1999 Research Report to the
Agriculture Research Foundation
and the
Oregon Processed Vegetable Commission

Title. Improving Goal Efficiency in Crucifers

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Summary

Goal impregnated fertilizer for weed control in broccoli. Two trials were conducted during 1999 to assess the potential of using Goal impregnated fertilizer for postemergence weed control in direct-seeded broccoli. At the Research Station in Corvallis, slight symptoms of Goal injury were noted on broccoli leaves shortly after application at the 1.5 and 3 leaf stages. Injury did not differ between fertilizer carriers of 16-16-16 or urea. Weed control was best with Goal fertilizer applied to 3 leaf broccoli at 0.5 lb ai/A and yield was 32 percent greater than the check plot (7.9 vs. 6.0 t/A). Yield may have been reduced with Goal impregnated fertilizer applied at 0.25 lbs ai/A to 1.5 leaf broccoli. Weed control was much less at the Stayton site because of excessive irrigation at one end of the plot.

This third 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.

Goal application timing and efficacy

Goal efficacy was much greater overall than in 1998. Soil moisture at planting was the main factor influencing emergence in both years. Tillage or herbicide application timing did not consistently influence soil moisture.

Project I. Effect of Goal Impregnated Fertilizer on Yield of Broccoli, Vegetable research Farm, Corvallis

Methods

Dyfonate (fonofos) was incorporated with last tillage on all plots. Treflan was incorporated on all plots except azafenidin treatments. Emperor broccoli was planted on May 1 with 4, 18-inch rows/plot. Plots were 30 by 6 ft wide with a 4 ft buffer between each plot. Slugbait was applied on May 21 and Sevin XLR applied on May 18 and 21 to control flea beetles.

Azafenidin was applied PES on May 3, followed by 1.7 inches of rain over the next two weeks. Goal impregnated fertilizer was applied on May 25 and June 1 to 1.5 and 3 leaf broccoli, respectively. Goal herbicide was applied to 16-16-16 or urea at 1 lb/ 400 lbs fertilizer and spread evenly on the plots with a hand-held drop spreader. Fertilizer checks (without the Goal herbicide) were applied on the same schedule. There was a slight amount of water on the plants at the 1.5 leaf application even though it was mid-afternoon.

On June 17, the south two rows of each plot were cultivated, followed by hoeing in these rows on June 21 and 23 to remove as many weeds as possible. The two north rows received no additional weed control treatments. Urea was side-dressed at 100 lbs N/A on July 6. A Diazinon drench was applied to stop root maggot injury. Broccoli was harvested on July 21, 24, 27 and 30 from two rows 16.4 ft in length in each plot. Heads were weighed, diameter measured, and heads evaluated for signs of disease or abnormalities.

Results and Discussion

Weed control was good to exceptional for all Goal impregnated fertilizer treatments. The primary species emerging through the Treflan were groundsel, nightshade, and sheperdspurse. Speedwell was abundant in the azafenidin treatments because Treflan was not applied in these plots. Speedwell was exceptionally tolerant of azafenidin.

Crop growth was reduced by as much as 23 percent at 6 WAP by Goal fertilizer applied at the 1.5 leaf stage of broccoli. This was more injury than noted in previous years, possibly due to the cool wet conditions during May. Even though the 1.5 leaf application was applied in mid-afternoon, a few scattered drops of water were noted on the seedlings. Pending rain and size of the weeds did not allow for a delay in application. This may have contributed to the increased injury noted. There did not seem to be any difference in crop injury between urea and 16-16-16 treatments. However, crop injury was much less when Goal fertilizer was applied at the 3 leaf stage. Azafenidin significantly reduced crop growth at both rates.

Broccoli yield (hand-weeded plots, Table 2). The hand-weeded plots measured the effects of the herbicides without weed competition. Yield of the Goal fertilizer treatments was consistently and slightly higher than the same fertilizer treatment without the herbicide (Table 2, Figure 1). This was probably caused by the additional disturbance required to remove weeds from the plots without Goal herbicide.

