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Tolerance of flax to pre- and post-emergence herbicides

Hørs tolerance over for jord- og bladherbicider

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Summary

The tolerance of flax to a number of pre- and post-emergence herbicides was tested in ten trials from 1985 to 1990. Screening experiments were carried out from 1985 to 1987, and yield trials were carried out from 1988 to 1990. Pre-emergence herbicides were tested in combination with watering shortly after the herbicide treatment in order to intensify an eventual damaging effect on the crop.

Trifluralin, linuron and lenacil could be used pre-emergence without causing crop damage. Chlorsulfuron, used pre-emergence, caused serious crop damage, when the herbicide treatment was followed by watering. Cyanazine and pendimethalin used pre-emergence also caused serious crop damage.

The best crop tolerance to post-emergence herbicides was found with bentazone, chlorsulfuron and clopyralid. Treatment with a number of other post-emergence herbicides and herbicide combinations caused crop damage varying from minor temporary damages and to serious damages reducing the yield to half of untreated. Listed according to decreasing crop tolerance results in the following ranking: metsulfuron methyl, bromoxynil, ioxynil, MCPA, mechlorprop, metsulfuron methyl + thifensulfuron and tribenuron methyl. With five selected post-emergence herbicides, no difference in crop tolerance was found on the 5-10 cm and 15-20 crop growth stage.

The weed control obtained after use of the pre-emergence herbicides were in order of decreasing effect: linuron, linuron + lenacil, chlorsulfuron and trifluralin. The post-emergence herbicides in general controlled the weeds satisfactorily, and they were more effective than the pre-emergence herbicides with the exception of clopyralid.

Key words: Flax, *Linum usitatissimum,* tolerance, pre-emergence, post-emergence, herbicides.

Resumé

Hørs tolerance over for en række jord- og bladherbicider blev undersøgt i ti forsøg i perioden 1985-1990. Fra 1985-1987 blev der udført en række screeningforsøg, og fra 1988-1990 udbytteforsøg. Jordmidlerne blev testet i kombination med vanding straks efter herbicidbehandlingen for at forstærke eventuelle afgrødeskader.

Trifluralin, linuron og lenacil kunne anvendes før fremspiring uden at skade afgrøden. Chlorsulfuron, anvendt som jordmiddel, forårsagede

kraftige afgrødeskader, når der blev vandet kort tid efter herbicidbehandlingen. Anvendelse af cyanazin og pendimethalin som jordmidler fremkaldte ligeledes kraftige afgrødeskader.

Bentazon, chlorsulfuron og clopyralid var de mest skånsomme bladmidler. Anvendelse af en række andre bladmidler og bladmiddelkombinationer gav afgrødeskader, der varierede fra små, forbigående skader til kraftigere skader, der halverede udbyttet. Nævnt efter aftagende skånsomhed var de øvrige herbicider: metsulfuron methyl, bromoxynil, ioxynil, MCPA, mechlorprop, metsulfuron methyl + thifensulfuron samt tribenuron methyl. Der blev ikke fundet nogen forskel i hørs tolerance på 5-10 cm's stadiet og på 15-20 cm's stadiet over for fem af de testede bladmidler.

Ukrudtsbekæmpelsen, der blev opnået efter anvendelse af jordmidlerne, var nævnt efter aftagende effekt: linuron, linuron + lenacil, chlorsulfuron og trifluralin. Bladmidlerne bekæmpede generelt ukrudtet tilfredsstillende, og de var mere effektive end jordmidlerne, med clopyralid som undtagelse.

Nøgleord: Hør, *Linum usitatissimum,* tolerance, jordherbicid, bladherbicid.

Introduction

The interest for growing of flax *(Linum usitatissimum)* increased in the 1980's. This applies to both flax grown as an oilseed crop and for fibre. Pests and diseases constitutes a minor problem when flax is grown in a croprotation, whereas effective weed control measures are essential because flax is a very poor competitor against weeds.

