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Green Beans: ^{pi} Broad-leaved Weed Control
with Fomesafen
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PROCESSORS & GROWERS RESEARCH ORGANISATION

Green Beans: Broad-leaved Weed Control with Fomesafen (FD 4276)

ICI Agrochemicals - 1990

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SUMMARY: FD 4276 (fomesafen) applied pre- and post-emergence at a range of rates was compared with standards Arresin (monolinuron) and Basagran (bentazone) for crop tolerance and weed control.

Residual activity was reduced by dry soil conditions, and the rate of 1.0 l/ha FD 4276 pre-emergence was inadequate and inferior to monolinuron. There was a clear dose response to FD 4276 post-emergence, and while 0.7 l/ha achieved similar level of weed control to Basagran, the 0.9 l/ha was needed for acceptable control. Dramatic yield increases were achieved where weeds were controlled. A herbicide programme appears necessary to achieve good weed control in green beans. FD 4276 was very selective even at high rates in green beans and early applications at 1 trifoliolate leaf crop stage (earlier than Basagran is recommended) caused negligible damage, even though weather conditions were hot and humid.

OBJECT:

1. To determine the rate of FD 4276 to give equivalent weed control and crop safety to the appropriate standard when applied post-emergence.
2. To compare FD 4276 applied pre-emergence with appropriate standard.
3. To monitor the effect of soil residues on following crops.
4. To obtain crop samples for residue analysis and taint testing.

TREATMENTS:

Material	Rate product l/ha	Timing
1 Untreated	-	-
2 fomesafen (FD 4276)	1.0	} pre-emergence of weed & crop
3 " "	2.0	
4 monolinuron (Arresin)	N*	
5 fomesafen (FD 4276)	0.3	
6 " "	0.5	} from 1-2 trifoliolate leaves crop
7 " "	0.7	
8 " "	0.9	
9 " "	1.8	
10 bentazone (Basagran)	3.0	

FD 4276 as 250 g/l formulation used.

* Normal rate for soil type

LAYOUT: Randomised block, four replications. Plot area 4 m x 5 m at outside sites (harvest 4 m x 0.6 m), 4 m x 8 m at Thornhaugh (harvest 0.9 m x 8 m).

SITE DETAILS:

Site	Soil type	Sowing date	Variety
1 Thornhaugh, Cambs	FSL	24/5	Nerina
2 Three Holes, Cambs	ZL	26/5	Groffy
3 Kirton, S. Lincs	ZL	31/5	Forum
4 Hoveton, Norfolk	SL	11/6	Nerina
5 Salhouse, Norfolk	SL	7/6	Nerina

METHOD: Trials were conducted at PGRO and at 4 sites in commercial crops on a range of soil types. The beans were sown with pneumatic precision drills at sites 2, 3, 4 and 5, and with a Nordsten cereal drill at site 1. Normal husbandry for the green bean crop was carried out at all sites.

Sprays were applied with a Van der Weij plot sprayer and Lurmark 015 F80 flat fan nozzles, delivering 200 l/ha water volume. Emergence of the crop was good at all sites except Thornhaugh where conditions were exceptionally dry. There was no rain after pre-emergence applications with the exception of site 2 where there was a storm 8 days later and site 1 where there was slight precipitation. Green bean plant counts were made 3 x 1/3m² quadrat, on plots for treatments 1, 2, 3, and 4 at all sites except site 1 where emergence was affected by drought.

Applications of post-emergence sprays were made when the crop was at an earlier stage than the 2 trifoliolate leaf stage recommended for bentazone since weeds growth was too advanced to delay spraying. Usually post-emergence bentazone is used as part of a programme with either trifluralin pre-sowing or monolinuron pre-emergence or both. At site 3 there was a very high population of *Chenopodium album* and *Urtica urens*. The weather conditions were warm and humid at sites 1 and 3, and well outside the recommendation for bentazone (Basagran) at Hoveton site 4.