Yield of the Goal fertilizer treatments was comparable to the check plot with no additional fertilizer, with the exception of Tr. 1. This treatment had the most early season injury (Table 1) and may have caused a yield reduction. Four cuttings were made from these plots to ensure that a delay in harvest would be documented if it occurred. Figure 3 indicates that yield of

Tr. 1 (and all others) was determined primarily by the 1st and 2nd cutting, and that broccoli could not recover from the initial injury in Tr. 1.

Treatments with urea fertilizer yielded higher than treatments with 16-16-16 at both application timings. Urea with 0.5 lb ai of Goal applied at the 3 leaf stage yielded 1.3 tons more than the check treatment.

Broccoli yield (unweeded plots, Table 3, Figure 2). These plots measured the total effect of Goal fertilizer (effects on yield from fertilizer and weed control) on broccoli yield. All of the Goal fertilizer treatments yielded higher than the check, again with the exception of Tr 1. Goal impregnated urea applied to 3 leaf broccoli at 200 lbs/A produced 1.9 ton/A more than the check treatment.

All but one of the fertilizer checks yielded greater than the unfertilized check plot. These data again emphasize the growth advantage to broccoli if fertilizer is broadcast when the plants are young.

Summary. This third 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 1. Goal impregnated fertilizer effects on crop injury and weed control, 2 weeks after 3rd leaf treatment, Corvallis, 1999.

	Herbicide	Carrier	N rate	fert rate	Timing	Goal rate	N	Growth variables			Weed control			
								Stand count	Broccoli growth	Phyto-toxicity	Groundsel	Shepherdspurse	Nightshade	Speedwell
			lb/A	lb/A		lb ai/A		no/8.2'	% red.	1-10	---------- % -------			
1	Goal	16-16-16	16	100	1.5 leaf	0.25	4	30	23	2	99	90	94	99
2	Goal	16-16-16	32	200	3.0 leaf	0.50	4	37	5	1	98	86	96	99
3	Goal	urea	46	100	1.5 leaf	0.25	4	35	18	1	78	94	98	100
4	Goal	urea	98	200	3.0 leaf	0.50	4	37	0	2	100	80	95	100
5	None	16-16-16	16	100	1.5 leaf	0	4	38	0	0	0	0	0	0
6	None	16-16-16	32	200	3.0 leaf	0	4	35	-3	0	0	0	0	0
7	None	urea	46	100	1.5 leaf	0	4	38	-3	0	0	0	0	0
8	None	urea	98	200	3.0 leaf	0	4	35	5	0	0	0	0	0
9	Check	none	0	0	-	0	4	35	0	0	0	0	0	0
10	Azafenidin		0	0	PES	0.025	4	29	18	0	25	48	35	0
11	Azafenidin		0	0	PES	0.05	4	11	63	0	100	100	100	38
FPLSD(0.05)								6	15	1	28	23	17	10

Table 2. Tolerance of broccoli to Goal herbicide and azafenidin in **hand-weeded** plots, Corvallis, 1999. Sum of four harvests.

	Herbicide	Carrier	N rate	Fert. rate	Timing	Goal rate	N	Yield	Heads harvested	Avg. Head wt	Avg. head diameter
			---lb /A---			lb ai/A		t/A	no/A	lbs	inches
1	Goal on fertilizer	16-16-16	16	100	1.5 leaf	0.25	4	6.1	6600	0.48	4.9
2	Goal on fertilizer	16-16-16	32	200	3 leaf	0.5	4	7.1	7400	0.41	4.6
3	Goal on fertilizer	urea	46	100	1.5 leaf	0.25	4	7.7	7600	0.51	5.1
4	Goal on fertilizer	urea	98	200	3 leaf	0.5	4	8.5	8400	0.47	5.2
5	Fertilizer check	16-16-16	16	100	1.5 leaf	0	4	5.4	5900	0.48	5.1
6	Fertilizer check	16-16-16	32	200	3 leaf	0	4	6.6	7200	0.37	4.2
7	Fertilizer check	urea	46	100	1.5 leaf	0	4	7.0	7100	0.43	4.7
8	Fertilizer check	urea	98	200	3 leaf	0	4	7.7	7600	0.49	5.4
9	Weeded check	none	-	-	-	0	4	7.2	7300	0.42	4.6
10	Azafenidin	none	-	-	PES	0.025	4	6.0	5800	0.40	4.5
11	Azafenidin	none	-	-	PES	0.050	4	4.0	3100	0.45	4.4
FPLSD (0.05)								0.6	2500	ns	ns

Table 3. Effect of Goal impregnated fertilizer on yield of broccoli in **unweeded** plots, Corvallis, 1999. Sum of four harvests.

