HERBICIDE EFFICACY EVALUATION

Author

B.J. Mitchell

Crops Research Centre

Oak Park, Carlow

ISBN 1 84170 1653

March 2001

CONTENTS

SUMMARY **1**

INTRODUCTION **1**

METHODS **2**

RESULTS AND DISCUSSION **3**

Winter barley 3

Winter wheat 5

Control of docks (*Rumex* spp.) in grassland 9

CONCLUSIONS **15**

REFERENCES **17**

SUMMARY

The objective of this series of trials was to determine if recently introduced herbicide formulations give better weed control in cereals and grassland than those presently in use. Effect on crop yield and quality was also examined where appropriate. In 1995, field trials were carried out with a new diflufenican/flurtamone formulation, Bacara, in winter wheat and barley. In both cases, the results showed that this new formulation gave commercially acceptable weed control of a wide range of annual weeds and grasses, when applied at doses between 260 and 350 g a.i. per hectare. None of the products tested had any adverse effects on crop yield or quality. Between 1996 and 1998 a number of new sulfonylurea herbicides, based on carfentrazone and flupyrsulfuron methyl (Lexus series), were tested at trial sites in Carlow and Clonmel. Most of the formulations gave weed control similar to Cougar, which was included in all these trials as standard comparison treatment, without affecting crop yield or quality.

New herbicide trials for the control of broad and curled leaf dock (*Rumex* spp.) in pasture were carried out. Most of the herbicides investigated gave better overall control of both species than the standard dicamba/mecoprop based products. One of the sulfonylyurea-based herbicides controlled broad leaf dock only, and occasionally retarded grass development, but had no effect on clover. Fluroxypyr-based products gave long term control of both dock species without any effect on the grass, but eliminated clover present in the sward. In all trials some dock regrowth was evident one year after treatment.

INTRODUCTION

The development of weed resistance to herbicides is not as frequent as the occurrence of fungicide resistance. However, in certain circumstances this has been recorded in the UK where both blackgrass and chickweed have demonstrated resistance to certain herbicides (Powels and Preston, 1995). To prevent this phenomenon the regular introduction of new herbicide molecules like the sulfonylureas is practiced. However, as new herbicides are introduced it is necessary for the manufacturer and the grower to know how they will perform under a wide range of field conditions and wide weed spectrum (Bayer *et al.,*

1998). Teagasc carries out efficacy testing of herbicides as a service to the agrochemical industry and also to have independent trial data for advisory services and growers.

The main objective of the work reported here was to determine the effect of new herbicides on annual weeds and grasses under Irish field conditions and, where appropriate, the effect on crop yield and quality was also monitored.

METHODS

The cereal herbicide investigations were carried out from 1995 to 1998, and the dock control investigations between 1990 and 1998. All treatments were applied in a water volume equivalent to 200 l/ha at a pressure of 2.4 bar. Experimental plot size was 50 square metres with at least four replications per treatment. The general trial layout was a randomized block design.

Weed assessments were recorded at specific times after herbicide application and were based on four quarter-metre quadrant counts per plot. Weed control results are expressed as per cent reduction in weed number compared to the untreated control and are listed as weed score in this report where 0 indicates no control and 10 indicates total weed control. All the cereal herbicides were applied in the autumn when the crop had 5 to 7 leaves, i.e. GS 25 Zadoks, and the weeds were 5.0 to 8.0 cm high. The dock herbicides were applied two weeks after the first silage cut. At this time the target plants were in full rosette, with leaves 20 to 30 cm long and actively growing.

RESULTS AND DISCUSSION

Winter barley

Investigations into the effect of carfentrazone/flurtamone (Bacara) on annual weeds and grasses in winter barley, cv. Pastoral, were carried out at Oak Park in 1995.

Effect on weeds

The main weeds present were common poppy, field speedwell, fumitory, fathen, red deadnettle, field pansy, chickweed and a small amount of cleavers. Weed density was heavy, with up to 200 weeds/m^2. The treatments, weed control values and crop yield are shown in Table 1.

