
2002
SOUTHERN MINNESOTA
BEET SUGAR COOPERATIVE
RESEARCH REPORT
SMBSC

TABLE OF CONTENTS

Back To Table of Contents

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Back To Table of Contents

2003 SMBSC Beet Seed Orders

Seed Company	%of our market
Betaseed	69.6
Crystal	14.5
Hilleshog	5.3
Holly / VDH	10.6

Seed Size	%of our market
Mini pellets	5.5
Regular pellets	37.0
Jumbo pellets	18.0
Pro 200	35.0
Gemcoat ELS	4.5

Tachigaren	%of our order
45 gram	79.0

Top Ten Varieties These 10 varieties plant 95% of acres

Beta 4811R - Approximately 37% of the acres
Beta 4930R
Beta 3945
VDH 46177R
Crystal R932
Crystal 999
Hilleshog 2411R
Beta 4818R
Crystal 952
Holly 110R

Rhizomania Resistant Seed

82.5% of the seed ordered was rhizomania resistant varieties.

*The above numbers are based on 108,000 acre order placed by the shareholders.

Back To Table of Contents

2002 Coded Variety Trial Procedures

The mission of the Southern Minnesota Beet Sugar Cooperative coded variety trials is to provide for an impartial appraisal of the genetic potential of candidate sugar beet varieties for SMBSC approval and sales under varying environments. Yearly trial data is used to compile a rolling three-year mean of yield and quality components that when subjected to minimum approval criteria, ensures the continual approval of productive varieties that maximize grower and cooperative returns.

The 2002 Southern Minnesota Beet Sugar Cooperative (SMBSC) Official Coded Variety Trials contained entries from six seed companies. Trials were placed across the cooperative growing area to represent typical growing conditions for 2002. Testing was conducted by the SMBSC Research department personnel.

Variety entries were coded at the University of Minnesota or the SMBSC research shop under the direction of Dr. John Lamb of the University of Minnesota. Once coded, the seed was provided to the SMBSC research department for official testing.

Site selection for trials is maintained when possible, with a specific set of shareholder/cooperators with an intention to preserve familiarity with and consistency of trial protocol. A three year rotation to sugar beet minimum (two interceding crops) is required for Official Coded Trial Testing. SMBSC recommends following University of Minnesota recommendations for soil fertility and subsequent soil amendments for coded trial locations. In some, but not all cases, the eventual soil fertility program is left to the discretion of the shareholder/ cooperator. Thus, soil test results of some sites have been obtained from the cooperator and may have been sampled or analyzed differently.

In 2002, the number of trial sites within the SMBSC growing area was reduced from eight to six, (from four rhizomania and four non-rhizomania sites to three rhizomania and three non-rhizomania sites). Due to the rapid expansion of rhizomania in the SMBSC sugar beet growing area and the difficulty in locating non-rhizomania fields, the three non-rhizomania locations eventually proved to be infested with the disease. Future SMBSC coded variety trials will be placed solely on rhizomania infested fields since the last estimate indicates that 85% of SMBSC fields are infested with the disease to some degree.

SMBSC coded variety trial spacing for all tests is set for 4-inch between seed drop with intention to thin to 8-inch spacing between beet centers. All official variety trials are replicated six times. Row spacing is 22 inches. Plot rows for all official variety trials are maintained at 30 feet with intention to harvest 25 to 26 feet of the center two rows of four-row plots except in the case of the biotech trials where the center two rows of six-row plots were harvested. A rectangular lattice plot design was utilized except in the case of the biotech variety performance trial where a randomized complete block design was used. Commercial, semi-commercial, and biotech trials are conducted as separate tests. A tilled area surrounding the Biotech trial was used to form a physical separation from the commercial and semi-commercial trials. Planting was performed with a modified 12-row John Deere 7100 vacuum planter. Emergence counts were obtained from the average of 12-foot sections of the two harvest rows per plot at 28-days after planting. Thinning to final stand occurred immediately following emergence counts (approximately four to six leaf beet stage).

Weed control was obtained through four chemical weed control ground applications conducted by the SMBSC research staff. Chemical weed control measures consisted of the micro-rate with ¼ oz./A rather than 1/8 oz./A Upbeet and Betanex, Betamix, or Progress rates adjusted upward as crop stage and product label allows. Clean up weed control was provided when needed by hand labor.

Experimental units had approximately 2 to 2.5 feet removed with a rototiller in late August to resolve border influence issues. Harvest row lengths were measured prior to harvest for estimation of yield. All beets from both center rows from each experimental unit were used for yield determination. One quality sample was taken from randomly sampled beets from each experimental unit for analysis of sugar and purity. Quality analysis was performed at the SMBSC quality lab at Renville.

Back to Table of Contents

2002 SMBSC Official Trial Location, Planting and Harvest Dates.

Trial #	Trial location	Entry Designation	Cooperator	County	Twnshp/Section	Description	Planting Date	Harvest Date
0256-01	Hector	Commercial	Rich Wehking	Renville	Brookfield / 8	NE4 of NW4	**1-May**	**1-Oct**
0256-11	Hector	Semi-commercial	Rich Wehking	Renville	Brookfield / 8	NE4 of NW4	**1-May**	**1-Oct**
0256-02	Prinsburg	Commercial	Post Bros.	Kandiyohi	Edwards / 21	SE4 of SE4	**7-May**	**19-Sep**
0256-12	Prinsburg	Semi-Commercial	Post Bros.	Kandiyohi	Edwards / 21	SE4 of SE4	**7-May**	**N/A**
0256-03	Gluek	Commercial	L&N Farms	Chippewa	Havelock / 1	SE4 of SE4	**6-May**	**21-Sep**
0256-13	Gluek	Semi-commercial	L&N Farms	Chippewa	Havelock / 1	SE4 of SE4	**6-May**	**20-Sep**
0256-04	Clara City East	Commercial	Bob Schwitters	Chippewa	Rheiderland / 30	NE4 of SE4	**14-May**	**24-Sep**
0256-14	Clara City East	Semi-commercial	Bob Schwitters	Chippewa	Rheiderland / 30	NE4 of SE4	**14-May**	**9/23/2024**
0256-34	Clara City East	Transgenic	Bob Schwitters	Chippewa	Rheiderland / 30	NE4 of SE4	**14-May**	**23-Sep**
0256-05	Lake Lillian	Commercial	Schmoll Bros.	Kandiyohi	E Lake Lillian / 21	SE4 of SW4	**3-May**	**28-Sep**
0256-15	Lake Lillian	Semi-commercial	Schmoll Bros.	Kandiyohi	E Lake Lillian / 21	SE4 of SW4	**3-May**	**28-Sep**
0256-35	Lake Lillian	Transgenic	Schmoll Bros.	Kandiyohi	E Lake Lillian / 21	SE4 of SW4	**3-May**	**27-Sep**
0256-06	Bird Island	Commercial	Rudeen Bros.	Renville	Kingman / 27	SW4 of SE4	**2-May**	**25-Sep**
0256-16	Bird Island	Semi-commercial	Rudeen Bros.	Renville	Kingman / 27	SW4 of SE4	**2-May**	**26-Sep**
0256-36	Bird Island	Transgenic	Rudeen Bros.	Renville	Kingman / 27	SW4 of SE4	**2-May**	**27-Sep**

Back to Table of Contents

Herbicides Applied to 2002 Official Trial Locations

Trial location	PPI/PRE	Post #1	Post #2	Post #3	Post #4	Transgenic Round Up Applic. #1	Transgenic Round Up Applic. #2
Hector	30-Apr	21-May	28-May	5-Jun	12-Jun		
Product	Nortron PPI	Progress	Microrate	Microrate	Microrate		
Prinsburg	30-Apr	24-May	29-May	6-Jun	12-Jun		
Product	Nortron PPI	Betamix	Microrate	Microrate	Microrate		
Gluek	7-May	24-May	29-May	6-Jun	12-Jun		
Product	Nortron PRE	Betamix	Microrate	Microrate	Microrate		
Clara City East	17-May	29-May	6-Jun	12-Jun		12-Jun	28-Jun
Product	Nortron PRE	Microrate	Microrate	Microrate			
Lake Lillian	N/A	21-May	28-May	5-Jun	12-Jun	12-Jun	28-Jun
Product		Betanex	Microrate	Microrate	Microrate		
Bird Island	N/A	21-May	28-May	5-Jun	12-Jun	12-Jun	28-Jun
Product		Progress	Microrate	Microrate	Microrate		

Back to Table of Contents

Fungicides Applied to 2002 Official Trials

	Cercospora Leafspot Fungicides			
Trial location	**Fung #1**	**Fung #2**	**Fung #3**	**Fung #4**
Hector	15-Jul	29-Jul	13-Aug	27-Aug
Product	Eminent	Agritin	Eminent	Agritin
Rate	13 oz	5 oz	13 oz	5 oz
Prinsburg	16-Jul	30-Jul	14-Aug	28-Aug
Product	Eminent	Agritin	Eminent	Agritin
Rate	13 oz	5 oz	13 oz	5 oz
Gluek	16-Jul	30-Jul	14-Aug	28-Aug
Product	Eminent	Agritin	Eminent	Agritin
Rate	13 oz	5 oz	13 oz	5 oz
Clara City East	16-Jul	30-Jul	14-Aug	28-Aug
Product	Eminent	Agritin	Eminent	Agritin
Rate	13 oz	5 oz	13 oz	5 oz
Lake Lillian	15-Jul	29-Jul	13-Aug	27-Aug
Product	Eminent	Agritin	Eminent	Agritin
Rate	13 oz	5 oz	13 oz	5 oz
Bird Island	15-Jul	29-Jul	14-Aug	27-Aug
Product	Eminent	Agritin	Eminent	Agritin
Rate	13 oz	5 oz	13 oz	5 oz

Back to Table of Contents

Table 1. Mean of Three Year Performance of 2003 SMBSC Approved Varieties, 2000 - 2002*

VIRAL DISEASED TRIAL DATA

Entry	Rec/T (lbs)		Rec/A (lbs)		Loss to Mol.		Yield (T/A)		Sugar %		CLS**		Emergence (%)		Aphanomyces RRI**	
	3 yr avg	*% of Mean*	*3 yr avg*	*% of Mean*	*3 yr avg*	*% of Mean*	*3 yr avg*	*% of Mean*	*3 yr avg*	*% of Mean*	*3 yr avg*	*% of Mean*	*3 yr avg*	*% of Mean*	*3 yr avg*	*% of Mean*
Hilleshog 2411Rz (711	296.19	102.21	7076.83	96.05	1.16	98.10	23.99	94.06	15.98	101.92	4.56	99.08			5.46	108.46
Van der Have H46177	296.00	102.15	7090.69	96.24	1.17	98.38	24.03	94.23	15.97	101.85	4.34	94.45	58.17	96.85	4.66	92.51
Beta 4818R (M813)	290.59	100.28	7276.55	98.76	1.19	100.07	25.11	98.47	15.72	100.26	4.74	103.00			4.72	93.77
Beta 4901R (BM0901)	289.20	99.80	7790.30	105.73	1.19	100.07	27.14	106.43	15.65	99.81	4.67	101.55		0.00		0.00
Beta 4600R	288.05	99.40	7144.48	96.97	1.19	100.35	24.82	97.32	15.60	99.49	4.83	104.96	62.00	103.22	4.78	94.83
Hilleshog 2408Rz (71(	287.13	99.08	7428.57	100.82	1.19	100.63	25.86	101.40	15.56	99.26	4.67	101.62			6.39	126.86
Beta 4930R	286.25	98.78	7740.16	105.05	1.20	100.91	27.06	106.11	15.51	98.96	4.31	93.65	60.02	99.93	4.64	92.18
Crystal R932	284.81	98.29	7395.27	100.37	1.20	101.48	26.01	101.98	15.43	98.45	4.68	101.69			4.60	91.39
Mean	**289.78**	**100.00**	**7367.85**	**100.00**	**1.19**	**100.00**	**25.50**	**100.00**	**15.68**	**100.00**	**4.60**	**100.00**	**60.06**	**100.00**	**5.04**	**100.00**

VARIETIES ALLOWED ONE YEAR OF FURTHER SALES

Van der Have H46140	287.91	99.36	6356.77	86.28	1.19	100.35	22.20	87.06	15.59	99.45	4.08	88.72	64.64	107.63	4.52	89.73
Beta 3945	287.44	99.19	6245.36	84.77	1.19	100.63	21.71	85.12	15.57	99.32	4.59	99.74	62.00	103.22	5.20	103.17
Beta 6904	281.95	97.30	5621.26	76.29	1.21	102.32	20.01	78.48	15.31	97.64	4.80	104.38	62.89	104.71	4.97	98.73
Beta 3820	278.89	96.24	6375.54	86.53	1.22	103.16	22.83	89.54	15.17	96.75	4.45	96.69	57.59	95.88	5.01	99.39
Crystal 952	278.46	96.09	6308.41	85.62	1.22	103.16	22.75	89.20	15.15	96.64	4.57	99.37	62.87	104.67	4.63	91.92
Hilleshog 7073Rz	278.18	96.00	6738.16	91.45	1.22	102.88	24.31	95.33	15.13	96.52	4.59	99.81	65.25	108.64	5.11	101.45
Van der Have H46109	275.26	94.99	5943.55	80.67	1.23	104.01	21.89	85.85	15.00	95.69	3.79	82.49	64.82	107.92	4.34	86.16
Crystal 999	275.03	94.91	6558.25	89.01	1.24	104.57	23.88	93.64	14.99	95.60	4.64	100.90	61.25	101.97	4.83	95.82
Hilleshog RH5	263.93	91.08	5352.88	72.65	1.27	107.10	20.51	80.43	14.47	92.31	3.52	76.54	65.05	108.30	4.96	98.47

SPECIALTY VARIETIES

Specialty

Beta 4811I APH & RZI	279.73	96.53	8015.31	108.79	1.22	102.88	28.59	112.10	15.20	96.98	4.60	99.95	60.57	100.84	4.23	83.98

* Varieties are ranked by Recoverable Sucrose per Ton (Rec/T (lbs)).
** Lower numbers indicate better Cercospora and Aphanomyces resistance.

Back to Table of Contents

Table 2. Mean of Two Year Performance of 2003 SMBSC Approved Varieties, 2001 - 2002*

VIRAL DISEASED TRIAL

Entry		Rec/T (lbs) 2 yr avg	Rec/T (lbs) % of Mean	Rec/A (lbs) 2 yr avg	Rec/A (lbs) % of Mean	Loss to Mol. 2 yr avg	Loss to Mol. % of Mean	Yield (T/A) 2 yr avg	Yield (T/A) % of Mean	Sugar % 2 yr avg	Sugar % % of Mean	CLS** 2 yr avg	CLS** % of Mean	Emergence (%) 2 yr avg	Emergence (%) % of Mean
Van der Have H46177R		281.59	102.25	6888.37	99.54	1.22	98.33	24.44	97.07	15.30	101.92	4.39	93.61	64.65	96.26
Hilleshog 2411Rz (7111)		279.85	101.62	6570.25	94.94	1.22	98.74	23.58	93.64	15.22	101.39	4.65	99.27		
Beta 4600R		276.73	100.48	6631.14	95.82	1.23	99.54	24.03	95.44	15.07	100.42	4.85	103.43	69.87	104.03
Beta 4901R (BM0901)		276.62	100.44	7441.51	107.53	1.23	99.54	27.08	107.54	15.06	100.36	4.62	98.52		
Beta 4930R		275.24	99.94	7165.18	103.54	1.24	99.95	26.05	103.45	15.00	99.96	4.53	96.70	66.97	99.71
Beta 4818R (M813)		273.88	99.45	6843.72	98.89	1.25	100.76	24.99	99.26	14.94	99.56	4.76	101.61		
Crystal R932		269.81	97.97	7013.10	101.34	1.26	101.57	25.98	103.17	14.73	98.16	4.87	103.86		
Hilleshog 2408Rz (7108)		269.48	97.85	6808.87	98.39	1.26	101.57	25.29	100.43	14.74	98.23	4.83	103.00		
		275.40	**100.00**	**6920.26**	**100.00**	**1.24**	**100.00**	**25.18**	**100.00**	**15.01**	**100.00**	**4.68**	**100.00**	**67.16**	**100.00**

VARIETIES ALLOWED ONE YEAR FURTHER SALES

Beta 3945		275.41	100.00	6043.09	87.32	1.24	99.95	21.78	86.49	15.01	100.02	4.65	99.16	71.06	105.80
Van der Have H46140		271.52	98.59	5876.40	84.92	1.25	100.76	21.69	86.15	14.83	98.79	3.99	85.07	73.15	108.91
Beta 6904		270.07	98.06	5609.94	81.07	1.26	101.57	20.70	82.20	14.76	98.33	4.86	103.75	71.82	106.93
Crystal 952		269.71	97.93	6231.60	90.05	1.26	101.57	23.04	91.51	14.75	98.26	4.67	99.69	73.47	109.38
Hilleshog 7073Rz		268.45	97.48	6308.71	91.16	1.26	101.97	23.55	93.54	14.68	97.83	4.63	98.84	73.33	109.18
Crystal 999		267.95	97.30	6367.31	92.01	1.27	102.38	23.76	94.35	14.66	97.66	4.67	99.59	70.00	104.22
Van der Have H46109		267.55	97.15	5818.85	84.08	1.26	101.97	21.87	86.85	14.64	97.56	3.86	82.29	74.52	110.95
Beta 3820		266.12	96.63	6114.30	88.35	1.27	102.78	22.84	90.72	14.58	97.13	4.47	95.42	65.52	97.55
Hilleshog RH5		258.92	94.02	5470.47	79.05	1.29	104.40	21.33	84.72	14.24	94.89	3.66	78.13	72.51	107.96

SPECIALTY VARIETIES

	Specialty														
Holly 110R (01HX045)	APH & RZM	284.82	103.42	6631.47	95.83	1.21	97.52	23.32	92.60	15.45	102.92	4.32	92.11		
Beta 4811R	APH & RZM	264.12	95.91	7194.58	103.96	1.28	103.19	27.26	108.27	14.48	96.49	4.92	104.92	69.17	102.99

TEST MARKET VARIETIES

Crystal R826	RZM & APH	280.50	101.85	6544.68	94.57	1.22	98.33	23.44	93.08	15.24	101.52	4.94	105.46		
Hilleshog 2445Rz (7145)	RZM Specialty	278.35	101.07	6646.18	96.04	1.23	99.14	23.95	95.11	15.18	101.12	4.15	88.59		

* Varieties are ranked by Recoverabe Sucrose per Ton (Rec/T (lbs)).

