Research Report to the
Agriculture Research Foundation
and the
Oregon Processed Vegetable Commission
(1998)

Title. Improving Goal Efficiency in Crucifers

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Summary

Goal impregnated fertilizer for weed control in broccoli. Two trials were conducted during 1998 to assess the potential of using Goal impregnated fertilizer for postemergence weed control in direct-seeded broccoli. The on-farm trial was initiated in mid-May; the trial at the OSU Vegetable Research Farm was planted in early July. Symptoms of Goal injury were noted on many leaves shortly after application at the 1.5 and 3 leaf stages at both sites, but this did not reduce yield. However, there was evidence of a slight delay in maturity as the first cut was generally a smaller proportion of the total yield than the second cutting compared to the check plots. The total number of heads harvested may have been lower in some of the Goal treatments, possibly because of early season crop damage. However, average head weight and size compensated and yield remained high.

These trials again confirm, as found in 1996 and 1997, that Goal impregnated fertilizer could be registered for use in direct-seeded broccoli. Suggested rates and use patterns are 0.25lb ai/A at the 1.5 leaf stage or 0.5 lb ai/A at the 3 leaf stage. Slight injury was apparent early in the season but the additional weed control and fertilizer benefits increased broccoli yield.

Goal application timing and efficacy

Witchgrass control was best when the soil was tilled in the afternoon just before Goal herbicide application or if the herbicide was applied to undisturbed soil in the early morning. Tilling the soil before Goal application late in the afternoon dramatically improved weed control. Tilling the soil in the morning before Goal application, however, may have reduced Goal efficacy, at least at the rate of 0.15 lb/A.

The relationship between soil moisture (shortly after the herbicide was applied) and herbicide efficacy was consistent at the 0.25 lb/A but not at 0.15 lb/A. At the rate of 0.25 lb/A, weed control correlated closely with percent soil moisture, regardless of the time of day Goal was applied or whether the soil was tilled before the Goal was applied.

1. Weed Control With Goal Impregnated Fertilizer In Broccoli (Jefferson)

Methods

The site was on a silt loam soil with a pH of 5.7, OM of 4.5%, and CEC of 28.1 Meq/100g. Potassium fertilizer was broadcast at 100 lbs P_2O_5/A with 5 lbs of Boron/A before planting. The cooperator applied and incorporated Treflan (0.5 lbs ai/A) before planting. Devrinol (1 lb ai/A) was applied after planting to one of four beds within the plot and incorporated with irrigation. Broccoli was direct-seeded on May 11 with 400 lbs/A of 13-39-0 banded at planting and Lorsban 10G applied in a 4" band over the row. Plots were cultivated twice after the first weed evaluation. Urea (360 lbs/A) was broadcast at 5 weeks after planting (WAP). Plots were not thinned.

The Goal impregnated fertilizer was applied to 20 by 7.5 wide (one bed width, 4 rows/bed) plots with 3 replications. The Goal was impregnated on the fertilizer at 1 lb ai Goal/400 lbs of 16-16-16. Check plots included fertilizer (16-16-16) without herbicide applied at the 1.5 leaf stage of broccoli.

Weed control and crop injury were evaluated on June 16, one week after the last herbicide application. The four-row plots were split in half so that the plots could be sequentially harvested; harvest in the first and second sequence commenced on July 24 and July 27, respectively with a second harvest taken in each sequence 3 days later. Broccoli heads were harvested from 2 rows 16.4 ft in length in each plot. The broccoli was weighed, head diameter determined, and heads evaluated for disease or growth abnormalities. Weed control was evaluated again after the second harvest.

Results and Discussion

Weed control averaged 73 % for the 1.5 leaf application although nearly 1 week elapsed between application and rainfall (Table 1.1). The second application timing gave exceptional weed control because rain occurred immediately after application. Nightshade and mustard control at harvest was exceptional; smartweed control was acceptable (Table 1.2).

Crop injury was greatest when applied at 0.5 lb Goal/A at the 3 leaf stage (Table 1.1). Symptoms of Goal injury were noted on many leaves shortly after application, but this did not reduce yield. None of the Goal herbicide treatments had less total yield than the unfertilized check plot (Treatment 7) in the either the first (Table 1.3) or second harvest sequence (Table 1.4, Fig. 1.1) . However, there was evidence of a slight delay in maturity as the first cut was generally a smaller proportion of the total yield than the second cutting compared to the check plots in both harvest sequences.

The total number of heads harvested may have been lower in some of the Goal treatments (Table 1.3, 1.4), possibly because of early season crop damage. However, average head weight and size tended to compensate and yield remained high.

This trial again confirms that Goal impregnated fertilizer could be registered for use in direct-seeded broccoli. Suggested rates and use patterns are 0.25 lbs ai Goal/A at 1.5 leaf or 0.5 lbs ai/A at 3 leaves. In this trial, some injury was apparent early in the season but the additional

weed control and fertilizer benefits compensated for the slight crop injury even when weed competition was low.

Table 1.1. Weed control and crop injury to broccoli with Goal impregnated fertilizer 1 week after 3 leaf application, June 16, 1998.

