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CABBAGE WEED CONTROL STUDY

Richard Greenland

Cabbage production has tremendous potential in North Dakota. A few farmers are growing cabbage but have difficulty controlling weeds because few herbicides are available for weed control in cabbage production. In these experiments we looked at several new herbicide and herbicide combinations for use in direct seeded and transplanted cabbage production.

MATERIALS AND METHODS

Soil:	Hecla sandy loam, Embden sandy loam, and Maddock sandy loam; pH=6.3; 2.6% organic matter; soil-P and soil-K were very high; soil-S was low.
Previous crops:	2001 - pumpkin and winter squash; 2000 - field corn; 1999 - edible bean.
Seedbed preparation:	Disked on Nov 1, 2001. Multiweeded (field cultivated) twice (direct seeded section on Apr 23 and transplanted section on May 2) to incorporate fertilizer and herbicides, and to smooth the seed bed.
Planting:	*Direct seeded cabbage*. Planted 'Fresco' cabbage on Apr 26 with a Monosem precision vacuum planter set to plant a row of barley cover crop (0.45 bu/acre in 18-inch rows) between and parallel to the cabbage rows. Cabbage seeds were spaced about 7 inches apart in 18-inch rows. Plants were later thinned to 15 inches apart (about 26,000 plants/acre). Seeds were placed ½ to ¾ inches deep into a flat, fine seedbed. *Transplanted cabbage*. Started transplants in the greenhouse on Apr 8. Transplanted 'Bronco' cabbage on May 13 in 18-inch rows. In-row spacing was 15 inches. Did not plant barley cover crop with transplanted cabbage. Irrigated with above ground drip tubes immediately following transplanting.
Plots:	Each plot was 6 ft wide by 17 ft long. There was a 2-ft border between plots. The study had 4 reps.
Fertilizer:	On April 18, broadcast 18 lbs N/acre and 20 lbs S/acre as 21-0-0-24. Sprayed 50 lbs N/acre as 28-0-0 on direct seeded only on April 23. Sprayed 60 lbs N/acre as 28-0-0 on June 7. Side dressed 50 lbs N/acre as urea on July 3.
Irrigation:	Underground drip irrigation as needed.
Pest Control:	Treflan (1 pt/acre) was applied to the direct seeded study on April 23. Fusilade + NIS (12 oz/acre + 1 pt/25 gal) was applied to the direct seeded study on May 29, and to the both studies on June 7. The Fusilade was to kill the barley cover crop (in the direct seeded study only) and any grass weeds. Weeds were also controlled using treatments listed in Tables 38 to 41. We hand weeded the check plots. Sprayed Sevin (1 qt/acre on May 29 and Jun 5) to control flea beetle. Sprayed Asana (8 oz/acre on June 20 and July 2), DiPel (1 lb/acre on Jun 20, Jun 28, Jul 19, Jul 29, and Aug 12), and Ambush (12 oz/acre on Aug 16) to control cabbage looper and cabbage worm.
Harvest:	A 10-foot section of the middle two rows was harvested on Aug 28 and 29.

RESULTS

Direct seeded cabbage. Dacthal gave good control of pigweed, fair control of lambsquarters, and very poor control of nightshade – resulting in no harvestable yield. Applied as a post treatment after Dacthal, Stinger gave better nightshade control than Tough, but neither gave acceptable control. Authority gave good control of pigweed, fair control of lambsquarters, and poor control of hairy nightshade. Valor severely injured cabbage and controlled weeds when applied at the two-leaf stage of cabbage. Injury and weed control were both lower when applied at the four-leaf stage. None of the treatments had yields as high as the handweeded check.

Transplanted cabbage. Cabbage injury was much less with the transplanted cabbage than when cabbage was direct seeded. Valor applied PRE severely injured cabbage and didn't control weeds very well. Valor injured cabbage less and controlled weeds better when applied POST2 or POST3. Prowl gave better pigweed control when applied PPI vs. PRE. Goal gave better nightshade but poorer pigweed control than Prowl PPI. Authority controlled pigweed and nightshade better when applied POST3, and controlled lambsquarters better when applied PRE or POST2. Treflan PPI improved weed control. All treatments except the Treflan + Authority + Valor treatment resulted in cabbage yields lower than the handweeded check.

Table 37. Cabbage weed control treatment application data at the Oakes Irrigation Research Site in 2002.

Application timing	Date	Time	Barley height	Cabbage height	Cabbage growth stage	Weed height	Weed growth stage
Direct seeded study							
PRE	April 29	9:30 am	0	0	0	0	0
POST1	May 10	10:30 am	1"	¼"	cot.	0	0
POST2	May 29	9:15 am	7"	2.5"	2.5 lf	½ to 2"	2 to 4 lf
POST3	June 7	3:20 pm	4"(dying)	4.5"	4 lf	½ to 3"	cot. to 6 lf
Transplanted study							
PPI	May 2	11:50 am	—[1]	0	0	0	0
PRE	May 10	11:10 am	—	0	0	0	0
POST1	May 14	10:30 am	—	4.5"	3.5 lf	0	0
POST2	May 20	10:15 am	—	5"	3 lf	¼"	cot.
POST3	May 28	10:10 am	—	3"	3 lf	½ to 1"	cot. to 2 lf
POST4	June 4	10:00 am	—	5"	5 lf	½ to 2"	cot. to 4 lf

Treatments were applied with a CO_2 backpack sprayer using AI 110-04 flat fan nozzles, 45 gpa, at 57 psi. Weed ratings were taken on June 3, June 13 or 17, and July 2.

[1]No barley cover crop planted in the transplanted study.

Table 38. Cabbage injury, barley cover crop injury, and redroot pigweed ratings for the 2002 direct seeded cabbage weed control study at the Oakes Irrigation Research Site.

Herbicides	Rates	Application timing	Cabbage injury			Barley injury	Redroot pigweed		
			6/3	6/17	7/2	6/3	6/3	6/17	7/2
			---------- 0 to 10[1] ----------						
Dacthal	8 lbs	PRE	0.3	0.0	0.0	0.0	9.3	9.3	8.0
Dacthal	8 lbs	POST1	0.3	0.0	0.0	0.0	10.0	9.8	8.8
Authority	2 oz	POST2	2.0	0.8	0.0	1.8	10.0	10.0	9.3
Valor	2 oz	POST2	7.0	6.3	5.8	6.3	10.0	10.0	10.0
Authority	2 oz	POST2	7.3	7.0	7.3	6.3	10.0	10.0	10.0
Valor	2 oz	POST2							
Authority	2 oz	POST3	0.0	5.0	4.5	0.0	9.8	10.0	9.3
Valor	2 oz	POST3							
Dacthal	8 lbs	POST1	0.5	0.0	0.0	0.0	9.3	9.8	9.3
Tough	12 oz	POST3							
Dacthal	8 lbs	POST1	0.5	0.3	0.8	0.0	9.3	9.0	6.8
Stinger	1/3 pt	POST3							
Handweeded check			0.0	0.0	0.8	0.0	10.0	10.0	10.0
LSD(0.05)			0.8	0.9	1.0	0.5	NS[2]	0.7	1.1
Probability			<.0001	<.0001	<.0001	<.0001	0.11	0.04	<.0001
C.V. (%)			29	29	32	23	5	5	8

[1]Ratings: 0 is no effect (no weed control or no crop injury); 10 is complete weed or crop kill.
[2]No significant differences between values in this column.

Table 39. Lambsquarters and hairy nightshade ratings and yields for the 2002 direct seeded cabbage weed control study at the Oakes Irrigation Research Site.

Herbicides	Rates	Application timing	Lambsquarters			Hairy nightshade			Cabbage yield
			6/3	6/17	7/2	6/3	6/17	7/2	
			---------- 0 to 10[1] ----------						tons/A
Dacthal	8 lbs	PRE	9.0	8.0	7.5	5.0	3.3	0.5	0.0
Dacthal	8 lbs	POST1	9.3	7.5	7.0	5.3	3.5	1.0	0.0
Authority	2 oz	POST2	9.8	8.3	7.0	8.8	7.0	4.5	3.8
Valor	2 oz	POST2	10.0	8.3	6.5	10.0	10.0	10.0	5.8
Authority	2 oz	POST2	10.0	9.3	9.0	10.0	10.0	10.0	21.4
Valor	2 oz	POST2							
Authority	2 oz	POST3	8.3	8.8	8.3	4.3	7.8	6.8	13.0
Valor	2 oz	POST3							
Dacthal	8 lbs	POST1	9.0	8.3	7.0	5.8	5.3	2.0	0.0
Tough	12 oz	POST3							
Dacthal	8 lbs	POST1	8.8	8.0	6.8	5.8	6.8	6.5	16.6
Stinger	1/3 pt	POST3							
Handweeded check			7.3	10.0	10.0	4.8	10.0	10.0	45.0
LSD(0.05)			1.4	1.2	1.2	1.3	1.3	1.0	6.9
Probability			0.009	0.011	<.0001	<.0001	<.0001	<.0001	<.0001
C.V. (%)			11	10	10	13	13	12	40

[1]Ratings: 0 is no effect (no weed control or no crop injury); 10 is complete weed or crop kill.

Table 40. Cabbage injury, barley cover crop injury, and redroot pigweed ratings for the 2002 transplanted cabbage weed control study at the Oakes Irrigation Research Site.

Herbicides	Rates	Application timing	Cabbage injury			Redroot pigweed		
			6/3	6/13	7/2	6/3	6/13	7/2
			---------- 0 to 10[1] ----------					
Prowl	1.5 pt	PPI	0.8	0.3	0.5	8.5	8.5	7.8
Prowl	1.5 pt	PRE	1.3	0.8	2.5	5.3	5.3	3.5
Goal 2XL	2 pt	PRE	2.5	2.0	0.5	7.8	7.3	5.3
Treflan	1 pt	PPI	0.0	0.5	1.0	9.8	10.0	9.8
Goal 2XL	2 pt	PRE						
Valor	2 oz	PRE	4.8	4.3	2.5	7.3	7.3	3.8
Valor	2 oz	POST2	0.8	0.8	0.8	9.3	9.8	7.8
Valor	2 oz	POST3	1.0	0.8	1.0	10.0	10.0	8.8
Authority	2 oz	PRE	0.8	0.8	0.3	9.0	9.0	6.0
Authority	2 oz	POST2	1.0	0.8	1.0	9.5	9.0	6.5
Authority	2 oz	POST3	2.0	1.0	1.3	10.0	10.0	9.5
Authority	2 oz	PRE	5.0	5.0	3.5	8.8	8.3	5.8
Valor	2 oz	PRE						
Authority	2 oz	POST2	1.5	1.3	1.3	10.0	9.5	8.8
Valor	2 oz	POST2						
Authority	2 oz	POST3	2.3	2.0	0.5	10.0	10.0	10.0
Valor	2 oz	POST3						
Treflan	1 pt	PPI	1.0	0.5	0.3	9.3	9.3	8.3
Dacthal	8 lbs	POST1						
Treflan	1 pt	PPI	1.0	0.3	0.3	9.3	9.8	8.3
Dual II Magnum	1 pt	POST1						
Treflan	1 pt	PPI	0.3	1.3	0.5	9.8	10.0	8.8
Outlook	1 pt	POST1						
Treflan	1 pt	PPI	1.5	1.0	1.3	10.0	10.0	10.0
Valor	2 oz	POST3						
Treflan	1 pt	PPI	1.5	0.8	1.5	10.0	10.0	10.0
Authority	2 oz	POST3						
Treflan	1 pt	PPI	3.0	2.3	1.5	10.0	10.0	10.0
Authority	2 oz	POST3						
Valor	2 oz	POST3						
Treflan	1 pt	PPI	0.5	1.0	0.8	9.8	9.8	8.3
Dacthal	8 lbs	POST1						
Stinger	a pt	POST4						
Handweed check			0.0	0.5	0.0	9.5	10.0	10.0
LSD(0.05)			1.5	1.1	1.3	1.2	1.0	1.2
Probability			<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
C.V. (%)			69	57	85	9	8	11

[1]Ratings: 0 is no effect (no weed control or no crop injury); 10 is complete weed or crop kill.

