Controlling *Datura* spp. in soybeans with bentazone

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SUMMARY

Experiments in 1974/75, 1975/76 and 1976/77 showed that excellent control of thornapple (*Datura* spp.) can be achieved in soybeans with bentazone. However, a repeated application technique was necessary to obtain the best control and maximum yield, a single application of a high rate (2.0 kg/ha) being inferior to two applications of 0.5 or 1.0 kg/ha.

Soybeans *cv* Lee were tolerant to three applications of 2.0 kg/ha with yield equivalent to hand weeded controls. Some slight leaf burning was noticed in one trial but could not be detected 10 to 14 days after spraying.

INTRODUCTION

Control of broadleaf weeds has been a major production problem to most soybean growers in New South Wales (Felton, 1973). In particular thornapple (*Datura* spp.) and Noogoora burr (*Xanthium* spp.) are widespread in irrigated soybeans in the north-west of New South Wales. Infestations of either weed can cause substantial yield losses through competition. Weeds reduce harvesting efficiency and it has been shown that broadleaf weeds are more deleterious than grasses (Burnside, 1973). Thornapple is also a harvest contaminant which can necessitate grading before delivery of grain.

Since 1971 most of the author's work with soybeans has been done on a 2 ha site which was sown to thornapple to ensure that weeds would be present in each plot. The first stage of the program investigated the effect of weeds on soybean yield and yield components (Felton, 1976). In this work weeds had no effect on yield when soybeans were grown in 25 cm rows but a 20% decrease when sown in 50 cm rows, 26% in 75 cm rows and 37% in 100 cm rows. Weed competition reduced soybean stem diameter, pods per plant, pods per m^2 and yield per plant. Weeds had no effect on the height of the bottom pod, yield per pod, seeds per pod or 100 grain weight. Next, the stage at which weed competition commences to reduce crop yield was studied. It was found that the onset of weed competition was not until at least 8 weeks after sowing. This result and the fact that available pre-emergence herbicides were unsatisfactory in controlling thornapple influenced the author to divert attention to post-emergence control.

Bentazone (3-isopropyl-IH-2,1,3-benzothiadiazin-4(3H)-one-2,2-diozide) became available for testing in 1973. In an initial screening trial bentazone applied as a post-emergence treatment controlled thornapple and was selective in soybeans. It was considered the most promising herbicide for use in controlling the problem broadleaf weeds in soybeans. This paper reports the results on the experiments with bentazone in the seasons 1974/75, 1975/76 and 1976/77.

MATERIALS AND METHODS

Each experiment was done at the Liverpool Plains Field Station, Breeza in the Namoi Valley of New South Wales. In each season soybeans *cv* Lee were sown in late November in 96.5 cm rows at a plant population of 250,000 to 300,000 plants per ha. The experimental site in 1974/75 and 1975/76 was sprayed with 0.8 kg a.i./ha trifluralin prior to sowing to ensure that only thornapple would be present as the competing weed. Trifluralin was not applied in the 1976/77 season.

Experimental plots were 4 rows wide x 10 m long.

Experiment 1 - 1974/75

Bentazone was one of five herbicides included in an evaluation trial. It was applied at 0.5, 1.0 and 2.0 kg a.i./ha on 13 January, 1975, 7 weeks after sowing and at 0.5 + 0.5, 1.0 + 1.0 and 2.0 + 2.0 as a repeated application on 20 December, 1974 and 22 January, 1975 at 4 and 8 weeks after sowing. All sprayed treatments were applied in 500ℓ of water per ha and three replicates of each treatment were arranged in randomized complete blocks. Weed data were obtained by removing two 1 m^2 quadrats per plot and soybean yield obtained from two rows x 5 m per plot. The weed samples were removed just prior to harvest.

Results

The effect of the bentazone treatments on weed control and soybean yield are presented in Table 1. There was no significant reduction in the soybean density and any phytotoxicity to the crop was mild and transient.