	Herbicide	Carrier	N rate	fert rate	Timing	Goal rate	N	Yield	Heads harvested	Avg. Head wt	Avg. head diameter
								t/A	no/A	lbs	inches
1	Goal on fertilizer	16-16-16	16	100	1.5 leaf	0.25	4	5.8	6700	0.44	4.8
2	Goal on fertilizer	16-16-16	32	200	3 leaf	0.5	4	6.2	7200	0.35	4.5
3	Goal on fertilizer	urea	46	100	1.5 leaf	0.25	4	6.9	7000	0.51	5.1
4	Goal on fertilizer	urea	98	200	3 leaf	0.5	4	7.9	7700	0.48	5.0
5	Fertilizer check	16-16-16	16	100	1.5 leaf	0	4	5.5	8100	0.30	4.3
6	Fertilizer check	16-16-16	32	200	3 leaf	0	4	6.8	8100	0.38	4.4
7	Fertilizer check	urea	46	100	1.5 leaf	0	4	7.5	8400	0.41	4.8
8	Fertilizer check	urea	98	200	3 leaf	0	4	6.8	7000	0.48	4.7
9	Unweeded	none	-	-			4	6.0	6800	0.38	4.3
10	Azafenidin	none	-	-	PES	0.025	4	3.5	4400	0.31	3.6
11	Azafenidin	none	-	-	PES	0.050	4	3.6	2500	0.67	4.9
FPLSD (0.05)								0.6	2500	0.11	0.9

Table 4. Herbicide application record sheet.
Crop and planting date: Broccoli var. Emperor; 5-1-99
Soil type: Silt loam; pH 6.7, % OM 6.98, CEC 26.1
Plot size: 6 X 30, 4 reps, 4-18 inch rows (4 rows-6 ft wide centered in 10 ft plots)
Design: RCBD

Herbicide	Treflan (0.75 lb/A)	Azafenidin	Goal fertilizer	
Application date	4-30-99	5-3-99	5-25-99	6-1-99
Application timing	PPI	PES	1.5 leaf	3.0 leaf
Start/end time	9:30-10:30	8:00-8:40	3:30-5:00 PM	6:30-7:30 AM
Air temp (F)	55/54/57	47/48/52	76-76-81	54/58/54
Rel humidity (%)	50	85	54	60
Wind direction/velocity (mph)	0	SW 3-5	N 0-6	0-3 W
Cloud cover (%)	0	50	0	100
Soil moisture	damp-dry	very wet	dry	dry
Plant moisture	-	-	a few (very few) wet drops on plant	dry (no dew)
Sprayer/PSI	BP/ 30	unicycle/30		
Mix size	3 gal	2100 ml/4 plots	1 lb of goal applied to 400 lbs of fertilizer	
Gallons H_2O/acre	20	20		
Nozzle type	8003	8003		
Nozzle spacing and height	20/18	20/18		
Soil inc. method and depth	2 inches with Rotera	Rain on	Irrigation 0.5" 5/26	Irrigation 0.5" 6/1
Rainfall	6/7	0.12"		
	6/8	0.09"		
	6/9	0.16"		