Table 41. Lambsquarters and hairy nightshade ratings and yields for the 2002 transplanted cabbage weed control study at the Oakes Irrigation Research Site.

Herbicides	Rates	Application timing	Lambsquarters 6/3	Lambsquarters 6/13	Lambsquarters 7/2	Hairy nightshade 6/3	Hairy nightshade 6/13	Hairy nightshade 7/2	Cabbage yield
			---------- 0 to 10[1] ----------						tons/A
Prowl	1.5 pt	PPI	9.8	8.8	7.8	6.8	4.0	2.5	0.0
Prowl	1.5 pt	PRE	9.0	8.3	7.0	6.3	3.5	3.8	0.0
Goal 2XL	2 pt	PRE	8.8	7.3	5.3	9.3	7.8	7.5	1.6
Treflan	1 pt	PPI	10.0	9.8	8.8	8.3	6.5	6.0	14.6
Goal 2XL	2 pt	PRE							
Valor	2 oz	PRE	9.5	8.5	6.8	8.8	7.8	6.8	0.0
Valor	2 oz	POST2	8.8	7.8	6.8	9.8	9.0	9.5	18.9
Valor	2 oz	POST3	9.8	9.0	8.0	9.8	8.5	6.5	17.0
Authority	2 oz	PRE	10.0	9.8	9.0	8.5	7.5	6.0	11.6
Authority	2 oz	POST2	10.0	9.5	8.0	8.3	7.5	5.5	5.7
Authority	2 oz	POST3	8.5	6.8	4.5	10.0	9.0	10.0	12.2
Authority	2 oz	PRE	9.5	9.5	8.5	9.0	8.5	6.8	4.3
Valor	2 oz	PRE							
Authority	2 oz	POST2	10.0	9.8	9.0	10.0	9.8	9.8	29.3
Valor	2 oz	POST2							
Authority	2 oz	POST3	9.5	8.8	7.5	10.0	10.0	10.0	27.8
Valor	2 oz	POST3							
Treflan	1 pt	PPI	9.8	9.3	8.8	7.0	5.3	3.8	0.8
Dacthal	8 lbs	POST1							
Treflan	1 pt	PPI	9.3	8.5	7.3	7.0	5.3	3.5	0.0
Dual II Magnum	1 pt	POST1							
Treflan	1 pt	PPI	9.5	9.0	7.8	6.8	5.5	3.5	1.9
Outlook	1 pt	POST1							
Treflan	1 pt	PPI	9.3	8.3	7.0	10.0	9.8	9.8	26.7
Valor	2 oz	POST3							
Treflan	1 pt	PPI	10.0	9.8	8.8	9.8	8.5	7.3	23.8
Authority	2 oz	POST3							
Treflan	1 pt	PPI	10.0	10.0	9.3	10.0	10.0	10.0	37.0
Authority	2 oz	POST3							
Valor	2 oz	POST3							
Treflan	1 pt	PPI	9.5	9.5	8.5	7.0	7.5	8.8	28.4
Dacthal	8 lbs	POST1							
Stinger	a pt	POST4							
Handweed check			9.8	10.0	10.0	9.8	10.0	10.0	40.7
LSD(0.05)			0.8	1.3	1.7	0.9	1.3	1.2	8.9
Probability			0.003	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
C.V. (%)			6	11	15	7	12	12	44

[1]Ratings: 0 is no effect (no weed control or no crop injury); 10 is complete weed or crop kill.

CARROT WEED CONTROL STUDY

Richard Greenland

Only a few herbicides are available for weed control in carrots. Treflan, Lorox, Poast and Fusilade are the most commonly used. In this study we evaluated five additional herbicides, Authority, Outlook, Dual II Magnum, Dacthal, and Valor, for their usefulness in carrot production.

MATERIALS AND METHODS

Soil:	Embden loam and Maddock sandy loam; pH=7.3; 2.1% organic matter; soil-P and soil-K were very high; soil-S was medium.
Previous crop:	2001 - potato; 2000 - pepper, onion, edible bean, field corn, sweetcorn, soybean, carrot, and cabbage; 1999 - field corn and ornamental corn.
Seedbed Preparation:	Coulter chiseled 15 inches deep twice – once on Apr 17 and again on Apr 18. Multiweeded (field cultivated) three times; once May 16 to smooth seedbed and twice May 20 to incorporate herbicide.
Planting:	Direct seeded Bolero carrots on May 21 with a Monosem precision vacuum planter set to plant a row of barley cover crop between the carrot rows. Carrot planting pattern was 3 lines per row (2 inches between lines in the row) with rows on 18-inch centers. Planting rate was about 800,000 seeds/acre for carrot and 0.45 bu/acre for barley.
Plots:	Plots were 17 ft long by 6 ft wide with a 2-ft border between plots. There were 4 reps.
Fertilizer:	On April 18, broadcast 18 lbs N/acre and 20 lbs S/acre as 21-0-0-24. Side dressed 50 lbs N/acre as urea on July 3.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Treflan (1.5 pt/acre on May 20) and Poast + Dash (1.5 pt + 1 pt/acre on June 17) were applied to all plots. Check plots were hand weeded. See Table 42 to 44 for other weed control treatments. Sprayed Asana (8 oz/acre on July 15, July 30 and Aug 13) and Sevin (1 qt/acre on Aug 27) to control leafhopper.
Harvest:	Carrots were harvested on September 11 to17. The harvest area was 3 ft of the center two rows of each plot.

RESULTS

Goal applied at either PRE or POST1 (carrots 1.5 inches tall) injured carrot plants and reduced carrot stand and yields. Valor injured carrot plants and reduced carrot stand and yields if applied PRE or POST1, but not when applied POST2 (carrots 3 inches tall). The best weed control and highest yields were with Lorox applied PRE and POST2, or with Dacthal applied EPOST followed by Lorox at POST2. The Lorox PRE followed by Valor POST2 treatment also produced good weed control and high yields. Authority applied POST2 did not control hairy nightshade and slightly injured carrots, resulting in lower carrot yields.

Table 42. Weed control and crop injury for the Oakes Irrigation Research Site 2002 carrot weed control study.

Herbicide(s)	Rate	Application timing[2]	June 24 ratings[1]				July 3 ratings[1]		
			crop injury	Colq[3]	Hns[3]	Ebns[3]	crop injury	Colq[3]	Hns[3]
			0 to 10						
Lorox	1 lb	PRE	0.8	9.3	7.8	9.8	0.5	9.3	7.0
Dacthal + Lorox	8 lbs + 1.5 lb	EPOST + POST2	0.3	10.0	7.3	10.0	0.3	10.0	9.8
Lorox + Dacthal	1 lb + 8 lbs	PRE + EPOST	1.0	10.0	9.8	10.0	0.8	10.0	10.0
Goal 2XL	1 pt	PRE	4.8	10.0	10.0	10.0	3.5	10.0	10.0
Goal 2XL	1 pt	POST1	4.3	10.0	10.0	10.0	3.3	10.0	10.0
Goal 2XL	2 pt	PRE	7.8	10.0	10.0	10.0	8.0	10.0	10.0
Goal 2XL	2 pt	POST1	5.3	10.0	10.0	10.0	4.8	10.0	10.0
Valor	0.5 oz	PRE	2.0	9.8	9.5	10.0	1.3	9.5	9.5
Valor	1 oz	PRE	2.8	9.8	10.0	10.0	3.0	10.0	10.0
Lorox + Valor	1 lb + 1 oz	PRE + POST1	3.8	10.0	10.0	10.0	3.5	10.0	10.0
Lorox + Valor	1 lb + 2 oz	PRE + POST1	5.0	10.0	10.0	10.0	5.3	10.0	10.0
Lorox + Valor	1 lb + 1 oz	PRE + POST2	1.8	9.5	8.5	10.0	1.0	9.3	8.8
Lorox + Valor	1 lb + 2 oz	PRE + POST2	0.8	9.3	8.0	10.0	0.8	9.3	8.8
Lorox + Authority	1 lb + 1 oz	PRE + POST2	0.5	9.8	7.5	10.0	2.0	10.0	8.0
Lorox + Authority	1 lb + 2 oz	PRE + POST2	0.8	10.0	8.5	10.0	2.5	10.0	9.3
Lorox + Lorox	1 lb + 1.5 lbs	PRE + POST2	1.0	9.8	8.8	10.0	1.3	10.0	10.0
Lorox	0.5 lb	PRE	0.0	9.8	7.5	10.0	0.0	9.8	6.8
Valor + Valor Lorox	0.5 + 2.0 oz 1.5 lbs	PRE + POST1 POST2	6.0	10.0	10.0	10.0	6.0	10.0	10.0
Authority	1 oz	POST2	0.0	9.0	4.0	9.0	2.0	9.5	4.3
Authority	2 oz	POST2	0.0	8.8	4.5	9.8	2.8	9.8	5.8
Hand weeded check			0.0	10.0	10.0	10.0	0.0	10.0	10.0
LSD (0.05)			1.3	0.6	1.2	0.3	1.7	0.5	1.6
Probability			<.0001	0.001	<.0001	<.0001	<.0001	0.002	<.0001
C.V. (%)			39	5	10	2	47	4	12

[1]Ratings are from 0 to 10: 0 = no weed control or crop injury, 10 = complete weed control or all carrots dead.

[2]PRE was on May 23. EPOST was on June 4 (barley 3 to 5" tall, carrot ½ to 1" tall, weeds ½" tall). POST1 was on June 14 (carrots 1.5" tall, weeds 1" tall). POST2 was on June 25 (carrots 3 to 4" tall, weeds (mostly hairy nightshade) 2 to 3" tall (previously treated) or 4 to 7" tall (previously untreated). Treflan (1.5 pt/A on May 20) and Poast + Dash (1.5 pt + 1 pt/A on June 17) applied to all treatments.

[3]Colq is common lambsquarters; Hns is Hairy nightshade; Ebns is Eastern black nightshade.

Table 43. Number of roots and yield of carrots in the Oakes Irrigation Research Site 2002 carrot weed control study.