Experiment 2 - 1975/76

Bentazone was applied at 0.25, 0.5, 1.0 and 2.0 kg a.i./ha at 4, 6, 8, 4 + 6, 4 + 8, 6 + 8 and 4 + 6 + 8 weeks after sowing. Each rate and time of application, plus weedy and weed free controls were arranged in four randomized complete blocks. Spraying dates were 18 December 1975, 5 January, 1976 and 19 January, 1976 and diluent volume was again at the rate of 500 ℓ/ha. Weed and yield data were determined as in Experiment 1.

Results

Bentazone rate or time of application again had no effect on soybean density or grain weight. Weed data are presented in Table 2. The influence of the treatments on soybean yield is shown by Table 3.

Experiment 3 - 1976/77

Bentazone was applied at 0.5, 1.0 and 2.0 kg a.i./ha on 21 December, 1976, 4 weeks after sowing, and 20 January, 1977, 8 weeks after sowing, and as a repeated application at both 4 and 8 weeks after sowing. These rates were applied at four diluent volumes, 600, 240, 140 and 80 ℓ of water per ha. Bentazone rates, time of application and diluent volumes were factorially combined. These, plus weedy and weed free controls were replicated three times in randomized complete blocks. Weed and soybean data were derived as in Experiment 1.

Table 1. Soybean herbicide trial - Breeza 1974/75 (Experiment 1)

Treatment kg a.i./ha	Weed control assessments		*Datura*		Soybeans	
	16 January 1975	6 February 1975	Density No./m^2	O.D.WT. g/m^2	Density No./m^2	Yield (12% H_2O) kg/ha
1. Hand weeded control	0	0.3	0.5 (1.00†)	4 (1.52††)	16.0	2549
2. Weedy control	7.7	9.0	26.3 (5.18)	411 (6.02)	14.3	329
3. Bentazone 0.5 + 0.5 (20/12 & 22/1)	4.3	2.3	4.0 (2.11)	69 (4.25)	19.2	2225
4. Bentazone 1.0 + 1.0 (20/12 & 22/1)	5.3	2.0	2.8 (1.83)	5 (1.86)	15.6	2061
5. Bentazone 2.0 + 2.0 (20/12 & 22/1)	4.3	0.7	0 (0.71)	0 (0)	19.3	2584
6. Bentazone 0.5 (13/1)	7.7	7.0	19.2 (4.44)	680 (6.52)	15.7	715
7. Bentazone 1.0 (13/1)	4.3	4.7	16.9 (4.18)	997 (6.91)	14.5	968
8. Bentazone 2.0 (13/1)	3.3	3.0	2.3 (1.68)	85 (4.49)	16.8	1754
L.S.D. 5%	-	-	(1.61)	(2.01)	n.s.	611

Weed control assessments 0 = No *Datura*
9 = Dense infestation

† $\sqrt{x + \frac{1}{2}}$ Transforms

†† $\log_e (x + 1)$ Transforms

n.s. not significant

Table 2. Bentazone in soybeans - Breeza 1975/76 (Experiment 2)