At site 3 there was a severe infestation of *Stellaria media* which was not controlled by FD 4276. Follow-up applications of Basagran were therefore made at rates of 3 l/ha for very large *S. media* on treatments 2 and 3, and *U. urens* on 4; 2 l/ha was applied where *S. media* was more stunted on plots treatments 5 - 9.

The season was exceptionally dry and at site 1, 4 and 5 there was virtually no rain from drilling to harvest. Temperatures were also higher than average at all sites.

Crop effects were assessed at intervals. Counts of weed species for 3 x 1/3m² quadrats and scores for overall weed control were recorded.

At site 1 plots were harvested when the green beans were at canning stages of maturity with a Ploeger plot machine, harvesting 3 rows per plot. At sites 2 and 3 an area of 0.6 m x 4 m was harvested by hand. Yields were recorded and maturity of the beans was assessed by measuring 10 bean seed lengths, the most mature seed taken from the most mature pods from a random sample of 10 plants per plot.

Samples of selected treatments were taken from all sites for residue analysis and were also canned and quick-frozen for taint testing by CFDR.

Results for yield and maturity were statistically analysed.

RESULTS:

1. Crop Effects - Plant counts after full emergence (for pre-emergence treatments) and crop scores are shown below.

Treatment	Rate l/ha	Site: Date:	Plant Counts					Crop Score			
			2 28/6	3 25/6	4 28/6	5 28/6	1 6/6	2 6/6	3 18/6	4 28/6	
1 Untreated	-	DAT:	30	25	17	21	9	8	18	17	
<u>Pre-emergence</u>											
2 FD 4276	1.0		44	46	44	46	10	10	10	10	
3 "	2.0		44	46	43	45	10	10	10	10	
4 Arresin	N		44	45	44	45	10	10	10	10	

Treatment	Rate l/ha	Site: Date:	Crop Score					(3) \$	Crop Score at Harvest									
			1 1/7	2 6/7	3 2/7	4 29/7	5 19/7		1 6/8	2 8/8	3 13/8	4 16/8	5 16/8					
1 Untreated	-	DAT:	34	38	32	47	41	23/7	10	10	10	10	10	10	10	10	10	10
<u>Pre-emergence</u>								(10) \$										
2 FD 4276	1.0		10	10	10	10	10	7.5	10	10	10	10	10	10	10	10	10	10
3 "	2.0		10	10	10	10	9.8	7.5	10	10	10	10	10	10	10	10	10	10
4 Arresin	N		10	10	10	10	9.2	7.5	10	10	10	10	10	10	10	10	10	10
<u>Post-emergence</u>								(10) \$										
5 FD 4276	0.3	DAT:	6	8	7	10	10	(10) \$	24	18	17	20	10	10	10	10	10	10
6 "	0.5		10	9.7	9.5	10	9.7	8	10	10	10	10	10	10	10	10	10	10
7 "	0.7		10	9.6	9	10	9.4	8	10	10	10	10	10	10	10	10	10	10
8 "	0.9		9.8	9.5	8.5	10	8.8	8	10	10	10	9.5	10	10	10	10	10	10
9 "	1.8		9	9	7.6	10	8.3	8	9.5	9.8	9.5	9	10	10	10	10	10	10
10 Basagran	3.0		6	9.1	3.8	8.5	5.2	-	9.1	9.5	4	7	10	10	5	10	10	9

after application of Basagran treatments 2 - 9

Crop Score 10 = no damage
 7 = acceptable damage
 0 = completely killed

There was no visible crop damage from any pre-emergence treatment; plant emergence was not delayed and plant population was not reduced. Conditions were very dry after pre-emergence application at all sites except Three Holes and therefore little herbicide was leached.

Since weed stages were becoming advanced, post-emergence applications were made early, before the 2 trifoliolate leaf stage for beans (the stage recommended for Basagran) at all sites. Weather conditions were hot and humid, and in some cases too high for safe application of Basagran. Consequently beans treated with Basagran at 3.0 l/ha (treatment 10) suffered leaf scorch and stunting. This damage was very severe at sites 3 and 5 and at site 3 the beans did not recover.

