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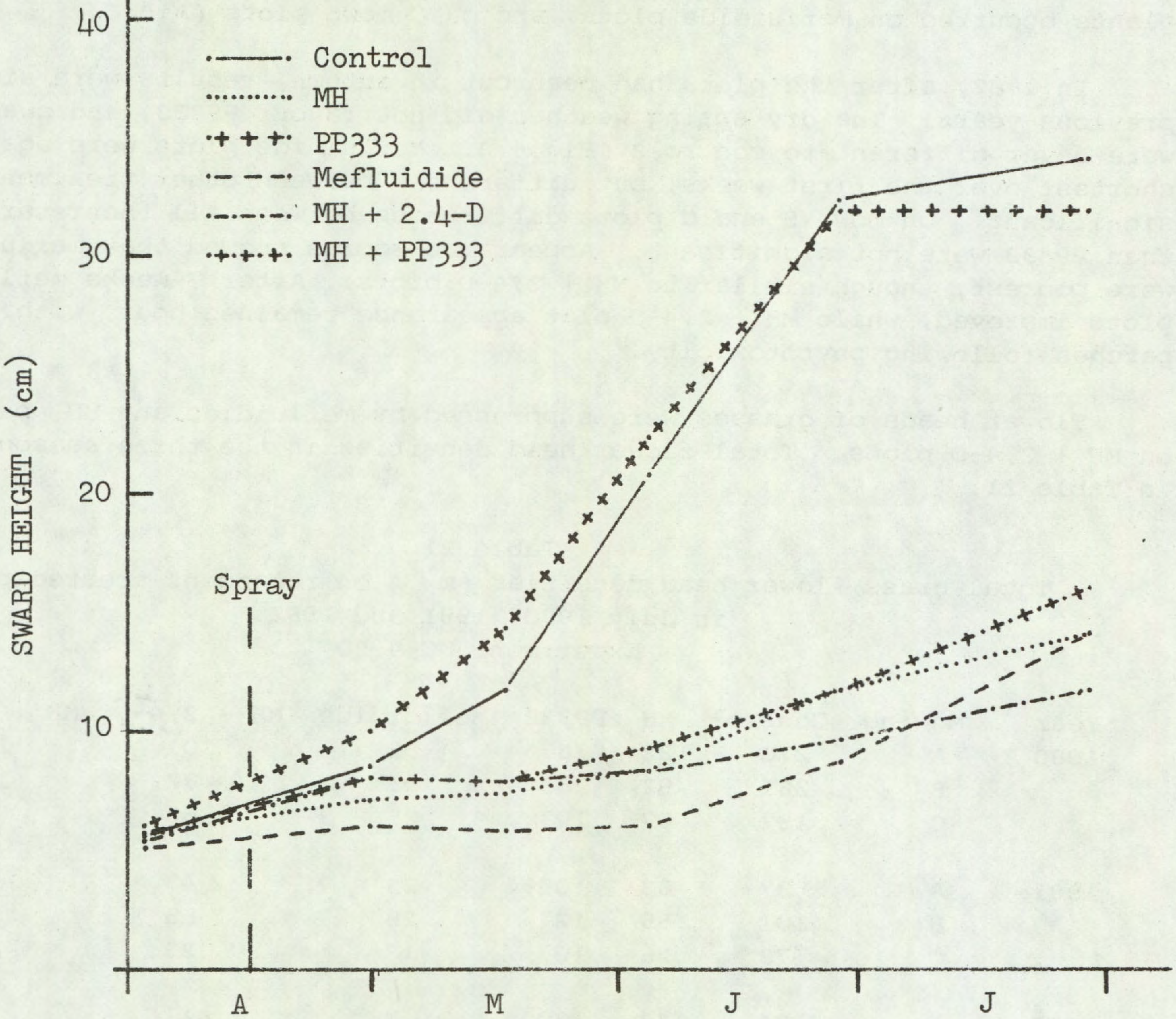

Fig.4. Sward heights of unmown (A) retardant treated plots in 1982, the third season of application. Experiment NC-4-80

The average percentage occurrences in the various assessments are given in Table 22, together with a note of species observed on the plots during each season. Among the grasses, there are indications of increases in frequencies of *A.elatius* and *A.pratensis*, with decreases in *L.perenne*, *Poa* spp. and possibly *H.lanatus*.

Table 22.
The occurrence of plant species in experiment NC-4-80 over three seasons.
Average frequencies from all plots.

	1980	1981	1982	Quadrats
		% Frequency		
Dicotyledons				
Ranunculus spp.	2.5	3.1	2.4	5.1
Ranunculus acris L.	+	+	+	
Ranunculus repens L.	+	+	+	
Ranunculus bulbosus L.	+	+	+	
Ranunculus ficaria L.		+	+	
Capsella bursa-pastoris (L.) Medicus	+	+	+	
Sisymbrium officinale (L.) Scop.	+			0.1
Cerastium fontanum Baumg.	0.3	0.1	0.1	0.7
Stellaria spp.	5.8	+	0.4	
Stellaria media (L.) Vill.		+	+	0.5
Stellaria graminea L.		+	+	2.6
Geranium dissectum L.			+	
Trifolium repens L.	2.2	0.7	0.4	2.2
Trifolium pratense L.	+	+	+	0.1
Lotus corniculatus L.	+	+	+	
Vicia cracca L.	+	+	+	0.4
Lathyrus pratensis L.			+	0.1
Potentilla reptans L.	+	0.4	0.9	11.2
Sanguisorba officinalis L.	1.0	+	0.6	7.0
Epilobium roseum Schreber			+	0.1
Anthriscus sylvestris (L.) Hoffm.	+	+	+	0.1
Conopodium majus (Gouan) Loret	+		+	0.8
Heracleum sphondylium L.	0.2	0.2	0.6	1.9
Polygonum aviculare agg.	+	+	+	0.5
Rumex acetosa L.	1.6	0.8	1.3	11.3
Rumex obtusifolius L.			+	
Veronica spp.	+	+		
Veronica chamaedrys L.			+	0.5
Veronica serpyllifolia L.			+	0.1
Plantago media L.			+	
Plantago lanceolata L.	+	+	+	1.0
Galium verum L.	+	+	+	0.8
Senecio vulgaris L.	+	+	+	0.4
Achillea millefolium L.	+	+	+	0.2
Matricaria perforata Merat	+			
Leucanthemum vulgare Lam.	+	+	+	0.4
Cirsium vulgare (Savi) Ten.	+	+	+	0.8
Cirsium arvense (L.) Scop.			+	0.1
Sonchus sp.			+	0.5
Crepis capillaris (L.) Wallr.	+			
Crepis paludosa (L.) Moench				0.4
Taraxacum officinale Weber, sensu lato	11.1	10.3	6.0	16.6

Table 22 continued.

Monocotyledons	1980	1981	1982	Quadrats
Luzula campestris (L.) DC.		+		
Festuca pratensis Hudson			+	
Festuca rubra L.	68.3	66.3	61.3	78.1
Lolium perenne L.	6.9	2.0	0.3	1.9
Poa spp. including P.annua L., P.pratensis L.	67.8	46.4	26.3	26.3
Dactylis glomerata L.	36.4	42.0	31.4	60.6
Bromus hordaceus L.	+	+	+	0.1
Bromus sterilis L.	+			
Elymus repens (L.) Gould	0.3	3.0	3.8	6.7
Avenula pubescens (Hudson) Dumort.		1.5	0.3	0.8
Hordeum vulgare L.	+			
Arrhenatherum elatius (L.) Beauv. ex J.& C.Presl	1.0	16.7	15.7	47.6
Holcus lanatus L.	32.1	43.4	16.9	47.5
Deschampsia cespitosa (L.) Beauv.	0.6	0.8	1.0	2.8
Agrostis spp.	48.1	40.0	43.0	
Agrostis capillaris L.				70.9
Agrostis stolonifera L.				9.9
Phleum pratense L.	+	+	+	0.7
Alopecurus pratensis L.	22.6	34.7	43.8	37.1
Anthoxanthum odoratum L.	0.7	0.6	0.1	1.1

+ = observed

Nomenclature: Flora Europeae (1964-1980), Cambridge University Press.