Herbicide(s)	Rate	Application timing[1]	Number of carrot roots (by carrot dia.)				Carrot yield (by carrot diameter)			
			>1.5"	1 to 1.5"	US #1	total	>1.5"	1 to 1.5"	US #1	total
			1000s/acre				tons/acre			
Lorox	1 lb	PRE	24	80	129	166	4.3	5.6	10.5	13.3
Dacthal + Lorox	8 lbs + 1.5 lb	EPOST + POST2	80	59	145	198	14.9	5.5	20.6	29.7
Lorox + Dacthal	1 lb + 8 lbs	PRE + EPOST	57	34	102	160	10.3	3.3	14.0	22.0
Goal 2XL	1 pt	PRE	51	33	87	126	9.8	2.9	12.9	19.6
Goal 2XL	1 pt	POST1	65	58	132	161	11.6	5.2	17.0	21.2
Goal 2XL	2 pt	PRE	8	7	16	33	2.4	0.6	3.0	8.3
Goal 2XL	2 pt	POST1	47	30	83	121	8.9	3.1	12.1	18.4
Valor	0.5 oz	PRE	64	56	126	162	13.0	4.8	18.0	23.4
Valor	1 oz	PRE	30	23	56	110	6.1	1.9	8.1	16.3
Lorox + Valor	1 lb + 1 oz	PRE + POST1	67	30	110	142	13.1	2.8	16.4	22.2
Lorox + Valor	1 lb + 2 oz	PRE + POST1	44	18	68	96	8.5	1.8	10.5	16.3
Lorox + Valor	1 lb + 1 oz	PRE + POST2	61	53	123	160	10.7	5.0	16.1	20.3
Lorox + Valor	1 lb + 2 oz	PRE + POST2	70	96	180	219	12.2	7.8	20.4	24.8
Lorox + Authority	1 lb + 1 oz	PRE + POST2	51	85	149	189	8.8	7.3	16.5	20.6
Lorox + Authority	1 lb + 2 oz	PRE + POST2	56	56	115	155	10.0	4.3	14.4	18.6
Lorox + Lorox	1 lb + 1.5 lbs	PRE + POST2	59	68	136	175	11.4	6.5	19.0	25.3
Lorox	0.5 lb	PRE	53	79	161	198	9.7	6.9	17.3	19.9
Valor + Valor Lorox	0.5 + 2.0 oz 1.5 lbs	PRE + POST1 POST2	33	12	46	73	7.6	0.9	8.6	15.5
Authority	1 oz	POST2	7	96	137	179	0.9	4.9	6.5	7.5
Authority	2 oz	POST2	15	131	179	209	2.2	8.0	11.0	12.2
Hand weeded check			90	85	185	244	16.7	8.7	25.8	32.7
LSD (0.05)			30	47	65	76	5.6	3.9	7.5	9.0
Probability			<.0001	<.0001	<.0001	<.0001	<.0001	0.0007	<.0001	<.0001
C.V. (%)			43	59	39	34	43	59	38	33

[1]PRE was on May 23. EPOST was on June 4 (barley 3 to 5" tall, carrot ½ to 1" tall, weeds ½" tall). POST1 was on June 14 (carrots 1.5" tall, weeds 1" tall). POST2 was on June 25 (carrots 3 to 4" tall, weeds (mostly hairy nightshade) 2 to 3" tall (previously treated) or 4 to 7" tall (previously untreated). Treflan (1.5 pt/A on May 20) and Poast + Dash (1.5 pt + 1 pt/A on June 17) applied to all treatments.

Table 44. Carrot root characteristics for the Oakes Irrigation Research Site 2002 carrot weed control study.

Herbicide(s)	Rate	Application timing[1]	Average root length	Average root size	Multiple root yield	US #1 yield	Overall score
			inches	oz/root	tons/acre	%	1 to 10
Lorox	1 lb	PRE	5.7 de	2.8 def	1.7 d-g	83 ab	6.6 a
Dacthal + Lorox	8 lbs + 1.5 lb	EPOST + POST2	6.9 a-d	4.8 abc	5.8 a	69 b-e	5.0 abc
Lorox + Dacthal	1 lb + 8 lbs	PRE + EPOST	6.3 bcd	4.4 bc	5.5 ab	63 def	4.0 bcd
Goal 2XL	1 pt	PRE	6.9 a-d	4.8 ab	4.6 a-e	67 b-e	6.4 a
Goal 2XL	1 pt	POST1	6.7 a-d	4.4 bc	2.2 b-g	80 abc	6.3 ab
Goal 2XL	2 pt	PRE	7.2 abc	6.3 a	4.2 a-e	40 g	1.5 e
Goal 2XL	2 pt	POST1	6.8 a-d	4.6 bc	4.1 a-e	68 b-e	6.5 a
Valor	0.5 oz	PRE	6.7 a-d	4.5 bc	3.1 a-g	78 a-d	6.6 a
Valor	1 oz	PRE	6.7 a-d	4.9 ab	5.3 abc	50 fg	2.5 de
Lorox + Valor	1 lb + 1 oz	PRE + POST1	7.6 a	5.1 ab	3.5 a-g	74 a-d	5.3 abc
Lorox + Valor	1 lb + 2 oz	PRE + POST1	7.1 abc	4.9 ab	4.4 a-e	63 c-f	5.0 abc
Lorox + Valor	1 lb + 1 oz	PRE + POST2	6.2 cd	4.4 bcd	1.9 c-g	78 a-d	4.8 a-d
Lorox + Valor	1 lb + 2 oz	PRE + POST2	6.4 a-d	4.0 bcd	3.0 a-g	82 ab	7.0 a
Lorox + Authority	1 lb + 1 oz	PRE + POST2	6.1 cd	3.6 b-e	1.2 efg	81 ab	6.3 ab
Lorox + Authority	1 lb + 2 oz	PRE + POST2	6.5 a-d	4.5 bc	2.5 a-g	78 a-d	5.9 ab
Lorox + Lorox	1 lb + 1.5 lbs	PRE + POST2	7.0 abc	4.6 bc	3.6 a-f	74 a-d	5.6 ab
Lorox	0.5 lb	PRE	5.7 de	3.2 cde	1.2 efg	86 a	6.0 ab
Valor + Valor	0.5 + 2.0 oz	PRE + POST1	7.5 ab	6.3 a	5.7 a	53 efg	3.1 cde
Lorox	1.5 lbs	POST2					
Authority	1 oz	POST2	4.2 f	1.5 f	0.1 g	87 a	4.9 abc
Authority	2 oz	POST2	4.8 ef	2.0 ef	0.6 fg	90 a	7.0 a
Hand weeded check			6.6 a-d	4.6 bc	4.8 a-d	77 a-d	6.1 ab
LSD (0.05)			1.2	1.6	3.5	17	2.3
Probability			<.0001	<.0001	0.02	<.0001	0.0001
C.V. (%)			13	26	74	16	30

[1]PRE was on May 23. EPOST was on June 4 (barley 3 to 5" tall, carrot ½ to 1" tall, weeds ½" tall). POST1 was on June 14 (carrots 1.5" tall, weeds 1" tall). POST2 was on June 25 (carrots 3 to 4" tall, weeds (mostly hairy nightshade) 2 to 3" tall (previously treated) or 4 to 7" tall (previously untreated). Treflan (1.5 pt/A on May 20) and Poast + Dash (1.5 pt + 1 pt/A on June 17) applied to all treatments.

ONION WEED CONTROL STUDY

Richard Greenland

Weed control is difficult in onions because onions do not compete well with weeds and few herbicides are available for onion production. Late emerging weeds are not shaded by the onions and grow vigorously. Although late emerging weeds do not reduce yield much, they interfere with harvest. In this experiment we looked at several new herbicides and herbicide combinations for use in onions, along with some new application timings for labeled herbicides.

MATERIALS AND METHODS

Soil:	Hecla sandy loam, Embden sandy loam, and Maddock sandy loam; pH=6.6; 2.0% organic matter; soil-P and soil-K were very high; soil-S was low.
Previous crops:	2001 - herbs, pepper, and sweetcorn; 2000 - field corn; 1999 - soybean.
Seedbed preparation:	Disked on Nov 1, 2001. Multiweeded (field cultivated) on April 23 to incorporate fertilizer and smooth the seedbed.
Planting:	Direct seeded Teton onions (174,000 seeds/acre) on April 25 with a Monosem precision planter set to plant a barley cover crop (0.45 bu/acre, 18-inch rows) between and parallel to the onion rows. Onions were planted in paired rows (2.5" apart), with the paired rows on 18" centers.
Plots:	Plots were 17 ft long by 6 ft wide on 8 ft centers (giving a 2-ft border between plots). The study had 4 reps.
Fertilizer:	On April 18, broadcast 18 lbs N/acre and 20 lbs S/acre as 21-0-0-24. Sprayed 50 lbs N/acre as 28-0-0 on April 23. Applied 28% N on May 31 (See treatments). Side dressed 50 lbs N/acre as urea on June 26.
Irrigation:	Underground drip irrigation as needed.
Pest control:	See Table 45 for herbicide treatments. Sprayed Maneb (2 lbs/acre on July 11 and on Aug 7), Ridomil MZ72 (2.5 lbs/acre on Aug 2), Ronilan (2 lbs/acre on Aug 16), and Dithane F45 (2 qt/acre on Aug 27) for disease control. No insect control needed.
Harvest:	Hand harvested on Sept 18 and 19. Bagged on Oct 7 and 8. Graded on Oct 29 and 30.

RESULTS

Valor injured onion when applied PRE. Nortron injured onion and severely injured the barley cover crop. Valor and Nortron controlled weeds early, but lost control later in the season. Onion yield for these treatments was close to zero because of onion injury and weed competition, except for when Buctril + Goal was added to the Nortron treatment. Buctril + Goal gave good control of pigweed and excellent control of lambsquarters and hairy nightshade. The half rate of Buctril + Goal did not injure onions less and was a little weak on pigweed and nightshade. Spraying 28% N increased redroot pigweed control slightly vs. broadcasting urea. Authority gave good weed control early, but lost control of hairy nightshade later in the season, which eliminated any onion yields. When Buctril + Goal was applied at POST4 and POST6, applying Dual, Outlook, Prowl, or Authority at POST5 did not improve late season weed control.

Table 45. Onion weed control treatments at the Oakes Irrigation Research Site, 2002.