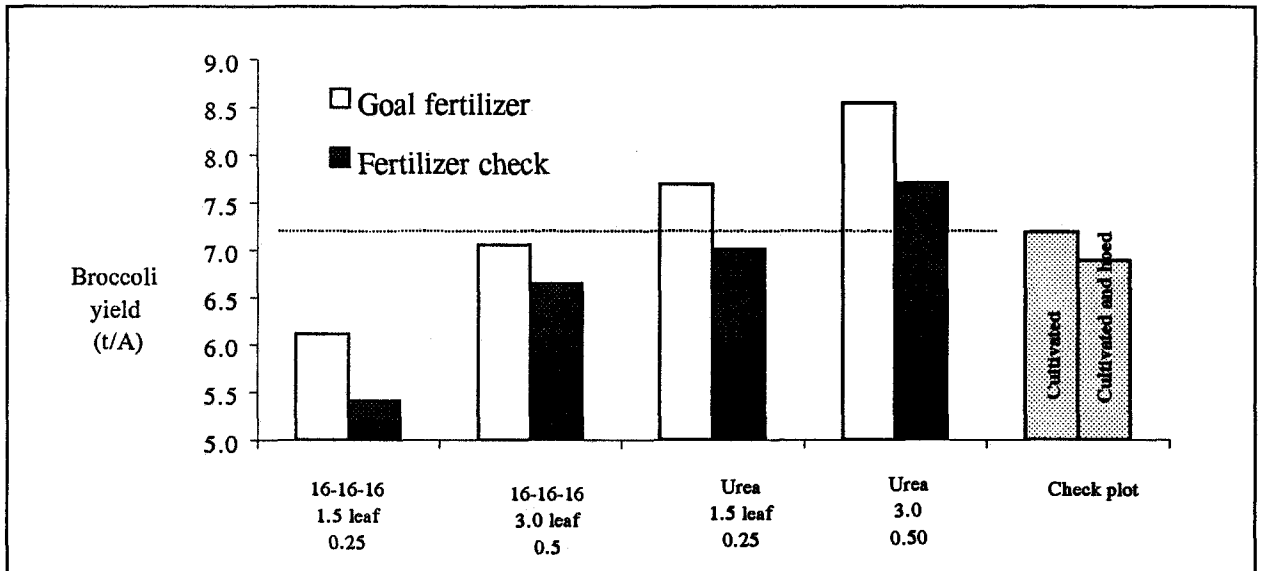

Figure 1. Goal fertilizer effect on broccoli yield in weeded plots, Corvallis, 1999.

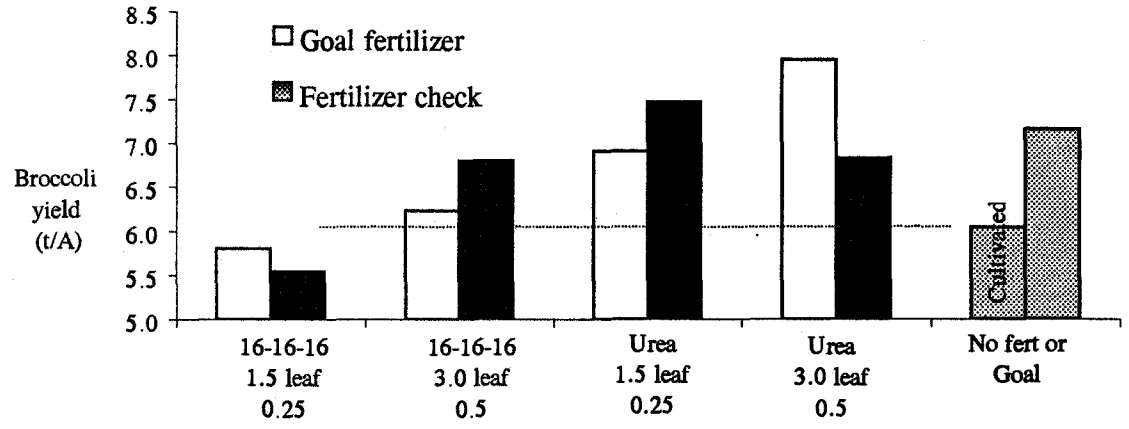

Figure 2. Goal fertilizer effect on broccoli yield in unweeded plots, Corvallis, 1999.