FD 4276 applied post-emergence appeared very safe to green beans at the one trifoliolate leaf stage and there were few visible effects from any rate, even 1.8 l/ha. Applications of FD 4276 at 1.8 l/ha to beans at simple leaf stage (site 3) caused more damage in the form of leaf crinkling followed by stunting. This damage was at an acceptable level and plants quickly recovered. Beans on all plots treated with FD 4276 at all sites completely recovered well before harvest.

2. Weed Control

Site 1 - Thornhaugh

Treatment	Rate l/ha	Date:	Weed Counts No/m ²						Weed Score	
			CHEAL	FUMOF	SOLNI	VERPE	ATRPA	STEME	Total	16/7
1 Untreated	-	12	9	4	7	3	3	38	0	0
<u>Pre-emergence</u>										
2 FD 4276	1.0	11	7	2	1	1	1	23	1	2
3 "	2.0	5	2	1	1	-	-	9	4	4
4 Arresin	N	3	7	2	3	1	-	16	3	6
<u>Post-emergence</u>										
5 FD 4276	0.3	10	5	4	2	2	1	24	1	4
6 "	0.5	8	6	2	2	1	1	20	2	5
7 "	0.7	6	5	2	3	-	1	17	3	5
8 "	0.9	6	4	1	1	1	1	14	4	6
9 "	1.8	5	1	1	-	-	1	8	5	7
10 Basagran	3.0	7	8	3	6	2	-	26	4	2

Weed Score 10 = complete control
 7 = acceptable control
 0 = complete kill

Weed numbers on untreated plots at this site were very low, and a few may have emerged after 25th June (when post-emergence sprays were applied). The main species were *Chenopodium album* which was not well controlled by any treatment and *Fumaria officinalis* which was only controlled pre- and post-emergence by high rates of FD 4276, as was *Veronica persica* and possibly *Solanum nigrum*. The very low number of *Stellaria media* were controlled by Arresin and Basagran. The *C. album* remaining grew vigorously, except on plots treated with FD 4276 which had a stunting effect. Treatments with the best weed control were with Arresin and FD 4276 @ 9.0 l/ha (and twice this rate), but levels were unacceptable. However post-emergence FD 4276 performed better than Basagran.

Site 2 - Three Holes

Treatment	Rate l/ha	Weed Counts No./m ² 16/7									Weed Score 16/7 8/8		
		Date:	POAAN	VIOAR	CHEAL	POLPE	BILCO	STEME	PAPRH	MYOAR	Total		
1 Untreated	-		28	24	7	3	8	3	5	8	91	0	0
<u>Pre-emergence</u>													
2 FD 4276	1.0		36	4	2	2	3	2	1	1	31	3.0	2.5
3 "	2.0		34	1	-	1	2	2	-	-	40	6.5	5.0
4 Arresin	N		-	8	-	-	1	-	-	-	11	8.3	7.0
<u>Post-emergence</u>													
5 FD 4276	0.3		25	21	3	2	5	2	4	8	72	1.0	1.0
6 "	0.5		31	11	2	1	3	2	1	5	56	3.2	2.5
7 "	0.7		30	18	2	-	3	1	1	6	61	4.2	3.2
8 "	0.9		28	7	2	-	2	1	-	3	43	5.2	4.5
9 "	1.8		26	-	-	-	-	2	-	1	29	7.8	7.2
10 Basagran	3.0		32	25	3	-	4	-	1	-	58	3.5	3.0

There were more weeds at site 2, mainly *Poa annua* which were only controlled by pre-emergence Arresin. *Viola arvensis* was only controlled by high rates of FD 4276 pre- and post-emergence. *C. album* and *Bilderdykia convolvulus*, both present in low numbers was best controlled with Arresin and the higher dose rates of FD 4276 pre- and post-emergence. All except the lowest rate 0.3 l/ha of FD 4276 seemed effective on *Papaver rhoeas*. Basagran, Arresin and FD 4276, pre and high rates post-emergence controlled *Myosotis arvensis*. FD 4276 pre- and post-emergence may also have given control of *Polygonum persicaria*, *Veronica persica* and *Sennecio vulgaris* present in low numbers. *Stellaria media* was controlled by Basagran and Arresin, but control with FD 4276 was poor.

