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Weed control and tolerance of horse beans to pre- and postemergence herbicides

Ukrudtsbekæmpelse i hestebønner og deres tolerance over for jord- og bladherbicider

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Summary

The tolerance of horse beans to a number of pre- and post- emergence herbicides was tested in eight trials from 1985 to 1990. Screening experiments were carried out from 1985 to 1987. The herbicides tested were used at normal and double of the normal dose. Pre-emergence herbicides were tested in combination with watering shortly after herbicide treatment in order to intensify possible damaging effects on the crop.

Horse beans were generally tolerant to the tested pre-emergence herbicides, and the tolerance was only reduced slightly when watering was carried out after herbicide treatment. None or very little crop damage was found after trifluralin incorporated pre-sowing, and after terbutryn and terbuthylazine + terbutryn pre-emergence. Linuron, cyanazine and pendimethalin caused slightly more but still minor damage which ic unlikely to influence the yield even after double of the normal dose.

Horse beans were not very tolerant to post-emergence herbicides, and only two of the tested herbicides, phenmedipham and bentazone, could be used without affecting the crop severely, although even these herbicides caused yield reductions in one year. Among the tested post-emergence herbicides were the best tolerance and the highest yields in all years obtained after phenmedipham treatment.

Post-emergence herbicides containing cyanazine, MCPA, terbuthylazine + bromofenoxim, metamitron and MCPB caused extensive crop damage.

The addition of oil additive to both bentazone and phenmedipham reduced crop tolerance. The use of cyanazine pre-emergence, in combination with post-emergence herbicides, enhanced the weed control without affecting crop damage or yield.

Key words: Horse beans, *Vicia fabae,* tolerance, pre-emergence, post-emergence, herbicides.

Resumé

Hestebønners tolerance over for en række jord- og bladherbicider blev undersøgt i otte forsøg i perioden 1985-1990. Fra 1985-1987 blev der udført en række screeningsforsøg. De afprøvede midler blev anvendt i den normalt anbefalede dosering og i dobbelt normaldosering. Jordmidlerne blev testet i kombination med vanding straks efter herbicidbehandlingen for at forstærke eventuelle afgrødeskader.

Hestebønnerne havde generelt en god tolerance over for de testede jordmidler, og tolerancen blev kun påvirket ubetydeligt, når der blev vandet efter sprøjtningen. Ingen eller meget små skader blev registreret efter trifluralin-behandling før såning, samt efter behandling med terbutryn eller terbuthylazin + terbutryn lige efter såning. Linuron, cyanazin og pendimethalin forårsagede noget større, men dog stadig små afgrødeskader, som sandsynligvis ikke vil påvirke udbyttet, selv efter anvendelse i dobbelt dosering.

Hestebønners tolerance over for bladmidler er begrænset, og kun to af de testede herbicider, bentazon og phenmedipham, kunne anvendes, uden at afgrøden blev påvirket uacceptabelt, og også disse herbicider forårsagede udbyttetab i et af årene. Blandt de prøvede bladmidler blev den bedste tolerance og det højeste udbytte i alle årene opnået efter phenmedipham anvendelse.

Bladmidler der indeholder cyanazin, MCPA, terbuthylazin + bromofenoxim, metamitron eller MCPB forårsagede for store skader på afgrøden.

Tilsætning af olie til såvel bentazone som phenmedipham reducerede afgrødetolerancen. Anvendelse af cyanazin efter såning i kombination med et bladmiddel øgede ukrudtseffekten uden at påvirke afgrødeskade eller udbytte.

Nøgleord: Hestebønne, *Vicia fabae,* jordherbicid, bladherbicid, tolerance.

Introduction

The acreage with horse beans *(Vicia fabae)* was negligible up to about 1980. Since then there has been an increased interest in growing pulse crops, especially peas, but the acreage with horse beans has also increased. Horse beans are less tolerant to some of the post-emergence herbicides used in peas due to a less developed wax layer on the leaves. The selectivity found in peas, caused by a reduced retention of herbicides with a high surface tension and applied in big droplets (1), is therefore not found in horse beans. At the moment the only registered post-emergence herbicide in horse beans is bentazone. This study investigates the tolerance of horse beans to various soil- and foliage applied herbicides.

