Research Report to the
Oregon Processed Vegetable Commission
and the
Agricultural Research Foundation

Title: Improving the Application and Efficacy of *Goal* on Crucifers

Project Leaders:

Ed Peachey and Ray William
Horticulture Dept.

Carol Mallory-Smith
Crop and Soil Science Department

Cooperator: Dale Lucht, Mollala, OR

Project status: Complete

Project Funding: $4,980

Objectives

1. Compare potential of fertilizer impregnated with *Goal* and pyridate (Tough herbicide) for postemergence weed control in direct seeded broccoli and cauliflower.
2. Evaluate impact of soil moisture and tillage schedule on *Goal* efficacy.

Summary

Goal impregnated fertilizer effectively controlled weeds in seeded broccoli when applied at 3-4 leaf stage or later and did not reduce yield. Pyridate controlled weeds but only at the earliest application. Crop injury from pyridate was severe when applied to 3-4 leaf broccoli, however. The use rate for pyridate may need to be linked to anticipated temperatures after application.

Applying Goal immediately after tillage in the afternoon or evening did not improve weed control, nearly the opposite of the trend noted in 1996. Weed species present were different than last year and heavy rainfall caused a last minute change in field site selection.

Progress

1. Goal Impregnated Fertilizer and Pyridate for Postemergence Weed Control in Broccoli.

Goal herbicide is currently registered on transplanted crucifers for weed control. Potential injury in direct-seeded crops limits the use of *Goal*. However, *Goal* can be impregnated on fertilizer to minimize damage to crops when applied postemergence. This technique has been used successfully in mint. Early weed suppression is essential and timing of the application is critical. Another potential herbicide for crucifers is pyridate. The objective of this research was to

compare weed control efficacy and tolerance of broccoli to both fertilizer impregnated with Goal and pyridate (Tough).

Treflan and Dyfonate (fonofos) were preplant incorporated before broccoli (var. San Miguel) was direct-seeded on May 13 into finely prepared soil with 600 lbs/ac of fertilizer (12-29-10) banded next to the seed row. Sevin insecticide was applied on May 30 and June 6 to control flea beetles. A Diazinon drench was applied on June 14 to prevent root maggot injury. The center row that was designated for harvest was thinned to a 12 inch in-row spacing on June 12. Urea fertilizer (100 lbs N/ac) was side-dressed on July 10. Only Treatment 7 was hand-hoed and cultivated.

Goal impregnated fertilizer (16-16-16) was applied at either 100 or 200 lbs ai/ac so that rates of 0.25 and 0.50 lbs ai/ac of Goal were applied to the plots. Treatments included three timings: when approximately 75 % of the seedlings had emerged but were still in the cotyledon stage; when 75 % of the broccoli had one full leaf emerged; and when seedlings had 3-4 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 as a broadcast spray when seedlings had 3-4 leaves or 5-6 leaves.

Broccoli was harvested on July 30 from 16.4 ft of the center row in each plot. Heads of 4 inches or greater were cut and weighed.

Results and Discussion

Crop growth and yield (Tables 1 and 2). Goal impregnated fertilizer applied to broccoli at the cotyledon stage significantly reduced early season broccoli growth and yield at both the 0.25 and 0.50 lb/A herbicide rates. When applied at the 1 leaf stage, crop injury was much less noticeable 6 WAP but was still significant at the 0.50 lb rate and also reduced yield. When applied to 3-4 leaf broccoli, injury to broccoli seedlings was minor and did not reduce yield compared to the unfertilized check. Average head weight of these treatments was slightly larger than that of the check treatment, probably because the number of harvestable heads was less than in the check treatments. However, impregnated fertilizer applied at the 3-4 leaf stage may have reduced yield compared to the same fertilizer treatments without Goal herbicide (Trs. 5 and 6 vs. Trs 8 and 9, respectively).

Pyridate significantly injured broccoli and reduced yield when applied at the 2 leaf stage. 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 6 leaf stage, injury was much less and broccoli yield was not reduced.