Table 1: Effect of the difflufenican, Bacara, on weeds and yield of winter barley 1995

Product	Dose g a.i./ha	*Weed score	Yield (t/ha)	Hectolitre wt.	1000 gr. wt.
Bacara	175.0	9	7.2	61.3	35.9
Bacara	262.5	9	7.4	62.5	39.1
Bacara	350.0	10	7.8	64.1	40.4
Cougar	900.0	10	7.5	64.1	41.5
Untreated	0.0	00	5.6	57.4	24.0
LSD +/-			0.44	1.2	3.6

* 00 = no weed control; 10 = 100% weed control

In most cases the level of weed control was commercially acceptable. Bacara at the lowest dose (175 g/ha) gave good kill but some weeds, particularly cleavers, were only suppressed. However, these weeds were non-competitive. The other Bacara treatments gave similar weed control to Cougar which was included in the trial as a standard comparison.

In 1996, a number of new formulations commercially named Lexus Class (carfentrazone/flupyrsulfuron), Lexus Millenium (flupysulfuron/thifousulfuron), and Harmony Express (carfentrazone/thifensulfuron), were investigated at Oak Park. In this trial, the products were applied alone and in combination with other herbicides and the results are shown in Table 2. Where all three products were used alone the overall weed control was low compared to the standard treatment, Cougar. When these products were applied in combination with isoproturon (Tolkan), or trifluralin (Treflan), the weed control was improved and any remaining weeds were less than half the size of those in the untreated control. None of the herbicide combinations were better than the standard Cougar treatment (Table 2).

Table 2: The effect of carfentrazone based herbicides on weed control and yield of winter barley, 1996

Product	Dose g a.i./ha	*Weed score	Yield (t/ha)	Hectolitre wt.	1000 gr.wt.
Lexus Class	20	7	8.1	55.3	45.1
Lexus/Tolkan	20 + 500	8	8.3	55.4	43.8
Lexus/Treflan	20 + 780	8	8.4	55.4	44.7
Lexus Millenium	35	7	7.7	54.5	44.6
Lexus M./Tolkan	35 + 500	8	7.9	54.4	44.8
Lexus M/Treflan	35 + 780	9	8.5	54.8	44.3
Harmony Express	40	5	7.4	52.3	43.0
Harmony/Tolkan	40 + 500	9	8.1	53.4	44.9
Harmony/Treflan	40 + 780	9	8.7	54.5	44.7
Cougar	900	9	8.8	55.8	45.4
Untreated	0	00	6.2	55.7	42.7
LSD +/-			0.5	0.6	1.6

* 00 = no weed control; 10 = 100% weed control

Effect on yield

The yields in all the herbicide treatments were significantly greater than the untreated control. This was expected, as the weed density in both trials was very high with up to 200 weeds/m^2. In the Bacara trial, the yield response to all the treatments was good and there were no adverse effects on the quality of the grain with regard to hectolitre or specific weight.

In the Lexus based trials, none of the treatments had any visible effects on the crop and most of them were significantly better than the untreated control in yield and seed quality. There was no significant difference between most of the treatments, except where Lexus Millenium and Haromy Express were applied alone and gave the lowest weed control.

Winter wheat

Between 1995 and 1998, a number of new herbicides were applied as autumn treatments to winter wheat, cv. Brigadier, to determine the effect on weeds and crop quality. No pre emergence herbicides were used and all the post emergence treatments were applied when the crop had 6 to 10 leaves, i.e. GS 30, and the weeds were 8.0 to 10.0 cm high.

In 1995, the main weeds in order of density were field speedwell, fumitory, poppy, red deadnettle, field pansy, chickweed and annual meadow grass. The treatments and results are shown in Table 3.

Table 3: The effect of Bacara on weeds and yield of winter wheat 1995

Product	Dose g a.i./ha	*Weed score	Yield (t/ha)	Hectolitre wt.	1000 gr. wt.
Bacara	175.0	9	12.1	73.4	51.3
Bacara	262.5	9	12.3	73.4	52.1
Bacara	350.0	10	12.2	73.1	51.9
Cougar	900.0	10	12.1	73.6	52.6
Untreated	0.0	00	12.0	74.3	51.8
LSD +/-			1.4	0.96	2.6

* 00 = no weed control; 10 = 100% weed control

All the treatments gave commercially acceptable weed control. The exceptionally good weed control achieved here was probably due to the fact that the weed density was light, 50 weeds/m^2, and crop growth was vigorous.

