cover, 7.7.94, New Downie, 1994**

Treatment g a.i./ha	Scentless Mayweed	Chickweed	Forget-me-not	Oilseed rape	Total weeds
Pendimethalin/ mecoprop-P sequence					
1500/600	0.1	0	0	0	0.1
1500/300	0.8	0	0	0	0.8
1500/0	1.0	0.5	0	0.8	2.3
750/600	0.3	0	0	0	0.4
750/300	1.7	0.1	0	0.2	1.0
750/0	3.0	3.7	0	1.4	8.1
375/600	0.4	0	0	0	0.4
375/300	0.7	0.3	0	T	1.1
375/0	4.3	4.3	0	3.0	11.6
188/600	0.5	T	0	0	0.6
188/300	2.2	0.1	0	0.3	2.6
188/0	4.3	5.0	T	2.3	11.7
Mecoprop-P alone					
600	0.2	T	0.4	0	0.7
300	0.8	0.1	0.1	T	1.1
Metsulfuron + Mecoprop-P					
6 + 1200	0	0	T	0	0.1
3 + 600	0	0	0.1	0	0.1
1.5 + 300	0	0	0.5	T	0.6
Untreated	5.0	10.0	0.7	3.7	20.4
SED	0.62	1.00	0.25	0.81	

APPENDIX III (3)

Table 6 **Spring barley - timing of herbicide, grain yield, New Downie, 1994**

g a.i./ha		Grain yield t/ha (85% DM)	% DM
Pendimethalin/Mecoprop-P sequence			
1500/600		5.55	84.2
1500/300		5.63	83.8
1500/0		5.63	84.0
750/600		5.62	83.8
750/300		5.57	84.1
750/0		5.74	83.9
375/600		5.75	83.3
375/300		5.53	83.5
375/0		5.79	83.7
188/600		5.80	83.6
188/300		5.51	83.8
188/0		5.81	83.6
Mecoprop-P alone			
600		5.51	83.7
300		5.60	84.1
Metsulfuron + mecoprop-P			
6 + 1200		5.49	84.2
3 + 600		5.59	84.0
1.5 + 300		5.61	83.9
Untreated		5.79	83.3
	SED	0.21	0.50

APPENDIX III (3)

Table 7 **Spring barley - timing of herbicide; weed % ground cover, Mungoswalls, 14.6.94**

Treatment g a.i./ha	Black bindweed	Knotgrass	Chanlock	Total weeds
Pendimethalin/mecoprop-P sequence				
1500/600	0	0	0	0
1500/300	0.1	0	0	0.1
1500/0	0.4	0	1.5	1.9
750/600	T	T	0	T
750/300	0	0	0.4	0.4
750/0	0.4	0	0.8	1.2
375/600	T	0	T	T
375/300	0.2	T	0.3	0.5
375/0	0.5	0	2.4	2.9
Mecoprop-P alone				
600	0.1	1.3	0	1.4
300	0.7	1.3	0.3	2.3
Metsulfuron + mecoprop-P				
6 + 1200	T	1.7	0	1.7
3 + 600	0.2	0.1	0	0.3
1.5 + 300	0.5	2.7	0	3.2
0.75 + 150	0.2	2.0	0.7	2.9
Untreated	0.7	0.7	1.7	3.1
SED	0.34	0.53	0.92	

APPENDIX III (3)

Table 8 Spring barley - timing of herbicide; grain yield, Mungoswalls, 21.8.94

g a.i./ha	Grain yield t/ha (85% DM)	% DM
Pendimethalin/mecoprop-p sequence		
1500/600	4.91	80.6
1500/300	4.93	79.1
1500/0	4.77	78.3
750/600	4.83	79.6
750/300	4.67	79.2
750/0	4.99	79.6
375/600	4.80	80.3
375/300	4.74	79.7
375/0	4.94	79.6
Mecoprop-P alone		
600	4.74	80.0
300	4.74	78.3
Metsulfuran + mecoprop-P		
6 + 1200	4.67	79.9
3 + 600	5.09	79.5
1.5 + 300	4.85	79.6
0.75 + 150	4.96	80.0
Untreated	5.04	79.3
SED	0.21	0.70

APPENDIX III (5)

The impact of timing on the dose response curves of spring barley herbicide treatments.

1. **Site details**

a.