Materials and methods

From 1985 to 1987, screening trials were carried out to investigate the tolerance of flax to pre- and post-emergence applied herbicides and herbicide combinations. Some of the trials with pre-emergence herbicides were carried out in combination with watering immediately after spraying in order to imitate conditions which could increase the risk of crop damage. The watering was carried out with special made frames distributing the water equally over the whole parcel. The plot size in these trials were 3.75 m^2 and most of the trials were carried out with different herbicide doses and levels of watering but without replicates. The herbicides was applied with a Hardi 4680-15E nozzle, delivering 200 l/ha at 3.0 bar and 3.6 km/h.

From 1988 to 1990, yield trials were made with some of the herbicides. The experimental design in these trials was a randomized complete block with four replicates, and a plot size of 25 m^2. Crop damage and weed control was assessed visually on a scale from 0-10 where 0 = no damage and 10 = all plants killed. A crop damage score on less than two to three normally gives no influence on final yield at harvest. Pre-emergence treatments were applied with a Hardi 4110-20 flat fan nozzle at 2 bar and 4.0 km/h resulting in a spray volume of 350 l/ha whereas post-emergence herbicides were applied with a Hardi 4110-14 flat fan nozzle, delivering 250 l/ha at 2.5 bar and 4.0 km/h. The post-emergence treatments were carried out when the weeds had developed 0-4 true leaves in 1985-1987. In 1988-1990, post-emergence sprayings were carried out at two crop growth stages, when the crop was 5-10 cm and 15-20 cm. The plots were harvested with a plot combiner and the grain yields were corrected to 91% dry matter content. The products used, their content of active ingredients and their recommended dose are listed in Table 1. In some of the trials half (½ N), and double of the recommended dose (2N) were also included. All trials were carried out on soils with a clay content between 12 and 17 per cent. Precipitation in the spring period in these years and the normal precipitation in the same period are shown i Table 2.

Table 1. The tested herbicides given by their trade names, content of active ingredients and recommended doses. Products marked by * are registered for use in flax in 1990 by *The National Agency of Environmental Protection.*

Product	Dose/ha kg or l (N)	Active ingredients	g a.i./ kg or l	g a.i./ ha
1. Ally 20 DF	0.02	metsulfuron methyl	200	4
2. Basagran 480*	3.0	bentazone	480	1440
3. Basagran MCPA*	2.0	bentazone	250	500
		MCPA	125	250
4. Brominal 400	2.0	bromoxynil	400	800
5. Bladex 500 SC*	2.0	cyanazine	500	1000
6. DPX L5300	0.013	tribenuron methyl	750	10
7. DPX XE 8698	0.044	metsulfuron methyl + thifensulfuron		
8. Express 75 DF	0.01	tribenuron methyl	750	7.5
9. Glean 20 DF*	0.02	chlorsulfuron	200	4
10. Linuron*	1.5	linuron	500	750
11. Matrigon	1.5	clopyralid	100	150
12. Mylone	1.0	ioxynil	120	120
		mecoprop	360	360
13. Oxitril	0.8	ioxynil	200	160
		bromoxynil	220	176
14. Stomp	5.0	pendimethalin	330	1650
15. Swipe 560 SCW	1.0	ioxynil	56	56
		bromoxynil	56	56
		mecoprop	448	448
16. Treflan*	1.5	trifluralin	480	720
17. Venzar	0.5	lenacil	800	400

Extravon, a non-ionic surfactant (octyl-phenol-polyethoxylate), was used as additive to chlorsulfuron and tribenuron methyl, and added to the spray liquid in a concentration of 0.05%.

Table 2. Precipitation (mm) in April, May and June in the years 1985-1990 and normal precipitation in the same period.

Month	Year						Normal precipitation
	1985	1986	1987	1988	1989	1990	
April	56	23	38	16	34	25	36
May	43	39	46	33	8	12	38
June	65	19	85	37	48	61	46

Results

The results of a trial with three soil applied herbicides at the recommended and double of the recommended dose are shown in Fig 1. The herbicides used were trifluralin, cyanazine and pendimethalin. Trifluralin was incorporated pre-sowing and cyanazine and pendimethalin were applied shortly after sowing. Only minor or no damage at all was found after treatment with trifluralin at both doses. Serious crop damage was found after treatment with cyanazine and pendimethalin at both doses.