	PPI herbicide		Goal herbicide		Fertilizer rate	Weed control	Biomass reduction	Phyto
			Timing	Rate				
				lb ai/A	lbs/A	%	%	(10 = all leaves showing Goal injury)
1	Treflan		1.5 leaf	0.25	100	73	0	1
2	Treflan		3 leaf	0.25	100	73	0	2
3	Treflan		1.5 leaf	0.5	200	93	3	2
4	Treflan		3 leaf	0.5	200	90	13	4
5	Treflan		1.5 leaf	0	100	0	3	0
6	Treflan		1.5 leaf	0	200	0	0	0
7	Treflan		-	0	0	0	0	0
8	Treflan	Devrinol	3 leaf	0.25	100	93	3	1
9	Treflan	Devrinol	3 leaf	0.5	200	95	17	2
10	Treflan	Devrinol	-	0	0	59	0	0
	$LSD_{0.05}$					37	10	1

Table 1.2. Weed control at harvest, Jefferson, OR, 1998.

	PPI herbicides		Goal herbicide		Fertilizer rate	Weed control			
			Timing	Rate		Nightshade	Smartweed	Mustard spp.	Total
				lb ai/A	lbs/A	%			
1	Treflan		1.5 leaf	0.25	100	100	88	100	92
2	Treflan		3 leaf	0.25	100	100	95	100	96
3	Treflan		1.5 leaf	0.5	200	100	83	100	83
4	Treflan		3 leaf	0.5	200	100	100	100	100
5	Treflan		1.5 leaf	0	100	0	0	0	0
6	Treflan		1.5 leaf	0	200	0	0	0	0
7	Treflan		-	0	0	0	0	0	0
8	Treflan	Devrinol	3 leaf	0.25	100	100	95	100	95
9	Treflan	Devrinol	3 leaf	0.5	200	100	83	100	67
10	Treflan	Devrinol	-	0	0	3	22	50	13
	$LSD_{0.05}$					7	36	48	43

Table 1.3. Goal impregnated fertilizer effects on broccoli yield and grade of first harvest sequence , Jefferson, 1998.

Preemergence herbicide	Goal herbicide		Fertilizer rate	N	Yield			Number of heads			Average head wt.			Head diameter			Diseased heads		
	Timing	Rate			1st cut	2nd cut	Total	1st cut	2nd cut	Total	1st cut	2nd cut	Avg.	1st cut	2nd cut	Avg.	1st cut	2nd cut	Avg.
		lb ai/A	lbs/A		----------t/A---------			------no/plot-----			-------kg-------			------inches-----			-------%-------		
1 Treflan	1.5 leaf	0.25	100	2	1.7	1.6	3.3	14.5	10.0	24.5	0.15	0.21	0.18	4.4	5.3	4.9	0.0	0.0	0.0
2 Treflan	3 leaf	0.25	100	3	1.1	2.2	3.3	10.3	16.3	26.7	0.17	0.18	0.17	4.5	5.0	4.8	0.0	0.0	0.0
3 Treflan	1.5 leaf	0.5	200	3	1.4	2.1	3.5	12.7	13.7	26.3	0.17	0.22	0.20	4.4	5.2	4.8	0.0	0.0	0.0
4 Treflan	3 leaf	0.5	200	3	1.5	2.2	3.7	14.0	13.0	27.0	0.17	0.22	0.20	4.1	5.5	4.8	0.0	0.0	0.0
5 Treflan	1.5 leaf	0	100	3	0.7	2.4	3.2	7.7	19.0	26.7	0.13	0.16	0.15	4.2	4.9	4.6	0.0	0.0	0.0
6 Treflan	1.5 leaf	0	200	3	0.7	2.2	2.9	5.7	15.7	21.3	0.17	0.18	0.17	4.9	5.1	5.0	0.0	0.0	0.0
7 Treflan	no fert	0	0	3	1.0	2.3	3.3	8.0	17.7	25.7	0.17	0.17	0.17	4.7	5.0	4.8	4.2	1.8	3.0
8 Treflan + Devrinol	3 leaf	0.25	100	2	1.2	2.4	3.5	9.5	14.5	24.0	0.15	0.22	0.19	4.8	5.4	5.1	0.0	5.0	2.5
9 Treflan + Devrinol	3 leaf	0.5	200	3	1.1	1.9	2.9	8.3	11.7	20.0	0.17	0.20	0.19	4.6	4.9	4.8	0.0	0.0	0.0
10 Treflan + Devrinol	none	0	0	6	1.1	2.8	3.9	8.3	19.7	28.0	0.20	0.19	0.19	5.1	5.1	5.1	0.0	0.0	0.0
LSD(0.05)							NS			NS			NS			NS			NS
CV							53			61			35			10			491

Table 1.4. Goal impregnated fertilizer effects on broccoli yield and grade of second harvest sequence, Jefferson, 1998