Back to Table of Contents

Table 3. Mean of One Year Performance of 2003 SMBSC Approved Varieties, 2002*

VIRAL DISEASED TRIAL DATA

Entry		Rec/T (lbs) 2002	Rec/T (lbs) % of Mean	Rec/A (lbs) 2002	Rec/A (lbs) % of Mean	Loss to Mol. 2002	Loss to Mol. % of Mean	Yield (T/A) 2002	Yield (T/A) % of Mean	Sugar % 2002	Sugar % % of Mean	CLS** 2002	CLS** % of Mean	Emergence (%) 2002	Emergence (%) % of Mean	Aphanomyces RRI** 2002	Aphanomyces RRI** % of Mean
Hilleshog 2411Rz (7111)		295.36	103.00	7390.20	99.42	1.16	97.38	25.37	97.22	15.94	102.62	4.59	99.70			5.12	103.12
Beta 4600R		292.44	101.98	7154.25	96.24	1.17	98.22	24.62	94.34	15.80	101.72	4.76	103.39	71.21	101.51	5.13	103.32
Van der Have H46177R		290.57	101.33	7290.03	98.07	1.18	99.06	25.20	96.57	15.71	101.14	4.13	89.71	59.45	84.74	4.88	98.29
Beta 4930R		287.07	100.11	7632.40	102.68	1.19	99.90	26.69	102.28	15.55	100.11	4.20	91.23	73.56	104.86	4.63	93.25
Beta 4901R (BM0901)		286.97	100.08	7584.56	102.03	1.19	99.90	26.68	102.24	15.54	100.05	4.52	98.18			4.47	90.03
Crystal R932		281.49	98.17	7644.63	102.84	1.21	101.57	27.20	104.23	15.28	98.37	5.06	109.91	73.50	104.77	4.18	84.19
Hilleshog 2408Rz (7108)		281.14	98.04	7369.88	99.15	1.21	101.57	26.33	100.90	15.27	98.31	4.87	105.78			6.57	132.33
Beta 4818R (M813)		278.97	97.29	7401.49	99.57	1.22	102.41	26.68	102.24	15.17	97.67	4.70	102.09	73.04	104.12	4.74	95.47
Mean		**286.75**	**100.00**	**7433.43**	**100.00**	**1.19**	**100.00**	**26.10**	**100.00**	**15.53**	**100.00**	**4.60**	**100.00**	**70.15**	**100.00**	**4.97**	**100.00**

VARIETIES ALLOWED ONE YEAR FURTHER SALES

Entry		Rec/T (lbs) 2002	Rec/T (lbs) % of Mean	Rec/A (lbs) 2002	Rec/A (lbs) % of Mean	Loss to Mol. 2002	Loss to Mol. % of Mean	Yield (T/A) 2002	Yield (T/A) % of Mean	Sugar % 2002	Sugar % % of Mean	CLS** 2002	CLS** % of Mean	Emergence (%) 2002	Emergence (%) % of Mean	Aphanomyces RRI** 2002	Aphanomyces RRI** % of Mean
Beta 3945		284.52	99.22	6608.28	88.90	1.20	100.73	23.05	88.33	15.43	99.34	4.79	104.05	70.42	100.38	4.99	100.50
Hilleshog 7073Rz		277.75	96.86	6706.55	90.22	1.22	102.41	24.29	93.08	15.11	97.28	4.83	104.91	79.53	113.37	4.83	97.28
Beta 6904		275.83	96.19	6053.45	81.44	1.23	103.25	21.90	83.92	15.02	96.70	4.90	106.43	72.34	103.12	4.82	97.08
Van der Have H46109		275.21	95.98	6239.44	83.94	1.23	103.25	22.97	88.02	14.99	96.51	3.82	82.98	79.24	112.95	3.62	72.91
Crystal 952		274.17	95.61	6475.03	87.11	1.24	104.09	23.53	90.17	14.95	96.25	4.74	102.96	76.04	108.39	4.19	84.39
Van der Have H46140		274.05	95.57	6041.27	81.27	1.23	103.25	22.04	84.46	14.94	96.19	3.91	84.93	74.00	105.49	4.29	86.40
Beta 3820		271.79	94.78	6719.31	90.39	1.25	104.93	24.74	94.80	14.84	95.54	4.42	96.01	71.68	102.18	4.82	97.08
Crystal 999		271.13	94.55	6564.40	88.31	1.25	104.93	24.27	93.00	14.80	95.28	4.78	103.83	73.71	105.07	4.91	98.89
Hilleshog RH5		260.92	90.99	5519.51	74.25	1.28	107.45	21.46	82.23	14.33	92.26	3.40	73.85	77.19	110.03	4.61	92.85

SPECIALTY VARIETIES

Entry	Specialty	Rec/T (lbs) 2002	Rec/T (lbs) % of Mean	Rec/A (lbs) 2002	Rec/A (lbs) % of Mean	Loss to Mol. 2002	Loss to Mol. % of Mean	Yield (T/A) 2002	Yield (T/A) % of Mean	Sugar % 2002	Sugar % % of Mean	CLS** 2002	CLS** % of Mean	Emergence (%) 2002	Emergence (%) % of Mean	Aphanomyces RRI** 2002	Aphanomyces RRI** % of Mean
Holly 110R	APH & RZM	292.52	102.01	7017.44	94.40	1.17	98.22	24.16	92.58	15.79	101.66	4.29	93.18			3.96	79.76
Beta 4811R	APH & RZM	271.08	94.53	7706.61	103.68	1.25	104.93	28.47	109.10	14.80	95.28	4.72	102.53	71.75	102.28	4.49	90.43

TEST MARKET VARIETIES

Entry		Rec/T (lbs) 2002	Rec/T (lbs) % of Mean	Rec/A (lbs) 2002	Rec/A (lbs) % of Mean	Loss to Mol. 2002	Loss to Mol. % of Mean	Yield (T/A) 2002	Yield (T/A) % of Mean	Sugar % 2002	Sugar % % of Mean	CLS** 2002	CLS** % of Mean	Emergence (%) 2002	Emergence (%) % of Mean	Aphanomyces RRI** 2002	Aphanomyces RRI** % of Mean
Crystal R826	RZM & APH	295.11	102.91	6917.49	93.06	1.16	97.38	23.69	90.78	15.92	102.49	4.95	107.52			4.53	91.24
Hilleshog 2445Rz (7145)	RZM Specialty	289.69	101.02	7013.03	94.34	1.18	99.06	24.34	93.27	15.66	100.82	4.30	93.40			4.67	94.06

Back To Table of Contents

Overview of the Viral Diseased Official Coded Variety Trials

- Although root yield has become more consistent with the availability and use of rhizomania-type varieties, sugar content appears to have become more difficult to obtain. Continued use of rhizomania-type varieties will warrant critical review of current nitrogen fertility management strategies.

- Variety approval for 2003 and into the future will be based on the 3-year variety performance in viral diseased trials. A recent Agricultural Staff estimate indicates that over 80% of the cooperative growing area is influenced by rhizomania to some degree.

- SMBSC has conducted virally diseased Official Coded Variety Trials since 2000. Observation of rhizomania tolerant varieties in the presence of the disease has consistently indicated that there are inherent varietal differences in the expression of the rhizomania tolerance gene.

- Recognition of disease tolerance differences among rhizomania-type varieties has prompted SMBSC to categorize the rhizomania-type varieties into levels of resistance based upon their performance in the viral diseased trials. Category I varieties have the highest viral disease tolerance, Category II diploids have the next highest disease tolerance, and Category II triploids have the lowest level of tolerance among the varieties containing the rhizomania gene.

- Generally, of the currently available varieties, the higher the category of resistance the more difficulty obtaining high sugar content

- Based upon SMBSC coded variety trial data, misplacement of a conventional susceptible variety into a field containing rhizomania will cost a shareholder between $150 to $250 per acre (depending upon disease severity), in lost potential revenue.

- In the presence of rhizomania, there exists the potential gain or loss of $50 per acre through correct placement of a variety resistance category to the expected disease severity of a field.

- Within rhizomania tolerance categories, there lies a wide array of aphanomyces tolerance levels. In 2002, there were several instances where the appropriate rhizomania variety was chosen but it did not have adequate aphanomyces tolerance. Be sure to make note of varietal aphanomyces ratings.

- To assist with identification of potential disease severity in a field and to facilitate matching to a specific tolerance category, SMBSC has developed a rhizomania variety selector program that can be accessed at the SMBSC website under the Agronomy heading. This program provides a useful tool to estimate likely rhizomania severity on a field by field basis through answering a series of questions. In addition, it takes into account your estimation of aphanomyces history in the field to select a set of varieties that limits your risk and maximizes potential. The program was designed by examining variety misplacements in real field situations and using coded variety and strip trial data to back into a correct variety placement.

Influence of row spacing and population on rhizomania resistant variety performance.

Objective:

Evaluate the yield and quality performance of a rhizomania type diploid variety in 11-inch row spacing and 12-inch plant spacing (47520 plants per acre) when compared to the standard 22-inch row spacing and 8-inch plant spacing (35640 plants per acre).

Experiment Procedure:

The experimental design was a randomized complete block with sub-samples making the experimental units. Samples were taken from within treatment blocks. The experiment consisted of three replications and twelve sub-samples per replication. The trials were located in the front of existing coded variety trial plots. The Gluek location was planted on May 6 and the Prinsburg location was planted on May 7. The variety planted was Beta 4811R in both locations. The 11-inch row blocks were achieved by planting with a standard 12-row small plot planter with 22-inch rows and then planting back through the plot area with the drive tractor wheels moved over one-half row. This effectively produced twenty-four 11-inch rows with two being driven on. Plots were thinned approximately 30 days after planting. The target plant spacing was eight inches in the 22-inch rows and twelve inches in the 11-inch rows. Plot sub-samples were hand harvested on September 7th at the Gluek location and on September 13th at the Prinsburg location. The individual and combined population, spacing, root yield, sucrose, sucrose purity, and Brei N data can be found in Tables 1 through 3.

Table 1. Root yield, sugar yield, and root quality for sugar beet grown in different row spacings (plant populations) at Prinsburg.

Plant Population	Row Spacing	Plant Spacing	Root Yield	Sugar Content	Rec. Suc. per Ton	Rec. Suc. per Acre	Purity	Brei N
plants/acre	- - - - - - - - in	- - - - - - - -	ton/acre	%	lbs.	lbs.	%	ppm
26540	22	10.75	20.87	13.16	236.03	4945.50	82.92	29.74
45740	11	12.47	20.03	13.30	239.03	4797.90	80.46	33.33
	LSD (0.05)		NS	NS	NS	NS	NS	NS

Table 2. Root yield, sugar yield, and root quality for sugar beet grown in different row spacings (plant populations) at Gluek.

Plant Population	Row Spacing	Plant Spacing	Root Yield	Sugar Content	Rec. Suc. per Ton	Rec. Suc. per Acre	Purity	Brei N
plants/acre	- - - - - - - - in	- - - - - - - -	ton/acre	%	lbs.	lbs.	%	ppm
32598	22	8.75	22.12	14.50	264.45	5873.59	83.48	45.44
45809	11	12.45	24.10	14.88	272.48	6550.88	84.97	33.33
	LSD (0.05)		NS	0.359	7.71	NS	NS	11.1

Table 3. Root yield, sugar yield, and root quality for sugar beet grown in different row spacings (plant populations) combined across locations.

Plant Population	Row Spacing	Plant Spacing	Root Yield	Sugar Content	Rec. Suc. per Ton	Rec. Suc. per Acre	Purity	Brei N
plants/acre	- - - - - - - - in	- - - - - - - -	ton/acre	%	lbs.	lbs.	%	ppm
29914	22	9.50	21.49	13.83	250.24	5409.50	83.20	37.59
45952	11	12.41	22.07	14.09	255.76	5674.40	82.72	33.32
	LSD (0.05)		NS	NS	NS	NS	NS	NS

Summary:

- The eventual plant spacing was wider than the target spacing in both treatments at both locations. This may indicate that estimations of spacing in the field tend to be underestimated due to beet leaf span or that further plant death occurs after the 4 to 6-leaf stage when thinning was done.

- Sugar content and recoverable sucrose per ton differences were significant in favor of 11-inch rows at the Gluek site only, but were not significant at the Prinsburg site or in the combined data.

- Differences in root yield, recoverable sucrose per acre, purity, and Brei N between 22-inch rows and 11-inch rows were non significant at both locations and in the combined analysis.

- Industry research out of Oregon State University supports the above data which suggests that differences between 8-inch plant spacing in 22-inch rows and 12-inch plant spacing in 11-inch rows is non significant in relation to root yield but can be significant in relation to sucrose content in the favor of 11-inch rows. SMBSC data indicate a fairly consistent 0.3% sucrose advantage to 11-inch rows which is also consistent with the Oregon State University data.

- This research did not take into account spacing options other than those indicated. Thus, this data should not discount the possible advantage to narrower row spacing and higher plant populations on yield or especially sucrose content under different plant spacings.

Back To Table of Contents

Tachigaren influence over time on Aphanomyces cochlioides presence in soil and the effect on sugar beet yield and sugar production

Objective:

1. Study the influence of Aphanomyces cochlioides inoculum over time (proposed 3+ years) in soil subjected to consecutive sugar beet production with 3 different levels of Tachigaren.
2. Investigate the influence of Tachigaren at 0, 45, and 75 grams per unit of seed (100,000 seeds) on yield and quality differences in soil subjected to consecutive years (3+) of sugar beet production.

Experimental procedure:

The experiment was established in the spring of 2000 to determine the influence of Tachigaren on the presence of Aphanomyces cochlioides and sugar beet yield. Experimental design was a randomized complete block design with 4 replications. Experimental units were 44 ft wide and 30 ft long, with sugar beets planted in 22-inch wide rows at 4-inch spacing. Soil barriers (silt fence) were installed after planting, removed prior to harvest, and reinstalled after harvest to prevent movement of soil across experimental units. Treatments of 0, 45, and 75 grams of Tachigaren 70WP per unit (100,00 seed) were applied to seed pelleted to a regular size (9.5-11.5/64 Diam.). Herbicides were applied with small plot equipment to avoid disruption of soil barriers (fence) and fungicides for cercospora leaf spot control were applied with aerial application.

Results and Discussion

Site data will be presented with the designation of 0050 being Buffalo Lake location and 0051 being Clara City location.

Root Rot Index

Presence of Aphanomyces cochlioides in the soil tested was indexed by the plant disease clinic at the University of Minnesota – Crookston (Table 1). The initial disease index for Aphanomyces cochlioides indicated very low levels or no presence of the fungal disease in the soils tested at both locations. Soil index values after one year of sugar beet production increased to high levels at the Buffalo Lake, MN location and remained low at the Clara City, MN site in the presence or absence of Tachigaren on the seed. The root rot index for Aphanomyces (RRI), although non-significant statistically, showed higher levels at the lower rates of Tachigaren regardless of the time after the initiation of testing. Sugar beets with no Tachigaren at the Buffalo Lake site gave a RRI of 12.37 % and 4.20% higher than seed treated at the 75 and 45-gram rate, respectively in the fall of 2000. However when averaged over all testing times, sugar beets with no Tachigaren at the Buffalo Lake site gave a RRI of 29.91 % and17.99% higher than seed treated at the 75and 45-gram rate, respectively.

The RRI at the Buffalo Lake site (Table 1.) indicated the influence of Tachigaren use over time on the presence of Aphanomyces in the soil. RRI decreased over time with the decrease being directly related to the rate of Tachigaren. The very low level of Aphanomyces cochlioides at Gluek site did not allow for a significant change in the presence of the disease at this site.

At the time of this write up the data for the Fall 2002 (end of experiment) RRI have not been completed. These data will be reported when completed.

Yield
Yield factors as influenced by Tachigaren treatments were non-homogeneous between years, but were homogeneous between locations within years. Therefore, the yield data is presented as separate locations by year (Tables 2-7) and also as combined data between locations within years (table 8-10).

Yield Summary

1. In 2000 sugar beet yield was higher at 45 and 75 gram rate than with 0 gram Tachigaren applied to the seed.
2. Recoverable sugar per acre in 2000 was higher at the 45 and 75 gram rate compared to the 0 gram of Tachigaren rate at the 0050 (Buffalo Lake) site. There were no statistical differences between treatments at the 0051 (Clara City) site.
3. Yield and recoverable sugar per acre were higher at location 0050 (Buffalo Lake) and 0051 (Clara City) in 2001 and 2002 for the 45 and 75 gram rate compared to the 0 gram rate applied to the seed.
4. The yield and recoverable sugar per acre advantage with the use of Tachigaren was similar at a low RRI site (0051-Clara City) when compared to a high RRI site (0050-Buffalo Lake).
5. When considering the sites combined within years (tables 8-10), yield and recoverable sugar per acre was significantly higher with Tachigaren applied at the 45 and 75 gram rate compared to 0 gram Tachigaren applied to the seed.

Table 1. Soil indices after Tachigaren treatments, 0050 and 0051 locations.

		Root Rot Index									
	Tachigaren Rate	Fall 2000		Spring 2001		Fall 2001		Spring 2002		average	
Key #	Treatment	0050	0051	0050	0051	0050	0051	0050	0051	0050	0051
1	0 Tachigaren	94.82	4.00	99.50	0	89.75	0.75	94.75	1.50	94.71	1.50
2	45 Tachigaren	90.62	1.48	60.50	0	70.00	1.00	85.75	4.00	76.72	1.62
3	75 Tachigaren	82.45	1.25	44.00	0	57.75	2.25	75.00	1.25	64.80	1.18
Mean		**89.30**	**2.24**	**68.00**	**0**	**72.50**	**1.33**	**85.17**	**2.25**	**78.74**	**1.43**
LSD (0.05)		**NS**	**NS**	**42.94**	**NS**	**NS**	**NS**	**NS**	**NS**	**17.41**	**NS**

Table 2. Tachigaren Influence on Aphanomyces Presence as indicated by yield data, 2000 0051 location (Clara City/Maynard MN area)

Key #	Treatment	Ton/Acre	Sugar %	LTM	RST	RSA
1	0 Tachigaren	21.53	17.42	1.05	327	7048
2	45 Tachigaren	22.54	17.37	1.06	326	7350
3	75 Tachigaren	22.97	17.54	1.05	330	7576
Mean		**22.35**	**17.44**	**1.05**	**328**	**7325**
LSD (0.05)		**1.17**	**NS**	**NS**	**NS**	**NS**

Table 3. Tachigaren Influence on Aphanomyces Presence as indicated by yield data, 2000 0050 location (Buffalo Lake, MN)

Key #	**Treatment**	**Ton/Acre**	**Sugar %**	**LTM**	**RST**	**RSA**
1	0 Tachigaren	19.66	17.96	1.02	339	6664
2	45 Tachigaren	21.55	18.03	1.02	340	7332
3	75 Tachigaren	21.65	18.12	1.02	342	7339
Mean		**20.95**	**18.04**	**1.02**	**340**	**7112**
LSD (0.05)		**0.77**	**NS**	**NS**	**NS**	**377**

Table 4. Tachigaren Influence on Aphanomyces Presence as indicated by yield data, 2001 0051 location (Clara City/Maynard MN Area)

Key #	**Treatment**	**TONS**	**SUCROSE**	**LTM**	**RST**	**RSA**
1	0 Tachigaren	16.91	15.69	1.18	290	4905
2	45 Tachigaren	20.87	16.22	1.14	302	6296
3	75 Tachigaren	19.45	16.16	1.14	300	5843
Mean		**19.08**	**16.03**	**1.16**	**297**	**5681**
LSD		**0.55**	**0.33**	**0.03**	**7**	**205**

Table 5. Tachigaren influence on Aphanomyces presence as indicated by yield data, 2001 0050 location (Buffalo Lake, MN area)

Key #	**Treatment**	**Tons**	**SUCROSE**	**LTM**	**RST**	**RSA**
1	0 Tachigaren	14.87	13.70	1.33	247	3680
2	45 Tachigaren	18.11	13.83	1.32	250	4532
3	75 Tachigaren	17.18	14.17	1.30	257	4419
Mean		**16.72**	**13.90**	**1.32**	**252**	**4210**
LSD		**1.65**	**0.34**	**0.02**	**7**	**291**

Table 6. Tachigaren Influence on Aphanomyces Presence as indicated by yield data, 2002 0051 location (Clara City/Maynard MN Area)

Key #	Treatment	TONS	SUCROSE	LTM	RST	RSA
1	0 Tachigaren	15.95	16.65	1.11	311	4943
2	45 Tachigaren	21.07	16.63	1.11	310	6470
3	75 Tachigaren	20.80	17.25	1.05	324	6728
Mean		**19.27**	**16.84**	**1.09**	**315**	**6047**
LSD		**2.26**	**.63**	**0.06**	**16.40**	**633**

Table 7. Tachigaren influence on Aphanomyces presence as indicated by yield data, 2002 0050 location (Buffalo Lake, MN area)

Key #	Treatment	Tons	SUCROSE	LTM	RST	RSA
1	0 Tachigaren	16.59	13.92	1.32	252	4176
2	45 Tachigaren	19.95	14.03	1.31	254	5065
3	75 Tachigaren	18.93	14.11	1.31	256	4852
Mean		**18.93**	**14.02**	**1.31**	**254**	**4698**
LSD		**2.28**	**NS**	**NS**	**NS**	**578**

Table 8 . Tachigaren influence on Aphanomyces presence as indicated by yield data 0050 and 0051 sites data combined, 2000

Key #	Treatment	Tons	SUCROSE	LTM	RST	RSA
1	0 Tachigaren	20.60	17.69	1.04	333	6856
2	45 Tachigaren	22.04	17.70	1.04	333	7341
3	75 Tachigaren	22.31	17.83	1.03	336	7457
Mean		**21.65**	**17.74**	**1.04**	**334**	**7218**
LSD		**1.23**	**NS**	**NS**	**NS**	**394**

Table 9. Tachigaren influence on Aphanomyces presence as indicated by yield data,0050 and 0051 sites data combined, 2001

Key #	Treatment	Tons	SUCROSE	LTM	RST	RSA
1	0 Tachigaren	15.89	14.69	1.25	269	4292
2	45 Tachigaren	19.49	15.02	1.23	276	5414
3	75 Tachigaren	18.31	15.17	1.22	279	5131
Mean		**17.90**	**14.96**	**1.24**	**275**	**4946**
LSD		**1.31**	**NS**	**NS**	**NS**	**867**

Table 10. Tachigaren influence on Aphanomyces presence as indicated by yield data,0050 and 0051 sites data combined, 2002

Key #	Treatment	Tons	SUCROSE	LTM	RST	RSA
1	0 Tachigaren	16.27	15.28	1.21	281	4560
2	45 Tachigaren	20.51	15.33	1.21	282	5768
3	75 Tachigaren	19.86	15.68	1.18	290	5790
Mean		**18.88**	**15.43**	**1.20**	**284**	**5383**
LSD		**2.91**	**NS**	**NS**	**NS**	**967**

CERCOSPORA LEAF SPOT CONTROL IN EASTERN NORTH DAKOTA AND MINNESOTA IN 2002

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Cercospora leaf spot, caused by the fungus *Cercospora beticola* Sacc. is the most serious leaf disease of sugarbeet (*Beta vulgaris* L.) in the production areas of North Dakota and Minnesota. This disease may cause reductions in tonnage and sucrose, and increase impurities. Losses as high as 30 percent in recoverable sucrose are fairly common under moderate disease conditions. Roots of diseased plants do not store in piles as well as roots of healthy plants. Limited tolerance to the triphenyl tin hydroxide (TPTH) fungicides was identified in the southern Red River Valley and southern Minnesota in 1994. This tolerance has increased in incidence and severity in the Red River Valley and southern Minnesota. Benzimidazole resistance is present in all production areas of North Dakota and Minnesota.

OBJECTIVES:

The research objectives of these trials were to evaluate the efficacy of labeled and experimental fungicides at controlling Cercospora leaf spot. These fungicides were applied alone, in tank mixes, or alternated at various application intervals not only to evaluate control, but also to evaluate management strategies to prevent or slowdown the buildup of tolerance or resistance to the fungicides. All 2002 test sites had known TPTH tolerance and benzimidazole resistance.