Site:	Nether Finlarg, Forfar, Angus
Farmer:	Mr J Rymer
Crop:	Spring barley, cv Camargue
Sowing date:	24 March 1993
Soil type:	SL Balrownie
Combine harvester:	8 September 1993

Randmised block design with 3 replicates, and one untreated control per block. Per size 2.3 x 20 m.

b.

Site:	Hillbrae, Udny, Aberdeen
Farmer:	SAC
Crop:	Spring barley, cv Tyne
Sowing date:	24.3.93
Soil type:	Sandy loam
Combine harvester:	19.10.93

Split-plot design with timing as main plot and herbicide treatments as sub-plots randomised within; 3 replicates. Plot size 3 m x 12 m.

c.

Site:	Hoprig, Haddington, East Lothian
Farmer:	Mr R Waddell
Crop:	Spring barley, cv Chariot
Sowing date:	30 March 1994
Soil type:	Clay loam, Winton
Combine harvester:	22 August 1994

Randomised block design, with 3 replicates, and one untreated control per block. Plot size 2.3 m x 20 m.

d.

Site:	Sunnybrae, Aberdeen
Farmer:	SAC
Crop:	Spring barley, cv Chariot
Sowing date:	4.4.94
Soil type:	Sandy loam
Combine harvester:	7.9.94

Randomised block design, with 3 replicates, and one untreated control per block. Plot size: 2.06 m x 18 harvested.

e.

Site:	Blackiemuir, Laurencekirk, Kincardineshire
Farmer:	
Crop:	Spring barley, cv Chariot
Sowing date:	23.3.94
Soil type:	Sandy loam
Combine harvest:	22.8.94

Randomised block design, with 3 replicates. Plots size: 2.06 m x 20 m harvested.

2. Herbicide treatments

Metsulfuron + mecoprop-P applied at three target timings:

Timing 1	=	2-4 leaf on broad-leaf weeds
Timing 2	=	4-6 leaf on broad-leaf weeds
Timing 3	=	6-8 leaf on broad-leaf weeds

Applied at 6 + 1200, 3 + 600, 1.5 + 300, 0.75 + 150 g a.i./ha, plus 0.375 + 0.75 g a.i./ha at Nether Ginlarg, Hoprig, Sunnybrae and Blackiemuir.

Treatments applied by knapsack sprayer calibrated to deliver 200 l/ha at 2-2.4 bar pressure through medium spray (BCPC classification) nozzles.

APPENDIX III (5)

Table 1 **Timing of herbicide treatment and weed control in spring barley, Nether Finlarg, August 1993**

Metsulfuron + mecoprop-P g a.i./ha	Oilseed rape	Hemp-nettle	Knot-grass	Pinapple-weed	Ann. M'grass	Red-shank	Chick-weed	Cleavers
Timing 1								
6 + 1200	0	0	0.3	0	5.3	0	0.1	0.7
3 + 600	0.1	0	0.2	0	12.7	0	0.1	0.5
1.5 + 300	0.1	0	T	0	6.3	0	0.1	0.6
0.75 + 150	2.3	T	2.6	0.3	4.0	T	1.7	2.3
0.375 + 75	5.0	0.3	1.2	0.7	10.0	0.1	6.3	3.5
Timing 2								
6 + 1200	0	0	0.2	0	6.3	T	3.7	2.1
3 + 600	4.7	0	0.3	0.2	5.0	0.1	15.3	3.0
1.5 + 300	5.7	0	1.5	1.8	9.0	0.2	16.7	2.2
0.75 + 150	9.3	1.0	4.0	3.8	16.3	0.1	26.7	4.5
0.375 + 75	13.0	0.2	4.3	1.5	4.0	0.1	37.3	2.3
Timing 3								
6 + 1200	0	0	0.8	T	7.0	0.1	15.3	0.7
3 + 600	0.6	0.1	2.0	0.1	5.0	0.2	28.7	2.0
1.5 + 300	3.0	0.3	2.3	0.8	5.3	0.1	24.0	6.9
0.75 + 150	4.0	1.9	4.7	6.7	10.0	0	46.3	2.0
0.375 + 75	12.3	2.5	2.7	1.2	10.7	0.2	35.3	1.8
Untreated (mean)	14.8	1.7	2.4	3.6	8.7	0.4	42.7	3.8
SED	2.75	0.99	1,83	2.75	5.19	0.09	6.66	2.06

APPENDIX III (5)