In 1997, the Lexus based weed control trials were carried out at Oak Park and Knockbeg College farm in Co. Laois. Weed density in Oak Park was heavy, with up to 230 plants/m^2, while that in Knockbeg was only 50 weeds/m^2. The treatments and results are shown in Tables 4 and 5.

Table 4: Effect of Lexus combinations on annual weeds and yield of winter wheat at Oak Park, 1997

Product	Dose g a.i./ha	*Weed score	Yield (t/ha)	Hectolitre wt.	1000 gr. wt.
Lexux/Tolkan	20 + 500	9	5.8	64.9	38.4
Lexus/Treflan	20 + 600	9	5.5	66.7	40.1
Lexus/Stomp	20 + 40	10	5.8	65.5	39.6
Cougar	600	9	6.2	65.3	39.5
Untreated	0	00	3.9	60.4	37.3
LSD +/-			1.4	2.8	2.7

* 00 = no weed control; 10 = 100% weed control

At Oak Park, weed density was high. All the Lexus combinations gave weed control equal to or marginally better then Cougar. The Lexus/Tolkan formulation did not give good control of charlock but gave total control of the other weeds.

Weed density at the Knockbeg site was light, with only 20 weeds/m^2, so meaningful assessment was limited. The main weeds were chickweed, fathen, groundsel and nipplewort. At this site, all the herbicide treatments gave total weed control, but this was not surprising due to the lack of serious weed competition as was the case at Oak Park. The treatments and results are listed in Table 5.

Table 5: Effect of Lexus combinations on annual weeds and yield of winter wheat at Knockbeg, 1997

Product	Dose g a.i./ha	*Weed score	Yield (t/ha)	Hectolitre wt.	1000 gr. wt.
Lexux/Tolkan	20 + 500	10	9.5	68.8	44.1
Lexus/Treflan	20 + 600	10	9.6	69.7	44.7
Lexus/Stomp	20 + 40	10	9.6	69.6	44.3
Cougar	600	10	9.4	68.9	44.0
Untreated	0	00	9.4	69.4	44.4
LSD +/-			0.5	1.4	2.6

* 00 = no weed control; 10 = 100% weed control

Effect on yield

At Oak Park, the mean crop yield was 5.8 t/ha with no significant difference between treatments. All treatments were significantly better than the untreated control. In the Knockbeg trial, the mean crop yield was 9.4 t/ha and there were no significant differences between any of the treatments, including the untreated control. Crop quality, viz hectolitre and specific weight, was not affected by any of the herbicide treatments.

The 1998 trials with Lexus were located in Kilkenny and Clonmel. Weed density was light in Kilkenny with only 60 plants/m^2. The main weeds in order of density were knotgrass, speedwell, groundsel and chickweed. Table 6 shows the treatments and results.

Table 6: Effect of Lexus combinations on annual weeds in winter wheat, 1998

Product	Dose g a.i./ha	*Weed score (Kilkenny)		*Weed score (Clonmel)	
		A	B	A	B
Lexus/Tolkan	25 + 500	10	9	9	9
Harmony/Tolkan	40 + 750	10	9	10	9
Affinity	1033.5	9	9	10	8
Lexus/Platform	10 + 450	10	10	10	7
Lexus/Cougar	10 + 450	10	9	10	8
Cougar	900	10	9	10	8
Untreated	0	0	0	0	0

* Weed score: A = after six weeks; B = pre harvest
0 = no weed control; 10 = 100% weed control

In Kilkenny, all treatments gave complete control of weeds, including annual meadow grass. The initial chemical effect was slow but most weeds were dead within three weeks of application. Any remaining weeds were about 5.0 cm high and non competitive when assessed prior to crop harvest.

Weed density at the Clonmel site was medium, 80 weeds/m^2, of which cleavers constituted 30 per cent. Other weeds present were speedwell, nipplewort, fathen and chickweed. All treatments gave commercially acceptable control of most of the weeds. None of the treatments gave complete control of cleavers in terms of total plant kill, but all remaining weeds were half the size and vigour of those in the untreated control. Crop yield and quality data were not recorded in these trials as they were not requested in the trial protocol.

The result of this series of trials indicates that many of the new formulations investigated were commercially acceptable for control of a wide weed flora, including cleavers. The flexibility of Bacara is noteworthy, in that at present it is recommended for use in winter oats only, whereas the Oak Park trials indicate that

it is also safe on wheat and barley. This would be a useful replacement for herbicides like Cougar if the use of isoproturon based products was to be restricted, as is predicted (Singh and Kirkwood, 1997).