Preemergence herbicide	Goal herbicide		Fertilizer rate	N	Yield			Number of heads			Average head wt			Head diameter			Diseased heads		
	Timing	Rate			1st cut	2nd cut	Total	1st cut	2nd cut	Total	1st cut	2nd cut	Avg.	1st cut	2nd cut	Avg.	1st cut	2nd cut	avg
		lb ai/A	lbs/A		-------t/A------			------no/plot-------			-------kg------			----inches----			-------%-------		
1 Treflan	1.5 leaf	0.25	100	2	3.5	1.8	5.3	18	14	32	0.26	0.17	0.21	6.5	5.0	5.7	3.0	4.6	3.8
2 Treflan	3 leaf	0.25	100	3	2.6	2.8	5.4	13	18	31	0.25	0.20	0.23	6.2	5.4	5.8	2.7	1.9	2.3
3 Treflan	1.5 leaf	0.5	200	3	3.2	2.6	5.8	15	17	32	0.27	0.20	0.23	6.4	5.5	5.9	0.0	0.0	0.0
4 Treflan	3 leaf	0.5	200	3	2.4	3.1	5.5	10	18	28	0.30	0.23	0.27	6.6	5.5	6.0	0.0	0.0	0.0
5 Treflan	1.5 leaf	0	100	3	3.0	1.7	4.7	15	12	27	0.25	0.19	0.22	6.2	5.1	5.7	0.0	0.0	0.0
6 Treflan	1.5 leaf	0	200	3	3.2	2.4	5.5	15	15	30	0.27	0.20	0.23	6.6	5.5	6.1	0.0	0.0	0.0
7 Treflan	no fert	0	0	3	2.7	2.2	5.0	15	16	31	0.22	0.18	0.20	5.9	5.0	5.5	0.0	0.0	0.0
8 Treflan + Devrinol	3 leaf	0.25	100	2	3.2	1.6	4.8	19	13	32	0.22	0.16	0.19	5.7	4.6	5.1	0.0	0.0	0.0
9 Treflan + Devrinol	3 leaf	0.5	200	3	2.5	1.6	4.2	14	13	27	0.23	0.16	0.20	5.8	4.5	5.2	0.0	0.0	0.0
10 Treflan + Devrinol	none	0	0	6	3.1	1.7	4.7	19	13	32	0.21	0.16	0.19	5.7	4.7	5.2	0.0	0.0	0.0
LSD(0.05)							NS			NS			0.03			0.5			NS
CV							32			34			10.0			7.0			95

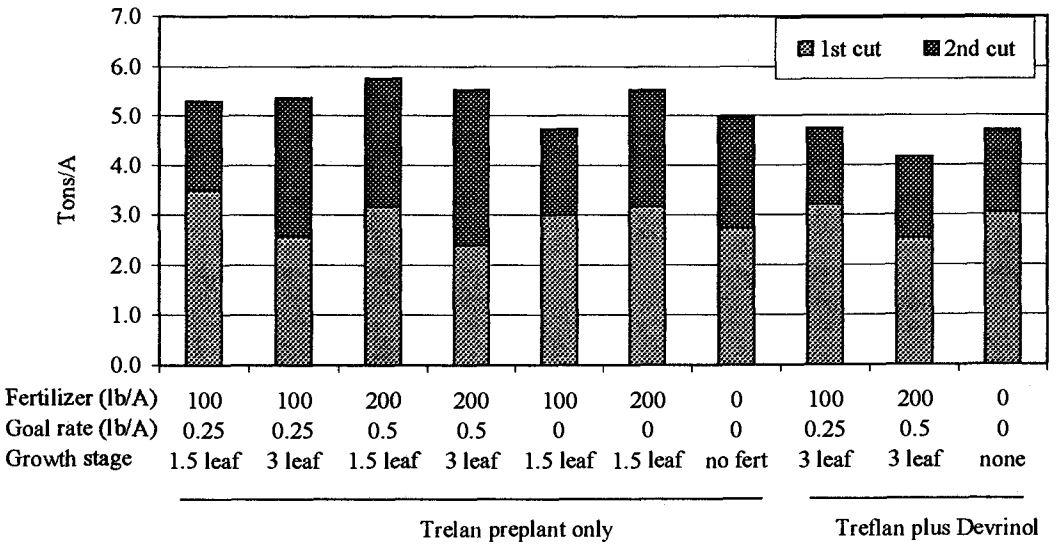

Figure 1.1 Goal impregnated fertilizer effect on broccoli yield for second harvest sequence (See Table 1.4), Jefferson, OR, 1998.