Table 2 **Spring barley - timing of herbicide**
Howest Data; Nether Finlarg 1993

Treatment (g a.i./ha)	Timing	Grain yield t/ha	DMC %	1000 seed weight g	Grain weed contamination 0.9 (bad)
Metsulfuron + mecoprop-P					
6 + 1200	1	5.25	78.2	47.7	1.0
3 + 600	1	5.21	77.9	48.0	0.7
1.5 + 300	1	5.34	78.3	49.3	1.0
0.75 + 150	1	5.25	77.3	49.2	1.3
0.375 + 75	1	5.39	77.2	49.0	1.3
6 + 1200	2	5.53	77.7	48.6	1.0
3 + 600	2	5.49	77.9	49.0	1.3
1.5 + 300	2	5.11	75.9	49.6	1.7
0.75 + 150	2	5.21	76.5	49.0	1.7
0.375 + 75	2	5.10	76.3	48.7	2.0
6 + 1200	3	5.28	78.1	49.5	0.7
3 + 600	3	4.97	77.7	49.0	1.0
1.5 + 300	3	5.26	77.3	48.9	1.0
0.75 + 150	3	5.23	76.8	49.0	2.0
0.375 + 75	3	5.12	76.6	46.2	1.7
Untreated		5.07	76.1	48.6	2.0
SED	0.42	0.9	1.44	0.59	

Timing 1: weeds 2-4 leaves
Timing 2: weeds 4-6 leaves
Timing 3: weeds 6-8+ leaves

APPENDIX III (5)

Table 3 **Spring barley - timing of herbicide weed % ground cover, 3.8.93, Nether Finlarg**

Metsulfuron + mecoprop-P treatment (g a.i./ha)	Timing	Vol. OSR	Hemp-nettle	Knot-grass	Pinapple-weed	Ann. M'grass	Chick-weed	Cleavers
6 + 1200	1	0	0	0.3	0	5.3	0.1	0.7
3 + 600	1	0.1	T	0.2	0	12.7	T	0.5
1.5 + 300	1	0.1	0	T	0	6.3	0.1	0.6
0.75 + 150	1	2.3	T	2.6	0.3	4.0	1.7	2.3
0.375 + 75	1	5.0	0.3	1.2	0.7	10.0	6.3	3.5
6 + 1200	2	0	T	0.2	0	6.3	3.7	2.1
3 + 600	2	4.7	0	0.3	0.2	5.0	15.3	3.0
1.5 + 300	2	5.7	0	1.5	1.8	9.0	16.7	2.2
0.75 + 150	2	9.3	1.0	4.0	3.8	16.3	26.7	4.5
0.375 + 75	2	13.0	0.2	4.3	1.5	4.0	37.3	2.3
6 + 1200	3	0	0	0.8	T	7.0	15.3	0.7
3 + 600	3	0.6	0.1	1.0	0.1	5.0	28.6	2.0
1.5 + 300	3	3.0	0.3	2.3	0.8	5.3	24.0	6.9
0.75 + 150	3	4.0	1.9	4.7	6.7	10.0	46.3	2.0
0.375 + 75	3	12.3	2.5	2.7	1.2	10.7	35.3	1.8
Untreated		14.7	0.5	2.4	3.6	5.7	42.3	3.8
SED		2.95	0.99	1.83	2.75	5.19	6.66	2.06

Timing 1: weeds 2-4 leaves
Timing 2: weeds 4-6 leaves
Timing 3: weeds 6-8 leaves

APPENDIX III (5)

Table 4 **Timing of herbicide treatment and grain yield, weight and weed contamination in spring barley, Nether Finlarg, 1993**

Metsulfuran + mecoprop-P (g a.i.)	Grain yield (85% DM) t/ha	Grain % DM	1000 grain wt (g)	Weed contamination 0-9 (severe)
Timing 1				
6 + 1200	5.25	78.2	47.7	1.0
3 + 600	5.21	77.9	48.0	0.7
1.5 + 300	5.34	78.3	49.3	1.0
0.75 + 150	5.25	77.3	49.2	1.3
0.375 + 75	5.39	77.2	49.0	1.3
Timing 2				
6 + 1200	5.53	77.7	48.6	1.0
3 + 600	5.49	77.9	49.0	1.3
1.5 + 300	5.11	75.9	49.6	1.7
0.75 + 150	5.21	76.5	49.0	1.7
0.375 + 75	5.10	76.3	48.7	2.0
Timing 3				
6 + 1200	5.28	78.1	49.5	0.7
3 + 600	4.97	77.7	49.0	1.0
1.5 + 300	5.26	77.3	48.9	1.0
0.75 + 150	5.23	76.8	49.0	2.0
0.375 + 75	5.12	76.6	46.2	1.7
Untreated (mean)	5.07	76.1	48.6	2.0
SED	0.42	0.90	1.44	0.59