Weed control (Table 1). Weed density was relatively low because Treflan was applied to the entire field. Nevertheless, many weeds still emerged and were visible at harvest. Goal impregnated fertilizer significantly reduced weed emergence and was most effective when applied at emergence. Even when applied at the 3-4 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 can effectively be used for weed control in broccoli with minimal risk of injury if applied at the 3-4 leaf stage or later. Pyridate controlled weeds but only at the earliest application. Crop injury was severe when pryidate was applied to 3-4 leaf broccoli, however. The use rate for Pyridate may need to be linked to anticipated temperatures after application.

Given that Goal is already registered for use on transplanted broccoli at a similar growth stage (although in *transplanted* broccoli), Goal impregnated fertilizer may be a good option at this time. One other consideration is that San Miguel is a vigorous variety; other varieties could be more sensitive.

2. Timing of Goal Application for Weed Control in Cauliflower

Growers have noted that weed control with Goal in transplanted cauliflower is erratic. Goal activity is often reduced when applied to a very dry soil surface in mid-day with high soil temperature. Rototilling just before application can improve weed control but the effect is unpredictable. Goal is tightly adsorbed to soil particles and may be permanently adsorbed if soil moisture is very low. These facts best explain these observations.

Goal was applied pre-transplant to the soil surface near Mollala, OR in either the afternoon or evening, before or after rototilling, and at three rates on July 14, 1997. Afternoon soil surface temperatures were at 97 F in the untilled strip. The four treatments based on rototilling timing established a moisture gradient at the soil surface. Treatments that required rototilling just prior to herbicide application were applied in continuous strips across the entire plot (four replications). Twelve treatments (three herbicide rates over four soil treatments) were positioned in each block. The plot width was 15 feet but herbicides were applied to only 10 feet and the remaining 5 feet was used to estimate weed control. Herbicides were applied immediately behind the rototiller and within 10 minutes after rototilling.

Emerged weeds were counted on August 16 and weed control estimated on September 22. Data were analyzed as a factorial split-plot with main effects of soil management and herbicide rate.

Results and Discussion

Weed control results differed from results of the 1996 trial, possibly due to different conditions (Tables 3-8). A heavy shower on July 13 prohibited transplanting on the selected site. Another field was chosen that had been treated with Treflan on July 3. This field was tilled early in the morning of July 14, the day Goal treatments were applied. Therefore, only a few hours separated soil drying and Goal application. Small strips were missed with the Treflan application and left narrow rows of barnyardgrass across the field and within the trial area.

Barnyardgrass was the primary weed present early in the season. Plots that were tilled immediately before Goal application had more barnyardgrass seedlings than plots that were not tilled in the early morning. There was no difference in emergence between the afternoon and evening applications on the untilled plots, although more weeds emerged in the afternoon tilled

plots than the afternoon untilled plots. Most of the strips of barnyardgrass that escaped the Treflan application did not occur within the areas used for evaluation within the plots. This did increase the difficulty in evaluating barnyardgrass emergence, however, and added to the variability of the analysis. Barnyardgrass was not present in the 1996 trial.

Nightshade escapes became apparent toward midseason as expected, because of its tolerance to Treflan. However, estimated nightshade control followed a very different pattern than noted in 1996 with lambsquarter and pigweed. This year's results indicated that tillage just before Goal was applied did not improve weed control, whereas in 1996 pigweed and lambsquarter control improved with tillage just before Goal application. It is unclear why this dramatic shift occurred. However, the situation this year was quite different than in 1997. As previously mentioned, we moved the trial to a field treated with Treflan because of rainfall just before transplanting. Additionally, there were only a few hours between the last tillage of the field and the initiation of this trial. In 1996 nearly a week transpired before the trial was initiated so that the soil surface had ample time to dry. Air temperature previous to July 14 was much lower this year than in 1996. Soil temperatures only reached 96 F compared to the 127 F recorded at herbicide application in 1996.

Considering these factors, we have theorized several possibilities for the difference in results: 1) the additional tillage in the afternoon or evening reduced the effectiveness of Treflan, thus allowing more weeds to escape in tilled areas; 2) a band of weed seeds was brought to the surface during tillage just before the Goal application; 3) the soil may not have had enough time to dry sufficiently to cause a difference in Goal efficacy when applied after tillage; and 4) the response of nightshade to Goal application timing differs compared to pigweed and nightshade.