Analyses of spring transect data have been made. In 1980 before treatments began the only significant effect was an apparent difference in amounts of *H.lanatus* on B plots. PP333 and mefluidide main plots had less *H.lanatus* on subplots which were subsequently cut in February 1981. The experiment area was uniform apart from this.

Statistically significant effects for the main mowing, retardant and subplot mowing are summarized in Table 23.

Consistent effects among the dicotyledons were few. *T.offinale* was encouraged on PP333 plots, while *R.acetosa* was encouraged by mefluidide. In general, mefluidide and PP333 plots maintained similar frequencies of dicotyledons as control plots (e.g. *Ranunculus* spp., *T.repens* and *P.reptans*). MH and MH + 2,4-D tended to reduce amounts of dicotyledons. Among the grasses, *F.rubra* was significantly reduced by PP333 on both PP333 and MH + PP333 plots. There was some evidence that MH and mefluidide increased amounts of *F.rubra*. Other effects caused by retardants were apparent increases in amounts of *L.perenne* on mefluidide and MH + 2,4-D plots in comparison to controls (amounts were in fact maintained, while they decreased on controls); lower frequencies of *Poa* spp. on MH plots, and of *D.glomerata* on mefluidide plots were noted. *A.elatius* was encouraged by PP333, while it was reduced on MH + 2,4-D plots. The resulting frequencies of grass species in August 1982, after three spring applications, are shown in Table 24. The effect of PP333 on *F.rubra* is particularly obvious.

Table 23

A summary of significant mowing and retardant effects on the frequency of species occurring in plots on experiment NC-4-80 at three times, in spring 1981 (1), 1982 (2) and in August 1982 (3).

Species	Time	Mowing	Retardant	Sub-plot cut in Feb. 1981
Ranunculus	1			
spp.	2			
	3		*** Control>1,4,5	
Stellaria graminea	3			* Cut<uncut
Trifolium repens	3		** Control=all;3=highest; 4=lowest	
Potentilla reptans	3		** 3=Control>rest	
Heracleum sphondylium	3			* Cut>Uncut
Rumex	2		** Only 3,1=Control	
acetosa	3		*** 3>all	** Cut<Uncut
Taraxacum	1		* Control=all;2=highest	
officinale	2		* Control=all;2=highest; 4=lowest	
	3		*** 2>Control>5,1,4	
Festuca	1		** Only 2<Control	
rubra	2		*** 2<5<Control<3,1	
	3		*** 2<5<rest	
Lolium perenne	3		** 3,4>Control	
Poa	1			* Cut>Uncut
spp.	2			* Cut>Uncut
	3		* Only 1<Control	
Dactylis	1	* A=B;A=C;B>C		
glomerata	2	* A=B>C		
	3		* Only 3<Control	
Arrhenatherum elatius	3	** A>B>C	*** 2>Control>4	
Holcus	1			*** Cut<Uncut
lanatus	2	* C=B>A		
Agrostis spp.	1			* Cut>Uncut
(capillaris)	3			** Cut>Uncut

Legend. A=Unmown; B=mown 2 weeks before spraying; C=mown 2 weeks after.
1=MH; 2=PP333; 3=mefluidide; 4=MH + 2,4-D; 5=MH + PP333.
*: P=0.05; **: P=0.01; ***: P=0.001.

Effects of mowing treatments were limited; mowing (B and C) encouraged *H.lanatus*, while it discouraged *A.elatius*. Late mowing (C) apparently reduced frequencies of *D.glomerata*. The subplot treatment in February 1981 had significant effects, reducing frequencies of *R.acetosa* and *H.lanatus*, and increasing frequencies of *Poa* and *Agrostis* species. In the cases of *Rumex*, *Poa* and *Agrostis* species the effect was significant in 1982.

Table 24
Average frequencies of grasses in quadrats on retardant treated plots. August 1982. Mean of mowing treatments
Experiment NC-4-80

Species	Control	MH	PP333	Mefluidide	MH + 2,4-D	MH + PP333
F.rubra	92	98	28	97	91	63
L.perenne	T	0	2	5	4	1
Poa spp	28	8	32	23	35	3
D.glomerata	70	68	58	44	53	72
E.repens	2	7	13	2	10	7
A.elatius	48	37	59	59	35	48
H.lanatus	51	35	53	58	39	49
D.cespitosa	3	3	3	6	2	1
A.capillaris	81	74	72	65	52	76
A.stolonifera	10	8	12	8	12	9
A.pratensis	40	37	49	20	40	38
A.odoratum	1	0	5	T	T	0

T = Trace, $<$ 1%

The effects of the retardants on the number of dicotyledon species was varied. Average numbers of dicotyledons per plot, taken from transect and quadrat assessments, are given in Table 25. The addition of 2,4-D reduced species number as expected. MH plots did not maintain dicotyledons, in contrast to road verge data (Willis, 1972). Only mefluidide maintained similar or greater numbers of dicotyledons as controls.

Table 25
Average number of dicotyledon species on plots treated with retardants. Transect data for spring 1980, 1981 and 1982; quadrat data for August 1982.

	Control	MH	PP333	Mefluidide	MH + 2,4-D	MH + PP333
1980	2.00	2.00	2.25	1.83	2.17	2.33
1981	1.56	0.89	1.44	1.33	0.33	0.78
1982	1.33	0.75	1.08	2.00	0.33	0.92
Quadrats	5.58	2.50	3.83	7.58	1.58	2.92

3.2.2.2. NC-1-81 Merrist Wood

Treatment details

A trial incorporating the same treatments as NC-4-80 was set out on an occasionally grazed *Agrostis-Festuca* sward at Merrist Wood. Plots were 2m by 2m with three replicates. A mixture of mefluidide + PP333 was included in the trials; doses were as follows:

MH	5.6 kg ha^{-1}
PP333	2.0
Mefluidide	1.0
MH + 2,4-D	5.6 +5.2
MH + PP333	4.0 +1.0
Mefluidide + PP333	0.75+1.0 and 0.15+1.5 in 1982

Treatments were applied in 1981 and repeated in 1982:

	1981	1982
Sprayed:	23.4.81	27.4.82
B cut:	9.4.81	13.4.82
C cut:	7.5.81	11.5.82
End-of-season cut:	13.11.81	11.5.82

Results

In 1981 both PP333 and mefluidide alone caused slight but acceptable sward discolouration; MH + PP333 plots showed more phytotoxic effects and mefluidide + PP333 plots were severely discoloured. A reduced amount of mefluidide in the mixture with PP333 resulted in a better appearance in 1982. Poorest appearance in the second season was found on MH + 2,4-D plots after 6 weeks. Mefluidide, mefluidide + PP333 and MH + PP333 plots had brownness scores which were statistically similar to MH + 2,4-D plots. MH and PP333 plots had scores similar to controls.

Sward heights measured in 1981 indicated that where there was greatest phytotoxicity (mefluidide + PP333 0.75 + 1.0 kg ha^{-1}) the plots were shortest. Poorest retardation was shown by MH and MH + 2,4-D (Fig.5). Mown B and C plots were shorter than unmown A plots. PP333-treated plots gave generally the best results. C mown mefluidide plots showed poorer retardation than B plots, indicating some removal of active material after spraying in 1981.

Statistical analysis of 1982 sward heights indicated that at 4 weeks mefluidide plots were shorter than all other treatments, which were in turn shorter than controls. By 6 weeks differences between retardants were less; mefluidide plots were shortest, but similar to mefluidide + PP333, and MH 2,4-D plots. By 12 weeks differences were no longer significant; mefluidide plots were similar to controls with mefluidide + PP333 plots shortest. There was no evidence of a later cut reducing mefluidide activity.

Grass flower head densities estimated in 1981 showed that mowing significantly reduced panicle numbers. Mefluidide gave the lowest numbers of heads (Table 26); significantly more were found on MH-treated plots. PP333 plots had densities significantly less than controls indicating some suppression of flowering, particularly of *Agrostis* and *Festuca* species which dominated the sward. In 1982, lower doses of mefluidide were included in the mixture with PP333 resulting in poorer inhibition of flowering (Table 26). Mefluidide again gave the lowest densities of grass heads, but in contrast to 1981 there was little indication of suppression by PP333; *L.perenne* appeared to be encouraged by PP333. Mowing treatments did not statistically affect densities in 1982.