Overall weed control at harvest was only acceptable for Arresin and FD 4276 post-emergence at 1.8 l/ha.

3 - Kirton

Treatment	Rate l/ha	Date:	Weed Counts No/m ² 13/7						% Cover 13/7	Weed Score			
			STEME	URTUR	CHEAL	POLPE	GALAP	MATss.		Total	STEME	2/7	13/7
untreated	-	61	118	12	6	2	3	202	100	0	0	0	0
<u>pre-emergence</u>													
FD 4276	1.0 ^{\$}	60	15	3	2	1	-	81	100	2.7	2.3	7.5	5.0
"	2.0 ^{\$}	56	11	3	2	1	-	73	70	3.8	3.2	8.8	6.0
Arresin	N ^{\$}	2	24	2	4	1	-	33	0	6.8	6.1	9.0	6.5
<u>post-emergence</u>													
FD 4276	0.3 [#]	54	14	6	3	1	2	80	100	3.5	3.6	5.2	4.0
"	0.5 [#]	52	6	4	1	1	1	65	80	5.0	4.2	6.3	5.5
"	0.7 [#]	50	3	2	-	-	-	55	80	5.5	5.0	7.5	7.0
"	0.9 [#]	50	-	-	-	1	1	52	50	5.8	6.5	9.6	8.0
"	1.8 [#]	41	-	-	-	-	-	41	30	6.2	6.8	9.8	9.0
Basagran	3.0	-	2	4	1	1	-	7	0	10.0	9.5	7.0	6.0

followed by 3.0 l/ha Basagran on 13/7

followed by 2.0 l/ha Basagran on 13/7

Site 3 weed populations were high, mainly *Urtica urens* and included an unusually large number of *S. media* which was not controlled by FD 4276, although the 1.8 l/ha rate post-emergence reduced vigour. Basagran and Arresin on the other hand gave excellent control. *Urtica urens* was very susceptible to Basagran and FD 4276 even at 0.5 l/ha post-emergence. *S. media* was less susceptible to FD 4276 pre-emergence although control was superior to Arresin.

FD 4276 gave some control of *C. album* pre-emergence, and post-emergence with rates of 0.7 l/ha and higher. FD 4276 also seemed to give some control of *S. vulgaris*, *Matricaria* spp., *Galium purpureum* and *P. persicaria* but weed numbers on the untreated plots were low.

Although most weeds were controlled by the early Basagran treatment (10), the crop was severely damaged and offered little competition to the weeds which remained and thus weed control by harvest was poor.

The programme with a follow-up application of 2.0 l/ha bentazone on treatments 7, 8 & 9 to control large plants of *S. media* was successful and gave acceptable weed control.

Site 4 - Hoveton

Treatment	Rate l/ha	Date: CHEAL	Weed Counts No/m ² 29/7				Total	Weed Score		
			URTUR	VIOAR	POAAN	19/7		29/7	16/8	
1 Untreated	-	37	22	1	6	66	0	0	0	
<u>Pre-emergence</u>										
2 FD 4276	1.0	12	3	1	2	18	6.0	5.0	3.0	
3 "	2.0	5	1	-	4	10	8.0	6.8	6.0	
4 Arresin	N	4	3	1	0	8	9.0	8.1	6.0	
<u>Post-emergence</u>										
5 FD 4276	0.3	24	13	1	5	43		2.0	1.0	
6 "	0.5	28	8	1	3	40		2.5	2.0	
7 "	0.7	23	7	-	5	35		3.5	3.0	
8 "	0.9	27	2	-	3	32		5.0	4.0	
9 "	1.8	18	2	-	4	24		5.8	5.0	
10 Basagran	3.0	22	1	2	4	29		3.5	4.0	