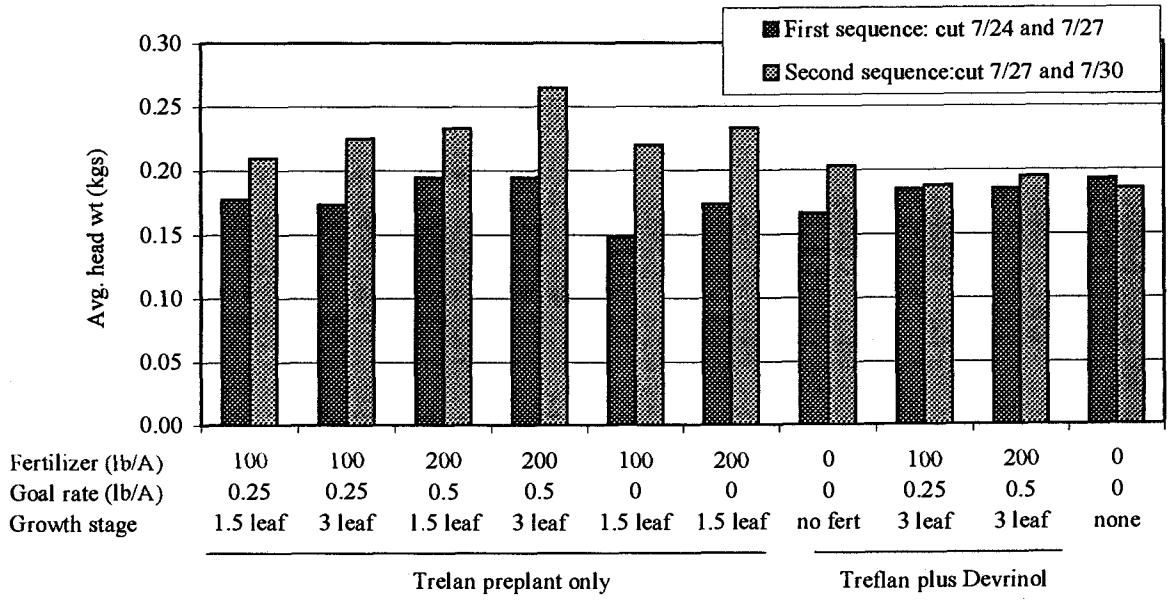

Figure 1.2. Goal impregnated fertilizer effects on average head weight for both harvest sequences, Jefferson, OR, 1998.

2. Tolerance Of Broccoli To Goal Impregnated Fertilizer, Vegetable Research Farm, Corvallis.

Methods

Treflan and Dyfonate (fonofos) were preplant incorporated on June 4. Because of very poor emergence in the first planting the plot was tilled again on June 28 and broccoli (var. Pirate) replanted on July 1 in 30 inch rows. Fertilizer was banded at planting (450 lbs 12-29-10/A) next to the seed row. Sevin insecticide was applied on June 10 and 17 to control flea beetles.

Goal impregnated fertilizer (16-16-16) was applied at either 100 or 200 lbs ai/A so that rates of 0.25 and 0.50 lbs ai/A of Goal were applied to plots 7.5 by 25 ft. The actual plot size was 10 ft by 25 but the shared row between plots was not treated with Goal fertilizer. Treatments included three timings when: approximately 75 % of the seedlings had emerged but were still in the cotyledon stage; 75 % of the broccoli had more than one leaf fully emerged; and when seedlings had 3 full leaves. Two check plots were included with the same rate of fertilizer but without the goal impregnated on the fertilizer prills. A wettable powder formulation of pyridate (without crop oil) was applied to assigned plots as a broadcast spray when seedlings had 3-4 leaves or 5-6 leaves.

The entire plot was cultivated on July 31 and the harvest row of each plot hand-hoed on August 3. A Diazinon drench was applied on August 6 to prevent root maggot injury. Urea fertilizer (100 lbs N/ac) was side-dressed on August 15.

Broccoli was harvested on Sept 16 and 21 from 16.4 ft of the center row in each plot. Heads were weighed, diameter determined, and heads evaluated for signs of disease or abnormalities. Harvest and yield data were analyzed with the repeated time procedure of SAS.

Results and Discussion

Crop growth and yield. Goal impregnated fertilizer applied to broccoli at the cotyledon stage significantly reduced early season broccoli growth (Table 2.1) and yield at both the 0.25 and 0.50 lb/A herbicide rates (Table 2.2). When applied at the 1.5 leaf stage, crop injury was much less noticeable at 4 WAP but was still significant at the 0.50 lb ai/A rate and may have reduced yield compared to the fertilizer check. When Goal impregnated fertilizer was applied to 3 leaf broccoli, injury to broccoli seedlings at both rates was minor and did not reduce yield compared to the unfertilized check.

Treatment effects were noted on the total number of heads harvested (Table 2.2). The relationship between heads harvested and average head weight was not consistent but did not influence overall yield. It is unclear whether the lower head number of Treatment 3 was due to herbicide injury or other factors. Crop injury was apparent early in the season when Goal was applied at the 1.5 leaf stage. Given the greater sensitivity of smaller seedlings to Goal, uneven but normal emergence may have exacerbated the herbicide injury and stunting of smaller seedlings, thus causing fewer heads with a greater weight.

Pyridate significantly injured broccoli but did not reduce yield when applied at the 3 leaf stage of broccoli. This strong response may have been due in part to the very hot weather that

followed within three days after application. When pyridate was applied at the 5 leaf stage, injury was less but weed control was poor.

Weed control. Weed density at this site was relatively high. The plot was plowed under one month after the first planting because of poor crop emergence and replanted. Weed control was exceptional with the early applications of Goal and diminished with later application timings (Table 2.1). Even when applied at the 3 leaf stage, weed control was as good as the pyridate treatments applied at the same stage, and much better than pyridate applied at the 5-6 leaf stage.