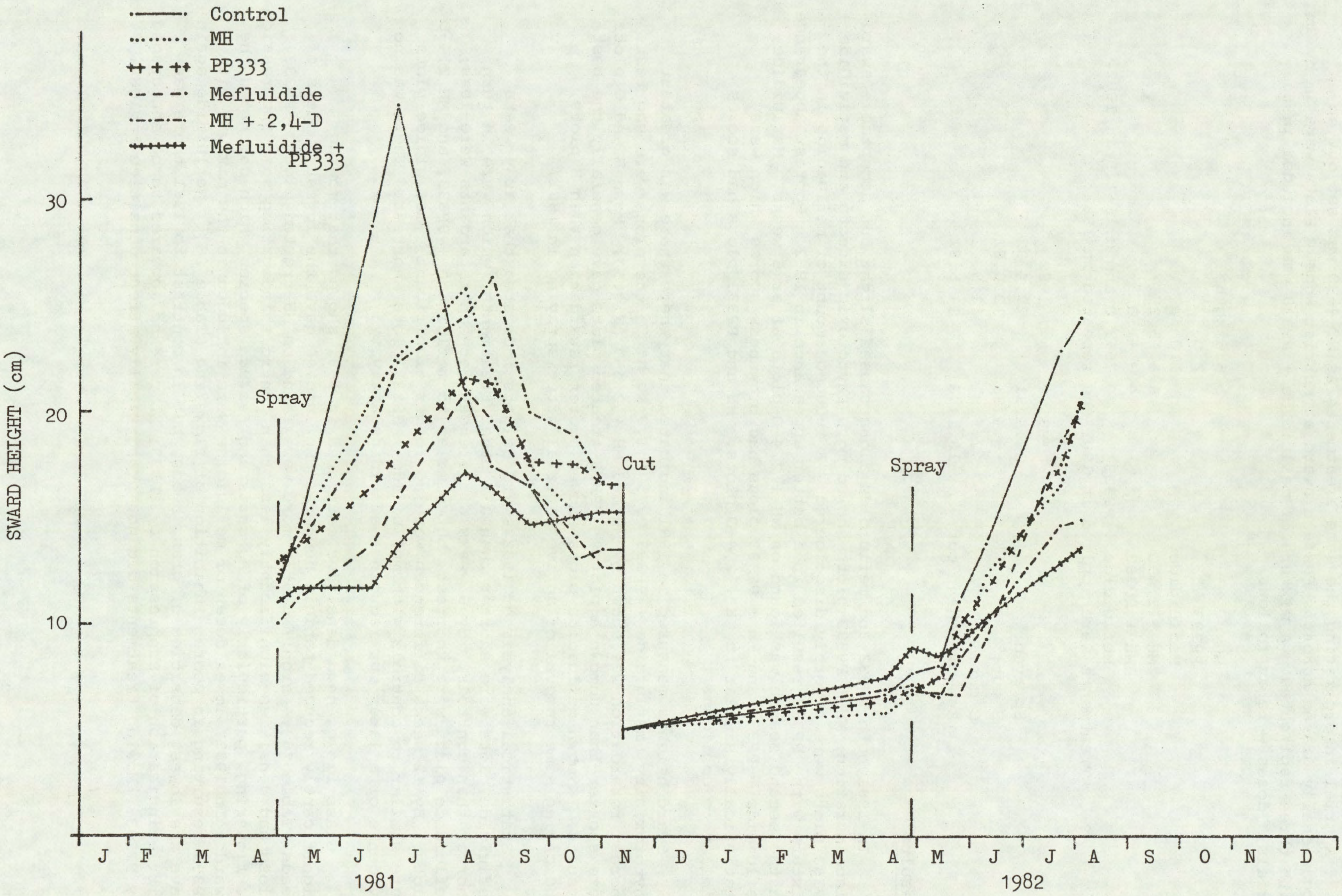

Fig.5. Sward heights (cm) of unmown (C) retardant-treated plots. Experiment NC-1-81

Table 26.
Maximum grass flower head densities (m^{-2}) on plots treated with retardants.
Data averaged for three mowing treatments. Experiment NC-1-81.
(T = Trace, $0.5m^{-2}$)

Species	Year	Control	MH	PP333	Mefluidide	MH+2,4-D	MH+PP333	Mefluidide + PP333
F.rubra	1981	33	18	17	10	20	24	9
	1982	38	27	30	10	20	37	40
Agrostis spp.	81	81	38	54	18	35	34	16
	82	45	25	33	1	19	22	11
L.perenne	81	12	9	12	6	7	4	7
	82	2	1	14	1	1	2	10
H.lanatus	81	12	14	16	4	13	8	4
	82	5	7	14	T	5	9	5
Poa spp.	81	14	5	7	2	3	5	2
	82	12	2	16	0	1	1	1
TOTAL	81	152	84	106	40	78	75	37
	82	102	61	107	12	46	70	67

3.2.2.3. NC-2-81 Merrist Wood

Treatment details

An area of gang-mown grass was selected and the following treatments applied on 23.4.81

MH	5.6 kg ha^{-1}
PP333	2.0
Mefluidide	1.0
MH + 2,4-D	5.6 +5.2
MH + PP333	4.0 +1.0
Mefluidide + PP333	0.75+1.0

The plots were mown to 5 cm 2 weeks after spraying on 7.5.81, and again at the end of the summer on 27.8.81. The sward composition, assessed by Merrist Wood students, was as follows:

Trifolium repens	79.3%
L.perenne	73.6
Poa spp.	52.4
Agrostis spp. (capillaris)	51.7
Taraxacum officinale	17.9
F.rubra	16.7

Results

At 4 weeks all plots showed differences to untreated controls, and discolouration was apparent on mefluidide and PP333 + mefluidide plots (score = 6). This had disappeared from mefluidide plots by 6 weeks, but light effects were seen on PP333, MH + PP333 and mefluidide + PP333 plots continuing to 10 weeks. These effects were acceptable, whereas initial appearance of mefluidide plots may not have been, particularly in a fine turf area. Broad-leaved species, particularly *Trifolium repens*, became prominent on PP333 and mefluidide + PP333 plots in August.

By four weeks, all sprayed plots were significantly shorter than controls, though mefluidide and PP333 + mefluidide plots were shorter than all others. At 8 weeks, while treatments were still shorter than controls, the foliar retardants, MH and mefluidide, gave swards taller than all PP333 treatments. MH + PP333 plots were shorter than all except PP333 + mefluidide plots. Two weeks later, at 10 weeks, control plots had lodged, and tallest plots were those treated with mefluidide. By 16 weeks control plots were flattened and lodging had occurred on MH, MH + 2,4-D and mefluidide plots. PP333 and PP333 + mefluidide plots were tallest.

Over the eight weeks after treatment MH and MH + 2,4-D treatments gave poor results. Mefluidide gave good initial retardation to 4 weeks, but by 8 weeks this had worn off. Best sward height retardation at 8 weeks was shown on PP333 plots, particularly the mixtures with MH and mefluidide.

Grass flower head densities 10 weeks after application were significantly reduced by the retardants (Table 27). Least effect on total number was given on PP333 plots, greatest on mefluidide + PP333 plots. Among individual grasses mefluidide and mefluidide + PP333 generally had greatest inhibitory effects. However, *L.perenne* was less affected (though not statistically) by these retardants, and there was evidence of *Poa annua* encouragement on MH + 2,4-D and mefluidide plots.

Table 27.
Flower head densities (m^{-2}) of major grasses, 10 weeks after spraying retardants. Experiment NC-2-81.