Treatment number	Herbicides	Rates	Application timing[1]
1	Prowl; Buctril + Goal	1.5 pt; 1.5 + 0.5 pt; 1.5 pt	POST1 & 5; POST4 & 6
2	Dacthal; Buctril + Goal; Prowl	8 lbs; 1.5 + 0.5 pt; 1.5 pt	PRE2; POST4 & 6; POST5
3	Valor	1.5 oz	PRE1
4	Valor	3.0 oz	PRE1
5	Prowl; Valor	1.5 pt; 1.5 oz	PRE1; POST4
6	Nortron	3 pts	PRE1
7	Nortron	6 pts	PRE1
8	Nortron; Buctril + Goal	3 pts; 1.5 + 0.5 pt	PRE1; POST4 & 6
9	Prowl; Buctril + Goal	1.5 pts; ¾ + ¼ pt	POST1 & 5; POST3 & 6
10	Prowl; Buctril + Goal	1.5 pts; ¾ + ¼ pt	POST1 & 5; POST4 & 6
11	Prowl; Buctril + Goal	1.5 pt; 1.5 + 0.5 pt	POST1; POST4 & 6
12	Buctril; Prowl; Buctril + Goal	1 pt; 1.5 pt; 1.5 + 0.5 pt	PRE3; POST1 & 5; POST4 & 6
13[2]	Prowl; Urea; Buctril + Goal	1.5 pt; 130 lbs; 1.5 + 0.5 pt	POST1 & 5; POST2; POST4 & 6
14[2]	Prowl; 28% N + urea; Buctril + Goal	1.5 pt; 15 gal + 33 lbs; 1.5 + 0.5 pt	POST1 & 5; POST2; POST4 & 6
15[2]	Prowl; 28% N; Buctril + Goal	1.5 pt; 25 gal; 1.5 + 0.5 pt	POST1 & 5; POST2; POST4 & 6
16	Prowl; Buctril + Goal; Dual II Magnum	1.5 pt; 1.5 + 0.5 pt; 1 pt	POST1; POST4 & 6; POST5
17	Prowl; Buctril + Goal; Outlook	1.5 pt; 1.5 + 0.5 pt; 1 pt	POST1; POST4 & 6; POST5
18	Prowl; Buctril + Goal; Authority	1.5 pt; 1.5 + 0.5 pt; 3 oz	POST1; POST4 & 6; POST5
19	Prowl; Authority	1.5 pt; 3 oz	POST1; POST5
20	Prowl; Buctril + Goal; Prowl	1.5 pt; 1.5 + 0.5 pt; 1.5 pt	PRE1 & 5; POST4 & 6
21	Handweed		

[1]See Table 46 for description of application timings.
[2]Except for these treatments, all treatments received 20 gal of 28% N applied POST2.

On May 29, Fusilade + NIS (12 oz/acre + 1 pt/25 gal) was applied to the entire study with a tractor mounted sprayer using AI 110-04 flat fan nozzles, 36 gpa, and 55 psi pressure. This was to kill the barley cover crop which was about 7 inches tall and vigorously growing.

Table 46. Treatment application data at the Oakes Irrigation Research Site, 2002.

Application timing	Date	Time	Barley height	Onion height	Onion growth stage	Weed height	Weed growth stage
PRE1	April 26	10:30 am	0	0	0	0	0
PRE2	May 10	10:15 am	1"	0	0	<¼"	cot.
PRE3	May 13	9:45 am	2"	0	0	¼"	cot.
POST1	May 24	9:00 am	4.5"	1"	loop to flag lf	½ to 1"	cot. to 2 lf
POST2	May 31	10:15 am	7.5"	3"	1 true lf	1 to 2"	2 to 4 lf
POST3	June 5	10:00 am	7" (dying)	4.5"	1.3 true lf	1 to 3"	2 to 5 lf
POST4	June 7	2:30 pm	6" (dying)	5"	1.8 true lf	1 to 5"	2 to 8 lf
POST5	June 11	4:00 pm	3" (dead)	6"	2.5 true lf	2"	mostly dead
POST6	June 25	3:15 pm	---	8"	5 true lf	1 to 6"	4 to 12 lf

Treatments applied with a CO_2 backpack sprayer using AI 110-04 flat fan nozzles, 45 gpa, and 57 psi (except POST2 was applied using 8002 flat fan nozzles, 15 to 25 gpa, and 36 psi).

Table 47. Onion injury, barley cover crop injury, and redroot pigweed ratings for the Oakes Irrigation Research Site 2002 weed control study.

Treatment number[1]	Onion injury			Barley injury	Redroot pigweed ratings			
	5/31	6/18	7/5	5/31	5/31	6/18	7/5	9/11
	0 to 10[2]							
1	0.0 a[3]	0.0 a	1.0 abc	0.0 a	9.3 a-d	9.8 ab	9.5 ab	8.3 a-d
2	0.0 a	0.5 a	1.0 abc	0.0 a	8.8 b-e	9.5 abc	9.0 abc	7.0 de
3	2.3 cd	0.3 a	3.8 e	0.0 a	8.5 cde	6.3 d	5.0 e	4.3 fg
4	2.8 d	0.3 a	1.8 cd	0.0 a	10.0 a	8.8 c	7.0 d	6.8 de
5	0.3 ab	0.0 a	0.8 abc	0.0 a	8.5 cde	6.8 d	4.5 e	3.5 g
6	4.0 e	1.3 b	5.3 f	7.0 b	9.5 abc	9.0 bc	8.0 cd	7.3 cde
7	4.3 e	1.8 b	3.0 e	9.0 d	9.8 ab	9.0 bc	8.8 bc	9.0 abc
8	2.3 cd	1.3 b	1.5 bc	7.5 c	10.0 a	10.0 a	10.0 a	9.0 abc
9	0.3 ab	0.0 a	0.5 ab	0.0 a	9.3 a-d	9.5 abc	8.8 bc	6.0 ef
10	0.8 ab	0.0 a	0.5 ab	0.0 a	9.4 abc	9.8 ab	9.3 ab	7.5 cde
11	1.3 bc	0.3 a	0.8 abc	0.0 a	9.3 a-d	10.0 a	10.0 a	8.0 bcd
12	0.3 ab	0.0 a	1.0 abc	0.0 a	8.7 b-e	9.8 ab	9.5 ab	6.6 de
13	0.0 a	0.3 a	0.8 abc	0.0 a	8.3 de	9.5 abc	9.5 ab	7.5 cde
14	0.3 ab	0.3 a	0.3 a	0.0 a	9.0 a-e	9.5 abc	9.8 ab	8.0 bcd
15	0.0 a	0.0 a	0.5 ab	0.0 a	9.5 abc	9.5 abc	9.5 ab	7.5 cde
16	0.3 ab	0.3 a	0.8 abc	0.0 a	9.3 a-d	10.0 a	10.0 a	8.0 bcd
17	0.0 a	0.0 a	1.3 abc	0.0 a	8.8 b-e	10.0 a	10.0 a	9.0 abc
18	0.5 ab	0.3 a	2.8 de	0.0 a	9.0 a-e	10.0 a	10.0 a	9.5 ab
19	0.8 ab	0.5 a	3.3 e	0.0 a	9.3 a-d	10.0 a	9.8 ab	8.3 a-d
20	0.7 ab	0.0 a	0.3 ab	0.0 a	8.1 e	8.8 bc	9.1 abc	6.3 def
21	0.0 a	0.0 a	0.5 ab	0.0 a	8.3 de	10.0 a	10.0 a	10.0 a
Probability	<.0001	<.0001	<.0001	<.0001	0.006	<.0001	<.0001	<.0001
C.V. (%)	89	145	58	19	8	7	9	18

[1]See Table 45 for treatments.
[2]Ratings: 0 is no effect (no weed control or no crop injury); 10 is complete weed or crop kill.
[3]Values in the same column followed by the same letter are not significantly different at the 0.05 level.

Table 48. Common lambsquarters and hairy nightshade weed ratings in the 2002 onion weed control study at the Oakes Irrigation Research Site.

Treatment number[1]	Common lambsquarters ratings				Hairy nightshade ratings			
	5/31	6/18	7/5	9/11	5/31	6/18	7/5	9/11
	---------- 0 to 10[2] ----------							
1	9.3 a-d[3]	10.0 a	10.0 a	10.0 a	8.5 bcd	10.0 a	10.0 a	9.0 ab
2	9.5 abc	10.0 a	10.0 a	10.0 a	6.0 f	10.0 a	10.0 a	7.8 bc
3	10.0 a	9.0 c	8.5 b	6.3 cd	9.3 ab	7.8 de	5.8 b	1.3 ef
4	9.8 ab	9.0 c	8.0 b	6.3 cd	10.0 a	9.0 bc	9.3 a	5.0 d
5	9.6 abc	9.3 bc	8.0 b	7.0 bc	8.5 bcd	8.5 cd	6.8 b	1.8 e
6	7.8 e	6.3 d	6.3 c	4.5 d	9.8 a	6.3 f	3.8 c	0.3 ef
7	9.5 abc	8.5 c	8.8 b	8.8 ab	9.4 ab	7.0 ef	4.3 c	0.0 f
8	9.3 a-d	10.0 a	10.0 a	10.0 a	9.0 abc	10.0 a	10.0 a	9.3 ab
9	9.0 bcd	9.8 ab	9.8 a	10.0 a	8.0 cd	9.8 ab	10.0 a	8.5 abc
10	8.8 cd	9.3 bc	10.0 a	9.8 a	8.3 bcd	9.8 ab	9.8 a	7.0 c
11	9.3 a-d	10.0 a	10.0 a	9.8 a	8.3 bcd	10.0 a	10.0 a	10.0 a
12	10.0 a	10.0 a	10.0 a	9.6 a	8.5 bcd	10.0 a	10.0 a	9.5 a
13	9.1 a-d	10.0 a	10.0 a	10.0 a	8.4 bcd	10.0 a	10.0 a	9.5 a
14	9.3 a-d	10.0 a	10.0 a	10.0 a	8.3 bcd	10.0 a	10.0 a	9.8 a
15	8.8 cd	10.0 a	10.0 a	10.0 a	8.0 cd	10.0 a	10.0 a	10.0 a
16	9.3 a-d	9.8 ab	10.0 a	10.0 a	7.5 de	10.0 a	10.0 a	10.0 a
17	9.3 a-d	10.0 a	10.0 a	10.0 a	8.0 cd	10.0 a	10.0 a	9.5 a
18	9.5 abc	10.0 a	10.0 a	10.0 a	7.5 de	10.0 a	10.0 a	10.0 a
19	9.5 abc	9.3 bc	9.8 a	9.8 a	8.0 cd	9.3 abc	6.0 b	0.0 f
20	9.8 ab	9.9 ab	9.9 a	9.9 a	7.4 de	9.7 ab	10.0 a	8.3 abc
21	8.5 de	10.0 a	10.0 a	10.0 a	6.5 ef	10.0 a	10.0 a	10.0 a
Probability	0.006	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
C.V. (%)	7	6	6	14	10	6	10	18

[1]See Table 45 for treatments.

[2]Ratings: 0 is no effect (no weed control or no crop injury); 10 is complete weed or crop kill.

[3]Values in the same column followed by the same letter are not significantly different at the 0.05 level.

Table 49. Onion yields and total number of bulbs in 2002 weed control study at the Oakes Irrigation Research Site.