APPENDIX III (5)

Table 5 **Timing of herbicide treatment and weed control and grain yield; Hillbrae, WAT, 1993**

Metsulfuron + mecoprop-P g a.i./ha	% Ground cover Hempnettle	Chickweed	Knotgrass	Total	Grain yield t/ha (85% DM)
Timing 1					
6 + 1200	0	0	0	0.7	4.90
3 + 600	1.7	0.3	0	2.3	4.85
1.5 + 300	2.0	1.0	0.7	5.0	4.87
0.75 + 150	3.7	0.3	1.7	9.0	4.84
Untreated	20.0	11.7	4.0	47.3	4.80
Timing 2					
6 + 1200	3.7	0.7	0.3	4.7	5.38
3 + 600	4.7	1.3	0.7	7.3	5.10
1.5 + 300	9.7	0.7	0.7	10.7	5.37
0.75 + 150	15.3	3.3	1.3	24.3	5.21
Untreated	30.0	13.3	2.3	54.7	4.89
Timing 3					
6 + 1200	4.3	0	0	4.3	5.12
3 + 600	8.0	0	0.3	8.7	5.11
1.5 + 300	12.0	1.7	1.0	15.3	5.16
0.75 + 150	17.3	2.3	2.3	22.0	5.44
Untreated	28.3	8.3	7.7	47.7	4.99
SED	2.92	1.27	1.04	3.55	0.39

APPENDIX III (5)

Table 6 **Timing of herbicide treatment and weed control, Hoprig, 18 August 1994**

Metsulfuron + mecoprop-P g a.i./ha	% ground cover (BLW) Oilseed rape	Chick-weed	Forget-me-knot	Knot-grass	Red Dead-nettle	BLW Total
Timing 1						
6 + 1200	0.1	0.1	0.9	0.1	0	1.2
3 + 600	0.4	0.2	1.8	0.5	0.2	3.1
1.5 + 300	2.0	0.2	1.7	0.4	0.2	4.5
0.75 + 150	6.0	3.5	1.8	1.2	0.1	12.6
0.375 + 75	5.3	3.0	3.7	0.5	0.1	12.6
Timing 2						
6 + 1200	0	0	1.0	0.9	0	1.9
3 + 600	2.0	0.2	2.2	1.4	0.2	6.0
1.5 + 300	3.3	0.3	3.0	1.8	T	8.4
0.75 + 150	6.3	3.0	3.3	0.5	0.4	13.5
0.375 + 75	10.0	5.3	4.0	1.0	0.7	21.0
Timing 3						
6 + 1200	T	T	0.5	0.1	0	0.7
3 + 600	T	0	1.3	1.3	T	1.7
1.5 + 300	1.2	T	2.8	0.2	0.2	4.5
0.75 + 150	5.3	1.7	5.0	2.0	0.5	14.5
0.375 + 75	8.0	2.5	2.5	0.4	T	13.5
Untreated	12.3	16.0	4.3	0.9	1.7	20.2
SED	1.39	2.81	1.03	0.88	0.37	

APPENDIX III (5)

Table 7 **Timing of herbicide and grain yield, Hoprig, 1994**

Metsulfuron + mecoprop-P (g a.i./ha)		Grain yield t/ha (85% DM)	% DM
Timing 1			
6 + 1200		5.95	79.0
3 + 600		5.97	78.0
1.5 + 300		6.19	78.7
0.75 + 150		6.05	78.3
0.375 + 75		6.33	78.9
Timing 2			
6 + 1200		6.16	78.1
3 + 600		6.09	79.3
1.5 + 300		5.73	78.5
0.75 + 150		6.25	79.2
0.375 + 75		5.75	79.3
Timing 3			
6 + 1200		6.03	78.9
3 + 600		6.02	78.9
1.5 + 300		6.16	77.2
0.75 + 150		5.60	78.4
0.375 + 75		6.25	77.8
Untreated		6.03	78.5
	SED	0.24	1.00