Summary. Goal impregnated fertilizer controlled nightshade and shepherdspurse effectively with minimal risk of yield loss when applied at 0.25 lbs ai/A at the 1.5 leaf stage of broccoli or 0.5 lbs ai/A at the 3 leaf stage of broccoli. Pyridate controlled smartweed but not shepherdspurse. AN20 did not control either nightshade or shepherdspurse.

This second year of data again indicates that Goal impregnated fertilizer could be registered for postemergence weed control in direct-seeded broccoli. Weed control will depend on precise timing of application and water management. Preplant weed suppression will be needed to maximize effectiveness of this technique in most cases.

Table 2.1. Crop injury and weed control by Goal impregnated fertilizer, pyridate and AN20 on July 31, 1998, 4 WAP , Corvallis, 1998.

	Herbicide	Goal herbicide		Fertilizer rate	Crop biomass red estimate	Phytotoxicity rating (0-10; 10=no surviving plants)	Nightshade	Shepherds-purse	Smartweed	Total
		Timing	Rate	lbs/A	compared to check plot with no fert		%			
					%	%				
1	Goal on fertilizer	cotyledon	0.25	100	74	0.0	96	100	98	97
2	Goal on fertilizer	cotyledon	0.50	200	88	0.0	100	100	75	99
3	Goal on fertilizer	1.5 leaf	0.25	100	15	0.0	85	99	58	85
4	Goal on fertilizer	1.5 leaf	0.50	200	38	0.0	96	95	73	95
5	Goal on fertilizer	3 leaf	0.25	100	10	0.5	65	98	55	74
6	Goal on fertilizer	3 leaf	0.50	200	9	1.5	88	95	73	89
7	Pyridate	3 leaf	0.47	0	16	3.0	83	18	48	73
8	Pyridate	3 leaf	0.94	0	38	3.3	94	45	67	81
9	Pyridate	5 leaf	0.47	0	0	0.5	0[1]	0	0	0
10	Pyridate	5 leaf	0.94	0	8	0.8	0	0	24	0
11	Fertilizer check	cotyledon	0.00	100	-5	0.0	0	0	8	0
12	Fertilizer check	cotyledon	0.00	200	-13	0.0	0	0	25	0
13	AN20	5 leaf	85 GPA		5	4.3	1	20	68	20
14	No herbicide or fertilizer	-	0.00	0	0	0.0	0	0	23	0
LSD(0.05)					15	0.8	8	11	10	54

[1] These plots were evaluated 3 days after treatment, therefore pyridate effects were minimal.

Table 2.2. Goal impregnated fertilizer, pyridate, and AN20 effects on broccoli yield, Corvallis, 1998.

Herbicide	Herbicide application		Fertilizer rate	N	Yield			No of heads			Average head wt			Average head diameter			Head diameter variance			Diseased heads
	broccoli growth stage	rate lbs ai/A	lbs/A		1st cut	2nd cut	Total	1st cut	2nd cut	Total	1st cut	2nd cut	Average	1st cut	2nd cut	Average	1st cut	2nd cut	Average	Average
					t/A			no/plot			grams			inches			avg. of standard deviations			
1 Goal fert.	cotyledon	0.25	100	1	0.4	1.6	2.1	0.8	4.0	4.8	500	350	425	7.2	6.4	6.8	1.8	0.8	1.3	0.0
2 Goal fert.	cotyledon	0.50	200	4	0.1	0.4	0.5	0.3	0.8	1.0	-	-	-	-	-	-	-	-	-	-
3 Goal fert.	1.5 leaf	0.25	100	4	5.0	2.6	7.7	10.3	4.8	15.0	416	474	445	7.5	6.6	7.0	1.1	1.3	1.2	0.0
4 Goal fert.	1.5 leaf	0.50	200	4	3.5	2.6	6.1	7.3	6.5	13.8	422	367	394	7.0	6.9	6.9	1.0	1.9	1.4	0.0
5 Goal fert.	3 leaf	0.25	100	4	5.0	2.0	6.9	10.8	4.5	15.3	395	388	391	7.1	7.5	7.3	1.0	2.0	1.5	0.0
6 Goal fert.	3 leaf	0.50	200	4	6.6	1.5	8.1	13.3	4.8	18.0	434	290	362	7.3	6.5	6.9	1.2	1.3	1.2	0.0
7 Pyridate	3 leaf	0.47	0	4	3.5	2.1	5.6	6.8	5.5	12.3	453	317	385	6.8	7.3	7.0	1.0	1.6	1.3	0.0
8 Pyridate	3 leaf	0.94	0	4	3.4	3.2	6.6	8.0	7.8	15.8	381	372	376	7.1	7.1	7.1	0.6	1.2	0.9	0.0
9 Pyridate	5 leaf	0.47	0	4	5.4	1.8	7.2	11.0	4.3	15.3	420	375	397	7.3	7.0	7.1	1.3	1.8	1.5	0.0
10 Pyridate	5 leaf	0.94	0	4	6.3	2.2	8.5	10.5	4.5	15.0	502	459	480	7.6	7.0	7.3	1.4	1.4	1.4	0.0
11 Fert. check	cotyledon	0.00	100	4	5.5	1.9	7.4	10.8	5.0	15.8	443	344	393	7.6	7.2	7.4	1.2	1.2	1.2	0.0
12 Fert. check	cotyledon	0.00	200	4	6.5	1.2	7.7	12.8	2.8	15.5	438	446	442	7.7	7.4	7.5	1.6	0.8	1.2	0.1
13 AN20	5 leaf	85 GPA		4	5.1	2.4	7.5	10.3	5.8	16.0	428	356	392	7.4	6.9	7.1	1.0	1.2	1.1	0.0
14 No herbicide or fertilizer		0.00	0	7	5.5	1.1	6.6	10.9	3.5	14.4	420	279	349	7.2	6.4	6.8	1.0	2.0	1.5	0.0
$FPLSD_{0.05}$					2.0	1.4	2.3	3.8	3.3	4	ns	ns	ns	ns	ns	ns	0.5	ns	ns	ns
Anova Time (1st cut vs. 2nd cut)						0.0001			0.0001			0.003			0.01			0.06		
Treatment						0.0001			0.0001			0.24			0.52			0.79		
Time * treat						.00001			0.0004			0.48			0.35			0.8		