Treatment number[1]	Onion yields						Total bulbs
	>3.5"	3 to 3.5"	2.25 to 3"	<2.25"	total US #1	total yield	
	cwt/acre						1000s/A
1	25 b-e[2]	108 abc	76 de	11 ab	209 abc	269 abc	63 ab
2	16 b-f	72 c	85 cde	12 ab	174 c	231 c	58 b
3	0 f	0 d	0 f	0 c	0 d	0 d	0 c
4	0 f	0 d	12 f	12 ab	12 d	28 d	17 c
5	0 f	0 d	0 f	0 c	0 d	0 d	0 c
6	0 f	0 d	0 f	0 c	0 d	0 d	0 c
7	0 f	0 d	0 f	0 c	0 d	0 d	0 c
8	36 abc	129 ab	59 e	7 bc	224 abc	273 abc	61 ab
9	16 b-f	104 abc	92 b-e	13 ab	212 abc	268 abc	68 ab
10	13 c-f	80 c	97 a-e	13 ab	190 bc	246 bc	65 ab
11	45 a	129 ab	91 b-e	7 bc	265 a	320 a	69 ab
12	18 b-f	72 c	86 cde	16 ab	176 c	226 c	60 b
13	15 b-f	92 bc	119 abc	17 ab	226 abc	275 abc	75 ab
14	10 ef	103 abc	127 ab	11 ab	240 ab	290 abc	75 ab
15	17 b-f	104 abc	106 a-d	18 a	226 abc	279 abc	73 ab
16	23 b-e	132 a	86 cde	10 abc	242 ab	288 abc	68 ab
17	14 def	134 a	83 cde	10 abc	231 abc	276 abc	64 ab
18	34 a-d	102 abc	74 de	10 abc	210 abc	285 abc	65 ab
19	0 f	0 d	0 f	0 c	0 d	0 d	0 c
20	14 b-f	101 abc	133 a	16 ab	248 ab	306 ab	82 a
21	36 ab	107 abc	101 a-e	13 ab	244 ab	294 abc	71 ab
Probability	0.0001	<.0001	<.0001	0.0013	<.0001	<.0001	<.0001
C.V. (%)	95	36	40	76	28	24	27

[1]See Table 45 for treatments.

[2]Values in the same column followed by the same letter are not significantly different at the 0.05 level.

PUMPKIN WEED CONTROL STUDY

Richard Greenland

Weed control is difficult in pumpkins because few herbicides are available for pumpkin production. In this experiment we looked at several herbicides and herbicide combinations for use in pumpkins.

MATERIALS AND METHODS

Soil:	Hecla sandy loam, and Embden sandy loam; pH=7.2; 2.9% organic matter; soil-P and soil-K were very high; soil-S was low.
Previous crops:	2001 - soybean; 2000 - potato; 1999 - carrot.
Seedbed preparation:	Coulter chiseled 15 inches deep on April 18. Multiweeded (field cultivated) on May 16 to smooth the seedbed.
Planting:	Pumpkin seeds planted 1 ft apart in rows on 8 ft centers on May 16. On June 12, thinned to an in-row spacing of one plant every 3 ft.
Plots:	Plots were 20 ft long by 8 ft (one row) wide. The study had 4 reps.
Fertilizer:	On April 18, broadcast 18 lbs N/acre and 20 lbs S/acre as 21-0-0-24. Side dressed 50 lbs N/acre as urea on June 13.
Irrigation:	Surface drip irrigation as needed.
Pest control:	Weed control treatments are given in Table 50. Because of no rain after planting, the area was lightly cultivated on May 22 to activate the herbicides. Sprayed Asana (8 oz/acre on June 10, 18, 25, and July 2) and Ambush (8 oz/acre on July 11 and 30) to control cucumber beetle.
Harvest:	Hand harvested on Sept 17 and 18.

RESULTS

None of the herbicides performed as well as the hand weeded check. Much of this could have been due to dry weather after herbicide application. We did a light cultivation to activate the herbicides, but that probably was not as good as half an inch of rain would have been. The surface drip irrigation is not an adequate method for activating the herbicides.

Table 50. Weed ratings and yield data for the 2002 Oakes Irrigation Research Site pumpkin weed control study.

Herbicide	Rates	July 8 weed ratings				Yield	Number of fruit	Head size
		Rrpw[1]	Colq[1]	Hns[1]	Ebns[1]			
		---------- 0 to 10[2] ----------				tons/acre	1000s/acre	lbs/fruit
Authority	3 oz	7.5 c	7.8 b	6.3 b	8.3 b	7.9 c	1.4 c	11.8
Outlook	1 pt	9.0 ab	7.3 b	5.8 b	9.8 a	9.1 c	1.8 bc	10.2
Raptor	5 oz	7.2 c	6.6 b	5.4 b	9.0 ab	12.8 ab	2.4 ab	11.1
Authority + Raptor	2 oz + 4 oz	8.3 bc	7.8 b	7.0 b	9.5 a	10.7 bc	2.0 abc	10.8
Outlook + Raptor	1 pt + 4 oz	9.8 a	6.8 b	7.8 b	10.0 a	13.0 ab	2.4 ab	10.9
Hand weed		10.0 a	10.0 a	10.0 a	10.0 a	15.8 a	2.7 a	12.0
Probability		0.004	0.02	0.007	0.04	0.0013	0.047	0.73
C.V. (%)		11	16	20	8	18	25	16

[1]Abbreviations used are: Rrpw - redroot pigweed; Colq - common lambsquarters; Hns - hairy nightshade; Ebns - Eastern black nightshade.

[2]Ratings: 0 is no effect (no weed control or no crop injury); 10 is complete weed or crop kill.

PUMPKIN COVER CROP AND LIVING MULCH STUDY

Richard Greenland

Pumpkins are planted in wide rows, leaving large areas of bare ground. In current pumpkin production, the between-row area is usually cultivated early in the season, before the pumpkin plants begin to run, to control weeds. This exposes the soil to erosion and also reduces soil organic matter. Later in the season hand weeding is used to control weeds. After harvest of pumpkins, little residue is left to protect the soil and it is usually too late in the season for cover crop establishment. Cover crops and living mulches planted between the pumpkin rows could prevent soil erosion and increase soil organic matter, but if they compete too much with the pumpkins then pumpkin yield could be reduced. In this study a barley cover crop was planted in early spring, leaving unplanted strips, 3 ft wide, for planting pumpkins in mid- to late-May. When the barley headed, it was flailed and a living mulch (hairy vetch, rye, soybean, and/or corn) was planted between the pumpkin rows. Data on height, stand, and vigor of pumpkin, living mulches, and weeds were collected to determine competitiveness of the living mulches. Total dry matter was measured at the end of the season. Our objective was to find a cover crop/living mulch combination that protects the soil, helps control weeds, but doesn't compete with the pumpkins enough to reduce pumpkin yield.

MATERIALS AND METHODS

Soil:	Embden loam and Gardena loam; pH=7.3; 2.2% organic matter; soil-P and soil-K were very high; soil-S was medium.
Previous crops:	2001 - potato; 2000 - sweetcorn, cabbage, onion, sugarbeet, field corn, pepper, soybean, carrot, wheat, and edible bean; 1999 - field corn.
Seedbed preparation:	Coulter chiseled 15 inches deep on April 18. Multiweeded (field cultivated) once on April 22.
Planting:	'Rockstar' pumpkin seeds were planted 1 ft apart in rows 8 ft apart on May 17. On June 12 thinned to an in-row spacing of one plant every 3 ft.
Plots:	Plots were 20 ft long by 16 ft (two rows) wide.
Fertilizer:	On April 18, broadcast 18 lbs N/acre and 20 lbs S/acre as 21-0-0-24. On April 22 sprayed 50 lbs N/acre as 28-0-0. Side dressed 50 lbs N/acre as urea on June 12.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Weeds were controlled by hand weeding the three foot strip (where the pumpkins were planted) on all plots and by weed control treatments given in Table 51. Sprayed Asana (8 oz/acre on June 10, 18, & 25, and July 2 & 30) and Ambush (8 oz/acre on July 11) to control cucumber beetles.
Harvest:	Hand harvested September 26 to October 2.

RESULTS

The pumpkin variety we used this year, Rockstar, was a very vigorous, vining type pumpkin. Pumpkins grew faster and were too big when we flailed the barley, so they were injured a little by the tractor, flail, and planter (when planting the living mulch). Just before flailing the barley, pumpkin plants were shorter in the check treatment than in treatments with a barley cover crop. Despite the injury, the pumpkins quickly covered the ground and drastically reduced living mulch growth, especially rye. Living mulch growth and end of season dry matter were much lower than last year. Neither the barley cover crop planted between pumpkin rows nor the living mulches affected pumpkin yield. The barley cover crop increased end of season dry matter and helped protect the soil.

Sweetcorn was planted in 2002 on the 2001 pumpkin cover crop study area. Lambsquarters and hairy nightshade growth was slightly greater on plots that had previously been planted to cover crops and living mulches, but sweetcorn yields were not affected.

Table 51. Treatments applied to the Oakes Irrigation Research Site 2002 pumpkin cover crop/living mulch study.

Cover crop/living mulch treatments[1]
No barley cover crop nor living mulch (check)
Barley cover crop; no living mulch
Barley cover crop; hairy vetch
Barley cover crop; rye
Barley cover crop; hairy vetch + rye
Barley cover crop; soybean
Barley cover crop; soybean + corn
Barley cover crop; corn

Weed control treatments

Herbicide - Buctril (1 pt/acre on May 17 before planting pumpkin) and Poast + Dash (1.5 + 1 pt/acre on June 20 just before flailing barley)

No herbicide - The 3 ft strips were cultivated just before planting pumpkins.

Note: The 3-ft wide strip the pumpkins were planted in was hand weeded in all plots. The area between the pumpkin rows was not weeded except for the check (no barley, no living mulch) plots.

Barley flail height treatments[2]

High - flailed at 1 ft high

Low - flailed at less than 1 inch high

[1]Barley was planted with a drill (6-inch row spacing) on April 22 in strips 5 ft wide, leaving 3-ft wide bare strips for planting pumpkins. Living mulches were no-till planted on June 26 with a Monosem specialty planter in 18-inch rows into the barley cover crop that had been flailed. A trash whipper was used ahead of the planter units to move the barley away from the planted row. Where two living mulches were planted, they were planted in alternating rows.

[2]Barley was flailed on June 21. This was just after barley headed, when the pumpkins began to run, and before planting the living mulches.

Table 52. Pumpkin number of fruits and yield response to a barley cover crop and living mulches in the Oakes Irrigation Research Site 2002 pumpkin cover crop/living mulch study.