The other new formulations were sulphonylunea-based and all exhibited good efficacy on a wide range of annual weeds and grasses, except in Clonmel where reduced weed control was a consequence of late herbicide application and subsequent crop damage by grazing animals. In the other trials, cleavers were completely controlled. Effective cleavers control is an important property for all new herbicides, as this is one of the most competitive weeds present in winter cereals and will cause serious yield loss and harvesting difficulties in all crops if not totally controlled (Courtney, 1991).

Control of docks (*Rumex* spp.) in grassland

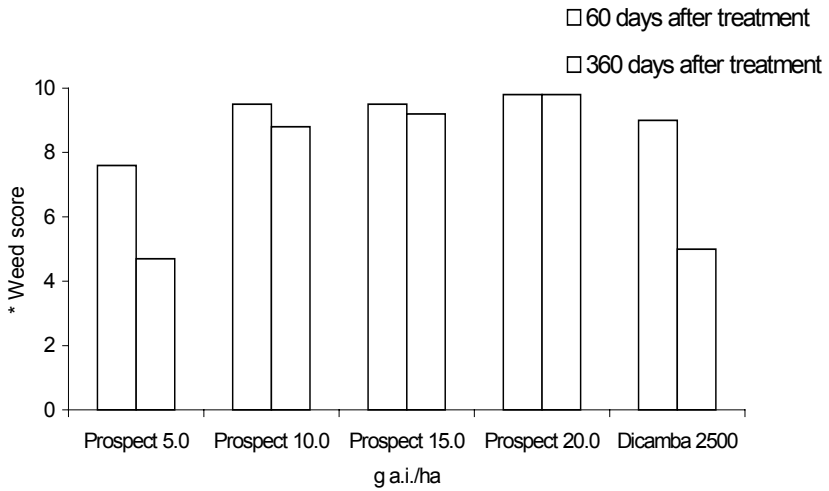
Low infestations of docks in grassland have always been tolerated, as they do not seriously affect the overall output of grazing animals. However, frequently docks rapidly increase to epidemic proportions, at which point they seriously interfere with the general production of the sward (Oswald and Haggar, 1983). It is well established that a dock population of 12 to 15 per cent in a pasture will reduce the *in vitro* digestibility of the grass (Courtney, 1972). It has also been shown that grass yield increased where medium dock populations were removed.

Herbicide trials, for the control of broad and curled leaf dock in grassland, were carried out at sites in Carlow, Kilkenny and Wexford between 1990 and 1996. The herbicides investigated were thifensulfuron methyl (Prospect), fluroxypyr (Starane), fluroxypr/triclopyr (Doxstar) and amidosulfuron (Eagle). The objective was to assess their ability to control broad and curled leaf docks and also their effect on the grass/clover composition of the sward.

All assessments were based on the result of four one-square-metre quadrant counts per plot recorded 90 and 360 days after treatment (DAT). The results are expressed as reduction in dock stand compared to the untreated control, i.e. weed score, where 0 indicates no control and 10 is total control. In these trials, only the established dock plants were counted in all cases. Docks known to be germinating from seed were disregarded.

Prospect

This trial was carried out at a site in Wexford in 1990. The dock population was 8 plants/m^2 in a perennial ryegrass/clover sward. The treatments and control values are shown in Fig. 1.



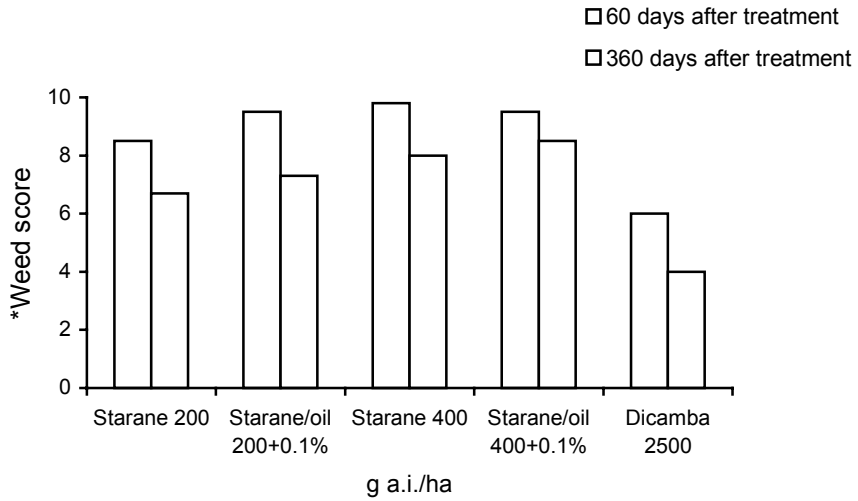
* 0 = no weed control; 10 = 100% weed control