APPENDIX III (5)

Table 8 **Yield response to treatment dose and timing at Scottish spring barley sites 1993/4**

Dose % of full dose and timing*	Yield (t/ha) Nether Finlarg	Hillbrae	Hoprig	Sunnybrae	Blackiemui	MEAN
Timing 1						
6.25	5.39	-	6.33	4.92	6.82	
12.5	5.25	4.84	6.05	4.84	6.86	
25.0	5.34	4.87	6.19	5.16	6.94	
50.0	5.21	4.88	5.97	5.37	6.60	
100.0	5.25	4.90	5.95	5.52	6.79	
Timing 2						
6.25	5.10	-	5.75	4.83	6.93	
12.5	5.21	5.21	6.25	5.20	6.74	
25.0	5.11	5.37	5.73	5.20	6.90	
50.0	5.49	5.10	6.09	5.20	6.62	
100.0	5.53	5.38	6.16	5.32	6.42	
Timing 3						
6.25	5.28	-	6.25	5.21	6.57	
12.5	4.97	5.44	5.60	5.30	6.64	
25.0	5.26	5.16	6.16	5.09	6.97	
50.0	5.23	5.11	6.02	5.18	6.92	
100.0	5.12	5.12	6.03	5.42	6.83	
Untreated	5.07	4.89	6.03	4.75	6.53	
SED	0.42	0.39	0.24	0.141	0.254	

APPENDIX III (5)

Table 9 **Overall broad-leaf weed control (% ground cover) response to treatment dose and timing at Scottish Group barley sites 1993/4**

Dose % of full dose and timing	% g cover (8-10 WAT) Nether Finlarg	Hillbrae	Hoprig	Sunnybrae*	Blackiemuir
Timing 1					
6.25	19.7	-	12.6	50.0	16.3
12.5	8.9	9.0	12.6	36.7	13.0
25.0	0.8	2.3	3.1	21.7	1.0
100	1.1	0.7	1.2	5.0	1.0
Timing 2					
6.25	58.6	-	21.0	46.7	14.7
12.5	49.3	24.3	13.5	36.7	11.0
25.0	27.9	10.7	8.4	30.0	5.7
50.0	23.5	7.3	6.0	26.7	4.0
100.0	6.0	4.7	1.9	10.0	1.3
Timing 3					
6.25	55.8	-	13.5	45.0	12.7
12.5	65.6	22.0	14.5	35.0	11.7
25.0	37.3	15.3	4.5	31.7	6.7
50.0	32.4	8.7	1.7	20.0	2.7
100.0	16.8	4.3	0.7	6.7	1.7
Untreated	67.3	49.9	20.2	58.3	43.3

APPENDIX III (5)

Table 10 **Overall broad-leaf weed control response to treatment dose and timing at Scottish spring barley sites, 1993/4**

Dose % of full dose	% control cf untreated (8-10 WAT) Nether Finlarg	Hillbrae	Hoprig	Sunnybrae	Blackiemuir	MEAN
Timing 1						
6.25	71	-	48	14	62	49
12.5	87	82	48	37	70	65
25.0	99	90	78	52	82	80
50.0	99	95	85	63	98	88
100.0	98	99	96	91	98	96
					Mean	76
Timing 2						
6.25	13	-	0	20	66	25
12.5	27	51	31	37	75	44
25.0	59	79	58	49	86	66
50.0	65	85	70	54	91	73
100.0	91	91	81	83	97	88
					Mean	59
Timing 3						
6.25	11	-	31	23	71	34
12.5	3	56	28	40	73	40
25.0	45	69	78	46	85	64
50.0	52	83	92	66	94	77
100.0	75	91	97	89	96	90
					Mean	61
Untreated	0	0	0	0	0	

APPENDIX IV (1)

Effect of crop variety on weed growth impact on the efficacy of reduced herbicide rates: Winter wheat

1. **Site details**

Site:	Bush, Midlothain
Farmer:	SAC
Crop:	Winter wheat: cultivars: Apollo, Riband, Hereward, Estima
Sowing date:	18.10.91
Weed species:	Stellaria media, Galesopsis tetrahit, Veronica persica
Soil type:	Clay loam
Combine harvest:	4.9.92

2. **Herbicide treatments**

Metsulfuron + mecoprop-P: 0, 3 g + 0.2 l, 15 g + 1 l/product/ha.