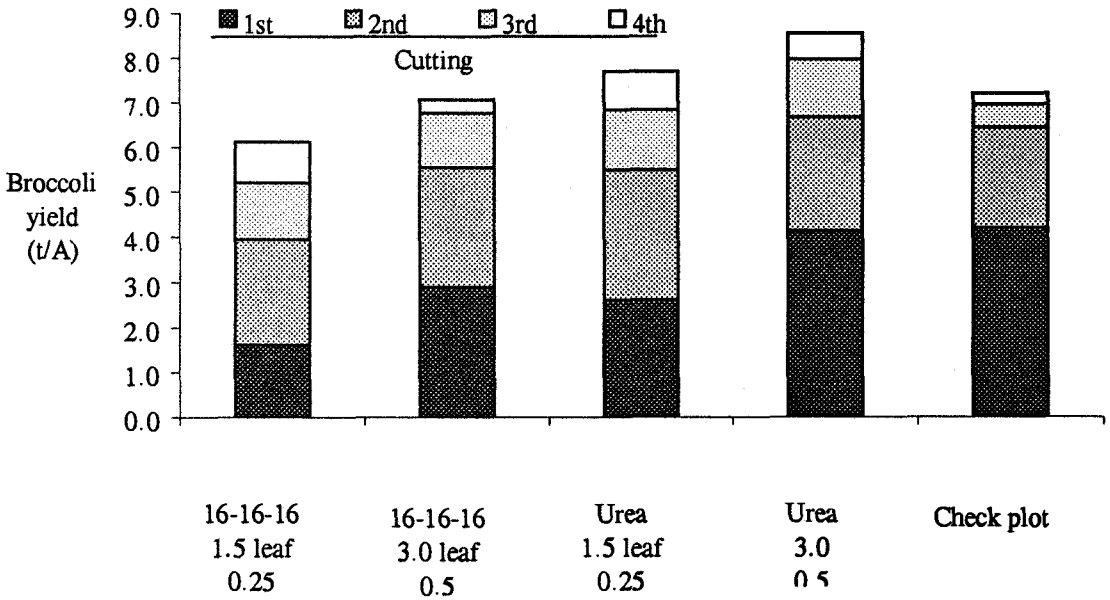

Figure 3. Effect of Goal impregnated fertilizer treatments on Broccoli yield timing, Corvallis, 1999.

Project II. Goal Impregnated Fertilizer for Postemergence Weed Control in Broccoli, Stayton.

Methods

The site was on a silt loam soil near Stayton, OR with a pH of 6.2, OM of 4.75%, and CEC of 22.4 meq/100g. The cooperator applied and incorporated Treflan (0.5 lbs/A) before planting. Devrinol (1 lb ai/A) was applied after planting to two treatments incorporated with irrigation. Excelsior broccoli was direct-seeded on May 24.

The Goal impregnated fertilizer was applied to 25 by 6.6 ft wide plots (one bed width, 4 rows/bed) with 3 replications. The Goal was impregnated on the fertilizer at 1 lb ai Goal/400 lbs of 16-16-16 or urea. Check plots included fertilizer 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. Broccoli heads were cut 2 times from 2 rows 16.4 ft in length in each plot. The broccoli was weighed, head diameter measured, and heads evaluated for disease or growth abnormalities.

Results and Discussion

Weed control was much less than in previous trials but predictable based on conditions following application. The plot was irrigated 4 days after the first Goal fertilizer application but the irrigation 'traveler' did not shut off properly and over-irrigated the research plot. The soil surface sealed and prills were moved into puddles. This encouraged a large flush of nightshade and greatly diminished the effectiveness of the Goal fertilizer. Even so, weed control was exceptional until harvest at the south end of the research plot that was unaffected by over-watering.

Yield was determined in the southern most replication, where the plots were not over-irrigated. This data indicates that yield with Goal impregnated fertilizer was as good or better than in the adjacent field and nearly double the yield in check treatment (Tr. 11-Treflan, Devrinol, and cultivation; but not hoed).

Table 1. Weed control and crop injury with Goal impregnated fertilizer, Stayton, OR 1999.