Materials and methods

From 1985 to 1987 screening trials were carried out to investigate the tolerance of horse beans to pre- and post-emergence applied herbicides and herbicide mixtures. Some of the trials with pre-emergence herbicides were carried out in combination with watering immediatly after spraying in order to immidate conditions which could increase the risk of crop damage (3). The watering was carried out with special made frames distributing the water equally over the whole parcel. The plot size in these trials was 3.75 m^2 and most of the trials were carried out with various doses or levels of watering but without replicates.

The herbicides were applied with a Hardi 4680-15E nozzle, delivering a liquid amount of 200 l/ha at 3.0 bar and 3.6 km/h.

From 1988 to 1990 some of the promising herbicides and mixtures were examined in yield trials and a 2-factorial experimental design was used with combinations of pre- and post- emergence herbicides. The post-emergence herbicides were either used alone or in combination with cyanazine applied pre-emergence.

The experimental design in these trials was a randomized complete block with four replicates and a plot size of 25 m^2.

From 1985 to 1989 crop damage was assessed on a scale from 0-10 where 0 = no damage and 10 = all plants killed. A crop damage score on less than two to tree is not expected to influence final yield. In 1990, crop damage was assessed with equipment which gives a direct estimate of green biomass (2). The scale goes from approx. 1.3 on bare ground to approx. 9.0 with the used adjustment. Within the range there is a linear

Table 1. The tested herbicides given by their trade name, content of active ingredients and recommended dose. Products marked by * are registered for use in horse beans 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. Actipron		adjuvant oil		
2. Basagran480*	3.0	bentazone	480	1440
3. Betanal	4.0	phenmedipham	160	640
4. Bladex 500 SC*	2.0[1]	cyanazine	500	1000
5. Goltix WG	3.0	metamitron	700	2100
6. Igran FW	2.5	terbutryn	490	1225
7. Linuron*	1.5	linuron	500	750
8. MCPB*	1.5	MCPB	400	600
9. Stomp	5.0	pendimenthalin	330	1650
10. Sun-oil 11 E		adjuvant oil		
11. Topogard	2.5	terbuthylazine	150	375
		terbutryn	350	875
12. Treflan*	1.5	trifluralin	480	720
13. Vegoran 500 FW	1.5	bromofenoxim	420	630
		terbuthylazine	80	120

[1] As pre-emergence herbicide. Used as a post-emergence herbicide the dose is between 500-750 g a.i./ha.

relationship between green biomass and the index presented in Table 5.

The measurement cannot distinguish between crop and weeds and the method can therefore only be used in a weed free environment. Comparisons in Table 5 should therefore not include untreated.

In the yield trials the pre-emergence herbicides 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 the post-emergence herbicides were applied with a Hardi 4110-14 flat fan nozzle at 2.5 bar and 4.0 km/h delivering 250 l/ha. Treatments with post-emergence herbicides were carried out when the weeds had developed 0-4 true leaves except when phenmedipham was applied as a split application at the cotyledon stage and 7-10 days later repeated. Weeds were counted and weighed on $4 \times 1/4m^2$ per parcel and the weed control figures shown in tables and figures are on weight basis. The group "cruciferous" consists of *Brassica napus* and *Sinapis arvensis.* The trials were harvested with a plot combiner and the grain yields were corrected to 86% dry matter content. The products used, their content of active ingredient and the recommended dose (1N) are listed in Table 1. In some of the trials also half (1/2N) and double of the recommended dose (2N) were tested. All trials were carried out on soils with a clay content of between 12 and 17%.

Precipitation in the spring period in these years and the normal precipitation in the same period are shown in Table 2.