	Treatment							
	Control	MH	PP333	Mefluidide	MH+2,4-D	MH+PP333	Mefluidide + PP333	S.E.
L.perenne	81	29	58	38	19	23	30	7.9
Agrostis	112	28	35	16	28	17	8	4.9
F.rubra	15	15	24	5	9	16	5	2.1
Poa spp.	13	19	10	29	42	10	5	2.0
TOTAL	221	91	127	88	98	67	48	9.3

Maximum culm heights measured after 10 weeks indicated PP333 significantly shortened all the grass species. The only other effect was that mefluidide reduced *Agrostis* spp. culm height.

3.2.2.4. NC-3-81. Whiteleaf Cross Picnic Area

Treatment details

The six retardants and mixtures under investigation were applied on 22.4.81 to four 2m by 2m plots in two replicate blocks. Doses were as for previous trials, with mefluidide + PP333 at 0.75 +1.0 kg ha^{-1}. Plots were cut two weeks after spraying, and two of the four plots were subsequently cut, and one re-sprayed, in July. Treatments were as follows:

	Sprayed	Cut	Sprayed	Cut
A:	22.4.81	-	-	-
B:	22.4.81	6.5.81	-	-
C:	22.4.81	6.5.81	-	21.7.81
D:	22.4.81	6.5.81	8.7.81	21.7.81

The sward composition was as follows:

Poa spp.	84.6%	L.perenne	56.7%
Phleum pratense	55.8	H.lanatus (+ mollis)	53.3%
Ranunculus repens	47.5	Agrostis spp.	35.4

Results

All treatments caused some discolouration in June, the least on PP333 and MH plots (score = 2.75) and the worst on mefluidide + PP333 (score = 4). Waterlogging of the clay soil in April was an added stress factor. Mefluidide plots were markedly discoloured in May (score = 4.75), but recovered by June (score = 3). However, MH + 2,4-D and mefluidide + PP333 plots did not show the same recovery.

Unmown A plots were taller than cut plots for 13 weeks; thereafter the differences were obscured. Shortest plots (Fig.6.) were those treated with mefluidide + PP333, which also gave greatest discolouration. Mefluidide and MH + 2,4-D gave next shortest swards, though differences between treatments were not usually significant. MH and MH + PP333 gave poorer retardation than found elsewhere. In late season mefluidide and MH plots had best appearance because grass flowering was suppressed. Reapplication to the D plots on 7 July 1981 was followed by a cut on 21 July. Analyses indicated the retardants had no additional effect to mowing in terms of sward height, only mefluidide + PP333 (at 0.25 + 1.0 kg ha^{-1}) significantly reduced growth during the fortnight after re-application.

Ranunculus repens was flowering at the time of respraying. Mefluidide produced petal loss, indicating a direct effect. Further investigations on dicotyledon reactions to mefluidide are required.

Numbers of grass flower heads 13 weeks after the first application and 2 weeks after respraying D plots are shown in Table 28.

Table 28.
Total grass flower head densities (m^{-2}) 13 weeks after treatment.
Experiment NC-3-81

Mowing	Control	MH	PP333	Mefluidide	MH+2,4-D	MH+PP333	Mefluidide + PP333	Mean
A	138	123	161	86	126	161	69	124
B	133	118	132	66	96	136	55	105
C	119	102	129	57	74	106	62	93
D	140	94	112	49	61	106	27	84
	SE 13.9(for all)							SE 3.8 (for mowing means)
Mean	133	110	134	65	89	127	53	
	SE 8.7(for retardant means)							

Unmown A plots had significantly more heads than other mowing treatments. Mefluidide, mefluidide + PP333 and MH + 2,4-D were effective in reducing grass heads, while other retardants were not. Statistical analysis of individual grass species densities showed no effects on *H.lanatus*, *L.perenne*, *Poa* or *Agrostis* species. Densities of *Phleum pratense* were reduced by mefluidide treatments ($P < 0.05$). Densities of individual grasses on C and D plots given in Table 29, indicate that mefluidide and MH were less effective on *H.lanatus* than found elsewhere. Results indicated that MH had a greater effect on *L.perenne* than mefluidide, though not statistically.

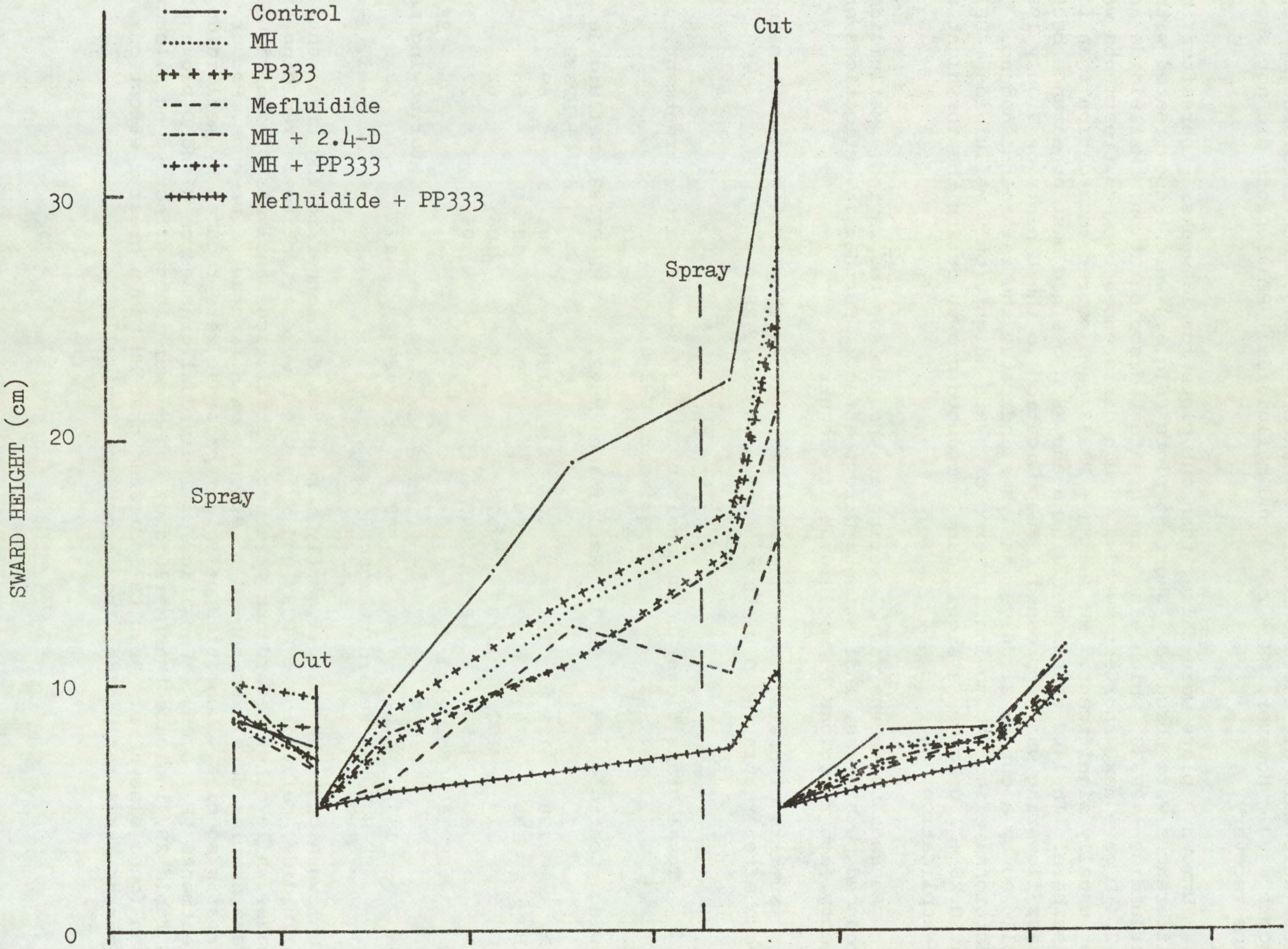

Fig.6. Sward heights of plots treated with growth retardants in April and July. Experiment NC-3-81

Table 29,
Grass head densities for four species 13 weeks after spraying on C and D plots.
Experiment NC-3-81

Mowing	Species	Control	MH	PP333	Mefluidide	MH+2,4-D	MH+PP333	Mefluidide + PP333
C	H.lanatus	38	58	26	35	16	34	34
	P.pratense	33	32	61	5	31	45	9
	L.perenne	28	9	23	14	12	18	13
	Poa spp.	13	4	15	3	9	5	10
D	H.lanatus	36	41	21	20	33	31	10
	P.pratense	54	44	50	4	8	54	1
	L.perenne	36	8	26	23	14	12	14
	Poa spp.	10	5	14	3	4	9	2

At 8 weeks the maximum height of all grasses was affected by the retardants, with the exception of *L.perenne* which was not affected by mefluidide. At 13 weeks no treatment affected *L.perenne*, *H.mollis* or *Agrostis* spp. height. Mefluidide plots maintained shortest *H.lanatus*, *P.pratense* and *Poa* spp. MH no longer affected *P.pratense*, but reduced maximum height of the other two grasses. There were indications that PP333 reduced lodging, probably by strengthening culms.