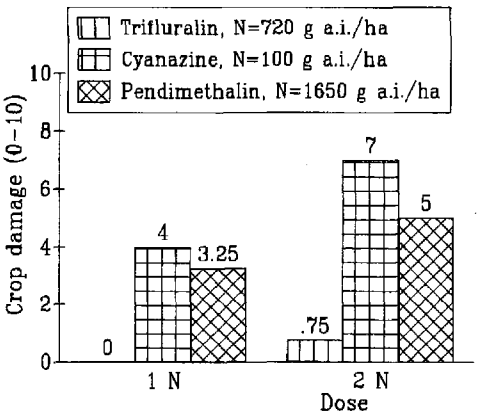

Fig. 1. Crop damage assessed on 28 May after treatment with pre-emergence herbicides at the recommended and double of the recommended dose.

The results of a screening experiment with pre-emergence herbicides are shown in Table 3. The figures are means of three trials in 1985-1987. The trials were watered with 0, 10 or 30 mm shorty after the herbicide treatment. Trifluralin, incorporated pre-sowing, linuron and linuron + lenacil caused slight crop damage at the low dose irrespectively of watering level.

The damage caused by these three herbicides and herbicide combinations was somewhat higher at the high dose, but again independent of watering level. Chlorsulfuron, used as a pre-emergence herbicide, caused only minor crop damage at both doses without watering. Watering after a pre-emergence treatment with chlorsulfuron increased crop damage considerably especially at the high herbicide dose and high watering level. None of the pre-emergence herbicides or herbicide combinations tolerated by the crop resulted in a satisfactory weed control.

Table 3. Crop damage and weed control assessed in June after the use of pre-emergence herbicides in the beginning of May. Mean of three trials in 1985-1987.

Treatment	Dose g a.i./ha	Crop damage (0-10)			Weed control (0-10)		
		Watering			Watering		
		0 mm	10 mm	30 mm	0 mm	10 mm	30 mm
1. Untreated		0	0.2	0.9	0	0	0
2. Trifluralin	576	0.8	0.6	1.0	4.2	4.2	4.1
3. Trifluralin	1152	2.3	2.2	2.8	4.1	4.3	4.6
4. Linuron	750	0.2	0.2	1.0	5.7	6.7	6.5
5. Linuron	1500	1.9	2.3	2.0	8.2	8.8	8.9
6. Linuron	500	0.6	0.3	0.7	5.9	6.6	8.1
lenacil	400						
7. Linuron	1000	1.0	1.6	1.7	7.2	7.7	8.8
lenacil	800						
8. Chlorsulfuron	4	0.9	2.7	4.1	4.0	5.3	5.8
9. Chlorsulfuron	8	0.9	3.8	5.4	5.7	6.1	6.9

Table 4 shows the results from three trials with post-emergence herbicides, carried out from 1985-1987. Some of the herbicides were tested in all three years, others only in one or two years. Most of the herbicides caused slight crop injuries, but only a few caused serious damage at normal dose. Bentazone, chlorsulfuron, clopyralid and metsulfuron methyl were harmless to the crop at normal dose, and doubling the dose only increased crop damage marginally.

The weed control obtained by the tested post-emergence herbicides is included in Table 4. The best weed control was achieved by herbicides

Table 4. Crop damage and weed control assessed in June after the use of post-emergence herbicides in the beginning of May. Mean of three trials in 1985-1987.

Treatment	Dose g a.i./ha	Crop damage (0-10)			Weed control (0-10)		
		½ n	1 n	2 n	½ n	1 n	2 n
1. Untreated		0	0	0	0	0	0
2. Bentazone	1440	0.1	0.2	0.3	6.7	7.9	8.3
3. Bentazone	500	0.9	1.5	2.4	7.1	8.3	8.4
MCPA	250						
4. Bromoxynil	800	1.3	1.7	3.6	8.6	9.2	9.2
5. Bromoxynil	600	1.0	2.0	5.6	9.0	10.0	10.0
MCPA	250						
6. Bentazone	960	0.7	1.8	3.4	8.9	9.2	9.5
Bromoxynil	600						
7. Ioxynil	120	0.3	1.6	4.6	7.3	8.3	9.6
Mecoprop	360						
8. Ioxynil	56	1.0	2.0	4.6	6.0	8.0	8.6
Bromoxynil	56						
Mecoprop	448						
9. Chlorsulfuron	4	0.1	0.8	1.1	7.7	7.9	8.2
10. Clopyralid	150	0	0.1	0.5	1.1	1.4	2.1
11. Metsulfuron methyl	4	0.2	0.5	1.7	7.0	6.4	7.8
12. Tribenuron methyl	10	4.4	5.3	5.7	7.2	7.7	7.8
13. Thifensulfuron	30	2.3	2.9	3.9	6.5	7.4	7.4
Metsulfuron methyl	3						