At site 4 the predominant weeds were *C. album* and *U. urens*, and where they were not controlled both species grew very large and competitive by harvest. Post-emergence sprays were applied at a later growth stage for crop and weed than at other sites, *C. album* may also have become less susceptible during hot weather when waxy leaf cuticles develop. Control of *C. album* was very poor with all post-emergence treatments. In contrast FD 4276 pre- and 0.9 and 1.8 l/ha post-emergence, and the standards gave good control of *U. urens*. As at other sites, only Arresin was effective on *P. annua*.

Weed control overall was poor from all treatments, with Arresin marginally the best.

Site 5 - Salhouse

Treatment	Rate l/ha	Date: CHEAL	Weed Counts No/m ² 19/7				Total	Weed Score		
			POAAN	STEME	POLAV	19/7		29/7	16/8	
1 Untreated	-	12	16	1	2	31	0	0	0	
<u>Pre-emergence</u>										
2 FD 4276	1.0	2	8	1	-	11	7.0	4.0	4.0	
3 "	2.0	2	4	1	-	7	8.0	5.0	6.0	
4 Arresin	N	2	-	-	1	3	9.0	9.0	9.5	
<u>Post-emergence</u>										
5 FD 4276	0.3	6	10	1	1	18	3.7	4.0	3.0	
6 "	0.5	4	7	1	1	13	3.2	5.0	5.0	
7 "	0.7	3	11	2	1	17	5.3	5.0	5.0	
8 "	0.9	2	8	1	-	11	6.3	7.0	8.0	
9 "	1.8	1	6	-	1	8	9.0	8.5	9.0	
10 Basagran	3.0	5	9	-	2	16	7.5	5.0	5.0	

At site 5 few weeds germinated on untreated plots. As at site 2, *P. annua* was only controlled with Arresin, both Basagran and FD 4276 pre- and post-emergence were ineffective. Arresin and FD 4276 gave some control of *C. album* pre-emergence, and there was a dose rate response for FD 4276 post-emergence. Basagran gave poor control of this weed which grew very large by harvest and of *Polygonum aviculare*. *S. media* which was present in very low numbers was not susceptible to FD 4276.

Overall, the best weed control was with Arresin, and FD 4276 at 0.9 and 1.8 l/ha performed well. Levels achieved with Basagran and other FD 4276 treatments were unacceptable.

3. Yield & Maturity Data

Treatment ^{\$}	Rate l/ha	Yield as % Untreated			Maturity			
		Site:	1	2	3	10 Seed length mm		
		Harvest Date:	9/8	8/8	13/8	1	2	3 [#]
1 Untreated	-		100	100	100	127	67	96
<u>Pre-emergence</u>								
2 FD 4276	1.0		151 ⁺	224 ⁺	478 ⁺	128	80	86
3 "	2.0		175 ⁺	249 ⁺	561 ⁺	127	77	88
4 Arresin	N		179 ⁺	255 ⁺	613 ⁺	130	78	104
<u>Post-emergence</u>								
5 FD 4276	0.3		138 ⁺	155 ⁺	523 ⁺	131	76	93
6 "	0.5		157 ⁺	189 ⁺	609 ⁺	122	78	92
7 "	0.7		137 ⁺	196 ⁺	653 ⁺	122	84	92
8 "	0.9		166 ⁺	215 ⁺	750 ⁺	124	75	88
9 "	1.8		176 ⁺	197 ⁺	743 ⁺	126	79	108
10 Basagran	3.0		142 ⁺	182 ⁺	398 ⁺	122	75	83
Yield of untreated t/ha			2.80	6.48	1.66			
Significance @ P = 0.05			SD	SD	SD	NS	SD	
LSD @ P = 0.05			31.8	37.6	134.4	-	6.0	
CV %			14.4	13.2	17.1	5.8	5.4	