In Spring 1982 insufficient data on the sward composition was collected for statistical analyses to be made. Nevertheless there were indications that *H.lanatus* was generally reduced in frequency, especially on uncut A plots. *L.perenne* also declined on A plots. *T.repens* was apparently encouraged on mefluidide + PP333 plots.

3.2.2.5. NC-6-81 WRO

Treatment details

The experiment was set up adjacent to NC-4-80 on permanent pasture which had previously been grazed. The design of the trial was similar, though half of the main plots were re-sprayed in July, in order to investigate season-long retardation. Main plots 4m by 6m, were divided into 2m by 4m split plots receiving the three mowing treatments A (uncut), B and C. Half of each split plot was re-sprayed in July. Three replicates were laid out, and the various treatments applied in 1981 and 1982, are listed in Table 30.

Table 30
Treatments and dates of treatments applied on experiment NC-6-81

Treatment	1981		1982	
Date spray	21.4.81	8.7.81	15.4.82	5.7.82
Retardants (kg ha^{-1})				
MH	5.6	5.6	5.6	4.0
PP333	2.0	2.0	2.0	1.0
Mefluidide	1.0	1.0	1.0	0.5
MH + 2,4-D	5.6 +5.2	5.6 +5.2	5.6 +5.2	4.0 +3.6
MH + PP333	4.0 +1.0	4.0 +1.0	4.0 +1.0	4.0 +1.0
Mefluidide + PP333	0.75+1.0	0.25+1.0	0.25+1.0	0.1 +1.0
Date of B cut:	2.4.81		2.4.82	
Date of C cut:	5.5.81		30.4.82	
End-of-season cut:	11.11.81		3.12.82	

Results

During 1981 plot scores were not collected. However, obvious discolouration was noted on mefluidide + PP333 plots for the summer, probably resulting from the high dose of mefluidide. Temporary effects were noted on mefluidide and MH plots. During 1982 brownness scores were greater for C mown plots than for A or B plots. PP333 plots had similar appearance to controls for 8 weeks. Poorest appearance was found on mefluidide, MH + 2,4-D and mefluidide + PP333 at 10 weeks. By 15 weeks mefluidide-treated plots had improved, and after 18 weeks mefluidide-only plots had better appearance than controls. Among July re-sprayed subplots poorest scores were found on MH + 2,4-D plots. Six weeks after re-spraying, subplots receiving PP333, mefluidide + PP333 and MH were similar to controls; mefluidide and MH + 2,4-D subplots were poorest.

Analyses of 1981 sward height data showed a significant effect of mowing, with A>B>C for seven weeks from spraying. In 1982 C plots were significantly shorter than A or B plots for 15 weeks. Retardants gave significantly shorter swards than controls for the 1981 season. At four weeks, mefluidide plots were shortest, and were similar to mefluidide + PP333 (marked phytotoxicity) and MH + PP333 plots. By ten weeks the effects of foliar-acting retardants were wearing off; PP333-treated plots were shorter. Following the July 1981 re-application all retardants except MH maintained shorter swards than with a single spray. Mefluidide + PP333 subplots were shortest but similar to mefluidide, MH + 2,4-D and MH + PP333 subplots.

In 1982 shortest swards, up to eleven weeks after spraying, were found on mefluidide, mefluidide + PP333 and MH + 2,4-D plots, though few significant differences between treatments were found. While PP333 plots were shorter than controls from five weeks, they were taller than other retardant plots. A significant carry-over effect from 1981 on subplots which received two doses of PP333 was observed, though this had disappeared by seven weeks. Four weeks after the July 1982 re-application mefluidide plots and MH-treated subplots were shorter than PP333 and control plots. Seven weeks after re-application mefluidide gave consistently shortest subplots.

Densities of grass flower heads were estimated in June, July and August in both 1981 and 1982. Maximum densities are given in Table 31. Effects of mowing on total densities were not significant. In 1981 lowest total densities were found on mefluidide and mefluidide + PP333 plots; in 1982 mefluidide again had lowest densities. PP333 did not statistically affect grass flowering. Among the individual grasses the following significant effects were noted:
F.rubra: Mefluidide gave lowest densities. In 1981 mefluidide + PP333 also reduced *F.rubra* heads.
L.perenne: Head numbers remained higher than controls in 1982 on PP333 and mefluidide + PP333 plots.
Poa spp.: Only PP333 plots maintained densities similar to control plots; foliar retardants significantly suppressed flowering.
D.glomerata: In 1981, PP333 and MH + PP333 plots had similar head densities to controls. In 1982 only PP333 plots were similar to controls; both MH and mefluidide suppressed flowering.
A.elatius: The species increased from 1981 to 1982, and only mefluidide and MH + 2,4-D successfully suppressed flowering.
H.lanatus: In 1981, PP333 and MH plots had similar densities to controls. Other retardants were similar to each other in effect. In 1982 greatest suppression was shown by mefluidide and MH + 2,4-D, with MH less effective. PP333 did not affect flowering.
Agrostis spp.: Mefluidide gave best suppression, with MH significantly poorer. PP333 did not affect flowering.
A.pratensis: PP333 had no effect on head numbers. Other retardants were equally effective in suppressing flowering.

Table 31.
Maximum densities (m^{-2}) of grass heads on retardant-treated plots in 1981 and 1982. Mean of 3 mowing treatments.
Experiment NC-6-81.

Species	Year	Control	MH	PP333	Mefluidide	MH+2,4-D	MH+PP333	Mefluidide + PP333
F.rubra	1981	26	13	19	5	13	14	3
	1982	7	3	4	T	4	5	5
L.perenne	81	23	3	5	2	3	5	3
	82	1	T	6	T	1	1	4
Poa spp.	81	27	6	22	2	7	6	2
	82	17	T	11	T	T	1	T
D.glomerata	81	13	4	8	1	1	7	1
	82	7	T	9	T	T	1	2
A.elatius	81	2	2	2	1	1	3	1
	82	8	7	11	1	1	13	10
H.lanatus	81	33	31	26	18	17	23	19
	82	11	4	16	T	1	10	9
Agrostis spp.	81	34	10	29	1	14	22	7
	82	62	18	46	1	9	37	9
A.pratensis	81	10	3	12	T	1	3	T
	82	16	1	22	T	1	2	T
Other species	81	10	3	7	3	5	4	1
	82	5	1	3	T	T	1	1
Total	81	178	75	130	33	62	87	37
	82	134	35	128	3	17	70	41

T=Trace, <0.5 m^{-2}

Maximum heights achieved by individual grass species were measured in July 1981 and 1982. In 1981 all retardants reduced heights of *H.lanatus*, *Poa* and *Agrostis* species. MH did not affect height of *F.rubra* while other retardants were effective. In 1982, PP333 reduced heights of *F.rubra*, but did not affect *A.elatius*, *H.lanatus* or *Agrostis* spp. height. Mefluidide gave shortest plants of the latter four species; less effect was noted with MH.

Sward composition

Changes in the composition of the treated swards were assessed by analysing transect and quadrat data collected in 1982. The average frequencies of species are given in Table 32., together with those species recorded as present in plots at other times. There were indications that *L.perenne*, *F.rubra*, *Poa* spp. and *H.lanatus* were declining, while *A.elatius* and *Agrostis* spp. were increasing.