	Number of pumpkins				Pumpkin yield				
Treatment	marketable	not marketable[1]	green	total	marketable	not marketable[1]	green	total	Fruit size
	number per acre				tons per acre				lbs/fruit
Cover crop, living mulch									
No barley, no mulch	1972	220	1181	3503	25.2	1.9	7.8	34.9	25.5
Barley, no mulch	1982	180	1061	3373	23.2	1.7	6.8	31.7	23.7
Barley, hairy vetch	2162	260	1041	3623	24.5	2.3	7.0	33.7	22.9
Barley, rye	1942	290	1091	3473	22.4	2.3	6.5	31.1	23.2
Barley, hairy vetch + rye	2102	200	881	3283	25.4	1.6	5.9	33.0	24.4
Barley, soybean	2072	120	831	3183	24.4	1.0	5.5	30.9	23.9
Barley, soybean + corn	2112	180	821	3153	24.8	2.0	5.4	32.2	24.1
Barley, corn	2082	190	801	3213	24.4	1.8	4.7	31.0	23.5
Probability	0.90	0.70	0.33	0.09	0.87	0.71	0.33	0.28	0.40
Herbicide treated									
No	2092	220	958	3411	24.5	1.8	6.3	32.5	23.6
Yes	2014	190	968	3291	24.1	1.9	6.1	32.1	24.3
Probability	0.67	0.28	0.95	0.65	0.84	0.82	0.84	0.77	0.40
C.V. (%)	19	89	44	14	15	99	53	13	10
Barley flail height									
High	2065	220	935	3349	24.3	1.9	5.8	32.0	23.7
Low	2065	186	929	3309	24.0	1.8	6.1	31.9	23.7
Probability	1.0	0.21	0.95	0.77	0.73	0.60	0.62	0.87	0.99
C.V. (%)	16	90	42	13	15	100	57	13	8

[1]Not marketable were those pumpkins that had disease spots, small rotten spots, major blemishes, or very odd shapes.

Table 53. Pumpkin stand, size, injury, ground cover, and end of season dry matter as affected by cover crop and living mulches in the Oakes Irrigation Research Site 2002 pumpkin cover crop/living mulch study.

Treatment	Stand[1]	Height[2]	Width[2]	Crop injury[3]	Ground Cover[4]	Dry matter[5]
	1 to 10	------ inches ------		-------- % -------		tons/acre
Cover crop/living mulch						
No barley, no mulch	9.6	11.0 b[6]	23.5	13 a	87	1.7 d
Barley, no mulch	9.6	14.6 a	22.3	22 bc	80	2.7 bc
Barley, hairy vetch	9.7	14.8 a	22.8	23 c	78	2.7 bc
Barley, rye	9.6	13.8 a	21.6	21 bc	76	2.5 c
Barley, hairy vetch + rye	8.0	14.3 a	22.1	19 b	77	2.8 bc
Barley, soybean	9.0	14.8 a	22.6	23 c	76	2.5 c
Barley, soybean + corn	9.7	14.7 a	22.8	21 bc	78	3.3 ab
Barley, corn	8.5	14.9 a	22.6	20 b	78	3.9 a
Probability	0.53	<.0001	0.94	<.0001	0.053	<.0001
Herbicide treated						
No	9.4	14.3	22.9	21	80	2.7
Yes	9.1	13.9	22.2	19	77	2.8
Probability	0.38	0.31	0.39	0.02	0.33	0.50
C.V. (%)	17	9	10	28	10	29
Barley flail height						
High	9.1	14.4	22.0	19	78	2.8
Low	9.2	14.7	22.8	23	77	3.0
Probability	0.81	0.54	0.30	0.08	0.75	0.07
C.V. (%)	15	7	8	23	8	31

[1]Pumpkin plants/17 ft of row before thinning. Plants later thinned to 6 plants/17 ft of row.

[2]Height and width measured on June 21.

[3]Injury to pumpkins measured on June 24 after flailing barley and planting cover crop. Injury was mostly mechanical injury from tractor and implements and from wind.

[4]Percent of ground covered by pumpkin plants on July 18.

[5]End of season dry matter.

[6]Values in the same column followed by the same letter are not significantly different at the 0.05 level. If no letters in column, then there were no statistically significant differences between values in that column.

Table 54. Effects of cover crops/living mulches used in pumpkins in 2001 on weed growth and sweetcorn planted in 2002.

	Weed ratings				Sweetcorn			
	Rrpw[1]	Colq[1]	Hns[1]	FT[1]	stand	vigor	ears	yield
	---------- 0 to 10[2] ----------				----- 1 to 10 ----		1000s/A	tons/A
Cover crop/living mulch								
No barley, no mulch	9.7	8.1 a[3]	8.1 a	9.8	6.7	7.7	12.2	6.2
Barley, no mulch	9.8	6.9 c	6.8 c	9.6	6.3	7.6	12.4	6.2
Barley, hairy vetch	9.8	7.0 bc	6.8 c	9.2	6.3	7.5	13.2	6.7
Barley, rye	9.7	7.1 bc	6.9 c	9.3	6.5	7.7	13.1	6.4
Barley, hairy vetch + rye	9.5	7.0 bc	6.8 c	9.4	6.6	7.4	12.4	6.2
Barley, soybean	9.6	7.4 b	6.9 bc	9.5	6.6	7.8	12.2	6.2
Barley, soybean + corn	9.8	7.1 bc	7.8 ab	9.4	6.1	7.6	11.8	5.8
Barley, corn	9.9	7.4 b	7.9 a	9.5	6.6	7.5	11.1	5.3
Probability	0.19	0.002	0.006	0.90	0.67	0.54	0.67	0.60
Herbicide treated								
No	9.8	7.2	7.1	9.0	6.5	7.6	12.6	6.3
Yes	9.6	7.3	7.3	9.9	6.3	7.6	12.1	6.1
Probability	0.21	0.82	0.33	0.03	0.21	0.93	0.29	0.37
C.V. (%)	5	10	9	7	14	6	22	23
Barley flail height								
High	9.8	7.1	7.0	8.9	6.5	7.6	12.1	6.0
Low	9.6	7.2	7.3	9.9	6.3	7.6	12.6	6.3
Probability	0.18	0.09	0.40	0.14	46	0.26	0.50	0.53
C.V. (%)	4	9	9	6	14	5	19	20

[1]Weed identification: Rrpw - redroot pigweed; Colq - common lambsquarters; Hns - hairy nightshade; FT - yellow and green foxtail.
[2]Ratings: 0 is no effect (no weed control or no crop injury); 10 is complete weed or crop kill.
[3]Values in the same column followed by the same letter are not significantly different at the 0.05 level. If no letters in column, then there were no statistically significant differences between values in that column.

EFFECTS OF PREVIOUS CROPS ON POTATO

Richard Greenland

To reduce disease problems and maintain potato quality, potato should be planted in a field only once every three or four years. The crops grown the other two or three years can affect the yield and quality of potatoes and the economic viability of the farming system. Presently, farmers earn money the year they plant potato (or rent their land for potato production), then have two or three lean years until they can plant potato again. This tempts many to shorten the rotation interval, resulting in increased possibility of crop failure, or yield and quality reduction when they do plant potato. Producers are requesting information concerning rotations involving potato. One alternative is to grow vegetables such as carrot, cabbage, onion, or sweetcorn in rotation with potato. These are high value crops that require irrigation and could increase farmer income substantially in years when potato is not grown. However, little information is available on the effects of vegetable crops planted in rotation with potato. Research indicates that some crops in the brassica family (of which cabbage is a member) reduce disease in potato planted the following year. Carrots may increase deleterious nematode numbers in some areas but may not be a problem in North Dakota. Standard rotations involving potato need to be developed. Given 10 crops with three or four year rotations, there are almost a thousand different rotations possible that include potato. By determining which crops potato does well or poorly after, the number of possibilities can be reduced. This study compares vegetable and other crops (with and without a cover crop) planted the year before potato and their effects on potato planted the subsequent year.

In 2001, ten crops (cabbage, carrot, field corn, sweetcorn, edible bean, onion, potato, soybean, sugarbeet, wheat) were planted on the study area. These crops were managed according to standard production practices for each crop and were harvested in late summer or fall of 2001. A cover crop was planted on half of each plot, either during crop growth (for corn) or after harvest (all other crops). Potato was planted in the spring of 2002 following the materials and methods below.

MATERIALS AND METHODS

Soil (2001 values):	Maddock sandy loam and Egeland loam; pH=7.6; 2.3% organic matter; soil-P and soil-K were very high; soil-S was medium.
Previous crop:	2001 - see Table 55; 2000 - field corn, sweetcorn, garden pea, and onion; 1999 - edible bean, carrot, and pumpkin.
Seedbed preparation:	Disked plots not planted with cover crop on 1 Nov 2001. All plots coulter chiseled 15 inches deep on Apr 18 and disked on 2 May 2002 to incorporate fertilizer.
Planting:	'Russet Burbank' potato seed pieces were planted 1 ft apart in rows 3 ft wide on May 3.
Plots:	We used a split-plot design with four replications. Main plots (for crops) were 20 x 80 ft. Each main plot was divided into two subplots, 20 x 40 ft. One subplot was not fall tilled and was planted to a cover crop. The other subplot was fall tilled and did not have a cover crop.

Fertilizer: On April 18, broadcast 18 lbs N/acre and 20 lbs S/acre as 21-0-0-24. Sprayed 28-0-0 on May 2 to bring soil test N + applied N to 57 lbs/acre. Side dressed 70 lb N/acre as urea on June 6. Fertigated 30 lbs N/acre as 32-0-0 on July 26.

Irrigation: Sprinkler irrigation as needed.

Pest control: Weeds were controlled by: dragging off on May 22; hilling on June 6; Poast + Dash (1.5 pt + 1 pt/acre on May 24); Dual II + Prowl (1.5 pt + 1.5 pt/acre on Jun 6); Matrix (1 oz/acre on Jun 21); rototilling between plots, and hand weeding. Admire (1.3 oz/1000 ft applied at planting), Asana (8 oz/acre on Jul 22) and Ambush (12 oz/acre on Aug 16 and Aug 27), controlled Colorado Potato Beetle. Diseases were controlled by: treating seed pieces with Maxim dust (25 lb/cwt); Ridomil MZ72 (2.5 lb/acre on Jul 3 and Jul 22); Rovral (2 pt/acre on Jul 15, Jul 31 and Aug 16); Manzate (1.5 and 2 lbs/acre on Jul 9 and Aug 7); and Dithane F45 (1.6 qt/acre on Aug 27).

Harvest: Harvested an 8 foot section of the center two rows. Reps 3 and 4 were harvested Sep 19 to Sep 23. Reps 1 and 2 were harvested Oct 8 to Oct 10.

RESULTS

Ten crops (cabbage, carrot, field corn, sweetcorn, edible bean, onion, potato, soybean, and wheat) were planted in 2001 at the Oakes Irrigation Research Site. All of these previous crops were grown successfully and managed according to standard production practices for each crop. Cover crops planted after wheat and cabbage harvest, and at last cultivation in field and sweet corn, were well established before winter. The rye planted after harvest of carrot, edible bean, onion, potato, sugar beet, and soybean grew well but did not have time to establish much cover before winter. Disease ratings were taken in the fall of 2002.

Spring soil tests ranged from 24 lbs N/acre after wheat to 57 lbs N/acre after potato (Table 56). Soil N was lower in the no-fall-till/cover crop treatment than in the fall tillage treatment.

Potato yields and quality were not significantly affected by the previous crop or the tillage/cover crop treatments (Table 57). Disease on potato vines was higher when the previous crop was potato or sugar beet. The cover crop increased potato disease in combination with some previous crops (cabbage, potato, and sugar beet) and decreased potato disease with other previous crops (carrot and corn) (Table 56).