PROCEDURES:

Research was conducted at Crookston, Breckenridge, and Willmar, Minnesota. The cultural practices and application dates for each location are in **Table 1**. At all locations, plots were 11 feet wide (6-22 inches rows) and 35 feet long. The middle four rows received the fungicide applications. The middle two rows of each plot were harvested for yield and quality determinations. The Breckenridge and Crookston analysis were completed at the American Crystal Sugar Company Quality Tare Laboratory, East Grand Forks, MN. Southern Minnesota samples were analyzed at the Southern Minnesota Beet Sugar Cooperative Laboratory, Renville, MN. The experiments were all arranged in a randomized complete block design with four replications. Cercospora leaf spot severity was rated on the KWS scale of 1 to 9. One indicates there was no disease, a rating of 3 indicates the early stages of economic loss level, and a rating of 9 indicates that the plants assessed had only new leaf growth, all earlier leaves being dead, and severe economic loss.

All sites were planted in April-May but there was a prolonged cold spring. Crookston and Willmar sites were inoculated with Cercospora beticola inoculum provided by Art Quinn, Betaseed, Shakopee. At Crookston and Willmar, disease severity was moderate to high, and at Breckenridge disease severity was low.
The fungicides tested in 2002 are listed in **Table 2**. The application interval for each treatment at each site is indicated in the tables for the respective sites.

RESULTS AND DISCUSSION:

The effect of the treatments for Cercospora leaf spot control for the test sites are shown in Tables 3, 4, and 5. The payment system for Crookston and Breckenridge was calculated using ACSC rates. A Section 18 label was granted for Eminent 125 SL on sugarbeet for the 2002 cropping season. **Another Section 18 label for Eminent 125 SL on sugarbeet in North Dakota and Minnesota will be requested for the 2003 cropping season**. Registration status of all other experimental fungicides for the 2003 cropping season is not known at this time.

Crookston:

Cercospora leaf spot severity was high, particularly during September, with the untreated check having a KWS Cercospora leaf spot rating ranging from 7.63-8.25 (**Table 3**).

All fungicide treatments resulted in significantly lowered Cercospora leaf spot rating, significantly higher recoverable sucrose per acre, and significantly higher yield than the untreated check. The most effective treatments were Eminent followed 21 d after by a mixture of Topsin + TPTH followed 14 d after with Headline; Eminent followed 21 d after with Headline followed 14 d after with TPTH; and an Eminent/TPTH/Headline/TPTH 14 d alternation program.

Breckenridge:

Cercospora leaf spot was first observed in mid-August and disease severity was low during the season with the untreated check plots having a KWS Cercospora leaf spot rating of 5.1 six days before harvest (**Table 4**).

All fungicide treatments resulted in significantly lower Cercospora leaf spot rating, and significantly higher recoverable sucrose per acre than the untreated check. The most effective treatments were Headline in alternation with TPTH; Eminent in alternation with TPTH and Headline; and Headline in alternation with Eminent.

Willmar:

Cercospora leaf spot severity was high with the untreated check plots having a KWS Cercospora leaf spot rating of 7.92 at harvest (**Table 5**)

All fungicide treatments, except the experimental HM 0125 in alternation with Headline, and Eminent applied at 21 d intervals in alternation with TPTH, resulted in significantly higher recoverable sugar per acre than the untreated check. All fungicide treatments, except Eminent applied at 21 d intervals in alternation with TPTH, resulted in significantly lower Cercospora leaf spot rating than the untreated check. The most effective treatments were Eminent in alternation with Headline; Eminent in alternation with TPTH; Eminent in alternation with Gem; Gem in alternation with TPTH; and Headline in alternation with TPTH – all applied at 14 d intervals. No phytotoxicity was observed.

SUMMARY AND CONCLUSIONS

At Willmar, under high Cercospora leaf spot disease pressure, four applications of two different classes of fungicides in an alternation program provided good disease control and resulted in high recoverable sucrose per acre.

At Crookston, under high Cercospora leaf spot disease pressure, and at Breckenridge, under low disease pressure, using two, three, or four different classes of fungicides in an alternation program, provided effective Cercospora leaf spot control and resulted in high recoverable sucrose per acre.

A. Fungicide with Section 18 Label

1. The availability of Eminent (a Section 18 was granted for 2002 and a request will be submitted to the EPA for another section 18 label for the 2003 growing season) will enhance the ability of growers to control Cercospora leaf spot and better manage fungicide resistance. Alternating Eminent with other classes of fungicides provides better disease control and delays the development of fungicide resistance.

B. Other Comments

1. The first fungicide application should be made when conditions first favor the disease or at disease onset. If the first application is late, control will be difficult all season.
2. Use the recommended rate of fungicides to control Cercospora leaf spot – do not cut rates!
3. The 5.0 oz/A TPTH rate should be used with an application interval of 10-14 days at southern Minnesota and 14 days in the Red River Valley.
4. Use Headline or Eminent as your first fungicide application. Do not use the fungicide or a fungicide from the same class of chemistry used in the last fungicide application in 2002 as the first fungicide application in 2003.
5. In the southern Minnesota, Minn-Dak, and Moorhead factory districts, the use of Headline or Gem, Eminent, and TPTH in an alternation program will effectively control Cercospora leaf spot.
6. In Hillsboro, East Grand Forks, Crookston, and Drayton factory districts, the use of Headline or Gem, Eminent, TPTH, or a tank-mix of Topsin and Penncozeb, in an alternation program will effectively control Cercospora leaf spot.
7. Only one application of a benzimidazole fungicide (Topsin M) in combination with a protectant fungicide (Penncozeb or TPTH) should be used in the Hillsboro, East Grand Forks, Crookston, and Drayton factory districts.
8. Please note that Headline and Gem, both strobilurins, received full (Section 3) registration and can be used for controlling Cercospora leaf spot on sugarbeet.
9. Never use the same fungicide or fungicides from the same class ‘back-to-back’.
10. Alternate, alternate, alternate! Alternate different chemistry fungicides.

The following shows the fungicides and their class of chemistry:

Strobilurins	**Sterol Inhibitors**	**Ethylenebisdithiocarbamates (EBDC)**
Quadris	Eminent	Penncozeb
Gem		
Headline		

Benzimidazole	**Triphenyltin Hydroxide (TPTH)**
Topsin M	SuperTin
Thiophanate Methyl 85 WDG	AgriTin

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Table 1. Cultural Practices And Application Date Information For Cercospora Leaf Spot Trials In 2002

	Crookston	Breckenridge	Gluek
Planting Date	May 4	April 30	May 13
Previous Crop	Wheat	Wheat	Corn
Variety	HM Agate	HM Agate	Beta 4705
Weed Control	Betamix –micro-rate Betanex – m/rate Upbeet – m/rate Stinger – m/rate Poast – m/rate MSO – micro-rate Hand labor Cultivation	Betamix –micro-rate Betanex – m/rate Upbeet – m/rate Stinger – m/rate Poast – m/rate MSO – micro-rate Hand labor Cultivation	Betamix –micro-rate Betanex – m/rate Upbeet – m/rate Stinger – m/rate Poast – m/rate Oil – micro-rate Hand labor Cultivation
Insecticide	Counter, Asana XL	Counter	None
Plant Population at Thinning	35,000 plant/A	35,000 plant/A	35,000 plant/A
Spray Application	**Crookston**	**Breckenridge**	**Gluek**
1st	July 26	July 25	July 15
2nd	August 9	August 8	**July 31**
3rd	August 16	August 15	August 5
4th	August 22	August 23	**August 14**
5th	August 30	August 29	August 28
6th	September 7	September 9	
Spray Volume (gpa)	20	20	20
Spray Pressure (psi)	100	100	120
Harvest Date	October 2	September 23	October 15

Table 2. Fungicides tested in 2002.

Fungicides	Status
Penncozeb	Registered
Topsin M	Registered
Super Tin, Agritin, Triphenyltin hydroxide (TPTH)	Registered
Quadris	Registered
Headline	Registered
Eminent	Section 18 granted for 2002
Gem	Registered

Table 3. Cercospora leaf spot control at Crookston in 2002 with registered and experimental fungicides.

Treatment, Rate of Product or ai/a or ha	Appl. Interval (d)	CLS * KWS	Recoverable Sucrose		Root Yield (T/A)	Sucrose (%)	LTM ** (%)	$/T	Gross $/A
			Lb/A	Lb/T					
Eminent 13 oz/Topsin 0.375 lb+ TPTH 3.75 oz/Headline 9 oz	21/14/21	3.13	8205	311.0	26.4	16.83	1.28	37.23	982
Eminent 13 oz/Headline 9 oz/TPTH 5 oz	21/14/14	3.38	8073	307.0	26.3	16.65	1.30	36.31	955
Eminent 13 oz/TPTH 5 oz/Headline 9 oz/ TPTH 5 oz	14	3.13	7943	307.5	25.8	16.67	1.30	36.43	940
Eminent 13 oz/Headline 9 oz	14	3.00	7938	303.5	26.2	16.53	1.35	35.51	928
Headline 9 oz/TPTH 5 oz/Eminent 13 oz / TPTH 5 oz	14	2.63	7932	301.5	26.3	16.40	1.33	35.05	922
Headline 9 oz/ TPTH 5 oz	14	3.13	7828	300.5	26.1	16.40	1.38	34.82	907
Headline 9 oz/Eminent 13 oz/TPTH 5 oz	14/21/14	4.00	7818	306.5	25.5	16.60	1.28	36.20	924
Eminent 13 oz/Topsin M 0.5 lb + Penncozeb 2.0 lb/Headline 9 oz	21/14/21	3.75	7815	311.5	25.1	16.93	1.35	37.34	937
Headline 9 oz/Eminent 13 oz/Headline 9 oz	21	2.88	7806	303.5	25.7	16.55	1.38	35.51	913
Headline 9 oz/TPTH 5 oz/Eminent 13 oz/Headline 9 oz	14	2.50	7781	301.5	25.8	16.38	1.30	35.05	904
Eminent 13 oz/TPTH 5 oz	14	3.75	7722	313.0	24.7	16.93	1.28	37.69	930
Headline + Poast + COC 9 oz + 1 pint + 1% v/v/TPTH 5 oz/Eminent 13oz/ Headline 9 oz	14	2.63	7666	304.5	25.1	16.43	1.20	35.74	902
Eminent 13 oz/Headline 9 oz/Eminent 13 oz	21	3.38	7641	306.0	25.0	16.58	1.28	36.08	900
Eminent 13 oz/Headline 9 oz (2 apps only)	21	4.50	7607	304.5	25.0	16.55	1.33	35.74	892
Gem 7 oz/TPTH 5 oz	14	3.50	7584	306.5	24.8	16.58	1.25	36.20	895
Quadris (8-leaf) 12 oz/Eminent 13 oz/TPTH 5 oz/Headline 9 oz/Eminent 13 oz	14	2.75	7551	299.0	25.2	16.25	1.30	34.48	871
Eminent 13 oz + Poast 1 pt + COC 1% v/v/TPTH 5 oz/Headline 9 oz/Eminent 13 oz	14	2.63	7545	298.0	25.3	16.25	1.35	34.25	867
Eminent 13 oz/Gem 7.0 oz	14	3.63	7533	307.5	24.5	16.68	1.30	36.43	892
Headline 9 oz/Eminent 13 oz	14	2.63	7518	299.5	25.1	16.43	1.45	34.59	869
Eminent 13 oz/TPTH 5 oz/Eminent 13 oz	21/14/21	3.50	7502	312.5	24.0	16.90	1.28	37.57	903
Eminent 13 oz/TPTH 5 oz/Headline 9 oz/ Eminent 13 oz	14	2.63	7433	293.5	25.3	16.03	1.35	33.22	841
HM0125 1.5 lb/Headline 9 oz	14	4.88	6756	284.5	23.7	15.78	1.55	31.16	740
Check 1	----	7.63	5416	282.5	19.2	15.70	1.58	30.70	589
Check 2	----	8.13	5394	280.0	19.2	15.55	1.55	30.13	581
Check 3	----	8.25	5143	283.0	18.2	15.55	1.40	30.82	561
Statistical Sign		**	**	**	**	**	**	**	**
LSD (P=.05)		0.69	590	15.5	1.4	0.71	0.17	3.56	103
CV		12.12	5.77	3.69	4.22	3.09	9.12	7.28	8.63

*Cercospora leaf spot measured on KWS scale 1-9 (no leaf spot – dead outer leaves, inner leaves severely damaged, re-growth of new leaves)
**LTM: Sugar loss to molasses

Table 4. Cercospora leaf spot control at Breckenridge in 2002 with registered fungicides.

Treatment and Rate/A	App. Inter-val	CLS *	Recoverable Sugar RSA	Recoverable Sugar RST	Net T/A	Sucrose Content	LTM**	$/T	Gross $/A
	d	KWS	lb	lb	t	%	%		
Headline 2.09 EC 9 fl oz (App 1,3) / TPTH 80 WP 5 oz (App 2,4)	14	1.3	7461	273	27.6	15.4	1.77	27.28	753
Eminent 125 SL 13 fl oz (App 1) / TPTH 80 WP 5 oz (App 2,4) / Headline 2.09 EC 9 fl oz (App 3)	14	1.3	7447	267	28.2	15.2	1.92	25.88	731
Headline 2.09 EC 9 fl oz (App 1,3) / Eminent 125 SL 13 fl oz (App 2,4)	14	1.1	7341	273	27.3	15.5	1.90	27.12	738
Headline 2.09 EC 9 fl oz (App 1,4) / TPTH 80 WP 5 oz (App 2) / Eminent 125 SL 13 fl oz (App 3)	14	1.1	7319	273	27.1	15.6	1.95	27.14	738
Eminent 125 SL 13 fl oz (App 1,3) / TPTH 80 WP 5 oz (App 2,4)	14	1.4	7237	270	27.1	15.3	1.90	26.53	721
Eminent 125 SL 13 fl oz (App 1,3) /Gem 7 oz (App 2,4)	14	1.2	7228	274	26.7	15.6	1.95	27.40	732
Eminent 125 SL 13 fl oz (App 1,3) / TPTH 80 WP 5 oz (App 2)	21, 14	1.5	7158	267	27.1	15.2	1.90	25.87	704
Eminent 125 SL 13 fl oz (App 1,4) / TPTH 80 WP 5 oz (App 2) / Headline 2.09 EC 9 fl oz (App 3)	14	1.2	7098	267	26.8	15.1	1.80	26.01	698
Headline 2.09 EC 9 fl oz (App 1) / TPTH 80 WP 5 oz (App 2,4) / Eminent 125 SL 13 fl oz (App 3)	14	1.3	7087	268	26.7	15.3	1.95	26.09	699
Eminent 125 SL 13 fl oz (App 1) / Topsin M 70 WSB 0.5 lb a.i + Penncozeb 75 DF 2 lb (App 2) / Headline 2.09 EC 9 fl oz (App 3)	21, 14, 21	1.2	7081	266	26.9	15.0	1.70	25.61	691
Eminent 125 SL 13 fl oz (App 1) / Topsin 70 WSB 0.375 lb + TPTH 80 WP 3.75 oz (App 2) / Headline 2.09 EC 9 fl oz (App 3)	21, 14, 21	1.2	7065	267	26.7	15.3	1.95	25.99	696
Eminent 125 SL 13 fl oz (App 1,3) / Headline 2.09 EC 9 fl oz (App 2)	21	1.4	6998	265	26.7	15.2	1.93	25.51	681
Eminent 125 SL 13 fl oz (App 1,3) / Headline 2.09 EC 9 fl oz (App 2,4)	14	1.1	6946	273	25.6	15.3	1.65	27.31	701
Eminent 125 SL 13 fl oz (App 1) / Headline 2.09 EC 9 fl oz (App 2) / TPTH 80 WP 5 oz (App 3)	21, 14	1.2	6906	267	26.2	15.3	2.02	25.82	676
Headline 2.09 EC 9 fl oz (App 1) / Eminent 125 SL 13 fl oz (App 2) / TPTH 80 WP 5 oz (App 3)	14, 21	1.2	6897	262	26.6	15.0	1.90	24.87	662
Headline 2.09 EC 9 fl oz (App 1,3) / Eminent 125 SL 13 fl oz (App 2)	21	1.5	6841	266	25.9	15.1	1.80	25.71	669
Eminent 125 SL 13 fl oz (App 1) / Headline 2.09 EC 9 fl oz (App 2)	21	1.3	6766	261	26.3	15.0	2.03	24.48	642
Gem 7 oz (App 1,3) / TPTH 80 WP 5 oz (App 2,4)	14	1.2	6692	265	25.5	15.2	1.92	25.54	653
Untreated Check		5.1	5915	261	23.0	15.1	2.05	24.49	564
LSD (P=.05)		0.5	693	19.3	2.1	0.8	0.27	4.25	118
CV		22.3	7.14	5.18	5.8	3.8	10.4	11.7	12.3

*Cercospora leaf spot measured on KWS scale 1-9 (no leaf spot – dead outer leaves, inner leaves severely damaged, re-growth of new leaves)
**LTM: Sugar loss to molasses

Table 5. Cercospora leaf spot control at Willmar in 2002 with registered fungicides.

Treatment and Rate/A	Application Interval	Recoverable Sucrose		Yield	Sucrose Content	LTM**	CLS*
		RSA	RST				
	d	Lb	t	t/a	%	%	KWS
Eminent 125 SL 13 fl oz (App 1,3) / Headline 2.09 EC 9 fl oz (App 2,4)	14	7288.67	317.17	22.99	16.93	1.08	4.25
Eminent 125 SL 13 fl oz (App 1,3) /Gem 7 oz (App 2,4)	14	7277.00	306.00	23.75	16.42	1.12	4.08
Gem 7 oz (App 1,3) / TPTH 80 WP 5 oz (App 2,4)	14	6788.83	312.50	21.63	16.73	1.10	4.42
Headline 2.09 EC 9 fl oz (App 1,3) / TPTH 80 WP 5 oz (App 2,4)	14	6590.83	317.67	20.74	16.96	1.08	5.08
Eminent 125 SL 13 fl oz (App 1,3) / TPTH 80 WP 5 oz (App 2,4)	14	6575.67	303.17	21.63	16.29	1.14	4.25
Headline 2.09 EC 9 fl oz (App 1,3) / TPTH 80 WP 5 oz (App 2,4)	14	6567.67	310.33	21.29	16.62	1.10	4.33
Headline 2.09 EC 9 fl oz (App 1,3) / Eminent 125 SL 13 fl oz (App 2,4)	14	6566.50	301.17	21.79	16.19	1.14	4.00
Eminent 125 SL 13 fl oz (App 1,3) / TPTH 80 WP 3.75 oz (App 2,4)	14	6453.67	298.50	21.66	16.08	1.15	4.92
Eminent 125 SL 13 fl oz (App 1,3) / Headline 2.09 EC 9 fl oz (App 2,4)	21	6375.33	293.67	21.75	15.85	1.17	4.92
Eminent 125 SL 13 fl oz (App 1,4) / Headline 2.09 EC 9 fl oz (App 2) / TPTH 80 WP 5 oz (App 3)	14	6364.83	301.50	21.13	16.21	1.14	4.00
Headline 2.09 EC 9 fl oz + Agro 1005 1% v/v (App 1-4)	14	6309.00	306.50	20.38	16.44	1.12	3.75
Eminent 125 SL 9 fl oz (App 1,3) / TPTH 80 WP 3.75 oz (App 3) / Eminent 125 SL 13 fl oz	14	6155.50	297.17	20.63	16.01	1.16	5.50
Headline 2.09 EC 9 fl oz (App 1,3) / Eminent 125 SL 13 fl oz (App 2,4)	21	6060.50	303.33	19.96	16.31	1.13	4.17
Eminent 125 SL 13 fl oz (App 1,4) / Topsin 70 WSB 0.375 lb + TPTH 80 WP 3.75 oz (App 2) / Headline 2.09 EC 9 fl oz (App 3)	21, 14, 21	5955.17	293.83	20.23	15.85	1.17	6.33
Eminent 125 SL 13 fl oz (App 1,3) / TPTH 80 WP 5 oz (App 2,4)	21, 14	5542.67	301.50	18.35	16.22	1.14	6.92
Untreated check		4510.33	290.67	15.53	15.71	1.18	7.92
LSD (P=.05)		1210.6	19.61	3.63	0.91	0.07	1.00
CV		16.98	5.67	15.45	4.89	5.71	17.55

[1]Cercospora leaf spot measured on KWS scale 1-9 (no leaf spot – dead outer leaves, inner leaves severely damaged, re-growth of new leaves)
[2]LTM: Sugar loss to molasses

Back To Table of Contents

THE EFFECT OF TILLAGE AND PHOSPHORUS FERTILIZER PLACEMENT ON PHOSPHORUS RUNOFF FROM SUGAR BEET PRODUCTION SYSTEMS

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Abstract

The objective of this study was to determine the differences in the amount of phosphorus (P) in runoff from land under sugar beet production caused by different management practices and phosphorus fertilizer placement. The study was set up as a split plot experimental design, replicated three times. The whole plot treatments were: 1) corn/soybean rotation, with moldboard plow as primary tillage before soybean; 2) corn/soybean rotation, with chisel plow as primary tillage before corn; 3) sugar beet/soybean/corn rotation, with moldboard plow as primary tillage before sugar beet; 4)sugar beet/soybean/corn rotation, with a DMI chisel plow as primary tillage before sugar beet; 5) sugar beet/soybean/corn rotation, with a DMI chisel plow as primary tillage before sugar beet with a spring cover crop of oats. The split plot treatments were broadcast or subsurface band application of phosphorus fertilizer. A rainfall simulator was used to create runoff events at an intensity of 2.2 inches per hour on soybean in whole plot treatment 1, on corn in whole plot treatment 2, and on sugar beet in whole plot treatments 3, 4, and 5. Runoff was collected and analyzed for orthophosphate (DP) and total phosphorus (TP). Runoff flow rate and sediment loss were also measured. Analysis of variance findings concluded no significant differences of DP and TP contents and concentrations among tillage/crop rotation or between P fertilizer placements. Regression analysis was conducted to relate which source, transport, or soil factors were influential in P loss. Six regression models were constructed. Phosphorus concentration models were heavily influenced by soil test phosphorus (STP) levels, while P content losses were influenced by transport factors such as runoff or sediment loss.