Treatment applied on 10.4.92 @ crop GS26. Design: 4 cultivars x 3 herbicides x 4 replicate blocks. Plots 2.3 x 20 m.

Herbicide treatments applied in 200 l/ha water with a medium quality spray (BCPC) at a minimum pressure of 2 bar.

APPENDIX IV (1)

Table 1 Crop ground cover and yield grain

Variety	Ground cover % GS11 12.12	Rabbit grazing GS11 12.12	Early ground cover 1-9 GS30 20.04	Crop % GS32 15.05	Dry matter % GS32 15.05	Yield of grain t/ha @ 15% MC
Apollo	13.3	0.0	4.7	46.7	77.0	7.8
Apollo tenth	15.0	0.7	5.0	48.3	76.8	8.2
Apollo half	15.0	0.0	4.7	68.3	76.8	8.1
Riband unt	10.0	0.3	6.0	53.3	74.9	9.8
Riband tenth	10.0	0.3	5.0	66.7	75.0	9.9
Riband half	10.0	0.0	5.3	65.0	75.0	9.8
Hereward unt	15.0	3.3	5.0	50.0	75.6	7.9
Hereward tent	13.3	3.7	5.0	65.0	76.5	8.1
Hereward half	13.3	3.3	5.0	66.7	75.6	8.2
Estica unt	8.3	8.3	3.0	56.7	78.3	7.6
Estica tenth	8.3	8.3	3.3	68.3	78.0	8.1
Estica half	8.3	8.3	2.7	71.7	78.6	8.3
Mean	11.7	3.1	4.6	60.6	76.50	8.49
SE	1.0	3.5	0.4	5.4	0.36	0.12
LSD	3.0	10.2	1.2	15.9	1.05	0.34
CV	15.4	197.0	15.1	15.5	0.81	2.37

APPENDIX IV (1)

Table 2 **Weed population on untreated plots and ground cover following treatment**

Variety	Chickweed No/m² GS30 20.04	Daynettle No/m² GS30 20.04	Speedwell No/m² GS30 20.04	Forget-me-knot GS30 20.04	Chick-weed % GS32 15.05	Daynettle % GS32 15.05	Total weeds %
Apollo unt	8.7	1.7	7.0	0.7	40.0	6.0	48.3
Apollo tenth	*	*	*	*	17.3	2.0	21.7
Apollo half	*	*	*	*	0.0	0.0	2.0
Riband unt	4.7	1.0	4.0	0.0	40.0	5.0	45.3
Riband tenth	*	*	*	*	9.3	0.0	11.7
Riband half	*	*	*	8	0.0	0.0	0.3
Hereward unt	4.3	1.3	7.7	1.0	43.3	5.7	49.3
Hereward tenth	*	*	*	*	6.7	0.3	7.7
Hereward half	*	*	*	*	0.0	0.0	0.3
Estica unt	9.0	2.3	7.3	0.3	23.8	6.7	33.0
Estica tenth	*	*	*	*	10.0	1.7	15.3
Estica half	*	*	*	*	1.7	0.0	2.3
Mean	6.7	1.6	6.5	0.5	16.0	2.3	19.8
SE	*	*	*	*	7.0	1.4	8.5
LSD	*	*	*	*	20.4	4.0	24.9 CV

APPENDIX IV (2)

Effect of crop cultivar on weed growth impact on the efficacy of reduced herbicide rates: Spring barley

1. **Site details**

Site:	Bush, Midlothain
Farmer:	SAC
Crop:	Spring barley cultivars: Shirley, Osprey, Derkado, Blenheim, Tyne
Sowing date:	24.3.92
Weed species:	Stellaria media, Viola arvensis, Myosotis arvensis
Soil type:	Clay loam
Combine harvest:	1.9.92

2. **Herbicide treatments**

Metsulfuron + mecoprop-P: 0, 3 g + 0.2 l, 15 g + 1 l product/ha.

Treatment applied on 10.4.92 @ crop GS26. Design: 5 cultivars x 3 herbicides x 4 replicate blocks. Plots 2.3 x 20 m.