Table 55. Previous crop management treatments.

2001 Crop	Variety or hybrid	Planting date	Harvest date	Cover crop	Cover crop planting date	Herbicides	Total N applied
Cabbage	Charmant	Apr 27	Aug 2 & 3	hairy vetch & forage sorghum	Aug 8	Treflan, Dacthal Poast, Lentagran	228 lbs
Carrot	Bolero	May 16	Aug 20, 28, 29	rye	Aug 31	Treflan, Lorox Poast	168 lbs
Field corn	Pioneer 38K07	May 1	Oct 5	hairy vetch	Jun 26	Frontier + Cypro	293 lbs
Sweetcorn	Honey Select	May 4	Aug 6	hairy vetch	Jun 26	Dual II	233 lbs
Edible bean	Navigator (Navy)	May 17	Sep 24	rye	Sep 25	Treflan, Dual II Poast	118 lbs
Onion	Teton	Apr 27	Sep 6	rye	Sep 25	Prowl, Poast, Buctril + Goal	228 lbs
Potato	Russet Burbank	May 10	Sep 24 & 25	rye	Sep 25	Dual II+Prowl, Poast, Matrix	223 lbs
Soybean	Novartis X9904RC	May 17	Sep 24	rye	Sep 25	Treflan, Dual II Roundup, Basagran	118 lbs
Sugarbeet	Blazer	May 11	Sep 24 & 25	rye	Sep 25	Tillam, Nortron, Betamix+Upbeet	168 lbs
Wheat	Russ	Apr 26	Aug 12	hairy vetch	Aug 13	Buctril	168 lbs

Table 56. 2002 spring soil N tests and fall disease ratings in the Oakes Irrigation Research Site 2002 crops previous to potato study.

Treatment (2001)	Cover crop	Soil Nitrogen 0 to 6"	Soil Nitrogen 6 to 24"	Soil Nitrogen Total	Disease rating
		---------- lbs/acre ----------			0 to 10[1]
Previous crop by Cover crop					
cabbage	No	22.0 bc[2]	27.0 b	49.0 b	1.5 a
	Yes	17.0 cde	15.0 f-i	32.0 cd	3.3 b-e
carrot	No	20.8 bcd	22.5 b-f	43.3 bc	2.5 abc
	Yes	4.5 j	10.5 hi	15.0 g	1.5 a
field corn	No	15.0 d-h	23.3 bd	38.3 bcd	4.3 e-h
	Yes	14.0 e-h	14.3 ghi	28.3 def	3.0 bcd
sweet corn	No	20.0 bcd	28.3 b	49.6 b	3.0 bcd
	Yes	15.0 efg	17.3 c-h	32.3 cd	2.3 ab
edible bean	No	23.5 b	15.0 d-i	38.8 bcd	3.0 bcd
	Yes	11.8 f-i	15.0 e-i	26.8 def	2.5 abc
onion	No	16.8 c-f	20.8 b-g	37.5 bcd	2.3 ab
	Yes	9.8 hi	21.8 b-e	31.5 cde	3.0 bcd
potato	No	33.0 a	51.8 a	84.8 a	4.8 gh
	Yes	10.8 ghi	20.8 b-g	29.1 def	6.3 i
soybean	No	20.5 bcd	24.0 bc	44.5 b	3.5 c-f
	Yes	7.8 ij	11.3 hi	19.0 fg	3.8 d-g
sugar beet	No	21.3 bc	22.5 bcd	43.8 b	4.5 fgh
	Yes	8.3 ij	9.8 i	18.0 fg	5.0 h
wheat	No	13.8 e-h	13.5 f-i	27.3 def	3.5 c-f
	Yes	10.5 ghi	10.5 hi	21.0 efg	3.3 b-e
Probability		<.0001	0.0008	0.0002	0.004
Previous crop (averaged over cover crop)					
cabbage		19.5 ab	21.0 b	40.5 bc	2.4 a
carrot		12.7 d	16.5 bc	29.2 d	2.0 a
field corn		14.5 cd	18.8 bc	33.3 bcd	3.6 ab
sweet corn		17.5 bc	22.8 b	40.9 b	2.6 a
edible bean		17.6 bc	15.0 bc	32.8 bcd	2.8 a
onion		13.3 d	21.3 b	34.5 bcd	2.6 a
potato		21.9 a	36.3 a	56.9 a	5.5 c
soybean		14.1 cd	17.6 bc	31.8 bcd	3.6 ab
sugar beet		14.8 cd	16.1 bc	30.9 cd	4.8 bc
wheat		12.1 d	12.0 c	24.2 d	3.4 ab
Probability		0.0003	0.0002	<.0001	0.004
Cover Crop (averaged over previous crop)					
No		20.7	24.9	45.7	3.3
Yes		10.9	14.6	25.3	3.4
Probability		<.0001	<.0001	<.0001	0.57
C.V. (%)		22	25	20	23

[1]Ratings are 0 = no disease to 10 = complete death of plant due to disease.

[2]Values in the same column and section followed by the same letter are not significantly different at the 0.05 level.

Table 57. 2002 spring soil organic matter and pH, and fall potato yield and quality in the Oakes Irrigation Research Site 2002 crops previous to potato study.

Treatment (2001)	Soil OM[1]	Soil pH	US #1 yield	Total yield	Tuber size	Hollow heart	Specific gravity
	%		---- cwt/acre ---		oz/tuber	%	g/cm^3
Previous crop							
cabbage	2.3	7.6	275	342	7.8	72	1.076
carrot	2.3	7.7	283	356	7.8	83	1.078
field corn	2.4	7.6	276	361	7.9	73	1.075
sweet corn	2.4	7.6	294	370	7.6	65	1.075
edible bean	2.4	7.6	276	348	7.7	73	1.077
onion	2.3	7.6	297	371	7.8	68	1.078
potato	2.4	7.6	289	379	7.7	80	1.074
soybean	2.4	7.7	332	416	8.0	83	1.077
sugar beet	2.4	7.8	296	365	7.7	80	1.077
wheat	2.3	7.7	316	389	7.5	78	1.078
Probability	0.99	0.65	0.39	0.38	0.98	0.66	0.91
Cover Crop							
No	2.3	7.6	293	366	7.7	74	1.077
Yes	2.4	7.6	294	373	7.8	77	1.076
Probability	0.22	0.21	0.93	0.58	0.83	0.58	0.80
C.V. (%)	11	1	16	14	6	25	0.4

[1]Organic matter.

Note: For these measurements, there were no previous crop by cover crop interactions.

Research on Potato Planting Configurations

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A third year of research was conducted to determine whether a furrow planting configuration is more productive than the conventional hilled configuration for irrigated potatoes on well-drained soils. Experiments were conducted during the 2000, 2001, and 2002 growing seasons. Collaborators were Richard Greenland at the NDSU Oakes Irrigation Research Site and Harlene Hatterman-Valenti from the NDSU Plant Sciences Department. A similar study was conducted at Dawson, ND in 2001 and Tappen, ND in 2002, but this report is only for the Oakes Irrigation Research Site.

The research involved small plots (each 12 ft wide by 40 ft long), the Russet Burbank variety, a row spacing of 36 inches, and a plant spacing of approximately 12 inches. All the furrow and hill planted plots were treated identically with respect to irrigation, fertilizer, herbicide, and fungicide amounts, using production practices typical of those for potatoes grown in the

conventional or hilled configuration. For the 2001 and 2002 seasons, hill and furrow planting configuration treatments were arranged in a randomized complete block experimental design with six replications. Soil temperature and soil moisture tension were measured hourly at 6- and 12-inch depths in the crop row and between crop rows, and at the seed piece depth.

The following categories were used to classify tubers from each plot: very small (tubers < 4 oz.), small (4-6 oz.), medium (6-10 oz.), large (10-16 oz.), very large (tubers > 16 oz.), US#1 (tubers > 4 oz.), marketable (tubers > 6 oz.), culls (tubers with growth cracks, excessive knobbiness, spoiled or rotten tubers, etc.), and total yield (all tubers). A tuber class of "other" consisted of total minus US#1 yield and a tuber class of "nonmarketable" consisted of total minus marketable yield. Yield summaries for the three years of research are presented in Table 58 for marketable, US#1, and total yields.

In 2002, yields were lower than expected because of verticillium and black dot disease pressures (G. Vogt, 2002 personal communication). Yield differences were not statistically significant at the 0.05 level between furrow (F) and hill (H) planting configurations, except for the following yield classes: small (85 cwt/acre for H vs. 71 cwt/acre for F), very small (89 cwt/acre for H vs. 63 cwt/acre for F), nonmarketable (184 cwt/acre for H vs. 139 cwt/acre for F), and weight percent of very large tubers (13.4% for F vs. 7.2% for H). It is worthy to note that although the furrow configuration had total yields that were 10% lower, on average, than those for the hill planted plots, the marketable yield was 15% greater for the furrow planted plots than for the hill planted plots (Table 58).

During hot weather in late June and early July (2002), soil temperatures at the seed piece depth in the crop rows were as much as 5 °C (9 °F) cooler for the furrow configuration than for the hill configuration (fig. 1). We attribute the cooler temperatures to faster canopy development and better shading of the soil surface for the furrow planted plots than for the hill plots.

At harvest time in 2002, we determined drawbar power requirements for each planting configuration. We measured drawbar pulling force and vehicle ground speed for two 60-ft test strips in each planting configuration using a one-row lifter operating at a ground speed of approximately 2/3 ft/sec (0.45 mph). At Oakes, the average drawbar power requirement was 1.1 hp for the hill configuration and 1.5 hp for the furrow configuration. At Tappen, similar tests indicated an average drawbar power requirement of 1.3 hp for the hill configuration and 1.1 hp for the furrow configuration. Excavation of the soil at Tappen showed that the tubers were often very close (1 to 3 in.) to the soil surface for the furrow configuration, alleviating concerns that tubers in the furrow planted plots would be too deep to harvest without significant machine modifications. The power values are low for reasons that include the following: 1) very slow ground speeds were used, hence the low power values, since power equals drawbar force times ground speed; 2) we do not include power measurements for the tractor power take off (PTO) shaft to drive chains, gears, etc. on the lifter; 3) the lifter is small and simply lifts the tubers, conveys them horizontally, and drops them out the back end of the machine; and 4) we are considering only the power required to pull the lifter once it is in the ground, not the power to get it into or out of the ground. For these reasons, the power results should be used for relative comparisons only. A better test would be to determine how a commercial potato lifter handles furrow planted potatoes in a production-sized field.

As in 2001, the furrow planting configuration appears to have an advantage in terms of crop development when compared with the hill configuration. For example, at Tappen in 2002, the furrow planted plots emerged two weeks after planting, while the hill planted plots emerged three weeks after planting. On 15 July 2002, we also noted that the furrow planted plots were further along in the flowering stage compared with the hill planted plots.

The furrow production system continues to show promise compared with the hill configuration in terms of yield and tuber size. We plan to continue the research subject to funding availability. Comments and questions about the project are welcome.

Table 58. Yield summaries for potato planting experiments.