Introduction

Environmental concerns over phosphorus (P) management have arisen in the past few decades. Many soils in agricultural production areas have elevated levels of soil test phosphorus (STP). Phosphorus can leave cultivated fields in a dissolved form in runoff (dissolved P, DP) or as an adsorbed form on eroded soil particles (particulate P. PP). Phosphorus can then enter surface water systems and cause accelerated eutrophication in streams, rivers, and lakes. Phosphorus in these surface waters can become long-term as well as short-term sources of nutrients for algae and other biota (Sharpley et al., 1992). The term eutrophication refers to the natural aging of freshwater bodies caused by nutrient enrichment. Since P is generally the limiting nutrient for algae and plant growth in these systems, a population explosion of these organisms is the result of excess P in freshwater (Sharpley et al., 1994). When the algae dies, microorganisms in the water decompose the algae. The microorganisms use the oxygen in the water to facilitate this process, which leads to a state of hypoxia, or fish kill (USEPA, 1996). Water use for recreation, industry, and drinking are also impacted by eutrophication. The United States Environmental Protection Agency (USEPA) has identified eutrophication as the main cause of impaired fresh surface water quality (USEPA, 1996).

Substantial research activity has focused on phosphorus runoff. Phosphorus runoff studies have been conducted with cropping systems that range from corn-soybean rotations in Iowa (Laflen and Tabatabai, 1984) to wheat-fallow rotations in Texas (Sharpley, 1995) to sorghum-soybean rotations in Eastern Kansas (Kimmel et al., 2001). There is little, if any, information of how P in runoff is affected by sugar beet production systems and associated management practices needed for profitable production. The small size of the sugar beet seed and the shallow depth of planting cause sugar beet production fields to have little crop residue from the previous crop at planting. This leaves the field more susceptible to soil erosion and subsequent P losses. An understanding of the impact of varying tillage practices and P fertilizer placement on P loss would lead to better P management on sugar beet production fields.

Materials and Methods

The experimental site was located in Chippewa County, Minnesota near Raymond, Minnesota on a Colvin-Spicer silty clay loam (fine-silty, mixed, superactive, frigid Typic Calciaquoll and fine-silty, mixed, superactive, calcareous, mesic Typic Endoaquoll) complex. The study was conducted during the 2000 and 2001 growing seasons. Runoff samples were collected in the summer of 2001.

The experimental was set up as a split-plot design replicated three times. The whole plot treatments (44 X 50 ft) were tillage/crop rotation system. The treatments were as follows: (1) corn/soybean rotation, with moldboard plow as primary tillage before soybean; (2) corn/soybean rotation, with chisel plow as primary tillage before corn; (3) sugar beet/soybean/corn rotation, with moldboard plow as primary tillage before sugar beet and chisel plow as primary tillage before soybean and corn; (4) sugar beet/soybean/corn rotation, with a DMI chisel plow as primary tillage before sugar beet and chisel plow as primary tillage before soybean and corn; and (5) sugar beet/soybean/corn rotation, with a DMI chisel plow as primary tillage before sugar beet, chisel plow as primary tillage before soybean and corn, and a spring cover crop of oats planted before sugar beet.

Whole plots were then split into a 8- 22 inch row subplot 17.7 X 50 ft in size. The two split plot treatments were phosphorus application methods of (1) broadcast application of 40 pounds phosphate per acre and (2) knife injection of 40 pounds phosphate per acre placed at a depth of 5 inches. Phosphorus fertilizer use was triple super phosphate (0-44-0). Phosphate fertilizer applications were completed in the spring prior to secondary tillage.

A rainfall simulator was used to generate runoff. Rain simulations took place on soybean in whole plot treatment 1, corn in whole plot treatment 2, and sugar beet on whole plot treatments 3, 4, and 5. An average rainfall intensity of 2.2 inches per hour was applied to each rain simulation plot.

Runoff was collected to determine runoff flow rate and P concentration. Runoff samples were taken over a period of one hour. Samples for orthophosphate and TP analysis were placed on ice and in the dark until they were transported to the lab for analysis. Orthophosphate was analyzed colormetrically on decanted samples using the method outlined by Murphy and Riley (1962). Total P was analyzed by the same method, after aggressive mixing of the sample and its digestion with sulfuric acid and mercuric acid (Olsen and Sommers, 1982). Particulate P was calculated as the difference between TP and DP.

Soil test P was analyzed using the Olsen-P soil test (Frank et al., 1997). The line intersect method (Laflen et al., 1981) was used to determine residue cover. Soil moisture samples were taken immediately before rainfall simulation, dried at 140 degrees F, and reported as %. A survey grade Astech GPS unit was used to determine slope of the landscape.

Results and Discussion

A summary of the means and ranges of DP, PP, and TP concentrations and contents can be found in Table 1. Also included in Table 1 are the means and ranges of soil and landscape characteristics. Analysis of variance (AOV) results show no significant differences in DP, PP, or TP content among tillage/crop rotation and between P fertilizer applications (Table 2). The results were similar for DP, PP, and TP concentrations. No practical differences were found. This may be a result of the nearly level landscape (0.6 to 2.8 %) landscape. The level landscape influenced the small runoff flow rates and sediment loss. Also, the residue cover values are inconsistent with what might be expected for different primary tillage systems. By the time of residue measurement (June 2001), the soil had been tilled with a field cultivator and planting had occurred. The effects of primary tillage on P loss were lost.

Table 1. Means and ranges of P loss, runoff, sediment, soil characteristics, and land characteristics.

			Range	
Property	Unit	Mean	Minimum	Maximum
DP content	lb P/A	0.16	0.07	0.33
PP content	lb P/A	0.73	0.21	1.75
TP content	lb P/A	0.90	0.29	1.96
DP concentration	ppm-P	0.96	0.46	1.80
PP concentration	ppm-P	4.32	1.10	10.72
TP concentration	ppm-P	5.28	1.89	12.52
Runoff	ml/second	6.38	2.53	18.83
Sediment loss	Lb/A	616	98	3429
Residue cover	%	8.5	3.0	12.3
Olsen-P soil test	ppm	40	9	109
Soil moisture	%	35.5	30.5	40.3
Slope	%	1.87	0.63	2.82

Table 2. Effect of primary tillage and P fertilizer application method on P concentration and P content in the runoff.

		P concentration in runoff			P content in runoff		
		Dissolved P	Particulate P	Total P	Dissolved P	Particulate P	Total P
Crop grown	Primary tillage	--------------- ppm --------------			-------- pounds P per acre --------		
Soybean	Moldboard plow	0.77	3.75	4.52	0.21	1.06	1.28
Corn	Chisel plow	1.06	4.95	6.01	0.22	1.14	1.37
Sugar beet	Moldboard plow	0.68	2.96	3.64	0.22	0.96	1.18
Sugar beet	DMI chisel	0.92	3.81	4.73	0.16	0.59	0.75
Sugar beet	DMI chisel plus cover crop	1.36	6.04	7.41	0.21	0.92	1.12
P fertilizer application method							
Broadcast		0.94	4.21	5.15	0.19	0.84	1.02
Knife injected		1.00	4.46	5.46	0.22	1.04	1.27
Statistical analysis		NS	NS	NS	NS	NS	NS

To understand what factors did effect P losses on this landscape regression analysis was used. The regression models developed included either a source variable such as soil test P or a transport variable such as amount of runoff water or sediment loss. For dissolved phosphorus only the soil phosphorus was important. The greater the soil test P the greater the concentration of dissolved phosphorus in the runoff. Soil test P and the amount of sediment moved by erosion was important for understanding the concentration and content of particulate P and total P that is lost from the landscape. Overall, the transport factors are the most important for predicting P loss from this landscape. If a grower can control erosion, they can limit P loss into fresh water bodies in the Southern Minnesota Beet Sugar Cooperative growing areas.

Conclusions

This study concluded no differences in P loss from any management practices related to sugar beet production. It also found no differences in P loss between sugar beet production systems and a corn/soybean rotation system. Phosphorus losses were also not influenced by any primary tillage (including a spring cover crop of oats) system or by the P fertilizer application method. Runoff flow rate or sediment loss was not affected by any management systems. This is most likely a result of the typically level lands that are used in sugar beet production.

The regression analysis indicate that reducing the soil test P levels, runoff, and sediment losses would provide an effective way to reduce P losses

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NITROGEN RECOMMENDATION RESEARCH IN SOUTHERN MINNESOTA FOR 2002

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Introduction

New nitrogen fertilizer recommendations have been developed for sugar beet production in Minnesota and North Dakota. A new study was established to confirm the recommendation and to determine the N contribution of sugar beet tops to a preceding corn crop. This study is also part of a larger research effort looking at fertilizer management during the whole rotation. In the past soybean has been grown after sugar beet in the rotation. Since soybean is a legume, little attention was given the nitrogen that was released from sugar beet tops grown the previous year. In the future sugar beet producers will be encouraged to increase the length of their crop rotation from the common three year sugar beet – soybean – corn rotation practiced now. Information on nutrient issues for corn grown after sugar beet is needed. One of the issues is how much N credit should be given for sugar beet tops. Work in the Red River Valley indicates sugar beet tops can provide a varying amount of N for a wheat crop. The amount depends on the nitrogen status of the sugar beet crop at harvest. Green tops are credited up to 70 pounds of N per acre while yellow N deficient tops are given 0 credit. This article reports the results of the sugar beet crop grown under differing N rates in the first year of this two year study.

Materials and Methods

To accomplish the objective of this study, two sites were established in 2002. The sites were located near Olivia and Maynard, Minnesota. The first year treatments were five nitrogen fertilizer rates of 0, 40, 80, 120, and 160 pounds N per acre at the Olivia site and 0, 50, 100, 150, and 200 pounds N per acre at the Maynard site. These sites had relatively low initial soil nitrate-N soil tests. These values plus the N recommendations are listed in Table 1. The initial nitrate-N soil samples were taken spring 2002 to a depth of seven feet in one foot increments.

Table 1. Initial soil nitrate-N and nitrogen fertilizer recommendations at the Olivia and Maynard, Minnesota sites in 2002.

	Initial soil nitrate (lb nitrate-N/A)			N recommendation (lb N/A)	
	0-2 ft.	0-4 ft.	0-7 ft.	0-2 ft.	0-4 ft.
Site	--- pounds nitrate-N per acre ---			- pounds N per acre -	
Maynard	32	49	90	68	81
Olivia	48	79	112	52	51

The fertilizer N treatments were applied early spring as urea to plots 44 ft X 44 ft in size. The cooperators provided the planting, weed control, and fungicide applications to the sites. The studies were hand harvested early October. Root yield and quality determined at the Southern Minnesota Beet Sugar Cooperative tare laboratory. Also at harvest, sugar beet top yield was determined and sub-samples were taken and analyzed for total N. After harvest, soil samples were taken to a depth of four feet in each plot and analyzed for soil nitrate.

Results and Discussion

Root yield, quality, and recoverable sucrose

Root yield was significantly increased with the first increment of fertilizer application (Table 2 and Table 3). The increase was 2.6 tons per acre with 50 pounds N per acre at the Maynard site (Table 2) and 5.4 tons per acre with 40 pounds N per acre at the Olivia site (Table 3). Root yields were not increased with additional N above the first increment of N application at either site.

Sucrose was reduced significantly by nitrogen fertilizer application at both sites. The average decrease was 0.38 % per 50 pounds of fertilizer N per acre at the Maynard site and 0.22 % per 50 pounds of fertilizer N per acre at the Olivia site. Loss to molasses was increased by nitrogen fertilizer application at both sites.

At Maynard, the recoverable sucrose per ton of sugar beet processed was reduced by 7.75 pounds per ton of processed sugar beet for every 50 pounds of N fertilizer applied per acre. The recoverable sucrose per acre increased with the first 50 pounds fertilizer N per acre applied. The increase was 622 pounds per acre.

Recoverable sucrose per ton of processed sugar beet was reduced 5 pounds per ton for every 50 pounds of fertilizer N per acre applied at the Olivia site. The recoverable sucrose per acre was increase by the first 40 pounds of fertilizer N per acre by 1533 pounds per acre. At both sites, the maximum recoverable sucrose per acre occurred at less amounts of soil nitrate-N plus fertilizer N than the current recommendations.

Table 2. Root yield, root quality, and recoverable sucrose for the Maynard site in 2002.

N rate	Root yield	Sucrose	Loss to molasses	Recoverable sucrose	
pounds N/A	tons/A	-------- % --------		pounds/ton	pounds/A
0	26.7	18.4	1.00	347	9276
50	29.3	17.9	1.02	338	9898
100	30.8	17.3	1.06	325	9959
150	27.5	17.2	1.06	323	8873
200	31.3	16.9	1.09	316	9827
Statistics					
N rate	0.03	0.0002	0.0005	0.0002	0.15
C.V. (%)	8.2	2.4	2.5	2.7	8.0

Table 3. Root yield, root quality, and recoverable sucrose for the Olivia site in 2002.

N rate	Root yield	Sucrose	Loss to molasses	Recoverable sucrose	
pounds N/A	tons/A	-------- % --------		pounds/ton	pounds/A
0	23.1	17.4	1.04	328	7693
40	28.5	17.3	1.05	324	9226
80	28.3	16.7	1.11	311	8789
120	28.4	16.7	1.09	313	8893
160	26.7	16.7	1.10	312	8332
Statistics					
N rate	0.02	0.02	0.02	0.02	0.03
C.V. (%)	9.3	2.4	2.8	2.7	8.4

Top Dry Matter, Top N Concentration, and Top N Content

The application of N fertilizer significantly increased top yield, N concentration, and N content at the Maynard site (Table 4). The top yield ranged from 4299 pounds per acre for the check sugar beet tops to 7104 pounds per acre for the 200 pounds N per acre treated sugar beets. The N concentrations ranged from 1.84 % for check sugar beet tops to 2.57 % for sugar beets grown with an extra 200 pounds N per acre. The resulting N contents of the sugar beet tops returned to the soil range from 79 pounds N per acre for the check beets to 184 pounds per acre for the beets grown with 200 pounds fertilizer N per acre.

Table 4. Top dry matter yield, nitrogen concentration, and nitrogen content for the Maynard site in 2002.

N rate	Top dry matter yield	N concentration	N content
pounds N/A	pounds dry matter/A	%	pounds N/A
0	4299	1.84	79
50	5046	2.05	104
100	5907	2.45	144
150	6410	2.43	154
200	7104	2.57	184
Statistics			
N rate	0.04	0.002	24.7
C.V. (%)	21.5	9.8	0.004

At Olivia, yield, N concentration, and N content of sugar beet tops were also increased by the addition of fertilizer N (Table 5). The top yield and N content at Olivia was considerably less than the top yield and N content at Maynard. The top yield increased from 2349 pounds per acre for the check sugar beet tops to 3205 pounds per acre for sugar beet tops treated with 160 pounds N per acre. The N content increased from 56 to 96 pounds N per acre from the check to 160 pound N treatments. The N concentrations at Olivia were greater than at Maynard. The N concentrations for the zero N plots were 2.37 % while the beets treated with 160 pounds N per acre had N concentrations of 3 %.

Table 5. Top dry matter yield, nitrogen concentration, and nitrogen content for the Olivia site in 2002.

N rate	Top dry matter yield	N concentration	N content
pounds N/A	pounds dry matter/A	%	pounds N/A
0	2349	2.37	56
40	2824	2.23	63
80	2754	2.61	72
120	3140	2.88	90
160	3205	3.00	96
Statistics			
N rate	0.07	0.002	0.002
C.V. (%)	15.2	8.2	16.2

Residual nitrate-N

Soil nitrate-N was measured from soil samples taken after sugar beet harvest late October 2002 at each site. At the Maynard and Olivia sites, there were no differences in residual soil nitrate caused by the fertilizer treatments applied Spring 2002, Table 6. At the Maynard site, the average soil nitrate-N in the 0-2 ft. depth was 32 pounds per acre while the average soil nitrate-N in the 0- 4 ft. was 46 pounds per acre. The average residual soil nitrate values at the Olivia site were 27 pounds per acre in the 0-2 ft. depth and 40 pounds per acre in the 0-4 ft. depth.

Table 6. Residual soil nitrate-N for 0-2 ft. and 0–4 ft. depths at the Maynard and Olivia sites in fall 2002.

Maynard site			Olivia site		
N rate	0-2 ft.	0-4 ft.	N rate	0-2 ft.	0-4 ft.
pounds N/A	- pounds nitrate-N/A -		pounds N/A	- pounds nitrate-N/A -	
0	31	43	0	28	42
50	28	40	40	23	35
100	30	42	80	27	39
150	41	62	120	29	41
200	32	45	160	29	42

Summary

The results from the two sites confirm the new N recommendations adopted in 2001. Excess nitrogen fertilizer reduces sugar beet root quality while root yield is not increased with applications above the optimum N rate. These sites have also set up conditions to test the effect of N credit from the sugar beet tops returned to the soil for the next corn crop in 2003. The fall 2002 soil nitrate-N test results indicate no differences in residual soil nitrate-N as a result of the spring 2002 N fertilizer treatment applications. There are different amounts of N in the sugar beet tops returned to the soil caused by the 2002 fertilizer treatments. The differences in 2003 corn yield response returned sugar beet top can be measured.

Back To Table of Contents

DEVELOPING N RATE RECOMMENDATIONS: SMALL vs. LARGE PLOTS

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Summary

Accurate fertilizer N recommendations are a primary responsibility of the land grant university and are essential for optimizing profitability for the farmer and minimizing loss of N to the environment. Twenty-nine small-plot and field-size strip experiments were conducted using Best Management Practices on farmer's fields in southern Minnesota from 1989 through 2001 to assess and validate University of Minnesota N recommendations for corn after soybeans. Corn responded to fertilizer N at all but two sites. The N rate needed to optimize fertilizer N in the small-plot studies ranged from 0 to 150 lb N/A and averaged 71 lb/A across all studies when using the least significant difference method (LSD). In the field-size strips, yields were optimized at N rates ranging from 60 to 120 lb N/A with an optimum N rate of 87 lb/A using the LSD method. The economic optimum N rate (EONR) was 105 lb N/A for the small-plot sites and 99 lb N/A for the field-size strip sites. Although different experimental procedures were used, optimum N rates determined by the small-plot and field-strip studies were very similar. These results suggest the 120-lb N rate presently recommended by the University of Minnesota is sufficient for expected corn yields ranging from 150 to 174 bu/A.

Introduction

Nitrogen (N) is an essential plant nutrient that is applied for corn in greater quantity than any other fertilizer in Minnesota. Applying the proper rate of N to achieve optimum corn yield is essential if producers are to maximize economic return and minimize N losses to the environment. The concept illustrated in Figure 1 demonstrates the significant impact that N rate has on crop yield. Yield and profitability per acre can be sacrificed if inadequate rates of N are applied. On the other hand, using too much N does not further increase yield but increases the potential for excessive losses of nitrate to ground and surface water while also reducing economic return to the grower.

Determining the optimum rate of fertilizer N for a crop involves assessing the amount of N becoming available from the soil and then determining the amount of fertilizer N needed to supplement the soil N to meet the crop's total N requirement. Because uncontrollable factors such as precipitation and temperature affect the release of N from soil organic matter and the amount of N needed by the crop in any particular year or location, the optimum rate of fertilizer N will likely vary from location to location and from year to year. Thus, one quickly sees the need for continually conducting studies to assess the magnitude and consistency of corn yield response to fertilizer N given the variations in weather and changing genetic potential.

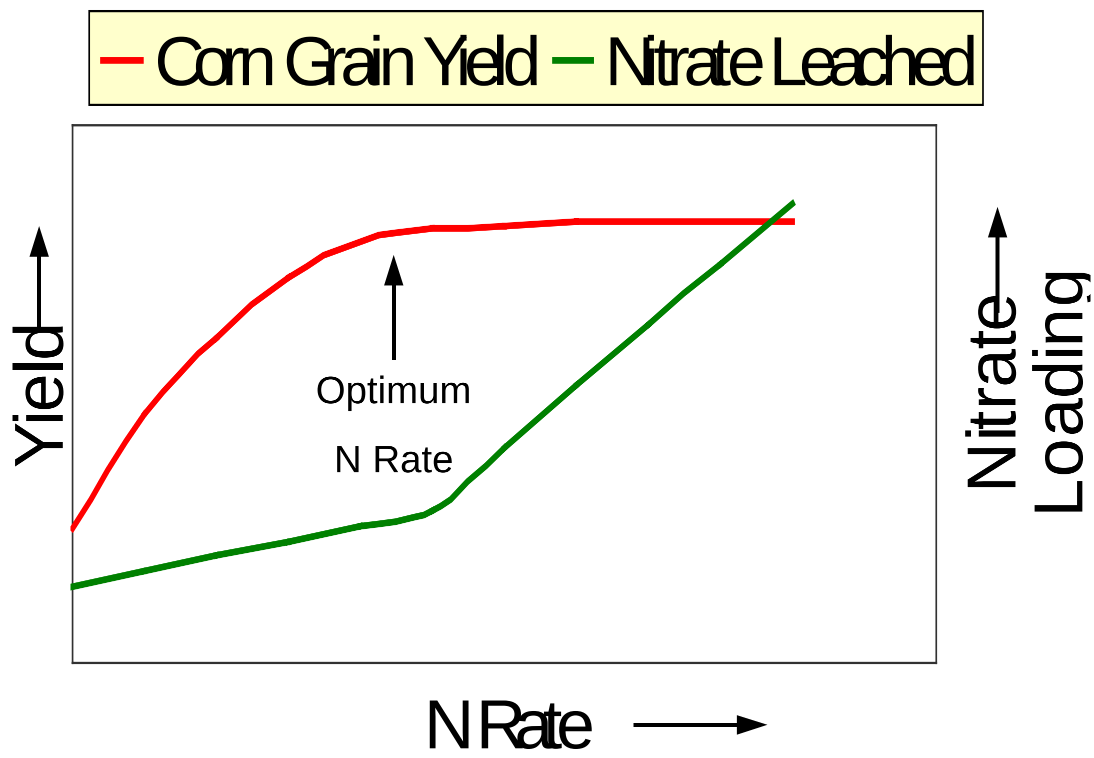

Fig. 1. Conceptual impact of nitrogen (N) rate on crop yield and nitrate loss from a corn production system.