APPENDIX IV (2)

Table 1 **Weed ground cover**

Variety	Poa annua % GS59 27.06	Forget-me-knot % GS59 27.06	Pansy % GS59 27.06	Chickweed % GS59 27.06
Shirley unt	1.33	1.7	0.0	0.0
Shirley tenth	1.33	0.0	0.0	0.0
Shirley half	3.33	0.3	0.0	0.0
Osprey unt	3.67	3.0	0.0	4.0
Osprey tenth	3.33	0.0	0.0	0.0
Osprey half	2.33	1.3	0.0	0.0
Derkado unt	1.00	3.3	0.3	4.0
Derkado tenth	1.67	3.3	0.0	0.0
Derkado half	1.50	3.3	0.0	0.0
Blenheim unt	5.00	3.3	0.0	8.3
Blenheim tenth	4.17	3.3	0.3	0.0
Blenheim half	4.33	0.0	0.0	0.0
Tyne unt	2.00	3.3	0.0	3.3
Tyne tenth	2.33	1.0	0.0	1.0
Tyne half	1.67	5.0	0.0	1.3
Mean	2.60	2.2	0.0	1.5
SE	1.42	1.7	0.1	2.6
LSD	4.12	4.8	0.3	7.6
CV	94.83	133.9	457.1	308.5

APPENDIX IV (2)

Table 2 **Crop ground cover and yield of grain**

Variety	Poa annua % GS25 22.05	Canopy density 1-9	Dry matter % GLS* 01.09	Yield of grain t/ha @ 15% MC
Shirley unt	9.0	8.0	77.7	5.7
Shirley tenth	9.0	8.0	77.3	5.7
Shirley half	8.3	8.0	77.9	5.7
Osprey unt	9.0	8.0	79.4	5.4
Osprey tenth	9.0	8.0	78.9	5.7
Osprey half	8.3	8.0	78.8	5.5
Derkado unt	7.0	9.0	76.3	6.7
Derkado tenth	7.0	9.0	75.5	6.6
Derkado half	6.7	9.0	75.8	6.8
Blenheim unt	7.7	7.3	77.6	6.5
Blenheim tenth	8.0	7.3	78.2	6.8
Blenheim half	7.7	7.3	77.9	6.7
Tyne unt	7.0	5.7	77.7	6.8
Tyne tenth	7.3	6.3	78.2	7.1
Tyne half	7.0	6.0	78.6	6.7
Mean	7.9	7.7	77.72	6.280
SE	0.3	0.4	0.52	0.183
LSD	0.8	1.1	1.50	0.529
CV	5.8	9.0	1.15	5.039

APPENDIX V (1)

Long-term reduced herbicide use sites

1. **Site details**

a.	Site:	Smith's Holding, Bush, Penicuik, Midlothian
	OS:	668 252
	Soil:	Sandy loam
	Altitude:	185 m
b.	Site:	Niddrie Mains, Winchburgh, West Lothian
	Soil:	Clay loam
	Altitude:	85 M
c.	Site:	Gleghornie, North Berwick, East Lothian
	Soil:	Clay loam
	Altitude:	80 M
d.	Site:	Remote, Pathhead, Midlothian
	OS:	650 405
	Soil:	Clay loam
	altitude:	140 m

2. **Rotations**

	1987/8	1988/9	1989/90	1990/1	1991/2	1992/3
Smith's Holding	WB	WB	WB	SOSR	SB	SB
Niddrie Mains	WW	WW	SB	WW	WOSR	WW
Gleghornie	WW	WW	WW	WW	WW	WW
Remote	SB	SB	SB	WW	SOSR	SB

3. **Treatments and Design**

Winter wheat sites led DFF + IPU in the autumn (crop GS12), with 100, 1000 g a.i./ha as the full dose plus mecoprop-P in the spring (crop GS30) at Niddrid Mains at 1200 g a.i./ha as the full dose.

3.2

Spring barley had metsulfuron + mecoprop-P at GS30 of the crop, with 6 + 1200 g a.i./ha as the full dose.

The design was three full randomised replicate blocks. Plots were 4 m x 18-24 m. Treatments were:

Insurance at full herbicide dose
Insurance at half herbicide dose
Threshold* at fully herbicide dose
Threshold* at half herbicide dose
Untreated

APPENDIX V (1)

*The thresholds were exceeded prior to treatment, accordingly all threshold plots were treated.

Treatments were applied by Azo prepane - pressurised knapsack sprayer calibrated to deliver 200 Kü /ha volume at 2.4 bars through T8003 nozzles (BCPC medium spray classification).