Treatments 9 and 12 with surfactant additive

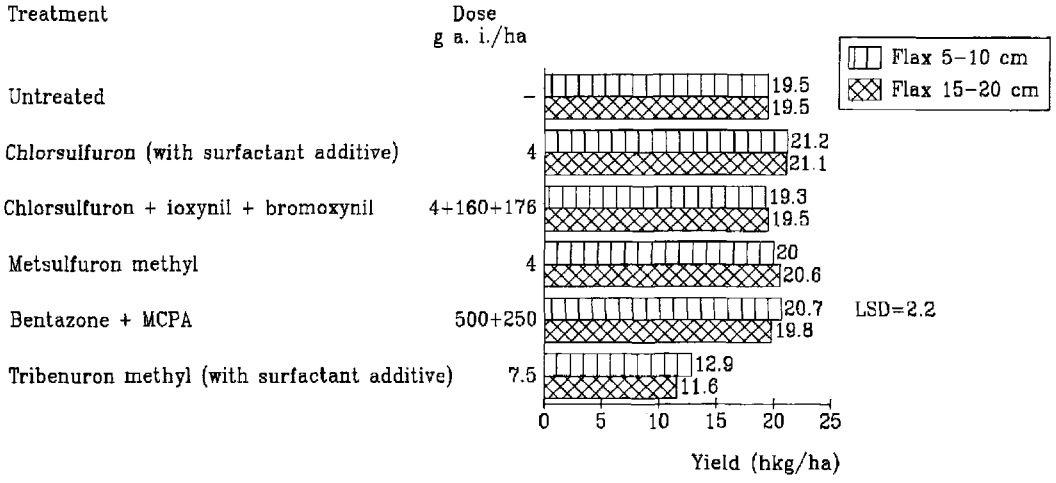

Fig. 2. Yield of flax after treatment with post-emergence herbicides at two growth stages.

which caused unacceptable crop damage, but acceptable weed control was also obtained by chlorsulfuron and bentazone which both possesses a good crop tolerance. The yield results of the trials carried out from 1988-1990 are shown in Fig. 2. No difference in crop tolerance was found between the two growth stages with any of the herbicides. Tribenuron methyl was only included in the trials one year, and the use of this herbicide reduced the yield to about 50% of the untreated control at both developmental stages. No significant differences were found between the other herbicides although yields after treatments with chlorsulfuron + bromoxynil + ioxynil was reduced by 10% compared to chlorsulfuron alone. Bentazone + MCPA and metsulfuron methyl damaged the crop more than treatment with chlorsulfuron alone, but this was not reflected in the yields.

Discussion and conclusions

A good crop tolerance was found to pre-emergence treatments with trifluralin, linuron and linuron + lenacil. Corresponding results with lenacil were found by *Balgheim* (1) who also found that the urea herbicide methabenzthiazuron (dose = 2800 g a.i. /ha) did not cause crop damage.

Cyanazine applied pre-emergence caused severe crop damage as did pendimethalin and similar results were also reported by *Balghheim.* The crop selectivity to chlorsulfuron, used as a pre-emergence herbicide, depends on the herbicide not coming into contact with the germinating seeds as severe crop damage was found after chlorsulfuron treatment followed by watering.

Chlorsulfuron, bentazone and clopyralid were the three post-emergence herbicides showing the best crop tolerance. The other post-emergence herbicides caused different degrees of crop damage, but these were often temporary.

References

1. *Balgheim, R.* 1989. Erste hessische Erfahrungen mit Herbiziden in Faserlein. Gesunde Pflanzen 41, 176-178.

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