	Treflan	Devrinol	Goal fertilizer		Fertilizer carrier	N	Crop injury		Weed Control	
	0.75 lb ai/A	1 lb ai/A	Timing	Goal herbicide rate	lbs of 16-16-16/A		Growth reduction	Phyto-toxicity symptoms	Night-shade	Shepherds-purse
				lb ai/A			%	1-10	%	
1	+	-	1.5 leaf	0.25	100	3	0.0	0.0	43	50
2	+	-	1.5 leaf	0.50	100	3	3.3	0.3	80	43
3	+	-	3 leaf	0.25	200	3	0.0	0.0	0	0
4	+	-	3 leaf	0.50	200	3	6.7	0.3	7	0
5	+	-	1.5 leaf	0	100	3	0.0	0.0	0	0
6	+	-	1.5 leaf	0	200	3	0.0	0.0	0	0
7	+	-	no fert	0	0	3	0.0	0.0	0	27
8	+	+	3 leaf	0.25	100	3	0.0	0.0	17	23
9	+	+	3 leaf	0.50	200	3	10.0	0.0	30	47
10	+	+	no fert	0	0	3	3.3	0.0	0	0
11	+	-	no fert	0	0	3	0.0	0.0	0	7
12	+	-	3 leaf	0.5	200 (urea)	3	6.7	0.3	23	43

Table 2. Goal impregnated fertilizer effects on broccoli yield, Stayton, OR, 1999. Yield is estimated from only one replication that was not affected by over-irrigation.

Tr. no.	Herbicides		Goal herbicide		Fertilizer rate	Total yield of 4 cuttings
	Treflan	Devrinol	Timing	Rate		
				lb ai/A	lbs/A	t/A
2.	+	-	1.5 leaf	0.5	100	6.3
4.	+	-	3 leaf	0.5	200	5.8
9.	+	+	3 leaf	0.5	200	6.7
11.	+	+	none	0	0	3.5
Growers practice	+	+	one weeding + cultivation		0	5.8

Project III. Goal Application Timing and Efficacy

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 herbicide 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 in the check plots were counted 17 DAT; seedlings in Goal treatments were counted 29 DAT.

Results and Discussion

Predominant weeds were pigweed and nightshade at this site but the populations was unevenly distributed. Pigweed and nightshade control was least when applied on freshly tilled soil in the afternoon. This is in contrast to 1998 data that suggested that control was best when applied to recently tilled soil in the afternoon. However, the data were highly variable in 1998 for pigweed and nightshade.

Witchgrass was not as evenly distributed across the field in 1999. However, trends were consistent with 1998 data if the 5PM tillage treatment was removed from the analysis. This indicated that other factors may have influenced emergence than just tillage. One possibility is soil moisture. There was a very good relationship between average soil moisture for each tillage treatment between the two years when averaged across soil moisture (Figure 1). Soil moisture was not consistently influenced by tillage in the two years (Table 2).

Summary

Even though Goal efficacy was much greater this year than in 1998, tillage before herbicide application and herbicide application timing (early morning vs. late afternoon) may have influenced witchgrass emergence. Results were not consistent in 1998 and 1999, however. It is likely that soil moisture at the time Goal herbicide was applied determined weed emergence, as slightly higher soil moisture levels were correlated with increased witchgrass control. Broadleaves may respond differently than grasses.

Table 1. Effect of Goal application timing, tillage, and rate on weed emergence, Corvallis, 1999.

Timing	Rate	Nightshade		Pigweed		Witchgrass		Misc. weeds		Total weed	Total broad-leaves	Total grasses	
		N	Mean	N	Mean	N	Mean	N	Mean	Mean	Mean	N	Mean
							%						
5 AM	0.15	3	99	4	100	4	95	4	97	99	100	4	95
5 AM	0.25	4	99	4	100	4	100	4	98	00	100	4	99
5 AM	0.50	4	100	4	100	3	97	4	100	100	100	3	97
5 AM Till	0.15	3	98	4	100	2	80	4	88	96	99	2	80
5 AM Till	0.25	4	99	3	100	2	97	4	98	99	100	3	98
5 AM Till	0.50	4	100	4	100	2	98	4	100	100	100	2	98
3 PM	0.15	1	100	4	100	2	98	4	94	98	100	2	98
3 PM	0.25	3	100	4	100	4	97	4	96	99	100	4	97
3 PM	0.50	3	100	4	100	2	87	4	100	100	100	2	87
3 PM Till	0.15	3	87	4	0.99	4	96	4	94	97	97	4	96
3 PM Till	0.25	4	97	4	0.98	1	97	4	90	95	98	2	96
3 PM Till	0.50	4	100	4	1.00	2	99	4	99	100	100	3	99

Table 2. Effect of tillage and Goal application timing on soil moisture at herbicide application, Corvallis, 1998-99.