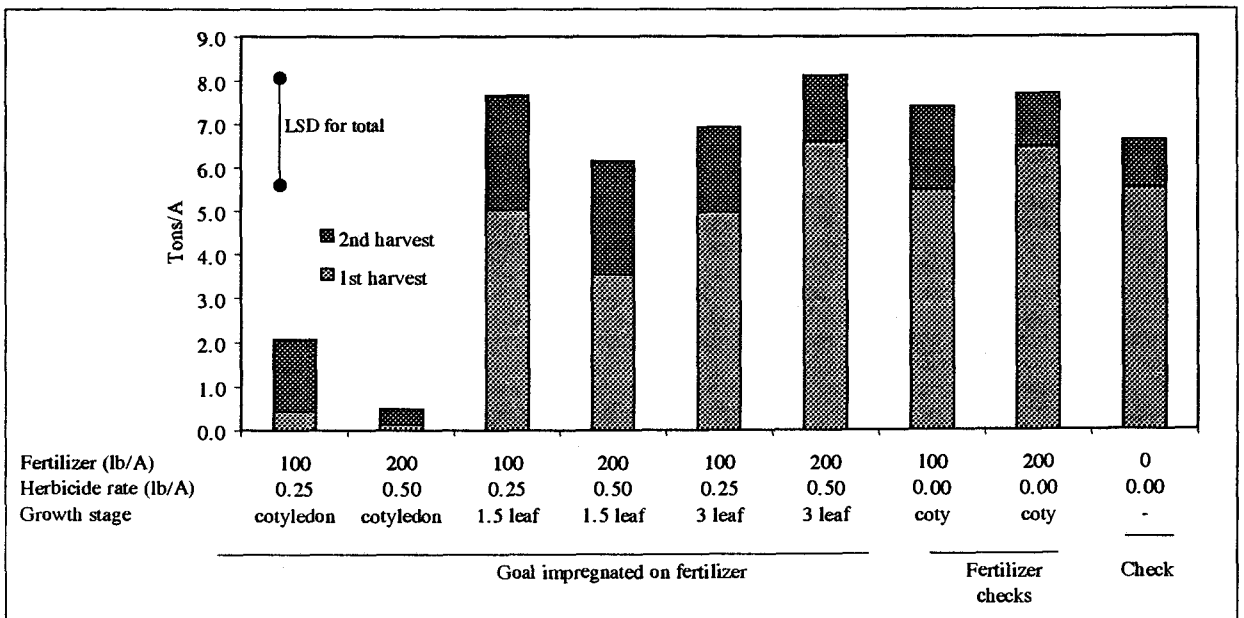

Figure 2.1.Effect of Goal impregnated fertilizer on broccoli yield, Corvallis, OR, 1998.