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

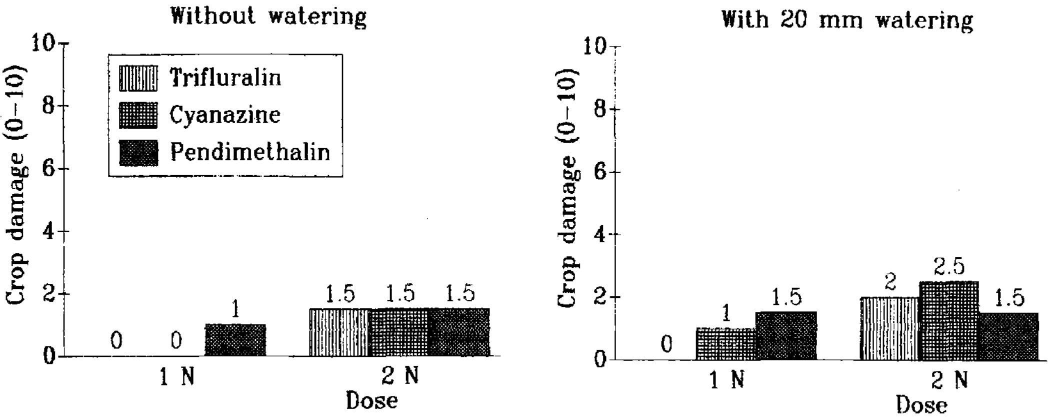

Fig. 1. Crop damage on June 14th (0-10) after treatment with pre-emergence herbicides at normal and double of the normal dose. Herbicide treatment was combined with 20 mm watering immediately after spraying.

Results

The results of two trials in 1985 and 1986 with three soil applied herbicides in normal and double of the normal dose are shown in Fig.1. The herbicides used were trifluralin, cyanazine and pendimethalin. Trifluralin was incorporated pre-sowing while cyanazine and pendimethalin were applied shortly after sowing. Half of the trial was watered with 20 mm shortly after herbicide treatment. Only minor or no damage at all was found after treatment with trifluralin and cyanazine in the recommended dose. After treatment with the three pre-emergence herbicides in double dose somewhat higher scores were given particularly in the watered plots. None of the damage recorded was however to a degree where it could be expected to influence yield.

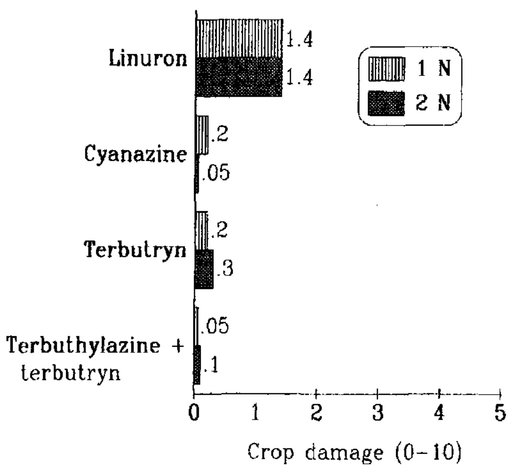

Fig.2. Crop damage scores (0-10) in mid June after treatment with pre-emergence herbicides at normal and double of the normal dose. Figures are means of herbicide treatments with and without watering.

Some corresponding trials were carried out in 1986 and 1987 with some other pre-emergence herbicides. The results of these trials are summarized in Fig. 2. Three levels of watering, 0, 10 and 30 mm were included in these trials. Only small differences in crop damage between the watering levels were found and the results in Fig. 2 are a mean of the three watering levels. All herbicides were applied post-sowing and, in general, only little crop damage was observed. The treatment with linuron at the high dose in 1987 resulted in the highest damage in these trials, but even this level of damage is not supposed to affect yields. Treatments this year were carried out in a period with unusual high precipitation.

In 1986-1987, screening experiments were carried out with post-emergence herbicides and herbicide mixtures. The results of these trials are shown in Table 3. Bentazone, bentazone + 1% actipron and phenmedipham caused only slight damage to the crop even in the high doses. Metamitron + 2.5% sun-oil influenced the crop slightly more, and cyanazine in combination with either bentazone or MCPB and terbuthyla-

Table 3. Crop damage (0-10) in horse beans mid June after herbicide treatments in the middel of May. Mean of two trials in 1986 and 1987.