Rate of bentazone kg a.i./ha	Time of application weeks after sowing	Weed assessments†		*Datura*	
		30 January 1976	16 February 1976	Density No./m^2	O.D.WT. g/m^2
Weed free	control	0	0.3	1 (1.4)††	2 (1.6)††
Weedy	control	8.9	8.1	43 (6.6)	361 (19.0)
0.25	4	7.3	5.8	41 (6.1)	225 (14.8)
0.5	4	5.3	4.3	23 (4.2)	145 (11.1)
1.0	4	5	3.8	25 (3.9)	95 (9.5)
2.0	4	2.8	2.3	3 (1.6)	46 (6.0)
0.25	4 + 6	6	4.5	17 (4.1)	265 (16.0)
0.5	4 + 6	2.3	2.3	11 (3.1)	101 (8.6)
1.0	4 + 6	0.8	0.3	1 (1.2)	22 (3.6)
2.0	4 + 6	0.5	0.5	3 (2.0)	9 (2.0)
0.25	4 + 8	6.5	4.5	20 (4.5)	193 (13.7)
0.5	4 + 8	2.3	1	2 (1.5)	19 (3.4)
1.0	4 + 8	0.3	0.3	1 (0.9)	5 (1.7)
2.0	4 + 8	0	0	0 (0.7)	0 (0.7)
0.25	6	8.3	7.3	30 (5.3)	325 (18.0)
0.5	6	6	5	24 (4.6)	253 (15.8)
1.0	6	4	4	15 (3.7)	133 (11.2)
2.0	6	2.3	2	5 (2.1)	129 (8.1)
0.25	6 + 8	6.5	5.8	36 (5.7)	235 (15.3)
0.5	6 + 8	2.5	1.5	5 (2.2)	68 (7.8)
1.0	6 + 8	0.5	0.3	0 (0.7)	0 (0.7)
2.0	6 + 8	0	0.3	0 (0.7)	0 (0.7)
0.25	8	8.5	7	41 (6.3)	253 (15.9)
0.5	8	7.5	6.3	40 (6.0)	283 (16.1)
1.0	8	6	4.5	13 (3.5)	108 (10.3)
2.0	8	3.5	3	4 (2.0)	53 (6.1)
0.25	4 + 6 + 8	5.5	4	14 (3.7)	165 (12.3)
0.5	4 + 6 + 8	0.3	0	0 (0.8)	1 (1.0)
1.0	4 + 6 + 8	0	0	1 (1.1)	25 (3.0)
2.0	4 + 6 + 8	0	0	0 (0.7)	0 (0.7)
			cv	(36%)	(38%)

† 0 = No *Datura*
9 = Dense infestations

†† $\sqrt{x + \frac{1}{2}}$ Transforms

Table 3. Bentazone in soybeans - Breeza 1975/76 (Experiment 2)

	Soybean yield 12% kg/ha
Weed free control	3683
Weedy control	2088

Bentazone kg a.i./ha	Time of application (weeks after sowing)						
	4	6	8	4 + 6	4 + 8	6 + 8	4 + 6 + 8
0.25	2585	2222	2293	2889	2908	2466	3878
0.5	3016	2719	2335	3401	3603	3293	3629
1.0	3324	3054	2962	3832	3721	3699	3806
2.0	3445	3532	2356	3767	3612	3802	3785
L.S.D.				491			

Results

The main effects of herbicide rate, time of application and diluent volume are presented in Table 4. The significant rate x time of application interactions for weed number, weed weight and soybean yield are shown in Table 5.

DISCUSSION

Bentazone has been shown to be an effective herbicide on thornapple and is safe in soybeans. However several important points need stressing:

1. With any treatment, weeds not contacted because of shielding from the crop or larger weeds, are not controlled. Therefore the equipment used must give good coverage. In the range tested the volume of diluent (Experiment 3) did not influence weed control or crop yield (Table 4). Conditions were ideal when this experiment was sprayed and as a result little or no drift was apparent with the low volume treatments. With less favourable conditions (e.g. hot and windy) the higher volume treatments may have been better. It is felt that the important indication is that bentazone may be applied at low volumes (e.g. with an aircraft) and still work efficiently.

2. In each experiment a repeated application, i.e. at 4 and 8 weeks after sowing, was in terms of both weed control and crop yield, more critical than the rate of bentazone used. This is explained by:

   (a) Weeds germinating after an early spraying time (4 weeks after sowing) being able to establish and compete with the crop later in the season.