Hundreds of field studies to determine the optimum rate of fertilizer N for corn following soybeans have been conducted by University soil scientists in Minnesota since the early 1960's. These studies have led to a set of N rate recommendations that are updated periodically as N calibration studies are continually conducted using the most recently developed corn hybrids with greater yield potential. The latest N rate recommendations for corn following soybeans published in 2000 are shown in Table 1.

Table 1. Nitrogen recommendations for corn after soybeans where the soil nitrate test is not used.[1/]

	Expected Yield (bu/A)				
Organic Matter Level [2/]	***100-124***	***125-149***	***150-174***	***175-199***	***200^{+}***
	- - - - - - - - - N to apply (lb/A) - - - - - - - - -				
L	***90***	***120***	***150***	***170***	***190***
M and H	***60***	***90***	***120***	***140***	***160***

[1/] ***Adapted from* Fertilizing Corn in Minnesota*, FO-3790, 2000.***
[2/] ***L = Low, less than 3.0%; M = Medium and H = High, more than 3.0%.***

In recent years, University of Minnesota N recommendations for corn have frequently been questioned by the fertilizer industry and some farmers and advisors as being too low for optimum yields and profitability. The fact that many of the studies were conducted on University experiment station land was often cited as a contributing factor to the recommendations being lower than deemed appropriate by the dealer/advisor/farmer. Thus,
N rate calibration studies located on farmer's fields were strongly encouraged. The following reports the results from these on-farm studies conducted for the period 1989 through 2001.

Experimental Procedures

Fourteen small-plot studies were conducted in nine southern Minnesota counties from 1989 through 1999. Location of these studies was equally divided between the loess soils (silt loam) of southeastern Minnesota and the glacial till soils (clay loam) of south central Minnesota. These small plots measured from 10 to 15 ft wide and 40 to 60 ft long and were replicated four to six times at each site. Soybean was the previous crop at all sites. The year, county, soil information, method and time of N application, and N source for each site are shown in Table 2. Tillage, planting, pesticide application, cultivation, and selection of hybrid and planting rate were all conducted by the farmers. University scientists applied the fertilizer N, hand-harvested the yields, and collected other appropriate field data (weather, past cropping and nutrient history, etc.). Best management practices for N including spring application and incorporation within 1 day were used to minimize N losses.

Table 2. Site characteristics for the small plot studies conducted on farmer's fields.

Site	*Year*	*County*	*Soil Texture*	*Method and Time of N Application, N Source*
A	***1989***	***Dakota***	***silt loam***	***Spring preplant, urea***
B	***1989***	***Olmsted***	"	" " "
C	***1989***	***Waseca***	***clay loam***	***Sidedress, ammonia***
D	***1990***	***Waseca***	"	" "
E	***1991***	***McLeod***	"	***Spring preplant, urea***
F	***1992***	***Blue Earth***	"	" " "
G	***1992***	***Dodge***	***silt loam***	" " "
H	***1992***	***Goodhue***	"	" " "
I	***1993***	***Nicollet***	***clay loam***	" " "
J	***1997***	***Blue Earth***	"	" " "
K	***1998***	***Dodge***	***silt loam***	" " "
L	***1998***	***Dodge***	"	" " "
M	***1998***	***Mower***	***loam***	" " "
N	***1999***	***Olmsted***	***silt loam***	" " "

Because concern was being expressed by some dealers, advisors, and farmers regarding the relevance of yield responses from small-plot studies, 15 field-size strip studies were conducted in five counties in southern Minnesota from 1997-2001. All sites followed soybeans and were located on glacial till soils in south central Minnesota. Sites were chosen by the farmer in conjunction with either local crop advisors, dealers, or state agency personnel. Site characteristics, method and time of N application, and N source used are shown in Table 3. The concentration of sites in Nicollet Co. was due to increasing nitrate concerns within the St. Peter Wellhead area and the presence of a multi-agency project to examine N use for corn in that area. Spring or sidedress application was used at 10 sites and fall anhydrous ammonia plus N-Serve was used at 3 sites. Fertilizer N was applied by the dealer or farmer in strips matching the applicator width (30 to 60 ft). Strip length ranged from about 400 ft to more than 1200 ft. All fertilizer N rates were replicated three times except for the two earliest sites (AA and BB) where only two replications were used. In addition, no zero N (0 lb N/A) strips were included at sites AA and BB and only one control strip was included at sites GG and KK. Because of these limitations, no statistical analyses were performed for these sites.

Table 3. Site characteristics for the field-size strip studies conducted on farmer's fields.

Site	Year	County	Texture	Method and Time of N Application, N Source
AA	1997	Nicollet	clay loam	Spring preplant, urea
BB	1998	Blue Earth	"	Fall ammonia
CC	2000	Nicollet	"	Spring preplant, urea
DD	2000	Nicollet	"	" " , "
EE	2000	Nicollet	"	Fall ammonia + N-Serve
FF	2000	Nicollet	"	" " "
GG	2000	Nicollet	"	Spring preplant, urea
HH	2001	Blue Earth	"	Sidedress, ammonia
II	2001	Brown	"	Spring preplant, ammonia
JJ	2001	Martin	"	Sidedress, ammonia
KK	2001	Nicollet	loam	Spring preplant, urea
LL	2001	Nicollet	clay loam	" " , "
MM	2001	Nicollet	"	" " , "
NN	2001	Nicollet	"	Fall ammonia + N-Serve
OO	2001	Redwood	"	Fall ammonia

At each field-strip site, tillage, planting, pesticide application, and hybrid and planting rate selection were all conducted by the farmers. The strips were combine-harvested using yield monitors. All yield data were collected by the farmer and/or consultant. The strip-average yields were then provided to the authors of this publication for statistical and economic analyses. University soil scientists also collected soil samples for pH, P, K, and NO_3-N analyses, took relative leaf chlorophyll data at tasseling, and made periodic inspections during the season at a majority of the sites.

Statistical analyses to determine the optimum rate of N for each site was conducted using three different statistical models: least significant difference (LSD), linear response plateau (LRP), and quadratic response plateau (QRP). The LSD, calculated at the 90% probability level, was conducted on all yield data from the sites that had three or more control (0 lb N/A) plots/strips. The economic optimum N rate (EONR) was calculated using the LRP and QRP response models based on a N price of $0.15/lb and a corn price of $2.00/bu. EONR analysis was conducted on all sites except I (only 4 N rates) and AA and BB (no control strips). A graphical representation of the three models used to determine the optimum N rate is shown in Fig. 2. Note the QRP model is slightly more liberal, giving an EONR of 105 lb N/A, compared to the more conservative LRP (89 lb N/A) and LSD (90 lb N/A) models in this example.

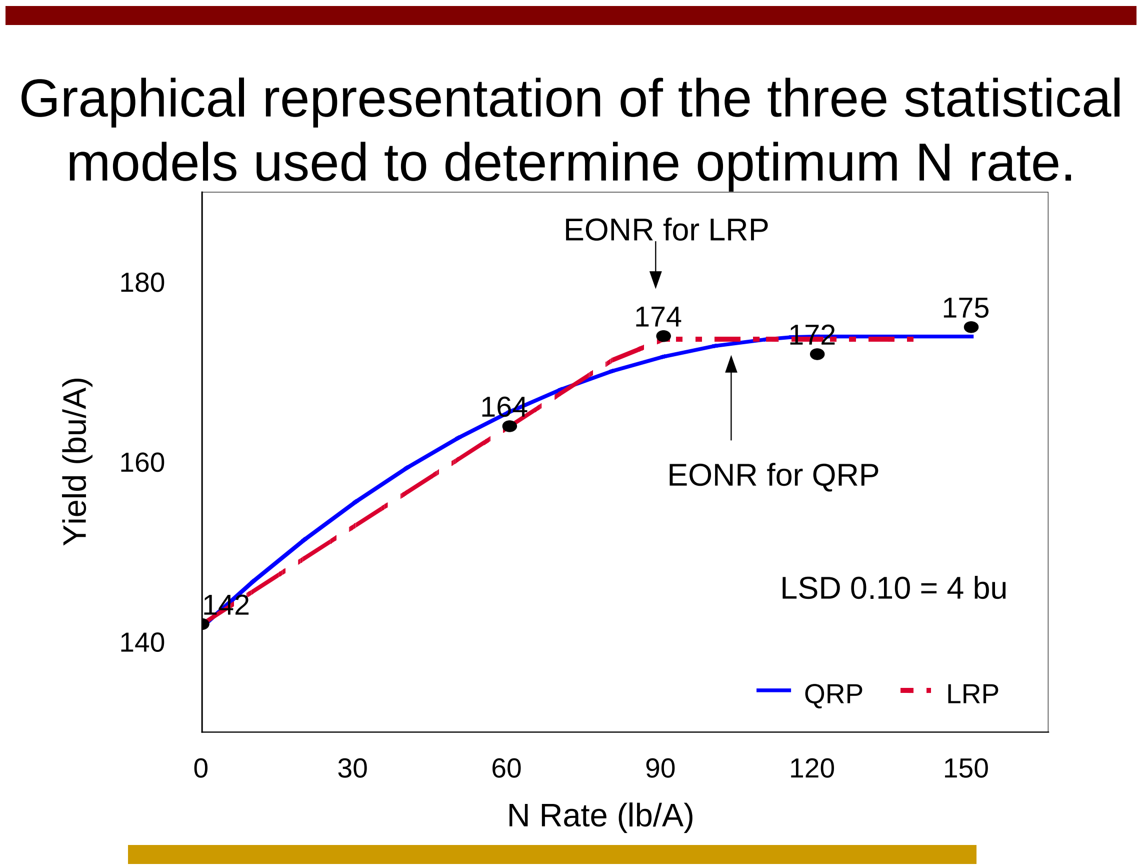

Fig. 2.   A graphical representation of the three statistical models used to determine the optimum N rate for an example data set.

Results and Discussion

<u>Small-plot studies</u>

Corn yields for each of the N rates and the statistical data using the three models illustrated in Fig. 2 are shown for all 14 sites in Table 4. The LSD value gives the smallest yield difference among treatments that is statistically significant at the 90% probability level. The optimum yield using the LSD is shown in bold print for each site. A response to fertilizer N was not obtained at two sites (A and J) even though yields at these sites ranged between 150 and 180 bu/A. This is not surprising and can be explained by the release of N from soil organic matter. Greater availability of soil N usually occurs following dry years and/or long-term applications of N (fertilizer and/or manure) in excess of crop removal. Using the LSD approach, corn yields were optimized at the 30-lb N rate at 1 site (L), at the 60-lb N rate at 4 sites (C, D, H, and K), at the 90-lb N rate at 5 sites, at the 120-lb rate at 1 site (F), and at the 150-lb rate at 1 site (E). Averaged across all 14 sites, the optimum N rate, using the LSD approach, is 71 lb N/A (82 lb N/A if using only the 12 responding sites) to produce a yield of 169 bu/A. The EONR averaged across all 12 sites that fit the LRP model was 70 lb N/A but ranged from 0 to 107 lb N/A. The QRP model fit 13 sites and gave an average EONR of 86 lb N/A. The range across sites was 0 to 140 lb N/A.

Table 4. Optimum fertilizer N rates for corn after soybeans based on small plots in farmer's fields.

	N Rate (lb /A)							LSD	EONR [1/]	
Site	0	30	60	90	120	150	180	(0.10)	LRP	QRP
	- - - - - - - - - - - - - - - - - Corn Yield (bu/A) - - - - - - - - - - - - - - -								- - lb N/A - -	
A	***150***	142	151	151	145	160	161	NS	0	0
B	163	176	178	***188***	186	190	192	12	96	126
C	138	-	***149***	152	155	150	-	10	78	80
D	147	-	***164***	171	166	164	-	14	71	76
E	104	-	138	158	161	***177***	183	11	107	140
F	107	132	144	156	***164***	168	161	13	102	131
G	105	123	*132*	***140***	145	144	138	11	91	105
H	115	137	***147***	148	152	156	-	15	80	92
I	80	-	101 [50]	***114***[100]	-	120	-	13	-	-
J	***178***	170	178	186	172	172	-	NS	0	0
K	175	191	***202***	207	208	206	-	18	69	89
L	175	***200***	185	214	203	193	201	18	-	82
M	147	164	190	***212***	210	217	185	12	84	108
N	146	159	175	***183***	173	178	-	8	67	86

[1/] EONR = Economic Optimum N Rate based on 15¢/lb N and $2.00/bu corn.

These data clearly show the variability encountered among site-years when determining an optimum N rate for corn. University scientists assess this variability and factor it in when making fertilizer N recommendations. Usually the recommendations tend to be slightly greater than a very strict interpretation of the response data would suggest. This slight cushion protects the farmer from risk of yield and profitability loss under unforeseen conditions. In this case, a N recommendation of 120 lb N/A was more than needed for optimum yields at 13 of 14 sites when using the LSD approach, at all 13 sites when using the LRP approach, and at 10 of 13 sites when using the more liberal QRP approach. Based on these yield responses to N in small-plot studies, the 120-lb N rate, presently being recommended by the University of Minnesota for 150 to 174 bu/A corn grown on these soils, was sufficient to optimize yield and profitability at 13 of 14 sites. Moreover, this rate of N could be considered excessive at one-half of the sites where a yield response to N did not occur at rates greater than 60 lb N/A.

Field-size strip studies

Corn yields for each of the 15 field-size strip studies are shown in Table 5. Least significant differences were calculated for 11 of the sites while EONR's were calculated for the 13 sites with 0-lb control plots. All 13 sites responded to fertilizer N. The yield shown in bold type for each site represents the N rate that optimized corn yield using the LSD approach. Yields were optimized at the 60-lb N rate at three sites, at the 90-lb rate at six sites, and at the 120-lb rate at two sites. Averaging these optimum N rates and associated yields across all 11 sites resulted in an optimum N rate of 87 lb/A and an average yield of 150 bu/A.

Table 5. Optimum fertilizer N rates for corn after soybeans based on <u>field-size strips</u> in farmer's fields.

	N Rate (lb /A)							LSD	EONR [1/]	
Site	0	30	60	90	120	150	180	(0.10)	LRP	QRP
	- - - - - - - - - - - - - - - - - Corn Yield (bu/A) - - - - - - - - - - - - - - -								- - lb N/A - -	
AA	-	-	152	155	156^{130}	162^{160}	-	[2/]	-	-
BB	-	-	-	200^{80}	200	200^{160}	-	[2/]	-	-
CC	128	-	159	***165***	169	168	-	5	92	106
DD	120	-	***141***	148	144	150	-	16	78	93
EE	116	-	150	***156***	158	161	-	6	91	104
FF	130	-	***157***	162	164	163	-	19	73	95
GG	135	-	163	168	172	165	-	[3/]	71	90
HH	103	-	140	***148***	146	153	153	9	75	104
II	123	-	145	137	***154***	156	156	18	137	169
JJ	93	-	***108***	109	110	110	-	7	65	68
KK	120	-	135	136	132	136	-	[3/]	50	55
LL	140	-	160	161	***166***	171	-	6	111	145
MM	138	-	145	***150***	146	148	-	4	84	65
NN	126	-	151	***157***	162	160	-	9	97	113
OO	113	-	143	***150***	151	153	148	11	74	96

[1/] EONR = Economic Optimum N Rate based on 15¢/ lb N and $2.00/bu corn.
[2/] Only two replications, no statistical analysis conducted. Actual N rates used shown by superscript numbers.
[3/] The 0-lb control strip was not replicated at these sites. Thus, a statistical analysis to determine the LSD was not conducted.

The EONR for the 13 sites using the LRP method ranged from 50 to 137 lb N/A with a 13-site average of 84 lb N/A. Twelve of the 13 sites had EONR's less than 120 lb N/A. When using the more liberal QRP method, EONR's ranged from 55 to 169 lb N/A and averaged 100 lb N/A for the 13 sites. Eleven of the 13 sites had EONR's less than 120 lb N/A.

Similar to the small-plot studies, these field-size experiments also demonstrate the site-to-site variability associated with arriving at an optimum N rate for corn. But in the aggregate, a 120-lb N rate was sufficient to optimize corn yield at all sites, when using the LSD approach. Using the LRP and QRP approaches, the 120-lb N rate was sufficient to optimize economic return at 12 of 13 sites and 11 of 13 sites, respectively.

<u>Small-plot vs Field-size strip studies</u>

Although the experimental procedures used were much different for these two types of field studies, the yield response curves to fertilizer N were remarkably similar between the small-plot and field-size strips (Fig. 3). Corn yields for the 0, 60, 90, 120, and 150-lb N rates were averaged across all 13 small-plot sites to determine the aggregate EONR for the small plots. Similarly, corn yields for the same N rates were averaged across all 13 field-size strip sites to determine the aggregate EONR and optimum yield for the field-size strips. The QRP-derived EONR's for the small plots and field-size strips were 105 and 99 lb N/A, respectively. Optimum yield was greater in the small plots (173 bu/A) compared to the field-size strips (152 bu/A). This was largely due to very high yields in the small plots in southeastern Minnesota in 1989, 1998, and 1999 when field-size strip studies were not conducted. These results clearly show that optimum fertilizer N rate recommendations are not affected by plot size, regardless whether yield response data come from small plot or field-size strip studies.

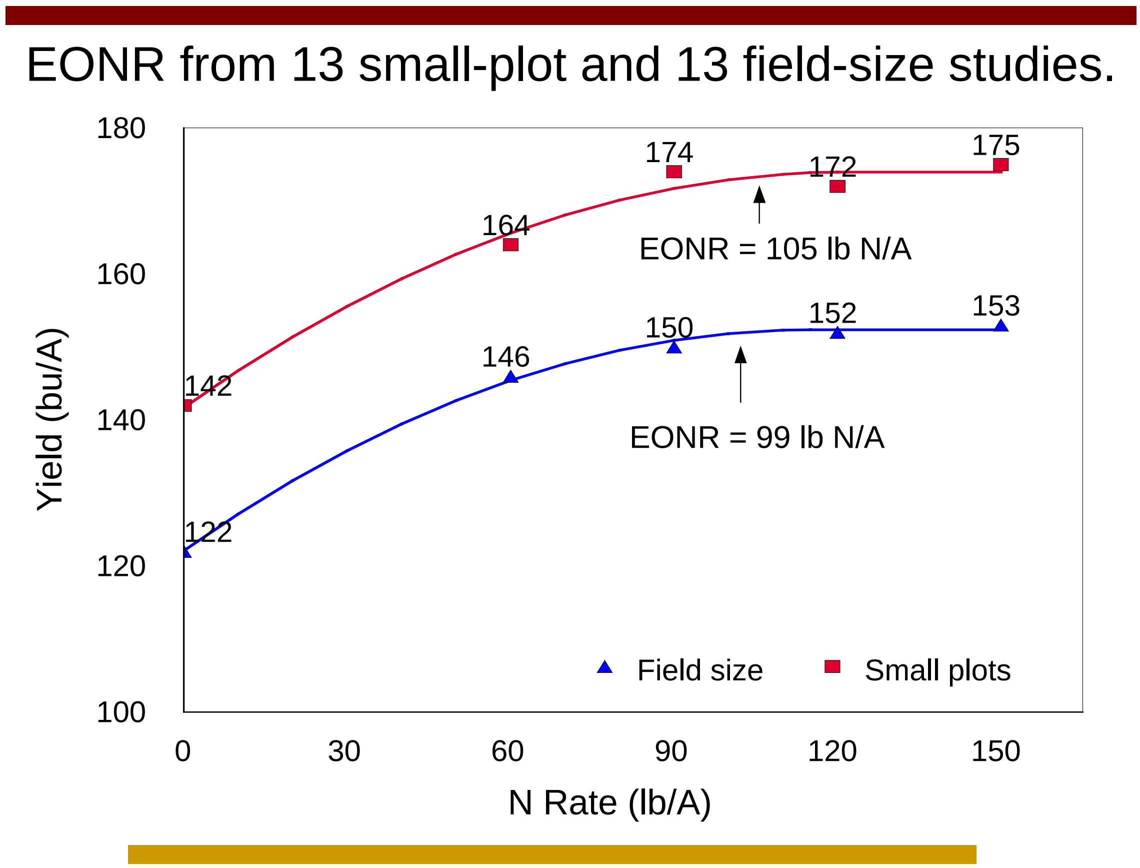

Fig. 3. Effect of fertilizer N rate on average corn yield and EONR from 13 small-plot and 13 field-size studies.