Table 32.
The occurrence of plant species in experiment NC-6-81 over two seasons. Average frequencies from all plots.

	1981	1982	Quadrats
	% Frequency		
Dicotyledons			
Ranunculus spp.	8.5	5.7	6.1
Ranunculus acris L.	+	+	0.7
Ranunculus repens L.	+	+	+
Ranunculus bulbosus L.	+	+	+
Ranunculus ficaria L.	+	+	+
Capsella bursa-pastoris (L.) Medicus	+		
Cardamine pratensis L.	0.2	0.1	
Cerastium fontanum Baumg.	1.5	0.2	1.7
Stellaria spp.	1.4	1.6	
Stellaria media (L.) Vill.			
Stellaria graminea L.			3.6
Trifolium repens L.	1.3	1.0	6.9
Trifolium pratense L.		+	0.2
Lathyrus pratensis L.	+	+	0.2
Potentilla reptans L.	0.1	+	1.0
Sanguisorba officinalis L.	0.6	0.1	9.6
Epilobium roseum Schreber			0.2
Anthriscus sylvestris (L.) Hoffm.	+	+	0.2
Conopodium majus (Gouan) Loret		+	0.4
Heracleum sphondylium L.	0.2	0.4	1.3
Polygonum aviculare agg.			0.6
Rumex acetosa L.	1.7	1.0	11.2
Veronica spp.	0.6	0.6	
Veronica chamaedrys L.	+	+	1.7
Veronica serpyllifolia L.	+	+	0.2
Plantago lanceolata L.			0.1
Galium aparine L.	+	+	
Bellis perennis L.	0.1		
Achillea millefolium L.	0.1	0.1	0.5
Leucanthemum vulgare Lam.			0.7
Cirsium vulgare (Savi) Ten.			0.3
Sonchus sp.			0.1
Taraxacum officinale Weber, sensu lato	2.9	0.6	3.3
Monocotyledons			
Luzula campestris (L.) DC.	+	0.2	
Festuca rubra L.	95.0	79.4	94.0
Lolium perenne L.	4.0	2.0	4.1
Poa spp. including P.annua L., P.pratensis L.	70.6	46.8	41.0
Dactylis glomerata L.	47.4	34.8	72.7
Cynosurus cristatus L.	+	+	
Bromus hordaceus L.	+	+	
Elymus repens (L.) Gould			0.2
Avenula pubescens (Hudson) Dumort.	2.1	1.6	3.1
Arrhenatherum elatius (L.) Beauv. ex J.& C.Presl	1.3	4.7	33.0
Holcus lanatus L.	55.3	21.0	63.2
Deschampsia cespitosa (L.) Beauv.	3.6	2.5	7.6
Agrostis spp.	26.1	39.9	
Agrostis capillaris L.			77.1
Agrostis stolonifera L.			4.2
Phleum pratense L.	+	+	0.4
Alopecurus pratensis L.	50.1	50.9	38.7
Anthoxanthum odoratum L.	4.0	1.0	4.4

+ = observed in plots
Nomenclature: Flora Europeae (1964-1980), Cambridge University Press.

Among the dicotyledons, *T.repens* was only found on PP333-treated plots in the spring transect assessment. In August statistically significant effects were found for *Ranunculus* spp., *R.acetosa* and *S.officinalis*. PP333 plots supported similar frequencies of *Ranunculus* spp. to controls. MH + PP333, mefluidide + PP333 and mefluidide plots had less of the species. Variable effects on *R.acetosa* were indicated; the species was more common on C mown plots. On uncut A plots all retardants gave lower frequencies than on controls, while the species was absent on MH and PP333 plots. On C plots, these retardants apparently reduced frequencies of *R.acetosa*, but on B plots MH and PP333 plots supported significantly higher frequencies than control plots. Only MH plots had frequencies of *S.officinalis* similar to control plots.

Effects on grass species are shown in Table 33 and described below:

Table 33
Average frequencies of grass species recorded in quadrats from retardant treated plots. Means of mowing and retreated subplots.
Experiment NC-6-81

	Frequency (%)						
Species	Control	MH	PP333	Mefluidide	MH+2,4-D	MH+PP333	Mefluidide + PP333
F.rubra	98	96	96	97	86	91	94
L.perenne	2	3	4	5	7	5	3
Poa spp.	37	26	39	32	52	59	41
D.glomerata	76	68	63	66	73	78	85
A.pubescens	1	3	1	2	7	4	4
A.elatius	36	36	33	33	34	27	32
H.lanatus	64	58	72	64	60	63	61
D.cespitosa	3	10	11	9	7	8	6
A.capillaris	78	75	75	81	74	77	81
A.stolonifera	7	6	2	2	3	3	7
A.pratensis	32	43	32	28	47	38	51
A.ordoratum	3	1	6	3	4	5	8

F.rubra: In spring, data analyses indicated mefluidide and MH + 2,4-D plots had greater amounts than controls. PP333 plots had less. In August, there was no evidence that PP333 reduced amounts of *F.rubra* (Table 33). No differences between chemicals were found on B and C cut plots, but on uncut A plots *F.rubra* was reduced by MH + 2,4-D, MH + PP333 and mefluidide + PP333.
Poa spp.: Meadow grasses were reduced by MH + PP333, MH and mefluidide, in spring. By August, more *Poa* spp. were found on MH + PP333, MH + 2,4-D, PP333 and mefluidide + PP333 plots than on other treatments (Table 33). On A plots only MH + PP333 had higher frequencies to controls; on B plots only MH + 2,4-D plots had more than controls. On C plots less *Poa* spp. were found on MH and mefluidide plots; other plots were similar to controls.
D.glomerata: A single application of MH + PP333 increased amounts of *D.glomerata* recorded in spring. A second application in July obscured this effect. Quadrat data showed lowest frequencies on PP333, mefluidide and MH plots. On A plots these frequencies were similar to controls; on B plots, controls had significantly greater amounts of *D.glomerata*. On C plots, only PP333 gave frequencies lower than on controls.
A.elatius: A significant mowing effect was recorded from the August data, with less found on re-sprayed B mown subplots than on A or C plots.
H.lanatus: Spring data indicated a general reduction on re-sprayed subplots; an effect also found in August on A and B, but not C, plots.
Agrostis spp.: Bents were apparently encouraged on re-sprayed subplots which were not mown (A), though the effect was not apparent in the August assessment.
A.pratensis: In spring unmown A plots which were treated only once in 1981 had

significantly more of the species than other treatments. In August there was an interaction between mowing and retardants; on A plots PP333 and mefluidide plots had similar amounts to controls, while other retardants encouraged the species. On B plots all retardants reduced *A.pratensis* except mefluidide + PP333 and MH + 2,4-D. On C plots, MH gave greater amounts than other retardants.

The number of dicotyledon species on the plots from the transect and quadrat assessments are given in Table 34.

Table 34
Average number of dicotyledon species per $8m^2$ plot in Spring 1981 and 1982, and in August 1982. Experiment NC-6-81

	Control	MH	PP333	Mefluidide	MH+2,4-D	MH+PP333	Mefluidide + PP333
1981	1.0	2.7	2.2	2.0	2.0	2.2	1.9
1982	1.4	1.1	1.7	1.4	0.4	0.6	1.4
Quadrats	5.6	3.0	3.7	7.2	1.8	2.9	4.7

There were indications of reductions where 2,4-D had been applied, and also on MH + PP333 plots. After two spring applications highest numbers of dicotyledons were found on mefluidide plots, with reasonable numbers on PP333 and mefluidide + PP333 plots.

3.2.2.6. NC-7-81 WRO

Treatment details

The experiment was set up to investigate the effects of applying mefluidide and MH at different times in spring and summer. The retardants were applied at 1.0 and 5.6 kg ha^{-1} respectively onto three replicate 2m by 2m plots on seven occasions:

A	17.4.81
B	29.4.81
C	8.5.81
D	21.5.81
E	27.5.81
F	3.6.81
G	19.6.81

Plots were not mown.