   (b) Inability to achieve adequate coverage of all weeds with a later spraying time. This is particularly clear in Experiments 1 and 2 even if the high rate used (2.0 kg a.i./ha) is considered. This rate is sufficient to control quite large weeds but because of the extent of the weed and crop canopy it is difficult for all weeds to

Table 4. Bentazone in soybeans - Breeza 1976/77 (Experiment 3)

	Weed assessments †			No. of *Datura* per m^2	O.D.Wt. *Datura* g/m^2	Yield (12% H_2O) kg/ha
	27 January 1977	9 February 1977	13 May 1977			
Weed free control	0	2	2	5 (2.44)††	72 (8.51)††	3207
Weedy control	9	8	8	58 (7.66)	466 (21.59)	1075
Bentazone (kg a.i./ha)						
0.5	4.8	4.7	5.0	20 (4.53)	201 (14.18)	2544
1.0	3.7	3.0	3.5	11 (3.36)	73 (8.60)	2646
2.0	3.0	2.7	3.1	10 (3.24)	66 (8.17)	3001
L.S.D. 5%	-	-	-	(0.41)	(1.58)	177
Time of application (weeks after sowing)						
4	6.9	6.6	7.3	51 (7.18)	377 (19.44)	1878
8	3.4	2.9	3.4	5 (2.41)	56 (7.50)	2976
4 + 8	1.2	0.8	0.9	2 (1.54)	16 (4.00)	3337
L.S.D. 5%	-	-	-	(0.41)	(1.58)	177
Volume of diluent ($l\ ha^{-1}$)						
600	4.2	3.7	4.1	14 (3.82)	122 (11.07)	2706
240	4.3	3.6	3.8	14 (3.77)	107 (10.35)	2702
140	3.3	3.3	3.6	11 (3.45)	90 (9.51)	2716
80	3.4	3.2	4.0	14 (3.79)	106 (10.33)	2798
L.S.D. 5%	-	-	-	n.s.	n.s.	n.s.

† 0 = No *Datura* 9 = Dense infestation

†† $\sqrt{x + \frac{1}{2}}$ Transforms n.s. Not significant $P<0.05$

Table 5. Bentazone in soybeans - Breeza 1976/77 (Experiment 3)

Bentazone kg/ha a.i.	Time of application, weeks after sowing	Number of *Datura* per m^2			O.D. Wt. *Datura* g/m^2			Soybean yield (12%) kg/ha		
		4	8	4 + 8	4	8	4 + 8	4	8	4 + 8
0.5		49 (7.05)†	12 (3.55)	8 (2.97)	412 (20.30)	152 (12.34)	97 (9.88)	1622	2711	3299
1.0		47 (6.92)	4 (2.21)	0 (0.94)	338 (18.40)	36 (6.00)	5 (2.25)	1701	2919	3319
2.0		57 (7.55)	2 (1.46)	0 (0.71)	385 (19.63)	17 (4.16)	0 (0.71)	2313	3297	3393
L.S.D. (5%)			(0.71)			(2.73)			307	

† $\sqrt{x + \frac{1}{2}}$ Transforms

intercept sufficient spray. In Experiment 3 bentazone applied at 2.0 kg a.i./ha, 8 weeks after sowing was almost as good as 1.0 kg a.i./ha at 4 weeks and again at 8 weeks (Table 5). This was most likely influenced by the growing conditions during January. Rainfall was low from sowing to early January which meant that two irrigations were necessary on 23 December, 1976 and 7 January, 1977. Following this second irrigation, flood rains occurred which resulted in a further 200 mm during the next 2 weeks. Consequently the experiment was waterlogged for almost 3 weeks. It has been observed at this and on other occasions that thornapple does not tolerate excessively wet conditions. This suppressed weed growth during the 4 to 8 weeks after sowing interval and resulted in the treatments applied 8 weeks after sowing being considerably more effective than had been the case in Experiments 1 or 2 (Tables 1 and 3). However, the significant ($P<0.05$) rate x time of application interactions (Table 5) again showed that 0.5 kg a.i./ha of bentazone is only moderately effective as a single application but is equivalent to 2.0 kg a.i./ha of bentazone as either a single application at 8 weeks or the repeated application of 4 and 8 weeks after sowing. This supports the findings of both Experiments 1 and 2.

To conclude it is felt that for the best commercial results soybean growers should budget on two sprays. For crops where inter-row cultivation can be carried out the cost of herbicide can be substantially reduced by combining a cultivation at 4 weeks after sowing with band spraying.

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