Nitrogen Influence on Sugar Beet Production Evaluated in Tested Strip

Introduction

Nitrogen influence on sugar beet production has been documented extensively in research conducted over many years. Recent studies conducted in the SMBSC growing area were the basis for establishing current University nitrogen recommendations for sugar beets. The new University nitrogen recommendations for sugar beets resulted in a 20 lbs./acre reduction compared to previous University nitrogen recommendation. Acceptance and application of the new recommendations is essential for the profitable production of sugar beets.

Nitrogen management in sugar beets requires consideration the new University recommendations. Investigations are needed to determine influences nitrogen position in the soil profile and the influence of total nitrogen on sugar beet production Studies were established to study the effect of soil residual plus applied nitrogen and position of nitrogen in the soil profile on sugar beet yield, quality, and profitability.

Methods

Test strips were established perpendicular to direction of planting orientation. Nitrogen was applied to provide relative variance of nitrogen levels for evaluation. Sugar beet production was conducted in accordance with normal production practices. Soil was sampled in one foot increments and analyzed for soil nitrates. Depth of soil sampling was from 1-6 feet in depth and was conducted in accordance with grower approval. Determination of soil sample points were specific to topography of field. Soil sampling points were geo-referenced for determination of data collection at a later date. Sugar beets were collected from the geo-referenced points for yield and quality. Four ten-foot sugar beet samples were harvested from each geo referenced point within each nitrogen rate strip. Sugar beets were weighed and analyzed for quality by the SMBSC tare lab.

Summary

Data was analyzed using correlation averaged by soil residual nitrogen in the 0-4 foot soil profile plus applied nitrogen at all sites with one exception. At location 10, the data was averaged at the two foot level for soil residual nitrogen plus applied nitrogen since soil samples of greater than two foot were not collected. Correlation coefficient (R^2) gives to the relationship between variables tested and is a measurement of the explanation of variance between two factors. An R^2 of .82 is that 82 percent of the variation can be explained by the variables considered. A perfect relationship would be an R^2 of 1. Twenty six variables were measured as follows:

Soil variables:

- Applied nitrogen
- Sugar beet top nitrogen credit
- Soil residual nitrogen 0-1 ft
- Soil residual nitrogen 1-2 ft.
- Soil residual nitrogen 2-3 ft.
- Soil residual nitrogen 3-4 ft.
- Soil residual nitrogen 4-5 ft.
- Soil residual nitrogen 5-6 ft.
- Soil residual nitrogen 0-2 ft .
- Soil residual nitrogen 0-4 ft.
- Soil residual nitrogen 0-6 ft.
- Soil residual nitrogen 0-2 ft. plus applied N
- Soil residual nitrogen 0-4 ft. plus applied N.
- Soil residual nitrogen 0-6 ft. plus applied N

Yield variables:

- Stand count
- Ton/Acres
- Purity
- Sucrose percent
- Brei Nitrate
- Extractable Sucrose per Ton
- Extractable Sucrose per Acre
- Revenue Per Acre

Data for Buffalo Lake site number 10 where soil was only sampled to the two foot level will not be presented or discussed. This is due to the soil variable data collected showing similar influences on yield factors as that experienced at the sites with soil tested to deeper levels. The issue is that the 2-4 soil residual nitrogen is unknown and the assumption would be that soil variables at deeper depths than two feet would have as much or a greater influence on the yield variables. This assumption is warranted due to results found at the other sites where four foot depth or greater soil samples were collected which will be discussed later in this article.

Soil residual nitrogen, accumulative soil nitrogen, and accumulative nitrogen plus nitrogen applied at the 0-6 foot depth did not give a good relationship to yield factors (Table 1). The same comparison at the five foot soil depth considering soil residual nitrogen, accumulative soil nitrogen, and accumulative nitrogen plus nitrogen applied did give a good relationship to yield factors tested. This indicates that knowing the soil nitrogen level at the 5-6 foot level is not essential, but the soil nitrogen level at the 4-5 foot level is important to optimize sugar beet production. Not all sites were tested to this level and testing to the 5+ foot soil profile level is currently inconceivable economically. Therefore the remainder of the discussion will pertain to the seven sites where soil was tested to depths of four foot which is currently the recommended practice.

The remaining sites will be discussed in general due to the tendency for the relationship between soil factors and yield factors to react similarly between sites. Sampling site averages for each location are presented in tables 3-9 and correlation coefficients (R^2) are presented in Tables 10-16. The sites in consideration range in location from Gluek, MN (western growing area) to Buffalo Lake, MN (eastern growing area). All sites were planted to a Rhizomania type variety except for the Maynard location or site number 1 where a conventional variety was planted.

Nitrogen credit from sugar beet tops averaged 71 pounds per acre and was positively influenced by nitrogen as soil residual or applied (Tables). Therefore, higher nitrogen credit from sugar beet tops is an indication of excess nitrogen. Sugar Beet quality only tended to be inversely related to nitrogen in sugar beet tops. Nitrogen from sugar beet tops would be available early to mid June of the following crop year according to past research. This nitrogen should be taken into account when growing a nitrogen demanding crop following sugar beets.

Tons per acre did not show a good relationship to the soil variable tested. This indicates that the level of applied or residual nitrogen did not increase or decrease the tons per acre significantly. Although the relationship was insignificant, the data indicated a tendency towards a negative relationship between nitrogen and tons per acre. In other words an increase in nitrogen resulted in a decrease in tons per acre. This is probably due to the relatively high levels of soil residual nitrogen at these sites.

Generally, sugar beet quality was negatively influenced by nitrogen as soil residual or applied. Soil residual nitrogen at the 0 to 4 foot soil profile tended to have a greater influence on sugar beet quality than the 0 to 2 foot soil profile. Sucrose and purity were negatively influenced by brei nitrate (Table 2). Brei nitrate was positively influenced by applied nitrogen and soil residual nitrogen. The greatest relationship to brei nitrate tended to be the 0-4 foot soil residual nitrogen plus applied nitrogen.

Revenue per acre was best correlated to nitrogen in the 0-4 soil profile and the relationship of revenue to nitrogen increased when considering 0-4 soil residual nitrogen plus applied nitrogen. Since the end result (and what is going to keep sugar beet growers in business) is the revenue they generate from an acre of sugar beets; this is the most important relationship.

Therefore, the primary conclusions to this research is that:

1. Soil should be tested to a 4 foot level and application of nitrogen to soil need not exceed the recommended nitrogen.
2. The results of this data indicate that nitrogen levels much below the University recommended nitrogen of 130 pounds was needed to optimize revenue per acre.
3. Sugar quality was highest with low brei nitrate (SMBSC goal of 20 ppm brei nitrate is a goal which would optimize sugar beet quality).
4. The greatest return was achieved with low soil residual nitrogen.
5. The response to low residual nitrogen lends to the need for proper nitrogen management in other crops in the rotation with sugar beet production.
6. Tons per acre does not increase and tended to decrease in response to the addition of nitrogen.
7. Revenue per acre highly correlated to soil residual nitrogen plus applied nitrogen and the relationship was negative in that relatively low soil residual nitrogen plus applied nitrogen gave the highest return per acre.

Table 1. Correlation coefficients of nitrogen as soil residual, applied or soil residual plus applied. Influence on sugar beet production at sites with a soil test at a six foot depth.

Combined analysis of three sites

Variables of influence	Purity Sites with 0-6 ft N test (3 sites)		Sucrose percent Sites with 0-6 ft N test (3 sites)		Tons per Acre Sites with 0-6 ft N test (3 sites)		Revenue per Acre Sites with 0-6 ft N test (3 sites)	
	Correlation coefficient (R^2)							
Applied Nitrogen	0.18		0.22		0.41		0.31	
Soil residual nitrogen 0-1 ft	-0.62	*	-0.85	**	-0.77	*	-0.85	**
Soil residual nitrogen 1-2 ft	-0.65	*	-0.63	*	-0.69	*	-0.66	*
Soil residual nitrogen 2-3 ft	-0.79	**	-0.78	*	-0.82	**	-0.83	**
Soil residual nitrogen 3-4 ft	-0.74	*	-0.65	*	-0.59	*	-0.65	*
Soil residual nitrogen 4-5 ft	-0.78	*	-0.90	**	-0.89	**	-0.94	**
Soil residual nitrogen 5-6 ft	-0.40		-0.27		-0.14		-0.22	
Soil residual nitrogen 0-2	-0.70	*	-0.74	*	-0.77	*	-0.77	*
Soil residaul nitrogen 0-4	-0.78	*	-0.77	*	-0.77	*	-0.79	*
Soil residaul nitrogen 0-6	-0.79	*	-0.77	*	-0.76	*	-0.79	*
Soil residual N 0-2 plus applied N	-0.37		-0.37		-0.22		-0.31	
Soil residual N 0-4 plus applied N	-0.71	*	-0.68	*	-0.58		-0.66	*
Soil residual N 0-6 plus applied N	-0.73	**	-0.70	*	-0.60	*	-0.68	*

Notes: variety planted were the same within each testing site, however across sites varieties were different. Varieties included in the three sites were Hilleshog 7073 at two of the sites and American Crystal 999 at one site. Homogeneity of variance was conducted on the data between sites and concluded that sites could be combined.

Table 2 . Correlation coefficients of nitrogen as soil residual, applied or soil residual plus applied. Influence on Brei nitrate of sugar beets at sites with soil testing to a four foot depth.

Variables of influence	Brei nitrate Maynard site # 1		Brei nitrate Gluek site # 2		Brei nitrate Rymond site # 3		Brei nitrate Renville site # 4		Brei nitrate Renville site # 5		Brei nitrate Bird Island site # 6		Brei nitrate Buffalo lake site # 9	
	Correlation coefficient (R^2)													
Applied Nitrogen	0.62		0.55		0.25		0.74		0.60		0.72		0.40	
Soil residual nitrogen 0-1 ft	0.81		0.22		-0.39		0.16		-0.26		-0.53		0.48	
Soil residual nitrogen 1-2 ft	0.75		0.73		-0.49		0.35		0.10		0.36		0.12	
Soil residual nitrogen 2-3 ft	0.91		0.33		0.42		0.42		0.15		-0.23		-0.34	
Soil residual nitrogen 3-4 ft	0.84		0.65		0.45		0.38		0.55		0.52		-0.40	
Accumulative soil nitrogen 0-2	0.57		0.73		-0.39		0.41		0.02		-0.53		0.49	
Accumulative soil nitrogen 0-4	0.72		0.65		0.38		0.50		0.32		0.27		0.44	
Accumulative soil N 0-2 plus applied N	0.56		0.91	*	0.18		0.81	*	0.81	*	0.69		0.51	
Accumulative soil N 0-4 plus applied N	0.92		0.82		0.70		0.82		0.49		0.77	*	0.51	
Purity	0.59		-0.79		-0.36		-0.92	*	-0.74		-0.87		-0.74	
Sucrose	0.79		-0.70		-0.60		-0.93	*	-0.49		-0.83		-0.81	
Revenue per acre	0.72		-0.88	*	-0.62		-0.83	*	-0.73		-0.83	*	-0.84	*

Table 3. Average for four data points collected from each sampling point from the nitrogen strip trials conducted in 2002, Maynard Mn. Location, site 1

Sample area	Applied nitrogen	Top Credit Nitrogen Lbs/A	0-2 Soil nitrate total	0-4 Soil nitrate total	0-6 Soil nitrate total	0-2 Total nitrate plus applied	0-4 Total nitrate plus applied	Stand count per 100 ft.	Tons/acre	Purity	Sucrose percent	Nitrate ppm	Extractable sugar/ton	Extractable sugar/A	Revenue per Acre
1	0	36	21	36	55	21	36	108	23.27	91.04	16.72	15.80	284	6607	793.61
1	35	51	21	36	55	56	71	115	25.88	91.08	17.29	13.95	294	7613	942.35
1	65	68	21	36	55	86	101	108	27.75	90.86	16.43	20.95	278	7710	908.71
1	95	61	21	36	55	116	131	125	26.28	91.13	17.10	25.85	291	7650	938.66
2	0	57	50	78	97	50	78	108	25.39	91.37	17.33	19.35	296	7521	936.09
2	35	49	50	78	97	85	113	103	26.19	91.71	16.63	16.65	285	7461	899.02
2	65	72	50	78	97	115	143	105	25.49	91.68	16.94	15.15	290	7402	906.55
2	95	59	50	78	97	145	173	113	25.27	91.44	16.42	15.10	280	7077	840.03
Average	**42**	**56**	**34**	**54**	**73**	**76**	**96**	**110**	**25.75**	**91.27**	**16.92**	**18.24**	**288**	**7423**	**903.57**

Table 4. Average for four data points collected from each sampling point from the nitrogen strip trials conducted in 2002, Gluek Mn. Location, site 2

Sample area	Applied nitrogen	Top Credit Nitrogen Lbs/A	0-2 Soil nitrate total	0-4 Soil nitrate total	0-2 Total nitrate plus applied	0-4 Total nitrate plus applied	Stand count per 100 ft.	Tons/acre	Purity	Sucrose percent	Nitrate ppm	Extractable sugar/ton	Extractable sugar/A	Revenue per Acre
1-N	0	78	140	171	140	171	183	22.50	91.05	15.28	24.30	258	5808	636.99
1-N	50	40	97	124	147	174	95	21.71	91.87	16.08	14.00	276	5984	699.89
2-N	0	102	94	122	94	122	190	23.68	90.19	16.29	31.00	273	6460	748.62
2-N	50	61	84	108	134	158	213	23.77	88.77	14.02	72.00	228	5414	510.68
3-N	0	69	140	171	140	171	138	23.48	88.58	16.12	31.33	263	6184	692.47
3-N	50	115	97	124	147	174	158	24.55	88.64	15.50	56.50	253	6208	666.12
4-N	0	81	94	122	94	122	165	26.44	91.00	16.33	21.70	277	7317	859.18
4-N	50	80	84	108	134	158	168	25.35	90.44	15.27	26.15	256	6480	703.58
Average	**25**	**78**	**104**	**131**	**129**	**156**	**163**	**23.94**	**90.07**	**15.61**	**34.62**	**260**	**6232**	**689.69**

Table 5. Average for four data points collected from each sampling point from the nitrogen strip trials conducted in 2002, Raymond Mn. Location, site 3

Sample area	Applied nitrogen	Top Credit Nitrogen Lbs/A	0-2 Soil nitrate total	0-4 Soil nitrate total	0-2 Total nitrate plus applied	0-4 Total nitrate plus applied	Stand count per 100 ft.	Tons/acre	Purity	Sucrose percent	Nitrate ppm	Extractable sugar/ton	Extractable sugar/A	Revenue per Acre
1	0	62	121	275	121	275	120	23.57	88.82	13.82	70.00	224	5290	488.85
1	50	81	121	275	171	325	133	24.02	88.77	13.61	129.50	221	5297	477.07
2	0	78	70	138	70	138	128	22.22	89.87	14.46	59.00	239	5316	534.88
2	50	101	70	138	120	188	148	24.01	89.99	14.71	63.50	244	5862	604.33
3	0	79	61	104	61	104	143	24.71	91.41	15.07	31.45	256	6315	685.23
3	50	109	61	104	111	154	108	26.40	89.56	14.38	53.00	237	6250	620.69
Average	**25**	**85**	**84**	**172**	**109**	**197**	**130**	**24.16**	**89.74**	**14.34**	**67.74**	**237**	**5722**	**568.51**

Table 6. Average for four data points collected from each sampling point from the nitrogen strip trials conducted in 2002, Renville Mn. Location, site 4

Sample area	Applied nitrogen	Top Credit Nitrogen Lbs/A	0-2 Soil nitrate total	0-4 Soil nitrate total	0-2 Total nitrate plus applied	0-4 Total nitrate plus applied	Stand count per 100 ft.	Tons/acre	Purity	Sucrose percent	Nitrate ppm	Extractable sugar/ton	Extractable sugar/A	Revenue per Acre
1	0	77	110	186	110	186	148	25.17	90.01	15.20	91	253	6365	682.77
1	140	49	108	277	248	417	120	25.57	89.76	14.75	99	244	6240	642.83
1	250	97	108	277	358	527	120	21.22	87.36	13.78	173	219	4638	412.07
2	0	32	108	150	108	150	125	23.79	89.82	15.98	35	266	6324	714.84
2	140	38	52	79	192	219	103	25.15	90.25	15.27	59	255	6412	694.05
2	250	79	52	79	302	329	100	22.98	89.59	14.93	109	247	5665	590.74
3	0	46	53	83	53	83	118	25.87	89.56	15.54	83	257	6651	726.21
3	140	55	137	168	277	308	105	27.02	88.53	14.13	113	229	6180	586.62
3	250	74	137	168	387	418	85	24.69	88.18	13.99	154	225	5559	515.98
Avarage	130	61	96	163	226	293	114	24.61	89.23	14.84	101.63	244	6004	618.46

Table 7. Average for four data points collected from each sampling point from the nitrogen strip trials conducted in 2002, Renville Mn. Location, site 5

Sample area	Applied nitrogen	Top Credit Nitrogen Lbs/A	0-2 Soil nitrate total	0-4 Soil nitrate total	0-2 Total nitrate plus applied	0-4 Total nitrate plus applied	Stand count per 100 ft.	Tons/acre	Purity	Sucrose percent	Nitrate ppm	Extractable sugar/ton	Extractable sugar/A	Revenue per Acre
1	0	44	57	147	57	147	70	24.87	85.39	14.33	159.00	221	5485	494.03
1	50	78	40	122	90	172	100	25.22	84.76	13.78	261.50	209	5272	435.92
2	0	64	48	130	48	130	87	22.76	84.48	14.59	137.50	221	5032	454.88
2	50	57	56	192	56	242	70	25.48	83.66	13.12	211.50	194	4953	356.28
3	0	42	38	87	38	87	83	24.74	88.80	14.75	105.00	240	5949	602.26
3	50	84	50	166	50	216	110	24.42	86.87	13.55	187.50	213	5200	443.43
Average	**25**	**61**	**48**	**140**	**56**	**165**	**86**	**24.58**	**85.66**	**14.02**	**177.00**	**216**	**5315**	**464.47**

Table 8. Average for four data points collected from each sampling point from the nitrogen strip trials conducted in 2002, Bird Island Mn. Location, site 6

Sample area	Applied nitrogen	Top Credit Nitrogen Lbs/A	0-2 Soil nitrate total	0-4 Soil nitrate total	0-2 Total nitrate plus applied	0-4 Total nitrate plus applied	Stand count per 100 ft.	Tons/acre	Purity	Sucrose percent	Nitrate ppm	Extractable sugar/ton	Extractable sugar/A	Revenue per Acre
1	0	83	31	100	31	100	160	27.46	86.07	15.30	50.50	239	6568	660.40
1	50	99	43	80	93	130	143	27.88	85.37	15.16	68.50	234	6525	638.46
1	110	101	31	100	141	210	158	26.69	85.55	15.18	69.00	235	6273	617.16
1	130	86	31	100	161	230	120	26.71	84.03	14.42	122.00	217	5783	506.50
1	150	116	31	100	181	250	128	30.70	83.10	14.04	136.50	207	6347	514.73
2	0	66	52	103	52	103	133	27.17	87.35	15.32	40.50	245	6649	687.36
2	50	124	31	100	81	150	118	30.35	86.11	14.61	75.00	228	6916	652.78
2	110	97	41	94	151	204	123	24.99	84.05	14.00	103.50	210	5248	437.16
2	130	119	41	94	171	224	138	26.45	85.84	14.42	100.50	224	5917	544.16
2	150	71	37	78	187	228	133	26.48	86.31	14.25	149.00	223	5897	538.83
3	0	73	48	83	48	83	135	28.46	88.00	16.23	28.80	263	7481	836.15
3	50	93	41	94	91	144	138	27.90	87.52	14.73	42.00	235	6566	647.20
3	110	121	43	80	153	190	143	26.08	85.02	14.26	84.50	218	5682	502.39
3	130	118	42.8	80.4	172.8	210.4	148	24.81	85.48	14.63	65.50	226	5602	522.17
3	150	99	30.4	85.2	180.4	235.2	125	23.47	85.64	14.80	91.50	229	5381	512.15
Average	88	98	38	91	126	179	136	27.04	85.70	14.75	81.82	229	6189	587.84

Table 9. Average for four data points collected from each sampling point from the nitrogen strip trials conducted in 2002, Buffalo Lake Location, site 9

Sample area	Applied nitrogen	Top Credit Nitrogen Lbs/A	0-2 Soil nitrate total	0-4 Soil nitrate total	0-2 Total nitrate plus applied	0-4 Total nitrate plus applied	Stand count per 100 ft.	Tons/acre	Purity	Sucrose percent	Nitrate ppm	Extractable sugar/ton	Extractable sugar/A	Revenue per Acre
1	0	76	60	121	60	121	118	20.61	85.19	15.36	48.50	236	4874	483.32
1	30	87	60	121	90	151	135	21.13	86.14	15.40	49.50	241	5094	517.25
1	50	74	83	118	133	168	123	18.71	82.75	14.69	84.00	215	4031	350.42
1	70	52	83	118	153	188	108	18.82	80.56	14.63	50.00	205	3860	308.55
2	0	74	32	89	32	89	133	22.37	87.84	15.56	40.50	251	5609	596.03
2	30	90	32	89	62	119	130	21.71	89.39	15.26	41.00	252	5463	582.83
2	50	94	59	104	109	154	143	24.09	86.54	14.90	43.00	234	5647	553.76
2	70	72	59	104	129	174	153	22.78	86.89	15.35	50.00	243	5543	569.02
3	0	47	52	122	52	122	140	24.41	85.46	15.72	26.20	244	5945	611.11
3	30	69	52	122	82	152	138	22.66	83.18	14.82	36.00	219	4971	444.23
3	50	70	151	187	201	237	135	26.63	81.78	14.08	65.50	202	5379	418.06
3	70	52	151	187	221	257	105	19.24	75.99	13.61	116.00	170	3269	163.43
Average	**38**	**71**	**73**	**124**	**110**	**161**	**130**	**21.93**	**84.31**	**14.94**	**54.18**	**226**	**4974**	**466.50**

Table 10. Correlation coefficients of nitrogen as soil residual, applied or soil residual plus applied. Influence on sugar beet production at Maynard MN site (site numbeer 1).