Treatment	Herbicide dose		
	1/2N	1N	2N
1. Untreated	0	0	0
2. Bentazone	1	1	1
3. Bentazone + 1% actipron	0	0	2
4. Bentazone + cyanazine	2	3	3
5. MCPB + cyanazine	1	2	4
6. Metamitron + 2.5% sun-oil	1	1	2
7. Phenmedipham	0	0	1
8. Terbuthylazine + bromofenoxim	1	2	3
LSD_{95}	0.6	0.6	1.1

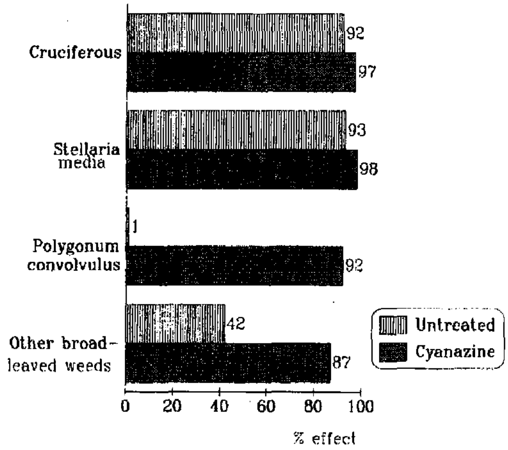

Fig. 3. Weed control of post-emergence herbicides alone and in combination with 1 kg/ha cyanazine applied pre-emergence. Avarage of all post-emergence herbicides (excl. untreated post-emergence).

zine + bromofenoxim caused severe damage to the crop. Herbicide mixtures containing MCPA- for instance bentazone + MCPA resulted in another trial in damage scores approx. to the same degree as obtained with cyanazine in the present experiment (results not shown).

The experimental layout in 1988 differed a little from that used the two following years. The results are shown in Table 4 and Fig. 3. A good weed control was in general achieved against the cruciferous weeds and *Stellaria media,* whereas *Polygonum convolvulus* only was controlled satisfactorily with MCPB + cyanazine (Table 4). This combination, however, damaged the crop, as can be seen from both the crop damage assessment and from the yields which were significantly lower compared to the treatments with phenmedipham. The scores for crop damage were, when compared to the treatment with bentazone + 1% actipron, significantly lower for both phenmedipham treatments, and the same tendency was found in the yield.

Table 4. Per cent effect on weeds, crop damage and yields of horse beans in 1988 after treatment with post-emergence herbicides. The figures are means from plots that were either untreated or treated with cyanazine (1 kg a.i./ha) pre-emergence.

Treatment	Dose g a.i./ha	% effect				Crop damage	Yield (hkg/ha)
		Cruciferous	*Stellaria media*	*Polygonum convolvulus*	other broadleaved weeds		
1. Untreated		0	0	0	0	0	58.1
2. Cyanazine pre-emergence	1000	39	87	0	88	0	58.6
3. Cyanazine + MCPB	750 540	91	100	91	86	3.3	57.4
4. Bentazone + 1% actipron	1440	100	100	0	74	2.0	59.4
5. Phenmedipham Phenmedipham	320 320	95	97	55	68	1.4	60.3
6. Phenmedipham	480	93	86	50	29	0.4	61.4
LSD_{95} (treatment 3-6)		8	9	ns	ns	0.4	2.8