Fig. 1: Effect of Prospect on docks in grassland, 1990

Assessment 60 days after treatment showed that all treatments gave a substantial reduction in dock population compared to the untreated control. The higher dose rate gave the best reduction. After 360 days, low level dock regeneration was recorded in most of the plots, particularly where the lowest dose of Prospect and the dicamba/mecoprop formulation were applied. The other treatments showed a significant reduction in the number of broad leaf dock but had no effect on any curled leaf dock except where the dicamba based formulation was used.

Starane

A dock trial with the herbicide Starane was carried out at Oak Park in 1992. Dock infestation was heavy, with 8 to 10 plants/m^2, and the overall distribution was uniform. Fig. 2 shows the treatments and weed control values.



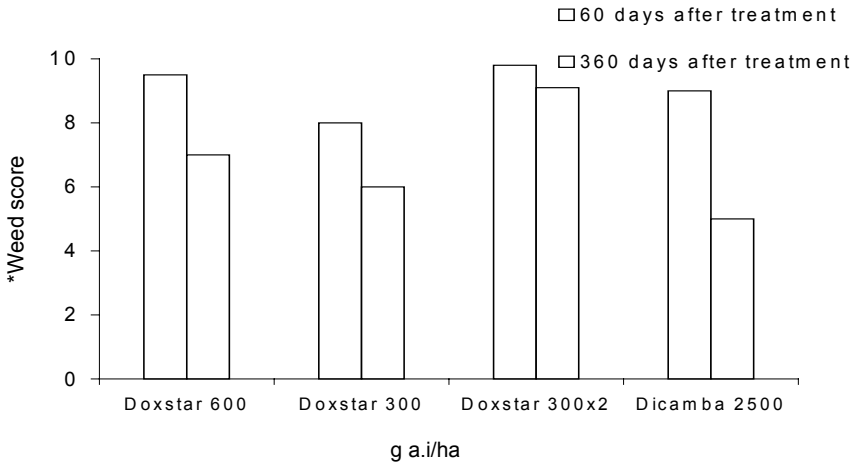
* 0 = no weed control; 10 = 100% weed control

Fig. 2: Effect of Starane on docks in a grass/clover sward, 1992

Assessments 60 days after treatment indicated that all treatments gave a significant reduction in dock numbers. The addition of a mineral oil to Starane enhanced the overall reduction compared to the standard dicamba/mecoprop treatment. After 360 days, the overall reduction in dock numbers was reduced in all treatments, particularly the low dose of Starane and the dicamba based treatment. The higher dose of Starane with the oil was marginally better than where used alone. However, all treatments were still superior to the untreated control, which is indicated by 0 (Fig. 2).

Doxstar

In 1994, fluroxypyr/triclopyr (Doxstar) introduced specifically for control of docks, was investigated in a trial on Knockbeg College farm. Dock infestation was heavy with 12 plants/m^2. This trial was carried out in July two weeks after second cut silage. All treatments and weed control values are shown on Fig. 3.



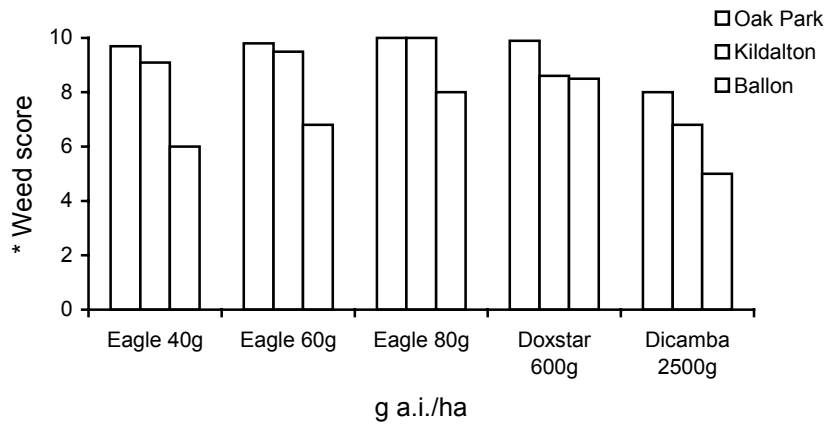
* 0 = no weed control; 10 = 100% weed control