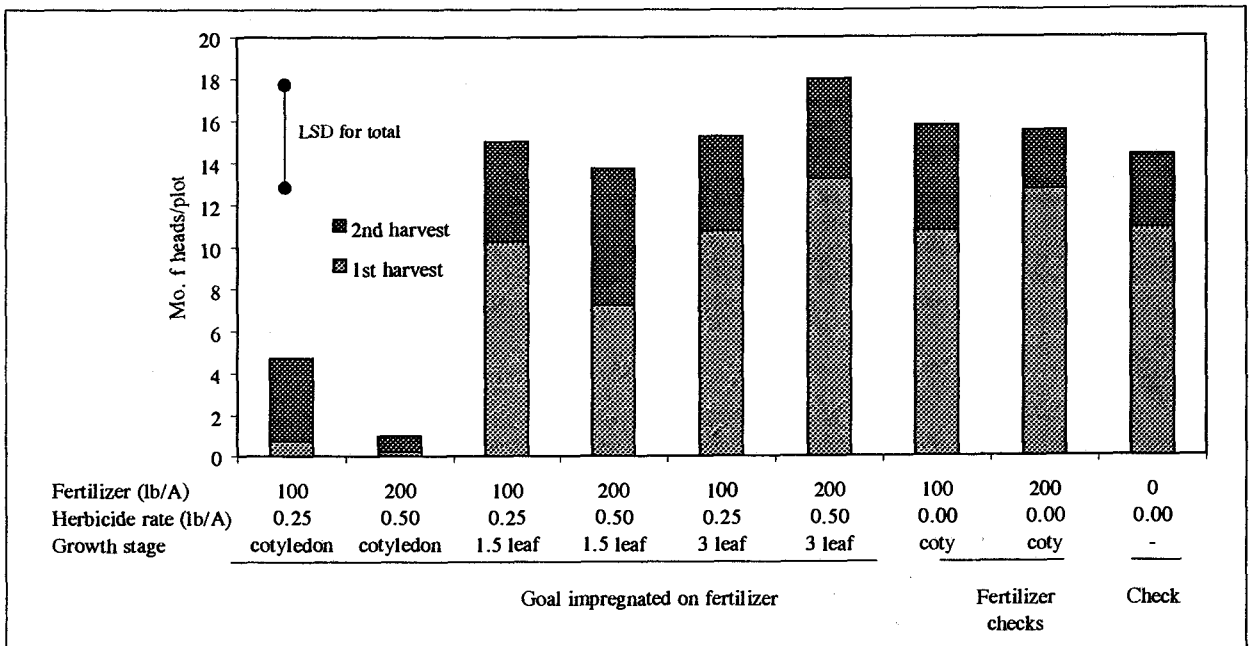

Figure 2.2.Effect of Goal impregnated fertilizer on number of broccoli heads harvvested, Corvallis, OR, 1998.

3. Goal Application Timing And Efficacy In Cauliflower

Methods

This trial was located at the Research Farm in Corvallis on a silty clay loam. The soil was rototilled several times two weeks before treatment application. The site was divided into 4 blocks with four 'timing and tillage' treatments assigned randomly to 4 plots within each block. Each treatment plot was further split into three subplots for the three herbicide rates.

Designated plots were tilled with a vertical tine tiller to 6 inches before herbicide application. Herbicide was only applied to half of each plot so that a check plot was included for every subplot. The entire trial was irrigated every 3 to 4 days during the first two weeks to encourage weed seed germination and emergence.

Weed seedlings were counted 3 weeks after the trial was initiated from either 0.25 or 1 m^2 areas depending on the number of seedlings. Weed density in the check plots ranged from 200 to 2600/m^2. Statistical analysis was preformed on percent control, calculated by dividing the number of seedlings in the herbicide plot by the number in the companion check plot.

Results and Discussion

Witchgrass was by far the most predominant and evenly distributed weed at the site but other weeds included nightshade and pigweed. Witchgrass control was best in plots where the soil had been tilled in the afternoon just before the herbicide was applied, or in plots that were treated with herbicide in the early morning (Table 3.1, Fig. 3.1). Tilling the soil before Goal application late in the afternoon dramatically improved witchgrass control. Tilling the soil in the morning before Goal application, however, may have reduced Goal efficacy.

The relationship between soil moisture (shortly after herbicide was applied) and herbicide efficacy was consistent at the 0.25 lb/A but not at 0.15 lb/A (Figure 3.2 and 3.3). Weed control was less than expected in the 4 AM tillage treatment at the 0.15 lb/A rate of Goal (Fig. 3.2). At low rates of Goal it may be possible that factors other than soil moisture influence efficacy.

As in 1996, applying Goal to hot and dry soil reduced efficacy by 50 %. Tillage before the mid-day application, which brought moist soil to the surface, more than doubled Goal efficacy. However, when Goal was applied in the early morning hours, tillage did not improve Goal efficacy. In fact, tillage in the early morning immediately before the herbicide was applied actually reduced Goal efficacy at the rate of 0.15 lbs ai/A. This was not the case at 0.25 lb ai/A. The reasons for this discrepancy are unclear.

Table 3.1. Effect of Goal application timing, tillage, and rate on weed emergence.

	Timing of Goal application	Tillage before Goal application	Rate	Soil moisture at application	Soil surface temp. at application	Nightshade	Pigweed	Witchgrass	Total
			lb/A	%	F	---------- % control.----------			
1.	4 AM	None	0.15	2.6 b[2]	62	95	95	80 ab	92
2.	4 AM	None	0.25			75	100	73 abc	77
3.	4 AM	None	0.50			100	96	95 a	91
4.	4 AM	Rototilled	0.15	3.9 a	63	98	100	49 bcd	68
5.	4 AM	Rototilled	0.25			90	100	82 ab	94
6.	4 AM	Rototilled	0.50			100	100	88 a	93
7.	5 PM	None	0.15	1.1 c	118	96	99	37 d	80
8.	5 PM	None	0.25			100	100	48 cd	87
9.	5 PM	None	0.50			100	100	94 a	98
10.	5 PM	Rototilled	0.15	4.2 a	96	69	98	91 a	92
11.	5 PM	Rototilled	0.25			98	100	82 ab	91
12.	5 PM	Rototilled	0.50			100	100	92 a	95
						NS	NS		NS

[1] Values in the same column followed by the same letter do not differ statistically (0.05).