Timing (1998/1999)	1998	1999	Average
4/5 AM	2.52%	3.30%	2.91%
4/5 AM TILL	2.53%	4.08%	3.31%
5/3 PM	1.75%	0.83%	1.29%
5/3 PMTILL	3.32%	2.06%	2.69%

Table 3. Herbicide application record sheet.

Soil type: silt loam pH: 6.2 OM: 6.74 CEC: 17.9
Plot size: 10 by 30 4 replications

Application date	8-24-99	8-24-99	8-25-99	8-25-99
Application timing	Aft	Aft, tilled soil	AM	AM tilled soil
Start/end time	2:20-2:35 PM	2:45-3:00 PM	5:20-5:35 AM	5:45-6:00AM
Air temp/soil temp (2")/surface	85/85/135	85/80/95	663/73/65	63/73/68
Rel humidity	47	47	90	90
Wind direction/velocity	0	5 NE	4 W	5 W
Cloud cover	0	0	0	5
Soil moisture (%)	Very dry	Dry	Very dry	Very wet
Sprayer/PSI	2.06	0.83	3.30	4.08
Mix size	2100 ml/ 4 plots	2100 ml/ 4 plots	2100 ml/ 4 plots	2100 ml/ 4 plots
Gallons H_20/acre	20	20	20	20
Nozzle type	8003	8003	8003	8003
Nozzle spacing and height	20/18	20/18	20/18	20/18

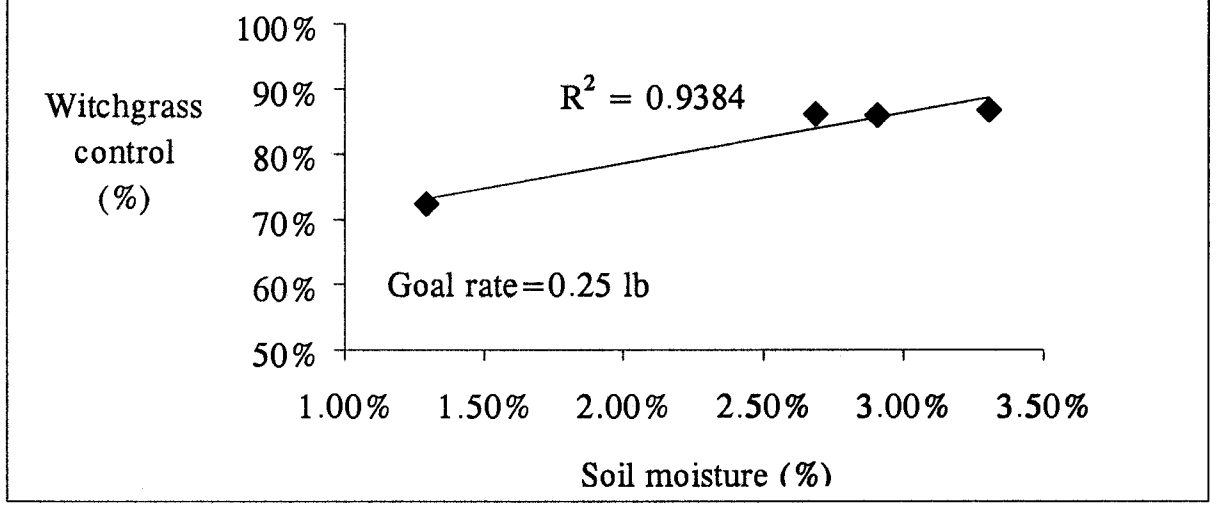

Figure 1. Soil moisture effects on witchgrass emergence. Percent soil moisture and witchgrass emergence is average of two years.