Results

No effects on brownness were recorded following application at times E,F and G. Following A,B and C spraying, mefluidide plots were more discoloured than MH plots giving an initial scorch over the first 2 weeks. MH also gave scorch after A and B spraying. At time D, the retardants had similar effects, giving a peak of brownness in July.

Application times spanned the period of sward growth and grass flowering, with the G application almost coinciding with maximum sward height. In late June, significant height retardation was found on both MH and mefluidide plots sprayed on dates A to E. Mefluidide plots were consistently shorter than MH plots. By July, mefluidide plots were significantly shorter than MH plots for applications up to date E (27.5.81), after which flowering was too advanced for suppression. Generally better results were given by mefluidide, especially by earlier applications.

Grass heads were counted in late August 1981. Analyses indicated that total head densities were significantly reduced on MH plots treated in April

(A), and on mefluidide plots sprayed on the first three application dates (Table 35).

Table 35
Total grass head densities in August on plots treated on different dates with MH and mefluidide.
NC-7-81

	Date	MH	Mefluidide	Control
A	17.4	44*	32*	94
B	29.4	61	38*	
C	8.5	74	38*	
D	21.5	106	87	
E	27.5	86	90	
F	3.6	109	100	
G	19.6	113	108	

S.E.=12

* Significantly ($P<0.05$) less than control plots

Analyses of individual grass species densities indicated significant effects were only produced in late-flowering grasses, *Agrostis* spp. and *Deschampsia cespitosa*. With these grasses the retardants caused significant suppression of flowering over the first six applications, though by the last date, MH was not effective. Statistically there were no differences between MH and mefluidide except on plots receiving the latest application.

Whilst the statistical analysis revealed only major effects on two species, the data indicated that early application affected other species. MH reduced densities of flower heads of *A.pratensis* at times A and B, *D.glomerata* at times A to C, and *Poa* spp. at times A and B. Mefluidide reduced head densities at application times A, B and C of *A.pratensis*, *D.glomerata*, *Festuca rubra* and *Poa* spp.

3.2.2.7. NC-8-81 Ferry Meadows Country Park

Treatment details

Two application methods were investigated with the retardants MH and mefluidide; finite doses were applied either by OPS at 200 l/ha, or using a Micron Herbi controlled droplet application (CDA) sprayer producing 250 u droplets and spraying at about 10 l/ha. MH was applied at 3.75 kg ha^{-1} and mefluidide at 1.0 kg ha^{-1}, to three replicate 2m by 4m plots on 12.5.81. The major sward components were *L.perenne* (87%), *E.repens* (79%) and *Agrostis* spp. (72%). Plots were not mown after spraying.

Data were collected in collaboration with Orton Longueville School, Peterborough.

Results

All retardant treatments caused unacceptable discolouration six weeks after treatment, possibly as a result of the amounts of *E.repens* and *L.perenne* in the sward and the late spring application when the sward had already reached 15 cm.

Sward height measurements indicated that by six weeks all treatments were active, with mefluidide applied by OPS giving shortest swards. MH applied by OPS gave next shortest swards, followed by mefluidide applied by CDA.

3.2.2.8. NC-9-81 Marlborough College

Treatment details

This trial was identical in design to NC-8-81. MH and mefludide at 3.75 and 1.0 kg ha^{-1} respectively were applied by OPS or Micron Herbi (CDA) sprayer on 13.5.81. The site was sown, gang mown grass on reclaimed land. Soil depth was about 2 cm over chalk rubble. Major sward components were *Poa annua* (99%), *Agrostis* spp. (46%), *L.perenne* (39%), *T.repens* and *Medicago lupulina* (90%) and *Bellis perennis* (37%). Plots were mown two weeks after treatment.

Data were collected in collaboration with Marlborough College.

Results

A fortnight after application, mefluidide plots had marginally higher brownness scores than MH or control plots. By June, scores for MH plots were the same or greater than for mefluidide; CDA applied mefluidide plots were similar to controls. Acceptable appearance was maintained.

Before plots were mown, two weeks after spraying, all sprayed plots were shorter than controls. Mefluidide OPS plots were shortest, significantly lower than mefluidide CDA and MH OPS plots. At six weeks, after the cut, differences in sward height were greater between application methods, with OPS treatments giving slightly shorter swards.

Grass flower head densities were estimated after 6 and 19 weeks (Table 36). At 6 weeks all the retardants reduced flower head densities. Mefluidide applied by OPS and both MH treatments were more effective than mefluidide applied using CDA. *L.perenne* flowering was not suppressed by CDA mefluidide applications. At 19 weeks no significant effect on head densities remained.

Table 36
Total grass head densities (m^{-2}) on plots sprayed with retardants conventionally (OPS) or using CDA
NC-9-81

		MH		Mefluidide		
Week	Control	OPS	CDA	OPS	DA	
6	54	14	14	11	39	S.E.:3.0
19	27	20	17	12	30	S.E.:5.5

3.2.2.9. NC-2-82 WRO

Treatment details

An area adjacent to experiment NC-6-81 on permanent pasture was used to investigate the effects of some newer growth retardants applied by OPS. Retardants were applied on 5.5.82 to three replicate 2m by 6m plots. Main plots were divided into 2m by 2m subplots which were (A) uncut, (B) cut on 2.4.82 or (C) cut on 19.5.82 after spraying. Retardants were as follows:

	kg ha^{-1}
Mefluidide + 2,4-D	1.0 + 5.0
Dikegulac	7.0
Dikegulac (+ mecoprop + 2,4-D) as "Dasul"	7.0
EL 500	1.0
WL 83801	3.0
WL 83801	6.0

Dikegulac and mefluidide are taken up through the foliage, while the latter two coded compounds are taken up through the roots.

Initial sward composition was similar to that of NC-6-81 (Table 32) with the exceptions of less *D.glomerata* and more *Agrostis* spp.

Results

Mefluidide + 2,4-D plots had poorest appearance for 8 weeks. After 12 weeks these and dikegulac alone plots had significantly lower brownness scores than other treatments, reflecting a lack of grass panicles, lodging and senescence. At 4 weeks EL 500 and WL 83801 had no effect on the swards; dikegulac plots, though better than mefluidide, had poorer appearance than controls.

A delay of five weeks occurred between the B cut and spraying, and no significant sward height difference between A and B subplots were recorded. C plots were significantly shorter for 15 weeks. Mefluidide + 2,4-D plots were shortest for the same period, while dikegulac and "Dasul" plots were shorter than controls between 4 and 8 weeks. The soil-acting retardants had no significant effect.

Grass flower head densities were estimated after 6 weeks, and total densities are given in Table 37.

Table 37
Total grass head densities six weeks after application of some newer retardants.
NC-2-82

Control	Mefluidide + 2,4-D	Dikegulac	Dikegulac as "Dasul"	EL 500	WL 83801 3.0 kg ha^{-1}	WL 83801 6.0
199	31	121	157	198	193	163
					S.E. = 9.1	

Mefluidide + 2,4-D gave lowest densities. Both dikegulac treatments and the higher dose of WL 83801 also had lower densities than controls. Analyses of individual grass species indicated that the only effect the soil-acting retardants had was for WL 83801 at 6.0 kg ha^{-1} to reduce *Agrostis* spp. (*capillaris*) densities. Mefluidide gave lowest densities of *A.elatius*, *A.pratensis*, *H.lanatus*, *Poa* spp. and *Agrostis* spp. Dikegulac alone had significant effects on densities of *H.lanatus* and *Poa* spp. Dikegulac as "Dasul" gave lower densities of *A.elatius* and *Poa* spp., though in the latter case it was less effective than dikegulac alone. As "Dasul", dikegulac encouraged the flowering of *Agrostis* spp..

The soil-acting retardants were adversely affected by extremely dry conditions before and after spraying (no rain for 17 days after application). Dikegulac gave some limited sward retardation, and mefluidide performed as expected.