Signatures **Date**

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Table 1. Early season broccoli growth response to Goal impregnated fertilizer and pyridate applied as a broadcast spray.

Herbicide	Growth stage	Date	Herbicide rate	Phytotoxicity (6/19)	Crop injury (6/27)	Weed control (6/27)
			lbs ai/ac	10=death; 1=slight symptoms	% biomass reduction estimate	%
1 Goal on fertilizer	≥ 75 % emerge	23-May	0.25	0	38	96
2 Goal on fertilizer	≥ 75 % emerge	23-May	0.50	2	75	100
3 Goal on fertilizer	≥ 75 % full 1 leaf	2-Jun	0.25	1	5	100
4 Goal on fertilizer	≥ 75 % full 1 leaf	2-Jun	0.50	3	30	99
5 Goal on fertilizer	3-4 leaf	14-Jun	0.25	1	10	85
6 Goal on fertilizer	3-4 leaf	14-Jun	0.50	1	0	98
7 Goal on fertilizer	applied after cultivation and thinning at 3-4 leaf stage	14-Jun	0.50	0	5	100
8 Fertilizer check	for Trs 1, 3 and 5	23-May	-	0	0	0
9 Fertilizer check	for Trs 2, 4 and 6	23-May	-	0	3	5
10 Pyridate	3-4 leaf	14-Jun	0.47	7	28	89
11 Pyridate	3-4 leaf	14-Jun	0.94	6	53	91
12 Pyridate	5-6 leaf	20-Jun	0.47	-	3	50
13 Pyridate	5-6 leaf	20-Jun	0.94	-	13	75
14 Check	no herbicide or fertilizer broadcast after planting	-	-	0	0	0
FPLSD (0.05)				2	22	17

Table 2. Broccoli yield response to Goal impregnated fertilizer and pyridate.

	Herbicide	Growth stage	Date	Herbicide rate	Gross yield	No heads harvested	Average head wt.
				lbs ai/ac	t/ac	no./16.4 ft	lbs/head
1	Goal on fertilizer	≥ 75 % emerge	23-May	0.25	2.6	11	0.468
2	Goal on fertilizer	≥ 75 % emerge	23-May	0.50	0.9	5	0.226
3	Goal on fertilizer	≥ 75 % full 1 leaf	2-Jun	0.25	2.7	10	0.517
4	Goal on fertilizer	≥ 75 % full 1 leaf	2-Jun	0.50	2.5	7	0.686
5	Goal on fertilizer	3-4 leaf	14-Jun	0.25	4.1	12	0.629
6	Goal on fertilizer	3-4 leaf	14-Jun	0.50	5.3	12	0.865
7	Goal on fertilizer	applied after cultivation and thinning at 3-4 leaf stage	14-Jun	0.50	3.5	13	0.505
8	Fertilizer check	for Trs 1, 3 and 5	23-May	-	4.6	15	0.560
9	Fertilizer check	for Trs 2, 4 and 6	23-May	-	6.0	15	0.762
10	Pyridate	3-4 leaf	14-Jun	0.47	1.9	7	0.509
11	Pyridate	3-4 leaf	14-Jun	0.94	3.3	10	0.660
12	Pyridate	5-6 leaf	20-Jun	0.47	4.3	12	0.729
13	Pyridate	5-6 leaf	20-Jun	0.94	5.4	14	0.732
14	Check	no herbicide or fertilizer broadcast after planting	-	-	4.1	15	0.514
	FPLSD (0.05)				1.9	5	0.207

Table 3. Weed emergence in response to goal herbicide application timing and rate August 16, 1997, 4 WAP.

	Timing	Herbicide rate	Nightshade	Pigweed	Barnyardgrass
		-lbs ai/ac-	---------- no/25 ft of inter-row area----------		
1	Aft, untilled	0.15	2	0	17
2	Aft, untilled	0.25	0	0	18
3	Aft, untilled	0.50	0	0	10
4	Eve, untilled	0.15	1	1	26
5	Eve, untilled	0.25	1	0	28
6	Eve, untilled	0.50	3	0	11
7	Aft, tilled	0.15	2	0	107
8	Aft, tilled	0.25	1	0	59
9	Aft, tilled	0.50	0	0	33
10	Eve, tilled	0.15	3	0	64
11	Eve, tilled	0.25	1	0	30
12	Eve, tilled	0.50	1	0	29
	FPLSD (0.05)		ns	ns	42

Table 4. Weed emergence in response to low rates of Goal at four application timings, August 16, 1997, (4 WAP).