Variables of influence	Purity Sites with 0-4 ft N test		Sucrose percent Sites with 0-4 ft N test		Tons per Acre Sites with 0-4 ft N test	Revenue per Acre Sites with 0-4 ft N test	
			Correlation coefficient (R^2)				
Applied Nitrogen	-0.55		-0.56		0.70	0.59	
Soil residual nitrogen 0-1 ft	-0.90	*	-0.68		-0.09	-0.500	
Soil residual nitrogen 1-2 ft	-0.92	*	-0.78		-0.19	-0.510	
Soil residual nitrogen 2-3 ft	-0.90	*	-0.78		-0.29	-0.600	
Soil residual nitrogen 3-4 ft	-0.90	*	-0.88	*	-0.27	-0.800	
Soil residual nitrogen 0-2	0.89	*	-0.69		-0.13	-0.530	
Soil residaul nitrogen 0-4	-0.90	*	-0.88	*	-0.23	-0.842	*
Soil residual N 0-2 plus applied N	0.83		-0.65		0.15	0.51	
Soil residual N 0-4 plus applied N	0.92	*	-0.93	*	0.39	0.91	*

Table 11. Correlation coefficients of nitrogen as soil residual, applied or soil residual plus applied. Influence on sugar beet production at Gluek MN site (site numbeer 2).

Variables of influence	Purity Sites with 0-4 ft N test (6 sites)		Sucrose percent Sites with 0-4 ft N test (8 sites)		Tons per Acre Sites with 0-4 ft N test (8 sites)		Revenue per Acre Sites with 0-4 ft N test (8 sites)	
			Correlation coefficient (R^2)					
Applied Nitrogen	-0.53		-0.42		0.26		-0.33	
Soil residual nitrogen 0-1 ft	-0.11		0.03		-0.36		-0.18	
Soil residual nitrogen 1-2 ft	-0.59		-0.45		-0.68		-0.81	
Soil residual nitrogen 2-3 ft	-0.13		-0.09		-0.59		-0.36	
Soil residual nitrogen 3-4 ft	-0.53		-0.52		-0.47		-0.73	
Soil residual nitrogen 0-2	-0.58		-0.43		-0.69		-0.80	
Soil residaul nitrogen 0-4	-0.48		-0.41		-0.62		-0.71	
Soil residual N 0-2 plus applied N	-0.78		-0.60		-0.33		-0.81	
Soil residual N 0-4 plus applied N	-0.65		-0.55		-0.51		-0.81	

Table 12. Correlation coefficients of nitrogen as soil residual, applied or soil residual plus applied. Influence on sugar beet production at Raymond MN site (site numbeer 3).

Variables of influence	Purity Sites with 0-4 ft N test (6 sites)		Sucrose percent Sites with 0-4 ft N test (8 sites)		Tons per Acre Sites with 0-4 ft N test (8 sites)		Revenue per Acre Sites with 0-4 ft N test (8 sites)	
			Correlation coefficient (R^2)					
Applied Nitrogen	0.47		-0.87	*	-0.02		-0.58	
Soil residual nitrogen 0-1 ft	-0.32		-0.64		0.35		-0.45	
Soil residual nitrogen 1-2 ft	-0.50		-0.31		0.35		-0.23	
Soil residual nitrogen 2-3 ft	-0.99	*	0.41		0.63		-0.38	
Soil residual nitrogen 3-4 ft	-0.44		0.93	*	0.60		0.27	
Soil residual nitrogen 0-2	-0.48		-0.48		0.29		-0.40	
Soil residaul nitrogen 0-4	-0.97	*	-0.50		-0.60		-0.28	
Soil residual N 0-2 plus applied N	0.04		-0.93		0.03		-0.63	
Soil residual N 0-4 plus applied N	-0.45		-0.83	*	-0.65		-0.99	*

Table 13. Correlation coefficients of nitrogen as soil residual, applied or soil residual plus applied. Influence on sugar beet production at Renville MN site (site numbeer 4).

Variables of influence	Purity Sites with 0-4 ft N test (6 sites)		Sucrose percent Sites with 0-4 ft N test (8 sites)		Tons per Acre Sites with 0-4 ft N test (8 sites)		Revenue per Acre Sites with 0-4 ft N test (8 sites)	
			Correlation coefficient (R^2)					
Applied Nitrogen	-0.61		-0.78		-0.46		-0.83	*
Soil residual nitrogen 0-1 ft	-0.38		-0.32		0.38		-0.18	
Soil residual nitrogen 1-2 ft	-0.23		-0.32		-0.35		-0.37	
Soil residual nitrogen 2-3 ft	-0.34		-0.40		-0.39		-0.45	
Soil residual nitrogen 3-4 ft	-0.23		-0.28		-0.34		-0.34	
Soil residual nitrogen 0-2	-0.53		-0.54		0.13		-0.43	
Soil residaul nitrogen 0-4	-0.49		-0.53		-0.24		-0.53	
Soil residual N 0-2 plus applied N	-0.72		-0.88	*	-0.38		-0.89	*
Soil residual N 0-4 plus applied N	-0.72		-0.87	*	-0.47		-0.90	*

Table 14. Correlation coefficients of nitrogen as soil residual, applied or soil residual plus applied. Influence on sugar beet production at Renville MN site (site numbeer 5).

Variables of influence	Purity Sites with 0-4 ft N test (6 sites)		Sucrose percent Sites with 0-4 ft N test (8 sites)		Tons per Acre Sites with 0-4 ft N test (8 sites)		Revenue per Acre Sites with 0-4 ft N test (8 sites)	
			Correlation coefficient (R^2)					
Applied Nitrogen	-0.33		-0.92	*	0.52		-0.71	
Soil residual nitrogen 0-1 ft	0.32		-0.37		0.71		0.06	
Soil residual nitrogen 1-2 ft	-0.65		-0.33		-0.13		-0.59	
Soil residual nitrogen 2-3 ft	-0.43		-0.76		0.10		-0.74	
Soil residual nitrogen 3-4 ft	-0.71		-0.93	*	0.40		-0.93	*
Soil residual nitrogen 0-2	-0.54		-0.42		0.07		-0.56	
Soil residaul nitrogen 0-4	-0.62		-0.83		0.24		-0.86	
Soil residual N 0-2 plus applied N	-0.51		-0.40		0.40		-0.45	
Soil residual N 0-4 plus applied N	-0.56		-0.98	*	0.41		-0.89	*

Table 15. Correlation coefficients of nitrogen as soil residual, applied or soil residual plus applied. Influence on sugar beet production at Bird Island MN site (site numbeer 6).

Variables of influence	Purity Sites with 0-4 ft N test (6 sites)		Sucrose percent Sites with 0-4 ft N test (8 sites)		Tons per Acre Sites with 0-4 ft N test (8 sites)		Revenue per Acre Sites with 0-4 ft N test (8 sites)	
	Correlation coefficient (R^2)							
Applied Nitrogen	-0.67		-0.64		-0.37		-0.77	*
Soil residual nitrogen 0-1 ft	0.55		0.40		-0.14		0.39	
Soil residual nitrogen 1-2 ft	-0.40		-0.25		0.60		-0.58	
Soil residual nitrogen 2-3 ft	0.18		-0.08		-0.04		-0.01	
Soil residual nitrogen 3-4 ft	-0.44		-0.43		0.28		-0.32	
Soil residual nitrogen 0-2	0.53		0.40		-0.05		0.42	
Soil residaul nitrogen 0-4	-0.16		-0.30		0.36		-0.10	
Soil residual N 0-2 plus applied N	-0.63		-0.63		-0.39		-0.76	*
Soil residual N 0-4 plus applied N	-0.71	*	-0.70	*	-0.32		-0.80	*

Table 16. Correlation coefficients of nitrogen as soil residual, applied or soil residual plus applied. Influence on sugar beet production at Buffalo Lake, MN site (site numbeer 9).

Variables of influence	Purity Sites with 0-4 ft N test (6 sites)		Sucrose percent Sites with 0-4 ft N test (8 sites)		Tons per Acre Sites with 0-4 ft N test (8 sites)		Revenue per Acre Sites with 0-4 ft N test (8 sites)	
	Correlation coefficient (R^2)							
Applied Nitrogen	-0.60		-0.53		-0.39		-0.64	
Soil residual nitrogen 0-1 ft	-0.69		-0.58		-0.40		-0.70	
Soil residual nitrogen 1-2 ft	-0.42		-0.24		0.10		-0.29	
Soil residual nitrogen 2-3 ft	0.30		0.27		0.73		0.49641	
Soil residual nitrogen 3-4 ft	0.66		0.51		0.47		0.69	
Soil residual nitrogen 0-2	-0.74	*	-0.61		-0.38		-0.73	*
Soil residaul nitrogen 0-4	-0.70	*	-0.58		-0.20		-0.64	
Soil residual N 0-2 plus applied N	-0.77	*	-0.65		-0.43		0.78	*
Soil residual N 0-4 plus applied N	-0.79	*	-0.67		-0.35		-0.77	*

Back To Table of Contents

Herbicide Program Influence on Weed Control and Sugar Beet Production.

Introduction
Weed control options have been dynamic over the past few years. We have seen the possibility of Roundup Ready and Liberty Link sugar beets on the brink of approval and yet fade away due to the lack of marketability and disease resistance. The future of Roundup Ready and Liberty Link sugar beets is unknown at this time. Therefore, conventional weed control programs will continue to be the primary method of eradicating weeds from sugar beets in the near future. Conventional weed control in sugar beets continues to change each and every year. Possible spray programs have changed with the renewed possibilities of effective and affordable preplant incorporated, preemerge or postemerge soil active herbicides, as well as generic postemergence herbicides. This is why a need for investigation into the efficacy of weed control options in sugar beets continue.

Methods summary
An experiment was conducted to evaluate various weed control programs for growers in the Southern Minnesota Beet Sugar Cooperative growing area. Three sites were selected, Belgrade (experiment 0221), Raymond (experiment 0222), and Buffalo Lake (experiment 0223) for this trial and each were established in a randomized complete block design with four replications. Plots were six rows wide and 30 ft long, with the treatment applied to the middle 4 rows. Sugar beets were planted at a four inch spacing with a J.D. 7000 planter.

Treatments were applied preplant incorporated (P), cotyledon stage of weeds (A), and sequential treatments were made on seven day spray intervals. Treatment B was applied 7 days after treatment A or approximately at the 2 leaf stage of sugar beet, treatment C was applied 7 days after treatment B or approximately at the 4 leaf stage of sugar beet, treatment D was applied 7 days after C or approximately at the 6 leaf stage of sugar beet. If the weed control program treatment was planned to skip a given treatment interval, then the time after the initial treatment for that specified treatment would trigger the initiation of the application. Application specifics are presented in tables 1, 2 and 3 for the Belgrade, Raymond and Buffalo Lake locations, respectively. Fungicide applications for cercospora leaf spot were made in accordance with normal production practices.
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Weed control of amaranth species was evaluated as a group. The amaranth species group in Southern Minnesota Beet Sugar Cooperative growers fields typically includes Redroot pigweed (Amaranthus retroflexus), powell amaranth (Amaranthus powellii), common and tall Waterhemp (Amaranthus radus and Amaranthus tuberculatus, respectively)

Ten feet from each of the middle two rows were harvested for yield and quality analysis. Buffalo Lake site was not harvested due to the extreme weed pressure. Sugar beets were analyzed for yield and quality through data collected from the SMBSC quality lab.

Results summary

Terms used within summary
Standard microrate- four applications of: Betamix at 8 oz./A + Upbeet at 1/8 oz./A + Stinger at 1.25 oz/A + Methylated seed oil/base blend (Base) at 2% V/V

Betamix conventional treatment – Four applications; application 1. Betamix at 16 oz./A application 2. Betamix at 20 oz./A Application 3. Betamix at 20 oz/A Application 4. Betamix at 24 oz/A

Dual is the product Dual II Magnum

Belgrade (experiment 0221)
Treatments at Belgrade only gave sugar beet injury (which was 9 percent or less) at the July 5 evaluation and had decreased to 0 by the August 15 evaluation (Table 4). Applying Outlook between postemergence herbicide treatments or the addition of Outlook or Dual II Magnum to the spray mixture did not significantly influence sugar beet injury. Betamix conventional treatment gave significantly higher control of amaranth species and similar control of lambsquarter compared to the standard micro rate. Increasing Betamix rate from 8 to12 oz. in the last two of four applications or adding 4 oz. of Nortron to the standard microrate increased control of amaranth species so the treatment was similar to that achieved by the conventional Betamix treatment. Soil active herbicides tended to give higher amaranth species and lambsquarter control when added to the postemergence weed control treatment. Outlook needed to be applied prior to fourth leaf sugar beet stage (C) to increase amaranth species control. Amaranth species control was significantly increased by applying Outlook between the second (B) and fourth (C) sugar beet leaf stage, with the second (B) sugar beet leaf stage application, or as a spit application with the second (B) and fourth (C) sugar beet leaf stage applications significantly increased amaranth species control compared to the standard microrate applied alone. Three applications when compared to four applications of the standard microrate with Outlook or Dual II Magnum in the spray mix, gave a reduced amaranth species weed control, although not significantly reduced. Therefore, the addition of Outlook as a lay-by treatment did not allow for a reduction in applications. However, Dual II Magnum applied preplant incorporated with three standard microrates applied postemergence significantly increased control of amaranth species compared to four standard

microrate applications. Nortron at 6 pt./acre applied preplant incorporated with two applications of the standard microrate or Betamix increased amaranth species control compared to four applications of the standard microrate or Betamix.

Sugar beet yield was not directly related to weed control or sugar beet injury (Table 5). This was due to the sugar beet stand being highly variable, even though the variability in sugar beet stand was not related to the effect of the herbicide treatment. Therefore, the results of this data in reference to yield performance will be discussed as related to data collected at other harvested sites (Raymond was the only other site which was harvested).

Raymond (experiment 0222)
Sugar beet injury at the Raymond location ranged from 0 to 39 percent at the July 9 evaluation (Table 6). Injury to the sugar beet had decreased by the August 16 evaluation so that only one treatment (#15) was statistically higher than the other treatments. The sugar beet injury at the August 9 evaluation ranged from 0-15 percent.

Lambsquarter and amaranth species control was generally very good with most of the treatments giving 85 percent or greater control. Whenever Outlook or Dual II Magnum were applied lay-by in the weed control treatment and the other postemergence products were reduced in rate or number of applications, the control of lambsquarters was below 90 percent and amaranth species control tended to be below 85 percent.

Treatments with preplant incorporated herbicides, such as Dual II Magnum, Nortron, or Eptam plus Roneet tended to give the highest yield and sugar per acre (Table 7). The addition of Outlook or Dual II Magnum as a lay-by treatment did not increase yield and sucrose per acre of the standard Microrate or conventional treatments.

Buffalo Lake (experiment 0223)
Sugar beet injury at the Buffalo Lake location was very dramatic (Table 8). The sugar beets were infected with aphanomyces and rhizomania, and the degree of infestation was greater as you moved from left to right within the plot area or across replications. When sugar beet injury ratings were taken, the above mentioned factors were taken into consideration. Injury to the sugar beets at the July 8 evaluation ranged from 0 to 55 percent. One month later at the August 13 evaluation the sugar beet injury decreased to a range of 0 to 34 percent. The reasons for the excess sugar beet injury were high temperature and relative humidity at the third, fourth and fifth spray timings (Table 3), disease in the plot area making the sugar beets more susceptible to injury, and the addition of a soil active herbicide (with the exception of Nortron) tended to increase sugar beet injury.

Treatments gave substantially higher control of lambsquarter than amaranth species. Conventional rate of Betamix tended to or did give higher level of weed control than the standard microrate. Increasing the rate of Betamix in the last two applications of the standard microrate increased control of lambsquarter and amaranth species so that the control tended to be greater than the conventional Betamix treatment. The addition of Nortron at 4 oz/A to the standard microrate only tended to increase control of amaranth species and tended to decrease lambsquarter control.

The best control of amaranth species and common lambsquarter of the treatments where Outlook was added to the weed control program was achieved when Outlook was applied at the full rate (21 oz/A) at the B application or two leaf stage of sugar beet. Reducing rates, number of applications, or applying Outlook later in the weed control program gave reduced weed control.

The best weed control achieved of the treatments where Dual II Magnum was applied in the weed control program occurred when Dual II Magnum was applied preplant incorporated. Dual II Magnum applied as lay-by treatment gave lower weed control compared to Dual II Magnum applied preplant incorporated.

Outlook and Dual II Magnum application as lay by treatments did not perform similarly. However, the best lay-by Outlook treatment applications were made in a four spray program compared to Dual II Magnum lay-by applications which were made in spray programs of something less than four spray applications. If Dual II Magnum was applied in a four spray program, then Dual II Magnum would probably have performed similarly to Outlook lay-by applications.

Amaranth species control was significantly lower when Nortron PPI was added to the weed control program when compared to Outlook or Dual II Magnum. Normally, Nortron performs as good or better than Outlook or Dual II Magnum. However, Nortron was applied with a reduced number of postemergence applications. A greater number of postemergence applications were needed at this site to obtain acceptable weed control due to the weed seed pressure at this site. Therefore, this author believes applications with Nortron in the weed control program at this site would have performed equal to or better than Outlook or Dual II Magnum if the number of applications would have been the same.

Table 1. Experiment specifics for Belgrade location, Experiment number 0221.

Variables	Experiment Number	Planting Dates	1 st appl. PPI	2 nd appl. Post	3 rd appl. Post	4 th appl. Post	5 th appl. Post
Dates	0221	4/29/2002	4/29/2002	5/17/2002	5/24/2002	5/31/2002	6/7/2002
Crop Stage			N/A	Cotyl.	Cotyl.-2 lf	2lf-4lf	4lf-6lf
Weed stage							
Amaranth			N/A	Cotyl.	Cotyl.-1/2 in.	Cotyl.-1.5 in.	Cotyl.-3 in.
Lambs Quarter			N/A	Cotyl.	Cotyl.-1/2 in.	Cotyl.-1.5 in.	Cotyl.-3 in.
Wind Mph			25	15	0-5	15	5-10
PSI			40	40	40	40	40
Temp.			45	50	71	81	84
Finish time			12 p.m.	2 p.m.	2:30 p.m.	3:30 p.m.	5:00 p.m.
Variety							
Evaluation 1 date		7/5/2002					
Evaluation 2 date		8/14/2002					
Harvest dates		9/10/2002					

Table 2. Experiment specifics for Raymond location, Experiment number 0222.

Variables	Experiment Number	Planting Dates	1 st appl. PPI	2 nd appl. Post	3 rd appl. Post	4 th appl. Post	5 th appl. Post
Dates	0222	5/9/2002	5/2/2002	5/27/2002	6/4/2002	6/11/2002	6/18/2002
Crop Stage			N/A	Cotyl.	Cotyl.-2 lf	2lf-4lf	4lf-6lf
Weed stage							
Amaranth			N/A	Cotyl.	Cotyl.-1/2 in.	Cotyl.-1.5 in.	Cotyl.-3 in.
Lambs Quarter			N/A	Cotyl.	Cotyl.-1/2 in.	Cotyl.-1.5 in.	Cotyl.-3 in.
Wind Mph			10	0-5	0-5	10	5-10
PSI			40	40	40	40	40
Temp.			50	82	78	82	89
Finish time			11:00 A.m.	12:00 p.m.	4:00 p.m.	7:30 p.m.	5:00 p.m.
Variety			Beta 4930				
Evaluation 1 date		7/9/2002					
Evaluation 2 date		8/16/2002					
Harvest dates		9/12/2002					

Table 3. Experiment specifics for Buffalo Lake location, Experiment number 0223.