3. **Results**

For full details of earlier results see the final report on H-GCA grant 9143/013. The following tables give the weed and yield/grain quality assessment details for 1992/3 season.

APPENDIX V (1)

Table 1 Weed levels, Gleghornie long-term trial, 1993

Treatment		Wild-oat	Annual Meadowgrass
Untreated		0	14.8
Threshold - full dose		0	0.2
Threshold - half dose		0.2	1.3
Insurance - full dose		0	0.2
Insurance - half dose		0	1.5
	SED	0.15	2.75

APPENDIX V (1)

Table 2 **Yield data, Smith's Holding long-term sites, 1993**

Treatment		Grain* yield t/ha	Dry matter (DM) %	1000 grain wt (g)	Specific weight	% weed content
Untreated		4.63	83.6	42.1	62.4	0.8*
Threshold - full dose		4.56	83.6	42.8	62.4	0.2
Threshold - half dose		4.62	83.3	41.6*	62.1	0.2
Insurance - full dose		4.40	83.7	42.6	62.6	0.1
Insurance - half dose		4.44	83.7	42.3	62.4	0.2
	SED	0.271	0.79	0.79	1.16	0.26

*At 85% DM

APPENDIX V (1)

Table 3 Weed levels, Smith's Holding long-term trial, 1993

Treatment		Hemp-nettle	Common chickweed	Fumitory	Charlock	Knotgrass	Annual meadow-grass
Untreated		8.0	33.3	8.8	4.5	8.5	9.7
Threshold - full dose		0.1	0	0	0	0.1	0.1
Threshold - half dose		0.1	0.1	0.1	0	0.2	0.1
Insurance - full dose		0.1	0	0	0	0.1	0.1
Insurance - half dose		0.1	0.1	0.1	0	0.3	0.1
	SED	0.42	3.68	1.67	1.15	0.46	0.30

APPENDIX V (1)

Table 4 **Weed levels, Smith's Holding long-term trial 1993**

Treatment	% ground cover (26.8.93) Hemp-nettle	Common chickweed	Charlock	Knotgrass	Black Bind-weed	Forget-me-knot	Red-shank	May-weed
Untreated	5.7	11.5	1.7	10.3	2.8	2.0	1.8	4.8
Threshold - full dose	0	0	0	2.0	0.2	0	0	0
Threshold - half dose	0	0	0	9.5	1.3	0.7	0.2	0
Insurance - full dose	0	0	0	1.5	0.2	0.5	0	0
Insurance - half dose	0	0.3	0	5.5	0.2	0.8	0	0
SED	2.65	-	-	2.65	0.54	0.38	0.42	

APPENDIX V (1)

Table 5 Yield data, Niddrie Mains long-term trial, 1993

Treatment	Grain* yield t/ha	Dry matter (DM) content %	1000* grain weight	Specific weight
Untreated	8.78	76.9	59.4	69.7
Threshold - full dose	9.48	77.1	58.2	69.9
Threshold - half dose	9.55	77.4	58.1	69.5
Insurance - full dose	10.72	76.5	60.1	69.7
Insurance - half dose	11.06	77.1	59.9	70.3
SED	0.553	0.39	1.71	0.84

*At 85% DM

APPENDIX V (1)

Table 6 Yield data, Remote long-term site, 1993

Treatment	Grain* yield t/ha	Dry matter (DM) %	1000 grain wt (g)	Specific weight
Untreated	7.39	83.2	48.8	70.1
Threshold - full dose	7.63	84.3	50.1	69.4
Threshold - half dose	7.32	82.8	49.9	69.1
Insurance - full dose	7.02	84.1	49.2	69.2
Insurance - half dose	7.46	83.0	49.5	70.4
SED	0.509	1,88	1.36	1.02

*At 85% dry matter (DM)

APPENDIX V (1)

Table 7 **Weed levels, Remote long-term site, 1993**

	% ground cover (25.5.93)				
Treatment	Common chickweed	Scentless mayweed	Ivy-leaved speedwell	Red deadnettle	Fumitory
Untreated	31.0	0	2.2	0	0.2
Threshold - full dose	22.0	0.8	1.3	0.2	0.3
Threshold - half dose	19.3	0	0.3	0.2	0.3
Insurance - full dose	10.5	0	0	0.2	0.2
Insurance - half dose	14.5	0	0.2	0	0.3
SED	3.98	0.51	0.85	0.26	0.32