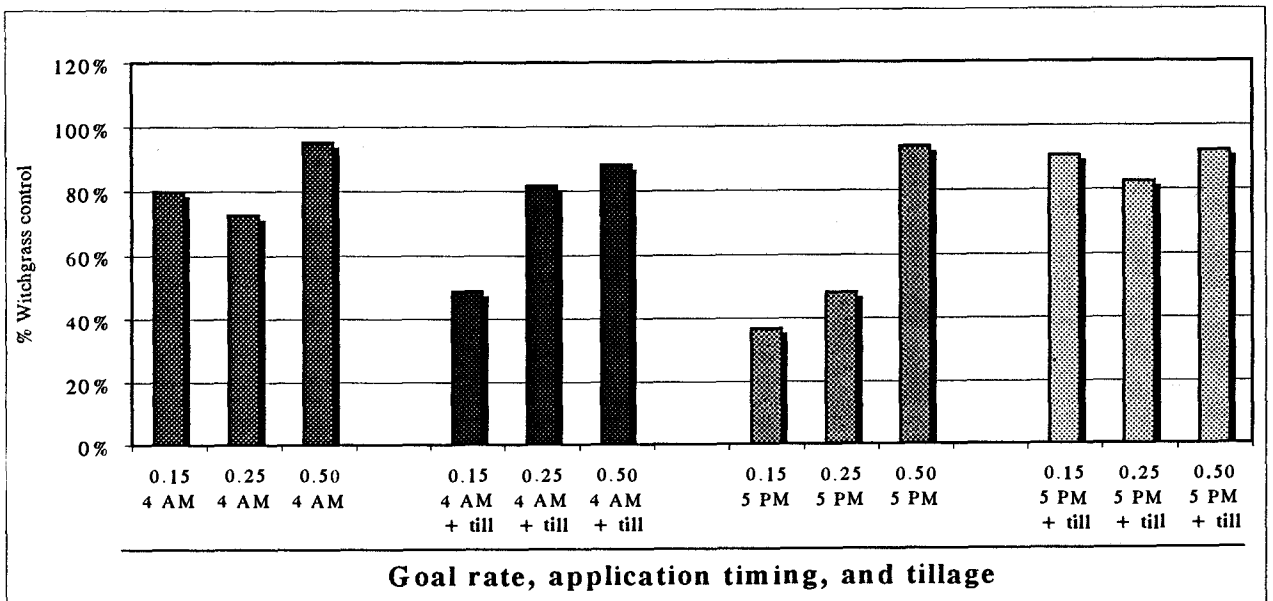

Figure 3.1. Effect of Goal application timing and rate on witchgrass control.

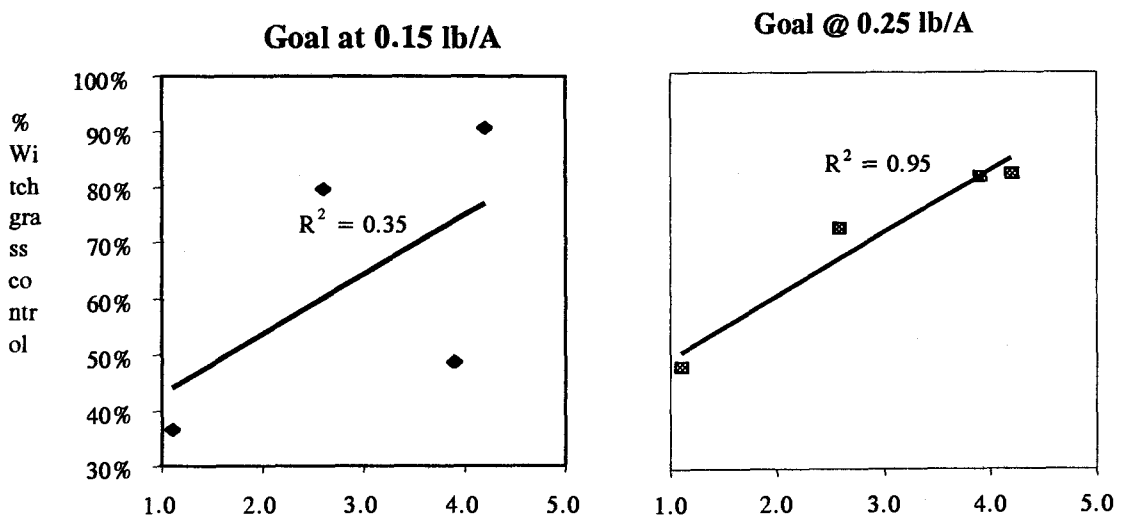

Figure 3.2. Relationship of soil moisture at Goal application to witchgrass control

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Project leader

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Project leader

Department Head