Fig. 3: Effect of Doxstar on docks (*Rumex* spp.) in a grass/clover sward, 1994

All treatments gave a significant reduction in dock number 60 days after treatment. However, 360 days later the split dose of Doxstar gave the best reduction and the dicamba based treatment gave the lowest reduction. Doxstar applied at full and half dose gave better dock control than the dicamba-based sprays 360 days after treatment (Fig. 3).

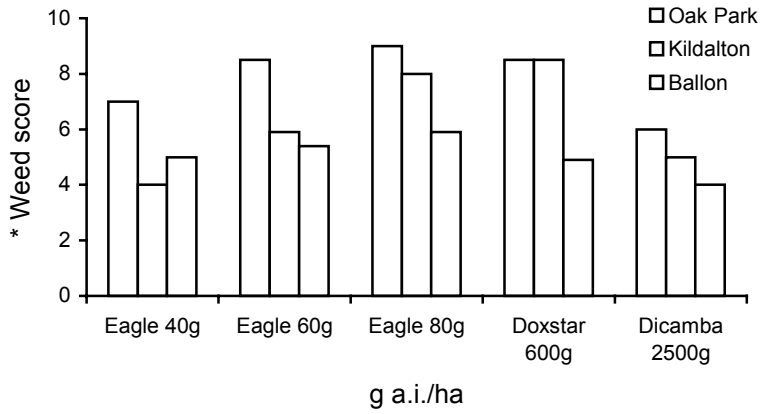
Eagle

In 1996, trials with the new sulfonyl urea herbicide, Eagle, were carried out at sites in Oak Park and Ballon in Carlow and Kildalton College in Kilkenny. Dock density at all sites ranged from 5 to 10 plants/m^2. The treatments and weed control values are shown in Figs. 4 and 4 (a).



* 0 = no weed control; 10 = 100% weed control

Fig. 4: Effect of Eagle on docks in a grass/clover sward, 60 days after treatment, 1996



* 0 = no weed control; 10 = 100% weed control

Fig. 4(a): Effect of Eagle on docks in a grass/clover sward, 360 days after treatment, 1996

At Oak Park, dock score ranged from 9 where Eagle was applied at 40 g/ha to almost total control at the higher doses, and similar results were obtained at Kildalton. The overall effect was not as good at Ballon, as heavy rain occurred shortly after spraying and only the highest dose of Eagle and Doxstar gave a good reduction in dock number. In all cases, the Eagle and Doxstar treatments were better than the standard dicamba based product. Assessments one year later indicated a general reduction in dock control in all cases. This ranged from 4 where the low dose of Eagle was used to 9 where the higher dose Eagle and Doxstar were used Fig. 4 (a). The dicamba based treatment gave the poorest control. At all sites, Doxstar and the 80 g dose of Eagle gave the best results Figs. 4 and 4 (a).

Effect on sward

In all the trials, the grass sward was generally perennial ryegrass with a medium clover population. Where Prospect was applied, in 1990, a dose of 5.0 g/ha had no visible effect on either grass or clover. At a dose of 15.0 g/ha and higher, grass growth was retarded and required 7 to 10 days to recover. None of the treatments had any effect on the clover. In 1992, none of the Starane treatments had any effect on the grass but all clover was killed. A similar result was obtained with Doxstar in 1994. Where Eagle was applied in 1996, most of the treatments did not affect the grass or clover, but in the Oak Park trial the 80.0 g/ha dose caused some temporary grass chlorosis and stunting. The grass fully recovered within 10 days of application.