	Timing	Herbicide rate	Nightshade	Pigweed	Barnyardgrass
		-lbs ai/ac-	---------- no/25 ft of inter-row area---------		
1	Aft, untilled	0.15	2	0	17
4	Eve, untilled	0.15	1	1	26
7	Aft, tilled	0.15	2	0	107
10	Eve, tilled	0.15	3	0	64
	FPLSD (0.05)		ns	ns	80

Table 5. Analysis of variance components for weed density August 16, 1997, (4 WAP), Mollala, OR. Values in bold indicate that the main effect listed in the left column was a primary factor influencing emergence of this weed.

	Nightshade	Pigweed	Barnyardgrass
Goal timing	0.60	0.67	**0.04**
Herbicide rate	0.17	**.0079**	**.0009**
Timing x herb rate	0.64	0.22	.027

Table 6. Estimated weed control on September 22, 1997 (10 WAP).

	Timing	Herbicide rate	Nightshade	Pigweed	Barnyardgrass	Total
		-lbs ai/ac-		---------- % ----------		
1	Aft, untilled	0.15	95	98	59	91
2	Aft, untilled	0.25	98	100	56	90
3	Aft, untilled	0.50	100	100	65	93
4	Eve, untilled	0.15	43	88	35	50
5	Eve, untilled	0.25	71	100	63	65
6	Eve, untilled	0.50	98	100	84	76
7	Aft, tilled	0.15	93	88	51	71
8	Aft, tilled	0.25	91	100	66	91
9	Aft, tilled	0.50	100	100	89	95
10	Eve, tilled	0.15	60	100	50	64
11	Eve, tilled	0.25	80	100	84	88
12	Eve, tilled	0.50	100	100	81	92
	FPLSD (0.05)		26	ns	ns	22

Table 7. Weed control estimate for lowest rates of Goal at four application timings, September 22, 1997 (10 WAP).

	Timing and tillage	Herbicide rate	Nightshade	Pigweed	Barnyardgrass	Total
		-lbs ai/ac-		---------- % ----------		
1	Aft, untilled	0.15	95	98	59	91
4	Eve, untilled	0.15	43	88	35	50
7	Aft, tilled	0.15	93	88	51	71
10	Eve, tilled	0.15	60	100	50	64
	FPLSD (0.05)		41	ns	ns	31

Table 8. Analysis of variance components for weed control estimates on September 22, 1997 (10 WAP). Values in bold indicate that the main effect listed in the left column was a primary factor influencing control of this weed.

	Nightshade	Pigweed	Barnyardgrass	Total
Goal timing	**0.10**	0.40	0.85	0.19
Herbicide rate	**0.0016**	0.15	**0.0006**	**0.0001**
Timing x herb rate	**0.07**	0.81	0.29	**0.09**