Year/ Planting Configuration	Yields[1]			Furrow Advantage		
	Mkt	US #1	Total	Mkt	US #1	Total
	---------- cwt/acre ----------			---------- % ----------		
2000						
Furrow	281[2]	433	537	61	29	13
Hill	174	335	477			
2001[3]						
Furrow	101	189	309	-10	-2	10
Hill	112	192	282			
2002[4]						
Furrow	126	198	265	15	1	-10
Hill	110	195	294			

[1] Marketable (Mkt) grade consists of tubers 6 oz. or larger in size; US#1 grade consists of tubers 4 oz. or larger in size; both Marketable and US#1 grades exclude those with cracks, knobs, and other defects.

[2] Plots in 2000 were not replicated. In other years, there were no significant differences in yields between hill and furrow treatments.

[3] Yields in 2001 were lower than expected and we attribute this to a herbicide drift or chemical burn injury on 10 July 2001, which was in the flowering period.

[4] Yields in 2002 were lower than expected and we attribute this to a combination of verticillium and black dot disease pressures (G. Vogt, 2002 personal communication).

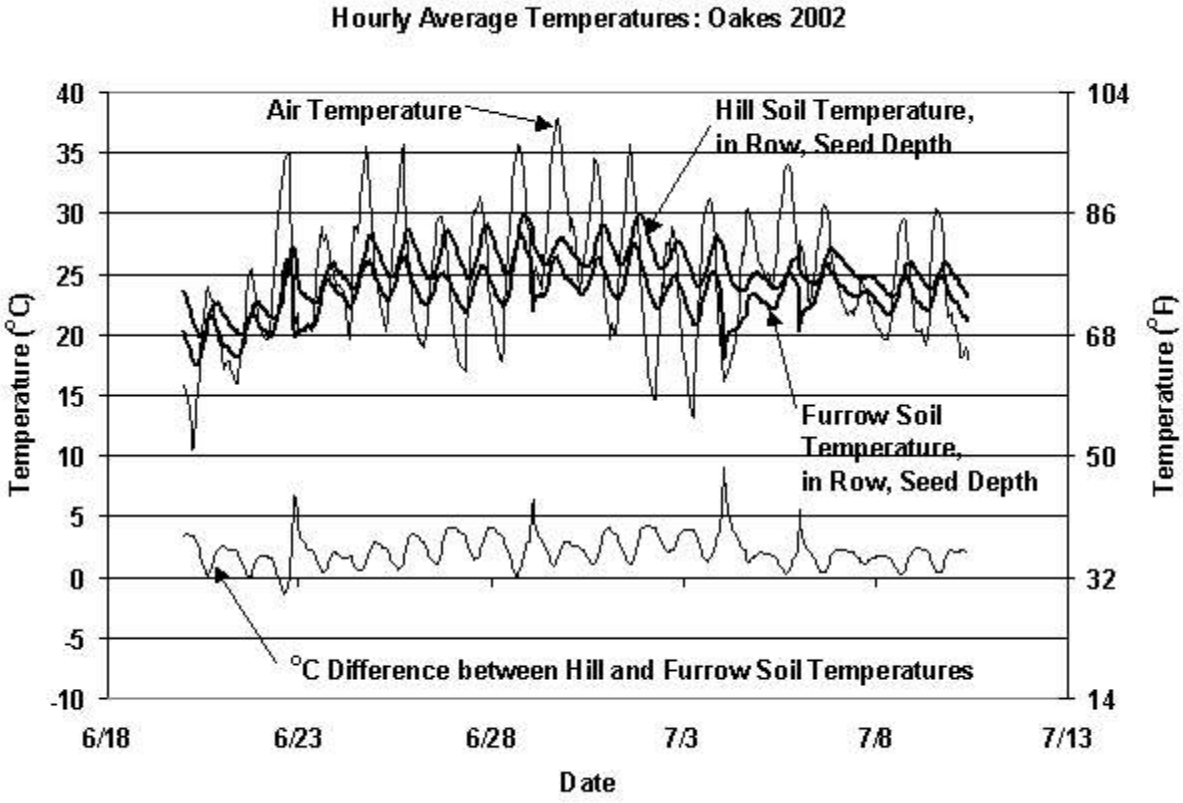

Figure 1. Hourly average air and soil temperatures for the potato planting study during late June and early July 2002 at Oakes, ND.

Control of White Mold in Dry Beans using Topsin and Lactofen

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Two studies were conducted at the NDSU Oakes Irrigation Research Site in the 2002 season. The first study compared the effectiveness of two doses of a new formulation of thiophanate methyl (Topsin) vs. two doses of the current commercial formulation (wettable powder) for control of white mold (Table 59). The second study compared the effectiveness of three doses of the herbicides Cobra and Phoenix as indirect methods for control of white mold (Table 60). Both experiments used a randomized complete block design with four replications. Each experimental plot had four rows 20 feet long planted to cv. 'Buster' at a density of 82,000 seeds per acre. Each row was planted 30 inches apart. Phytotoxicity of the herbicides, white mold incidence, white mold severity and yield were recorded from the two center rows. Weeds were controlled with Basagran, mechanical cultivation, and hand weeding. At flowering time, 250 ml of a 10^4 ascospore suspension was sprayed on the center two rows of each experimental plot. Fungicides were mixed with water buffered at pH 7.0 in Fargo and applied within 2 hours using a CO_2 backpack sprayer. The sprayer was equipped with drop nozzles on a 10 ft boom set up to deliver 37 gal/acre at 35 psi.

Twenty randomly selected plants from each experimental plot were evaluated for white mold incidence and severity on July 26 and Aug 9. Severity was evaluated using a 0 to 5 scale where 0 = 0%, 1 = 5%, 2 = 15%, 3 = 40%, 4 = 65%, and 5 = 85% or more of plant tissues infected. Phytotoxicity was measured as the proportion of canopy reduction of treated plants compared to the untreated plot in each replication. The center two rows of each plot were harvested on Aug 27. Beans were dried in forced air driers at 120 °F for approximately 5 days. Yields were expressed in pounds per acre at 8% moisture content. Statistical analysis was conducted using Proc GLM (SAS package). Probability levels of P=0.05 were used for all evaluations. LSD values were calculated and used for mean comparisons for incidence, severity and yield.

RESULTS

White mold did not develop as aggressively as in previous years despite the ascospore inoculation and the continuous irrigation of experimental plots during and after flowering. Hot weather at flowering time slowed down white mold development. By the first week of August, white mold incidence was at almost one half of what is usually seen in these kinds of trials at Oakes. The new formulation, TD-244701, at both rates was as effective as the commercial bag formulation in controlling white mold. Untreated controls had a final white mold incidence of 33% with a severity of 17%. No differences in yield were detected among treatments (Table 61).

A similar situation was observed in the lactofen study. The low disease pressure observed did not reduce yields significantly in the untreated control compared to plots protected with Topsin 70 WP. Likewise, plants treated with 2 or 3 fl oz of Phoenix had significantly less white mold incidence and severity than the untreated plots but similar yield (Table 62). The application of 1 fl oz of Phoenix/acre resulted in significantly less toxicity compared to other herbicide treatments, but did not result in less white mold or higher yields.

This is the second season of evaluation of lactofen (as Phoenix or Cobra) for control of white mold on dry beans. In both seasons less disease was observed in herbicide-treated plots compared to the untreated controls, but these differences did not translate into higher yields. However, the yield gap between herbicide treated and untreated plots has been reduced from 2001 to 2002. Additional changes and fine tuning is required to optimize the use of lactofen as an alternative option to manage white mold on dry beans. We plan on continuing evaluating lactofen in future field and greenhouse studies.

Table 59. Schedule of applications of two formulations of thiophanate methyl for control of white mold on dry beans.

Treatment	Rate/acre	Schedule
Untreated check		
Topsin 70 WSB	1.5 lb	Single application at 100% bloom
Topsin 70 WSB	1.0 lb	First application at 20-30% bloom, second application 7 days later
TD-2447-01	32.0 oz fl	Single application at 100% bloom
TD-2447-01	21.3 oz fl	First application at 20-30% bloom, second application 7 days later

Table 60. Schedule of applications of two formulations of lactofen for control of white mold on dry beans.

Treatment	Rate/acre	Number of applications	Schedule
Phoenix	1 fl oz	1	pre-bloom
Phoenix	2 fl oz	1	pre-bloom
Phoenix	3 fl oz	1	pre-bloom
Cobra	2 fl oz	1	pre-bloom
Cobra	3 fl oz	1	pre-bloom
Topsin 70 WP	1.5 lb	1	20-30% bloom
Untreated control			

Table 61. Effect of two formulations and two doses of thiophanate methyl on control of white mold on dry beans.

		Incidence[1]		Severity[2]		
Treatment	Rate	7/26	8/5	7/26	8/5	Yield[3]
		%				lbs/acre
Untreated check		10	33	13	17	2933
Topsin 70 WSB	1.5 lb	12	19	9	16	2988
Topsin 70 WSB	1.0 + 1.0 lb	12	24	7	10	2978
TD-2447-01	32 fl oz	2	18	5	14	2881
TD-2447-01	21.3 + 21.3 fl oz	8	21	6	17	2967
LSD (P=0.05)		10	13	2	10	257

[1] Incidence based on number of infected plants divided by total number of observations.
[2] Severity is based on average percentage disease of infected plants.
[3] Yield expressed at 8% moisture content.

Table 62. Effect of different formulations and doses of lactofen on control of white mold on dry beans.

Treatment	Rate	White mold (Aug 5)		Herbicide phytotoxicity		Yield[3]
		Incidence[1]	Severity[2]	8/8	8/15	
		---------- % ----------				lbs/acre
Phoenix	1.0 fl. oz	25.0	5.8	18.8	12.5	2947
Phoenix	2.0 fl. oz	16.3	2.3	25.0	16.3	2833
Phoenix	3.0 fl. oz	18.8	2.3	25.5	22.5	2687
Cobra	2 fl oz.	37.5	7.7	21.3	17.5	2795
Cobra	3 fl oz.	31.3	6.2	22.5	15.0	2875
Topsin 70 WP	1.5 lb	30.0	6.8	0.0	0.0	3005
Untreated control		36.3	8.2	0.0	0.0	2882
LSD (P=0.05)		13.9	5.1	5.4	5.9	396

[1] Incidence based on number of infected plants divided by total number of observations.
[2] Severity is based on average percentage disease of infected plants.
[3] Yield expressed at 8% moisture content.

APPENDIX A

Sources of vegetable seeds

Seed company code	Company name
AT	American Takii
BE	Bejo Seeds
DP	D. Palmer Seed Co.
DVG	Dutch Valley Growers
HS	Harris Seed Co.
JS	Johnny's Selected Seeds
MM	Mesa Maize Inc.
PS	Petoseed Company
RU	Rupp Seeds Inc.
RG	Roger’s
SK	Sakata Seeds
SM	Seminis Seeds
SS	Sun Seeds Inc.
ST	Stokes Seeds Inc.
SW	Seedway Inc.
SWK	SeedWorks
VL	Vilmorin Inc.