Throughout this series of trials all the products successfully reduced dock numbers. Some dock regrowth was recorded 12 months after treatment but the overall effect was still better than the untreated control. The most notable aspect arising from these trials was that none of the herbicides completely eliminated all the docks. Prospect at the recommended dose of 9.0 to 11.0 g a.i./ha gave commercially acceptable reduction in dock number without damaging grass or clover. Applications in excess of this dose resulted in some grass damage. The trial indicated that, while Prospect can give commercially acceptable reduction in broad leaf dock number, it did not control curled leaf dock. This may limit its usefulness in a mixed dock population. Starane and Doxstar have a similar chemical composition and mode of action. Starane is more popular applied as a cereal herbicide, but as trials have shown it can be relatively effective on both dock species where clover is of no consequence. Doxstar was introduced specifically for dock control and like Starane it is toxic to clover but gives effective control of both dock species up to 12 months after application.

Eagle is not yet approved for use in grassland. A dose of 60 to 80 g a.i./ha gave commercially acceptable reduction in dock numbers 12 months after application. The relatively poor results in Ballon may be attributed to rain immediately after spraying, and some of the poor results in Kildalton were probably a result of severe poaching by cattle shortly after spraying. In both Ballon and Kildalton, half of the regenerated docks were not as vigorous as those in the untreated plots.

The original objective of these trials was to determine the effect of these new herbicides on docks and pasture. The results generally indicate that, while not totally effective, all the herbicides used significantly reduced dock populations one year after spraying and were much better than the standard dicamba/mecoprop formulations. In all cases, good dock control programmes must include good management practices, as recent work at Johnstown Castle (Humphreys and Culliton, 1997) indicated a close connection between dock growth and the nutrient content of farm slurry, which is frequently used in intensive grass production systems.

CONCLUSIONS

Cereals

- The new diflufenican formulation, Bacara, gave similar weed control to Cougar when applied for the control of annual weed and grasses in winter wheat and barley.

- All the new carfentrazone based products gave commercially acceptable weed control in winter barley when applied in combination with isoproturon or trifluralin.

- In the winter wheat trials, all the carfentrazone combinations used gave weed control equal to the standard herbicide Cougar.

- The 1998 results were similar to those of 1997 but in the Clonmel trial some of the cleaver plants recovered after spraying.

- None of the new herbicide formulations had any adverse effect on crop yield or quality in winter wheat or barley.

Grassland

- All the new products tested gave better and longer term suppression of docks than the standard dicamba/mecoprop formulations.

- Prospect did not give good control of curled leaf dock.

- Starane and Doxstar gave good suppression of both broadleaf and curled dock.

- The herbicide Eagle gave good suppression of broadleaf and curled dock.

- With regard to the treated sward, the Starane and Doxstar based formulations had no visible adverse effect on the grass but both eliminated any clover present.

- Where Prospect was applied, the grass growth was retarded by higher than recommended doses but the clover was not affected. In one case, the highest dose of Eagle also caused some temporary grass damage.

- In all the dock trials some re-growth was apparent in the treated areas twelve months after application but all treatments were better than the untreated control.

REFERENCES

Bayer, E.M., Duffy, M.J., and Hay, J.V. 1998. Sulfonylurea Herbicides. In Herbicides. Chemistry, degradation and mode of action. Ed. Kearney and Kaufman. 117 - 189. M. Dekker Inc, New York.

Courtney, A.D. 1972. Docks in grassland, their influence on herbage productivity. Proceedings 11th British Weed Control Conference. 2. 315 - 322.

Courtney, A.D. 1991. The role of competition in developing an appropriate rate strategy for weed control in barley. Brighton Crop Protection Conference. Weeds. 3. 1217 - 1223.

Humphreys, J. and Culliton, N. 1997. Aspects of the role of cattle slurry in dispersal and seedling establishment of Rumex obtusifolius seed in grassland. Irish Journal of Agriculture and Food Research. 36. 1. 39 - 49.

Oswald, A.K. and Haggar, R.J. 1983. The effect of Rumex obtusifolius on the seasonal yield of two mainly perennial ryegrass swards. Grass and Forage Science. 38. 187 - 191.

Powels, S.B. and Preston, C. 1995. Herbicide cross resistance and multiple resistance in plants. Herbicide Resistance Action Committee. Monograph No 2. Brussels, Belgium.

Singh, S. and Kirkwood, R. 1997. New management approaches for isoproturon resistant Phlaris minor in India. Brighton Crop Protection Conference. Weeds. 1. 357 - 362.