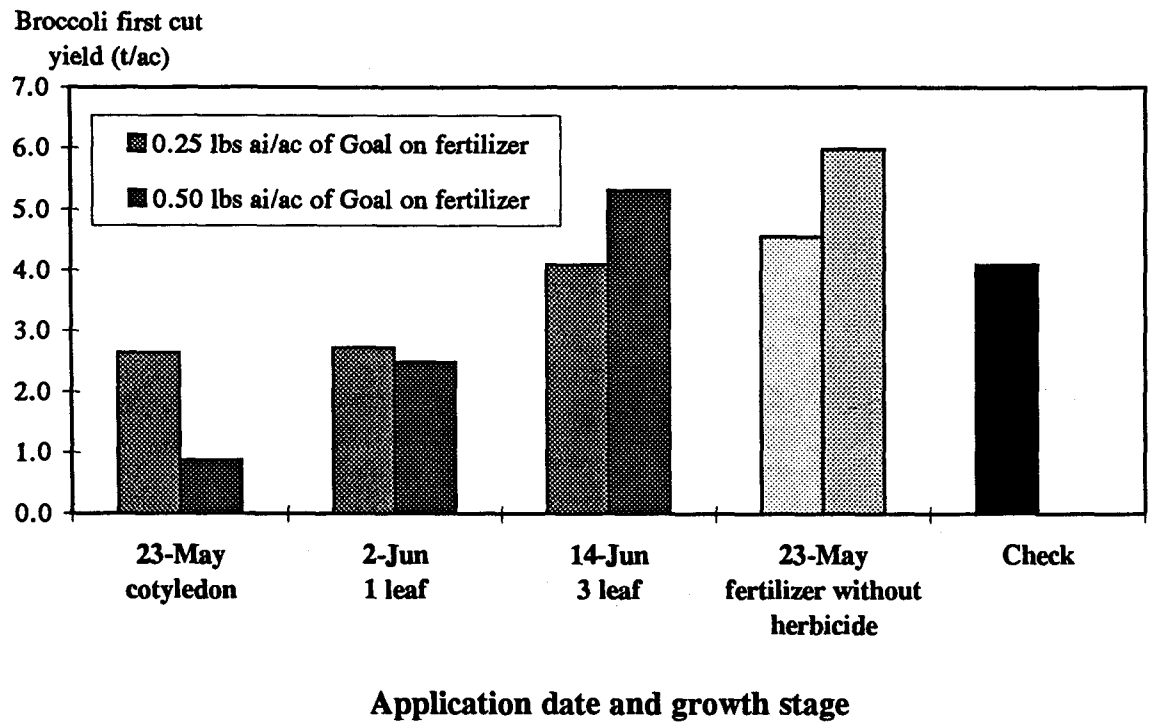

Figure 1. Effect of Goal impregnated fertilizer on broccoli first cut yield, 1997.

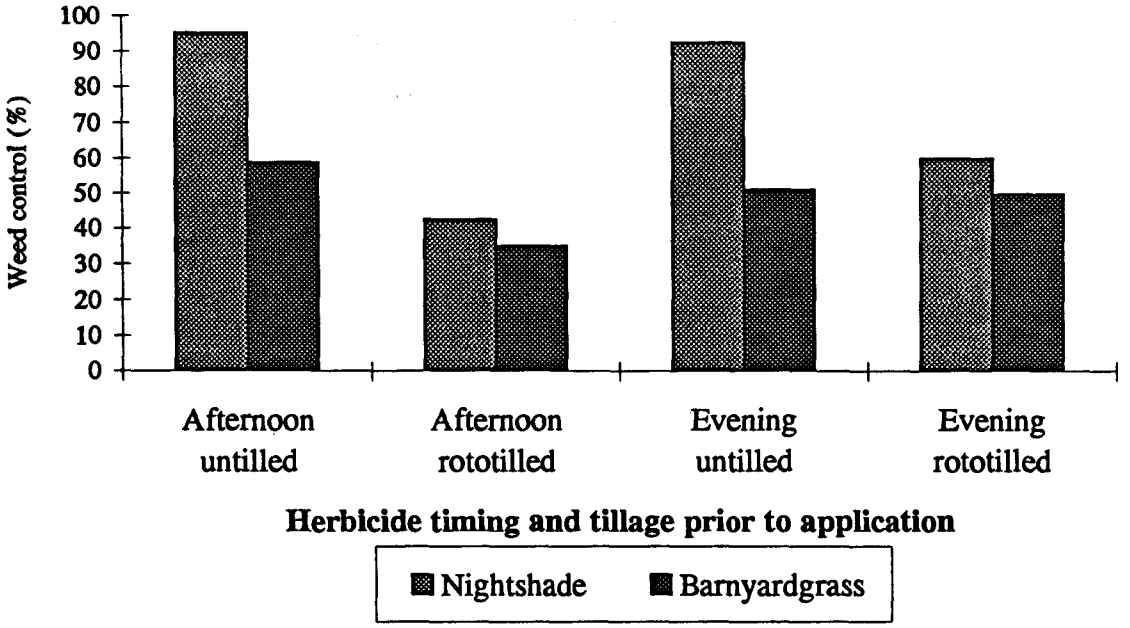

Figure 2. Effect of Goal herbicide application timing (0.15 lb/A) and tillage prior to application on weed control in cauliflower, 10 weeks after application.