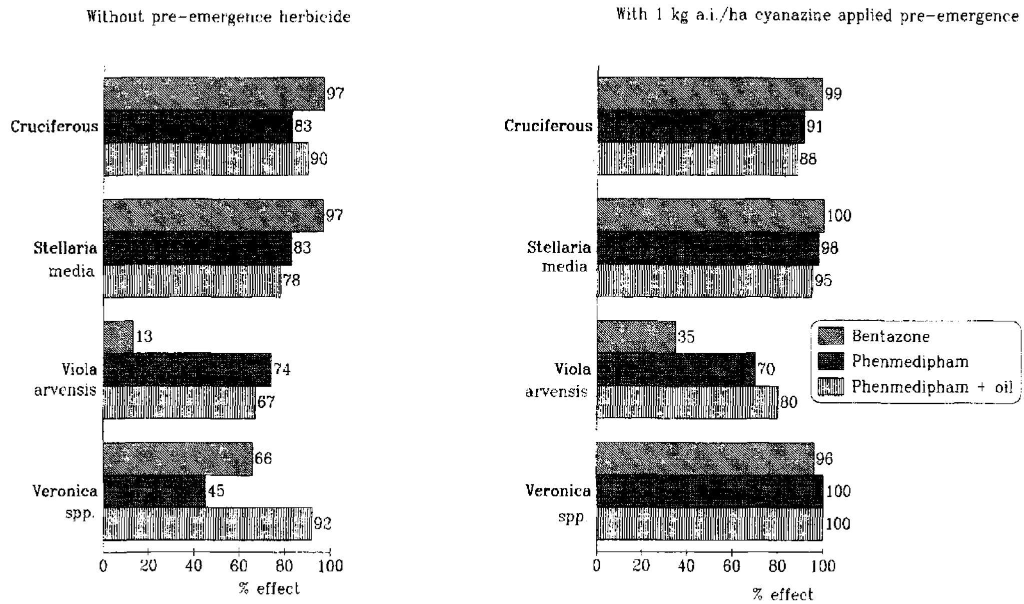

Fig. 4. Per cent weed control of post-emergence herbicides alone and in combination with 1 kg/ha cyanazine applied pre-emergence. Phenmedipham was applied as a split application.

The use of cyanazine pre-emergence has generally improved the weed control without influencing either crop damage or yield. The weed effects in the 1989-1990 trials are shown in Fig. 4, while the crop damage scores and yields are shown in Table 5. The yields and crop scores are not summarized for the two years. The year 1989 was unfavourable for the growth of horse beans and the yields obtained this year were very low whereas the yields in 1990 were above normal. Furthermore, 1989 was very dry in the spraying season and, in general, all crops were

Table 5. Effect on growth and yield of horse beans. Experiments in 1989 and 1990 with post-emergence herbicides.

Treatment	Dose g a.i./ha	1989		1990		
		Crop damage scores (0.9)	Yield (hkg/ha)	Crop Biomass measurement (1.3-9)		Yield (hkg/ha)
				May	June	
Untreated		0	25.8	(2.1)	(5.7)	55.2
Bentazone	1440	0	27.4	1.8	4.4	50.3
Phenmedipham	640	0	31.5	2.0	4.7	52.7
Phenmedipham + Oil	640	1	28.5	2.1	4.6	51.5
LSD_{95}		0.7	3.7	0.1	0.3	2.8

Phenmedipham treatments were carried out as a split-application with 320 g a.i./ha per treatment and an interval of 7-10 days.

very tolerant to herbicides. This was also the case with horse beans where almost no damage was seen after the treatments.

The split application treatment with phenmedipham without additive yielded, despite no differences in crop damage were found, significantly more than both the untreated control and the plot treated with bentazone. Horse beans were less tolerant in 1990, and significant reductions in crop biomass were noticed after all herbicide treatments. This was also reflected in the yields as bentazone and phenmedipham + additive reduced the yields significant compared to the control. A similar tendency towards a reduced yield was also found with phenmediphan alone. Treatments with phenmedipham with or without additive reduced the crop biomass significantly less than the bentazone, and also the yields reveled a tendency towards a better tolerance to the phenmedipham treatments.

Discussion and conclusions

The recommended sowing depth of horse beans is approx. 7-10 cm. This means that the germination of correctly placed seeds takes place below the layer where the pre-emergence herbicides are placed, even if these are incorporated shallowly pre-sowing as trifluralin. In general, a good crop tolerance was found to a number of pre-emergence herbicides. This also applies to trifluralin which was the only herbicide incorporated pre-sowing. Some slight crop damage was seen from some of the other pre-emergence herbicides at the high dose, but linuron, cyanazine, terbutryn, terbuthylazine + terbutryn and pendimethalin seem in general to be safe to horse beans. Watering shortly after herbicide treatment did not significantly change crop tolerance to any of these pre-emergence herbicides.

Horse beans are not tolerant to the post-emergence herbicides normally used in peas. Post-emergence herbicides and herbicide mixtures containing the active ingredients cyanazine, terbuthylazine + bromofenoxim or MCPA caused severe damage to the crop. Mixtures containing MCPB also cause some damage as did metamitron + oil additive.

Bentazone and phenmedipham were the two active ingredients which were the safest for the crop though some damage and even yield reduction were seen one year. Crop damage from bentazone and phenmedipham was enhanced when an oil additive was added.

Horse bean yields were in all three years higher after treatment with phenmedipham than after bentazone.

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