3.2.2.10. NC-5-82 Wooburn Green Picnic Area

Treatment details

Larger areas of sown amenity grass were treated on 5.5.82 as follows:

MH	5.6 kg ha^{-1}	180 m^2
MH + 2,4-D	5.6 + 5.2	200 m^2
Mefluidide	1.0	250 m^2

Sward composition assessments revealed the following:

P.annua	98%	L.perenne	91%
D.glomerata	38%	T.repens	31%
E.repens	27%	Agrostis spp.	20%
Ranunculus spp.	20%		

Results

After 4 weeks treated areas were much shorter than untreated areas with mefluidide giving shortest swards. Some phytotoxicity was apparent on the three plots, the worst on mefluidide treated areas which appeared tussocky with clumps of *L.perenne*. A dose of 1.0 kg ha^{-1} appears to be too high for short grass, and there is information which indicates *L.perenne* is less susceptible to mefluidide than other species. In August after the area had been mown, the plots had poor but acceptable appearance. The dry weather conditions after spraying may have contributed to poor appearance, particularly affecting *P.annua*.

3.3 Discussion

3.3.1. Results with growth retardants.

Six compounds (Table 17) have been investigated in log-sprayed and finite dose experiments. Dikegulac, a retardant sold as "Atrinal" or "Cutlass" for use on trees and shrubs, is only active on grasses at high rates (> 7.0 kg ha^{-1}). Experiences with the soil acting compounds EL 500 and WL 83801 are limited. On the two occasions EL 500 was applied, in summer and a dry spring, no activity was recorded. Little activity was found with WL 83801 on the one occasion it was tried. Both compounds, being soil-active, require sufficient soil moisture for movement, and it is likely that dry conditions at application contributed to poor results.

The majority of experiments have investigated maleic hydrazide (MH), mefluidide and PP333 (paclobutrazol). The attributes of these retardants are summarized in Table 38. Spring applications gave best results. MH and mefluidide, both foliar retardants, had similar effects on swards. Mefluidide was faster in its effect than MH, and gave better inhibition of flowering in grasses. Under stress conditions both compounds could give some phytotoxity; mefludide plots treated at 1.0 kg ha^{-1} showed worst effects. The acceptability of the effects is subjective, but in most trials plots appeared reasonable for rural situations. In finer areas poorer results were found (NC-2-81, NC-5-82) and lower rates of mefluidide (0.5-0.75 kg ha^{-1}) may be appropriate. Foliar retardants did not work well where there was much standing dead vegetation to intercept sprays. Tall vegetation can be cut before spraying, if sufficient time elapses for regrowth to occur. Mowing at application can improve the uniformity of the sward. Short swards (<15 cm) can be successfully mown a fortnight before, or preferably a fortnight after spraying. Product recommendations allow a period of about seven days before mowing. An investigation into the time of application over spring and summer (NC-7-81), indicated that early spraying was best. April applications gave best results.

Table 38.
A summary of the attributes of MH, mefluidide and PP333.

Chemical	Mode of uptake	Speed of effect	Period of suppression (weeks)	Inhibition of flowering	Effects on species: Fine	Coarse
MH	Foliar	+	8 - 10	+	+	++
Mefluidide	Foliar	+++	8 - 10	++	+	++
PP333	Soil	+ (dependant on rainfall)	8 - 14	-	++	+/-

Both foliar retardants affect the composition of the sward. Broad leaved grasses are more affected than fine leaved species, so that more desirable fine species are encouraged, notably *F.rubra* (NC-4-80). This agrees with the effects of MH on road verge floras (Willis & Yemm, 1966; Willis, 1972). Most grasses are retarded for the 8-10 week period, but there was some evidence that *L.perenne* was less affected by mefluidide (NC-2-81, NC-5-82). Among the dicotyledons evidence has been collected that repeated use of MH may reduce species number, whereas mefluidide at least maintains species number (Tables 25 & 34), if not improving it. This compound has been observed to affect the flowering of dicotyledons (NC-1-80, NC-3-81), but the effect has yet to be characterised.

Soil-acting PP333 is dependant on moist conditions for movement in the soil, and on rainfall to wash sprayed material into the root zone. In 1980 and 1982 dry spring weather delayed activity, while almost immediate effects were seen in 1981 (NC-4-80). The compound does not inhibit flowering, though culm heights of some species are shortened and strengthened so that lodging is prevented or delayed. Not all species are equally affected; finer grasses are well retarded, but deep rooted species are less affected. *A.elatius* is not affected by PP333. The consequence of repeated use of PP333 in mixed swards is likely to be the encouragement of less or unretarded species which are often undesirable. Nevertheless, the longevity of activity is attractive, and in situations where only susceptible species are present it may be useful.

Two mixtures of retardants have been investigated; MH + PP333 and mefluidide + PP333. The MH + PP333 (4.0 + 1.0 kg ha^{-1}) combination gave good results in 1980, as the effects of the two compounds were staggered. MH was active initially; dry weather prevented P333 from becoming active for about six weeks. In 1981, the retardants were active at the same time, giving more vigorous suppression with consequent poorer appearance. In 1982 the combination gave swards consistently, though not significantly, taller than other retardants except PP333 alone. The mefluidide + PP333 mixture was investigated from 1981. The selected dose of 0.75 + 1.0 kg ha^{-1}, while producing excellent control of sward height (generally better than mefluidide (1.0 kg ha^{-1}) alone), also produced marked discolouration. Subsequent applications have examined reduced amounts of mefluidide in the mixture. Reduced mefluidide doses resulted in poorer suppression of flowering, though *Agrostis* spp. remained susceptible. Less phytotoxicity occurred with less mefluidide, and on finer swards (NC-1-81) with longevity of activity, the combination gave best long-term retardation. It would appear that the mefluidide + PP333 mixture has more potential than the MH mixture giving more predictable effects. However, the mefluidide mixture may be limited to finer swards, as coarser grasses will be unaffected by PP333 and higher doses of mefluidide ($>$0.25 kg ha^{-1}) may be required to suppress flowering. In mixed species swards there may be no advantage in adding PP333.

The control of dicotyledons as well as grass retardation may be required in some situations. A proprietary mixture of MH + 2,4-D has been investigated, and in one trial a mefluidide + 2,4-D mixture has been applied. MH + 2,4-D has given consistently, though not significantly, better retardation than MH alone, giving control of most dicotyledons present at the time of spraying. In 1982, applications of MH + 2,4-D to trials NC-4-80 and NC-6-81 produced unexpected phytotoxicity on the grasses, the reasons for which are unknown. The combination of mefluidide + 2,4-D was successfully applied in 1982, giving good sward retardation and dicotyledon control. The mixture has been reported (Pers comm. 3M) to reduce retardation, but the amount appears not to be significant.

The use of applicators other than knapsack sprayers has been briefly investigated (NC-8-81, NC-9-81). It would appear that MH and mefluidide can be applied with the Micron Herbi CDA sprayer, though activity did not usually match that achieved with precision spraying (OPS). The use of CDA equipment may be of particular use on slopes or where the creation of paths is required.

3.3.2. Costs

At the present time, only MH is freely available. Both mefluidide and PP333 have yet to receive commercial clearance in the UK, though the firms concerned are preparing applications. The estimated cost of applying MH or MH + 2,4-D is £40 - £50 ha^{-1} excluding labour. This needs to be compared with mowing costs. Available figures for various operations are given by Parker (1982) (Table 39).

Table 39
Maintenance costs, including labour, using different types of mower.

Mower type	Cost £ ha^{-1}	Number of cuts per year	Total cost £ ha^{-1} $year^{-1}$
500 mm cylinder mower	66.80	24	1603.00
500 mm cylinder mower (cuttings removed)	76.80	24	1844.00
500 mm rotary mower	94.90	6	569.00
450 mm "Hover" rotary (on banks)	251.70	4	1007.00
1.7m Triple cylinder mower	22.20	12	266.00
3.5m 5 Unit gangmower	7.00	24	168.00
2.1m Tractor rear-mounted flail	28.50	2	57.00

Figures given by a Borough Council Work Studies Department in August 1981 are shown in Table 40. Essentially similar figures emerge from the two Tables. Pedestrian-controlled machines are generally expensive to use. Banks are also difficult and costly to mow. Extensive areas can be looked after cheapest either by gang mowing frequently or flail cutting twice a year.

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