⁺ Significantly higher yield than untreated

^{\$} At site 3 follow-up with Basagran @ 3.0 l/ha treatments 2 & 3; @ 2.0 l/ha treatments 5 - 9

[#] maturity samples bulked from 4 replicates, not analysed

There were severe yield reductions on untreated plots, even for low weed populations (site 1) in a dry season where there was competition for moisture. Removal of a population of 200 weeds/m² at site 3 which included competitive species *Chenopodium* and *Urtica urens*, increased yield up to 87%.

All treated plots yielded significantly better than untreated plots. Treatment yields appeared to be a reflection of weed control achieved, at site 1 the highest yields were for treatments 4, 8 and 9, at site 2 for treatments 4 and 8. At site 3 there was a trend for yield % to increase with increasing herbicide dose, and hence weed control achieved, however treatment 10 which caused visible crop damage appears to have also caused some yield reduction.

Maturity of beans was not influenced by herbicide treatment at site 1, but at site 2 weeds significantly delayed maturity of the untreated beans. Maturity data for site 3 was not analysed, but beans with most advanced maturity, treatments 4 and 9, were on plots with the best weed control.

CONCLUSIONS: FD 4276 (fomesafen) appears to be highly selective in green beans. There was no visible crop damage or effect on plant population from FD 4276 at 1.0 or 2.0 l/ha or Arresin pre-emergence. However at most sites there was very little rain and less leaching than in some seasons.

Weather conditions at, and following, applications of post-emergence sprays were generally much warmer than usual, and timings were early (before 2

trifoliolate leaf, the earliest crop stage recommended for Basagran). In spite of this there were few damage effects visible from FD 4276 applied at 1st trifoliolate leaf stage or later. Applications at simple leaf stage (at site 3) of the 1.8 l/ha rate caused damage in the form of leaf crinkling, but effects were temporary and at an acceptable level. Damage from Basagran however was severe and unacceptable at sites 1, 3 and 5 and at site 3 this resulted in yield reduction.

The efficacy of pre-emergence residual treatments was reduced by dry soil conditions, and control with Arresin was only acceptable at two sites (2 and 5). The rate of 1.0 l/ha FD 4276 was inadequate, and even 2.0 l/ha gave an inferior performance overall to Arresin in most cases, although control of *U. urens* and *Viola arvensis* was better with FD 4276.

At most sites there was a clear dose response to post-emergence applications of FD 4276, rates of less than 0.9 l/ha appeared inadequate, although the 0.7 l/ha rate achieved a similar or higher level of weed control to Basagran at most sites.

There were considerable reductions in bean yields where weeds were not controlled, and effective control may not be achieved without a herbicide programme. Either trifluralin or monolinuron would control species such as *P. annua* and *S. media* which are resistant to FD 4276; or a very early treatment with FD 4276 could be followed by bentazone at reduced rates if *S. media* was a problem (at site 3).

This years trial programme suggested the following weeds are susceptible (S)/resistant (R) to FD 4276 at 0.9 l/ha post-emergence:-

<u>S</u>	<u>MR</u>	<u>R</u>
<i>Urtica urens</i>	<i>Myosotis arvensis</i>	<i>Stellaria media</i>
<i>Viola arvensis</i>	<i>Fumaria officinalis</i>	<i>Poa annua</i>
<i>Polygonum persica</i>		
<i>Chenopodium album</i> (up to 6 TL)		
<i>Papaver rhoeas</i>		
<i>Veronicapersica</i>		
<i>Solanum nigrum</i>	?	
<i>Atriplex patula</i>	?	
<i>Matricaria</i> spp.	?	
<i>Senecio vulgaris</i>	?	
<i>Lamium purpureum</i>	?	

Volunteer potatoes severely damaged

C.M. Knott
October 1990