Variables	Experiment Number	Planting Dates	1 st appl. PPI	2 nd appl. Post	3 rd appl. Post	4 th appl. Post	5 th appl. Post
Dates	0223	4/30/2002	5/3/2002	5/23/2002	5/30/2002	6/6/2002	6/14/2002
Crop Stage			N/A	Cotyl.	Cotyl.-2 lf	2lf-4lf	4lf-6lf
Weed stage							
Amaranth			N/A	Cotyl.	Cotyl.-1/2 in.	Cotyl.-1.5 in.	Cotyl.-3 in.
Lambs Quarter			N/A	Cotyl.	Cotyl.-1/2 in.	Cotyl.-1.5 in.	Cotyl.-3 in.
Wind Mph			10	15	0-5	15	0-5
PSI			40	40	40	40	40
Temp.			40	78	85	83	86
Finish time			1:15 p.m.	2:15 p.m.	11:00 a.m.	3:30 p.m.	5:15 p.m.
Variety			Beta 4600				

Evaluation 1 date	7/8/2002
Evaluation 2 date	8/13/2002

Table 4. Hebicide program influence on weed control efficacy
Experiment number 0221

Trt #	Appl. Time	Treatment Description	Herbicide rate	Eval1 Amar.	Eval 2 Amar.	Eval 1 Lambs Quarter	Eval 2 Lambs Quarter	Eval 1 S. Beet Injury	Eval 2 S. Beet Injury
1	a	Weed Free check		99	99	99	99	0	0
1	b	Weed Free check							
1	c	Weed Free check							
1	d	Weed Free check							
2	a	Betamix	16 oz.	84	74	94	86	4	0
2	b	Betamix	20 oz.						
2	c	Betamix	20 oz.						
2	d	Betamix	24 oz.						
3	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	63	58	90	84	1	0
3	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
3	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
3	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
4	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	78	69	94	86	3	0
4	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
4	c	Betamix+Stinger+Upbeet+MSO	12 oz.+1.25 oz.+1/8 oz+2%						
4	d	Betamix+Stinger+Upbeet+MSO	12 oz.+1.25 oz.+1/8 oz+2%						
5	a	Betamix+Stinger+Upbeet+MSO+Etho.	8 oz.+1.25 oz.+1/8 oz+2%+4 oz.	74	65	98	93	1	0
5	b	Betamix+Stinger+Upbeet+MSO+Etho.	8 oz.+1.25 oz.+1/8 oz+2%+4 oz.						
5	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
5	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
6	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	95	89	98	93	1	0
6	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
6		**Outllook (applied between b&c application)**	**21 oz. (applied between b&c application)**						
6	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
7	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	96	93	97	89	6	0
7	b	Outlook+Betamix+Stinger+Upbeet+MSO	21 oz+8 oz.+1.25 oz.+1/8 oz+2%						
7	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
7	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
8	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	77	69	97	90	1	0
8	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
8	c	Outlook+Betamix+Stinger+Upbeet+MSO	21 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
8	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
9	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	97	91	98	91	5	0
9	b	Outlook+Betamix+Stinger+Upbeet+MSO	12 oz+8 oz.+1.25 oz.+1/8 oz+2%						
9	c	Outlook+Betamix+Stinger+Upbeet+MSO	9 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
9	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
10	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	86	76	95	85	9	0
10	b	Outlook+Betamix+Stinger+Upbeet+MSO	21 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
10	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
11	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	89.8	81.3	93.3	85.0	2.5	0.0
11	b	Outlook+Betamix+Stinger+Upbeet+MSO	12 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
11	c	Outlook+Betamix+Stinger+Upbeet+MSO	9 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
12	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	96	89	96	88	8	0
12	b	Outlook+Betamix+Stinger+Upbeet **(no oil)**	21 oz+8 oz.+1.25 oz.+1/8 oz **(no oil)**						
12	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
12	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						

Table 4. Hebicide program influence on weed control efficacy ***(Continued)***
Experiment number 0221

Trt #	Appl. Time	Treatment Description	Herbicide rate	Eval1 Amar.	Eval 2 Amar.	Eval 1 Lambs Quarter	Eval 2 Lambs Quarter	Eval 1 S. Beet Injury	Eval 2 S. Beet Injury
13	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	97	90	99	91	8	0
13	b	Outlook+Betamix+Stinger+Upbeet **(no oil)**	12 oz+8 oz.+1.25 oz.+1/8 oz **(no oil)**						
13	c	Outlook+Betamix+Stinger+Upbeet **(no oil)**	9 oz+8 oz.+1.25 oz.+1/8 oz+1.5% **(no oil)**						
13	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
14	p	Dual	32 oz.	97	91	94	86	3	0
14	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
14	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
14	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
15	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	77	66	95	84	4	0
15	b	Dual+Betamix+Stinger+Upbeet+MSO	32 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
15	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
16	p	Nortron	4.5 pt.	64	61	70	64	6	0
16	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
16	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
17	p	Nortron	6 pt.	91	83	96	78	0	0
17	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
17	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
18	P	Dual	32 oz.	81	74	86	69	8	0
18	a	Betamix	16 oz.						
18	b	Betamix	20 oz.						
18	c	Outlook	21 oz.						
19	P	Eptam+Roneet	2+2	77	71	91	80	0	0
19	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
19	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
19	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
20	p	Nortron	6 pt.	89	81	96	85	0	0
20	b	Betamix	16 oz.						
20	c	Betamix	20 oz.						
21	a	Betamix	16 oz.	48	46	56	51	0	0
21	b	Betamix+Outlook	16 oz.+12 oz.						
21	c	Betamix+Outlook	16 oz.+ 9 oz						
21	d	Betamix	20 oz.						
			LSD (0.05)	**20**	**17**	**14**	**13**	**3**	**NS**

Table 5. Hebicide program influence on yield of sugar beets
Experiment number 0221

Trt #	Appl. Time	Treatment Description	Herbicide rate		Tons/ Acre	Sucrose percent	Loss to Molasses	Recov. Sucrose per Ton	Recov. Sucrose per Acre
1	a	Weed Free check			22.51	13.09	1.36	235	5279
1	b	Weed Free check							
1	c	Weed Free check							
1	d	Weed Free check							
2	a	Betamix	16 oz.		11.38	13.65	1.33	246	2795
2	b	Betamix	20 oz.						
2	c	Betamix	20 oz.						
2	d	Betamix	24 oz.						
3	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		13.43	13.36	1.35	240	3246
3	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
3	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
3	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
4	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		16.69	14.04	1.32	254	4227
4	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
4	c	Betamix+Stinger+Upbeet+MSO	12 oz.+1.25 oz.+1/8 oz+2%						
4	d	Betamix+Stinger+Upbeet+MSO	12 oz.+1.25 oz.+1/8 oz+2%						
5	a	Betamix+Stinger+Upbeet+MSO+Etho.	8 oz.+1.25 oz.+1/8 oz+2%+4 oz.		8.83	13.34	1.35	240	2140
5	b	Betamix+Stinger+Upbeet+MSO+Etho.	8 oz.+1.25 oz.+1/8 oz+2%+4 oz.						
5	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
5	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
6	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		14.84	14.07	1.32	255	3797
6	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
6		**Outllook (applied between b&c application)**	**21 oz. (applied between b&c application)**						
6	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
7	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		14.42	14.16	1.30	257	3758
7	b	Outlook+Betamix+Stinger+Upbeet+MSO	21 oz+8 oz.+1.25 oz.+1/8 oz+2%						
7	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
7	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
8	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		13.94	13.91	1.32	252	3502
8	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
8	c	Outlook+Betamix+Stinger+Upbeet+MSO	21 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
8	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
9	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		16.83	17.30	1.23	321	5084
9	b	Outlook+Betamix+Stinger+Upbeet+MSO	12 oz+8 oz.+1.25 oz.+1/8 oz+2%						
9	c	Outlook+Betamix+Stinger+Upbeet+MSO	9 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
9	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
10	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		13.28	15.40	1.22	284	3729
10	b	Outlook+Betamix+Stinger+Upbeet+MSO	21 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
10	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
10									
11	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		17.83	14.89	1.23	273	5039
11	b	Outlook+Betamix+Stinger+Upbeet+MSO	12 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
11	c	Outlook+Betamix+Stinger+Upbeet+MSO	9 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
11									
12	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		14.15	14.24	1.30	259	3678
12	b	Outlook+Betamix+Stinger+Upbeet **(no oil)**	21 oz+8 oz.+1.25 oz.+1/8 oz **(no oil)**						
12	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
12	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						

Table 5. Hebicide program influence on yield of sugar beets ***(Continued)***
Experiment number 0221

Trt #	Appl. Time	Treatment Description	Herbicide rate		Tons/ Acre	Sucrose percent	Loss to Molasses	Recov. Sucrose per Ton	Recov. Sucrose per Acre
13	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		16.55	13.76	1.33	249	4142
13	b	Outlook+Betamix+Stinger+Upbeet **(no oil)**	12 oz+8 oz.+1.25 oz.+1/8 oz **(no oil)**						
13	c	Outlook+Betamix+Stinger+Upbeet **(no oil)**	9 oz+8 oz.+1.25 oz.+1/8 oz+1.5% **(no oil)**						
13	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
14	p	Dual	32 oz.		14.86	14.13	1.31	256	3814
14	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
14	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
14	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
15	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		13.77	13.32	1.35	240	3287
15	b	Dual+Betamix+Stinger+Upbeet+MSO	32 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
15	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
15									
16	p	Nortron	4.5 pt.		9.88	13.99	1.32	253	2521
16	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
16	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
16									
17	p	Nortron	6 pt.		19.77	13.91	1.32	252	4945
17	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
17	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
17									
18	P	Dual	32 oz.		15.79	13.82	1.32	250	3923
18	a	Betamix	16 oz.						
18	b	Betamix	20 oz.						
18	c	Outlook	21 oz.						
19	P	Eptam+Roneet	2+2		23.76	14.49	1.28	264	6289
19	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
19	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
19	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
20	p	Nortron	6 pt.		20.26	14.48	1.29	264	5346
20	b	Betamix	16 oz.						
20	c	Betamix	20 oz.						
20									
21	a	Betamix	16 oz.		17.24	14.32	1.29	261	4506
21	b	Betamix+Outlook	16 oz.+12 oz.						
21	c	Betamix+Outlook	16 oz.+ 9 oz						
21	d	Betamix	20 oz.						
			LSD (0.05)		***5.42***	***2.38***	***0.10***	***49***	***1532***

Table 6. Hebicide program influence on weed control efficacy in sugar beets
Experiment number 0222

Trt #	Appl. Time	Treatment Description	Herbicide rate		Eval 1 Amar.	Eval 2 Amar.	Eval 1 Lambs Quarter	Eval 2 Lambs Quarter	Eval 1 S. Beet Injury	Eval 2 S. Beet Injury
1	a	Weed Free check			99	99	99	99	0	0
1	b	Weed Free check								
1	c	Weed Free check								
1	d	Weed Free check								
2	a	Betamix	16 oz.		95	88	98	90	6	0
2	b	Betamix	20 oz.							
2	c	Betamix	20 oz.							
2	d	Betamix	24 oz.							
3	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		94	85	99	93	13	3
3	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
3	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
3	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
4	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		93	86	97	90	16	3
4	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
4	c	Betamix+Stinger+Upbeet+MSO	12 oz.+1.25 oz.+1/8 oz+2%							
4	d	Betamix+Stinger+Upbeet+MSO	12 oz.+1.25 oz.+1/8 oz+2%							
5	a	Betamix+Stinger+Upbeet+MSO+Etho.	8 oz.+1.25 oz.+1/8 oz+2%+4 oz.		96	86	99	93	18	4
5	b	Betamix+Stinger+Upbeet+MSO+Etho.	8 oz.+1.25 oz.+1/8 oz+2%+4 oz.							
5	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
5	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
6	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		84	79	97	91	39	13
6	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
6		**Outllook (applied between b&c application)**	**21 oz. (applied between b&c application)**							
6	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
7	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		97	89	99	84	34	13
7	b	Outlook+Betamix+Stinger+Upbeet+MSO	21 oz+8 oz.+1.25 oz.+1/8 oz+2%							
7	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
7	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
8	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		98	93	99	95	25	6
8	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
8	c	Outlook+Betamix+Stinger+Upbeet+MSO	21 oz.+8 oz.+1.25 oz.+1/8 oz+2%							
8	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
9	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		91	84	99	94	20	6
9	b	Outlook+Betamix+Stinger+Upbeet+MSO	12 oz+8 oz.+1.25 oz.+1/8 oz+2%							
9	c	Outlook+Betamix+Stinger+Upbeet+MSO	9 oz.+8 oz.+1.25 oz.+1/8 oz+2%							
9	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
10	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		97	88	99	86	35	13
10	b	Outlook+Betamix+Stinger+Upbeet+MSO	21 oz.+8 oz.+1.25 oz.+1/8 oz+2%							
10	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
10										
11	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		91	83	92	83	20	3
11	b	Outlook+Betamix+Stinger+Upbeet+MSO	12 oz.+8 oz.+1.25 oz.+1/8 oz+2%							
11	c	Outlook+Betamix+Stinger+Upbeet+MSO	9 oz.+8 oz.+1.25 oz.+1/8 oz+2%							
11										
12	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		98	93	99	88	11	1
12	b	Outlook+Betamix+Stinger+Upbeet **(no oil)**	21 oz+8 oz.+1.25 oz.+1/8 oz **(no oil)**							
12	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
12	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							

Table 6. Hebicide program influence on weed control efficacy in sugar beets ***(Continued)***
Experiment number 0222

Trt #	Appl. Time	Treatment Description	Herbicide rate		Eval 1 Amar.	Eval 2 Amar.	Eval 1 Lambs Quarter	Eval 2 Lambs Quarter	Eval 1 S. Beet Injury	Eval 2 S. Beet Injury
13	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		99	96	99	95	29	6
13	b	Outlook+Betamix+Stinger+Upbeet **(no oil)**	12 oz+8 oz.+1.25 oz.+1/8 oz **(no oil)**							
13	c	Outlook+Betamix+Stinger+Upbeet **(no oil)**	9 oz+8 oz.+1.25 oz.+1/8 oz+1.5% **(no oil)**							
13	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
14	p	Dual	32 oz.		92	83	99	95	18	3
14	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
14	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
14	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
15	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%		91	83	90	84	30	15
15	b	Dual+Betamix+Stinger+Upbeet+MSO	32 oz.+8 oz.+1.25 oz.+1/8 oz+2%							
15	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
15										
16	p	Nortron	4.5 pt.		93	83	98	90	20	8
16	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
16	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
16										
17	p	Nortron	6 pt.		97	95	95	94	30	11
17	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
17	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
17										
18	P	Dual	32 oz.		97	89	96	92	26	9
18	a	Betamix	16 oz.							
18	b	Betamix	20 oz.							
18	c	Outlook	21 oz.							
19	P	Eptam+Roneet	2+2		98	94	99	90	24	9
19	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
19	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
19	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%							
20	p	Nortron	6 pt.		96	89	98	91	23	8
20	b	Betamix	16 oz.							
20	c	Betamix	20 oz.							
20										
21	a	Betamix	16 oz.		81	74	89	81	13	4
21	b	Betamix+Outlook	16 oz.+12 oz.							
21	c	Betamix+Outlook	16 oz.+ 9 oz							
21	d	Betamix	20 oz.							
			LSD (0.05)		8	9	7	7	20	14

Table 7. Hebicide program influence on yield of sugar beets
Experiment number 0222

Trt #	Appl. Time	Treatment Description	Herbicide rate	Tons/ Acre	Sucrose percent	Loss to Molasses	Recov. Sucrose per Ton	Recov. Sucrose per Ton
1	a	Weed Free check						
1	b	Weed Free check						
1	c	Weed Free check						
1	d	Weed Free check						
2	a	Betamix	16 oz.	13.74	15.68	1.19	290	3927
2	b	Betamix	20 oz.					
2	c	Betamix	20 oz.					
2	d	Betamix	24 oz.					
3	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	11.54	14.24	1.30	259	2988
3	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
3	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
3	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
4	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	13.91	14.37	1.30	261	3644
4	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
4	c	Betamix+Stinger+Upbeet+MSO	12 oz.+1.25 oz.+1/8 oz+2%					
4	d	Betamix+Stinger+Upbeet+MSO	12 oz.+1.25 oz.+1/8 oz+2%					
5	a	Betamix+Stinger+Upbeet+MSO+Etho.	8 oz.+1.25 oz.+1/8 oz+2%+4 oz.	13.52	15.94	1.16	296	3935
5	b	Betamix+Stinger+Upbeet+MSO+Etho.	8 oz.+1.25 oz.+1/8 oz+2%+4 oz.					
5	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
5	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
6	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	13.89	14.41	1.29	262	3654
6	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
6		**Outllook (applied between b&c application)**	**21 oz. (applied between b&c application)**					
6	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
7	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	10.81	14.60	1.27	267	2923
7	b	Outlook+Betamix+Stinger+Upbeet+MSO	21 oz+8 oz.+1.25 oz.+1/8 oz+2%					
7	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
7	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
8	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	16.00	13.65	1.33	246	3953
8	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
8	c	Outlook+Betamix+Stinger+Upbeet+MSO	21 oz.+8 oz.+1.25 oz.+1/8 oz+2%					
8	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
9	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	15.12	14.32	1.27	261	3874
9	b	Outlook+Betamix+Stinger+Upbeet+MSO	12 oz+8 oz.+1.25 oz.+1/8 oz+2%					
9	c	Outlook+Betamix+Stinger+Upbeet+MSO	9 oz.+8 oz.+1.25 oz.+1/8 oz+2%					
9	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
10	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	14.41	14.45	1.28	263	3765
10	b	Outlook+Betamix+Stinger+Upbeet+MSO	21 oz.+8 oz.+1.25 oz.+1/8 oz+2%					
10	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
10								
11	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	13.20	14.98	1.25	275	3593
11	b	Outlook+Betamix+Stinger+Upbeet+MSO	12 oz.+8 oz.+1.25 oz.+1/8 oz+2%					
11	c	Outlook+Betamix+Stinger+Upbeet+MSO	9 oz.+8 oz.+1.25 oz.+1/8 oz+2%					
11								
12	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	11.55	15.09	1.23	277	3114
12	b	Outlook+Betamix+Stinger+Upbeet **(no oil)**	21 oz+8 oz.+1.25 oz.+1/8 oz **(no oil)**					
12	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
12	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					

Table 7. Hebicide program influence on yield of sugar beets ***(Continued)***
Experiment number 0222

Trt #	Appl. Time	Treatment Description	Herbicide rate	Tons/ Acre	Sucrose percent	Loss to Molasses	Recov. Sucrose per Ton	Recov. Sucrose per Ton
13	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	17.43	13.20	1.34	237	4130
13	b	Outlook+Betamix+Stinger+Upbeet **(no oil)**	12 oz+8 oz.+1.25 oz.+1/8 oz **(no oil)**					
13	c	Outlook+Betamix+Stinger+Upbeet **(no oil)**	9 oz+8 oz.+1.25 oz.+1/8 oz+1.5% **(no oil)**					
13	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
14	p	Dual	32 oz.	19.61	14.27	1.30	260	5101
14	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
14	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
14	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
15	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	11.24	13.94	1.32	252	2890
15	b	Dual+Betamix+Stinger+Upbeet+MSO	32 oz.+8 oz.+1.25 oz.+1/8 oz+2%					
15	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
15								
16	p	Nortron	4.5 pt.	15.01	14.31	1.30	260	3940
16	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
16	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
16								
17	p	Nortron	6 pt.	16.48	14.38	1.27	262	4322
17	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
17	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
17								
18	P	Dual	32 oz.	13.06	14.33	1.29	261	3381
18	a	Betamix	16 oz.					
18	b	Betamix	20 oz.					
18	c	Outlook	21 oz.					
19	P	Eptam+Roneet	2+2	14.79	15.18	1.23	279	4152
19	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
19	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
19	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%					
20	p	Nortron	6 pt.	18.04	14.06	1.31	255	4594
20	b	Betamix	16 oz.					
20	c	Betamix	20 oz.					
20								
21	a	Betamix	16 oz.	14.10	14.53	1.27	265	3718
21	b	Betamix+Outlook	16 oz.+12 oz.					
21	c	Betamix+Outlook	16 oz.+ 9 oz					
21	d	Betamix	20 oz.					
			LSD (0.05)	4.75	1.15	0.08	24	1285

Table 8. Hebicide program influence on weed control efficacy in sugar beets
Experiment number 0223

Trt #	Appl. Time	Treatment Description	Herbicide rate	Eval 1 Amaranth	Eval 2 Amaranth	Eval 1 Lambs Quarter	Eval 2 Lambs Quarter	Eval 1 Sugar Beet Injury	Eval 2 Sugar Beet Injury
1	a	Weed Free check		99	99	99	99	0	0
1	b	Weed Free check							
1	c	Weed Free check							
1	d	Weed Free check							
2	a	Betamix	16 oz.	66	45	90	78	9	1
2	b	Betamix	20 oz.						
2	c	Betamix	20 oz.						
2	d	Betamix	24 oz.						
3	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	38	30	84	73	13	0
3	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
3	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
3	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
4	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	64	50	93	84	13	3
4	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
4	c	Betamix+Stinger+Upbeet+MSO	12 oz.+1.25 oz.+1/8 oz+2%						
4	d	Betamix+Stinger+Upbeet+MSO	12 oz.+1.25 oz.+1/8 oz+2%						
5	a	Betamix+Stinger+Upbeet+MSO+Etho.	8 oz.+1.25 oz.+1/8 oz+2%+4 oz.	54	43	74	64	9	1
5	b	Betamix+Stinger+Upbeet+MSO+Etho.	8 oz.+1.25 oz.+1/8 oz+2%+4 oz.						
5	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
5	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
6	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	92	79	97	85	31	11
6	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
6		**Outllook (applied between b&c application)**	**21 oz. (applied between b&c application)**						
6	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
7	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	75	63	92	75	31	15
7	b	Outlook+Betamix+Stinger+Upbeet+MSO	21 oz+8 oz.+1.25 oz.+1/8 oz+2%						
7	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
7	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
8	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	80	69	89	76	25	13
8	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
8	c	Outlook+Betamix+Stinger+Upbeet+MSO	21 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
8	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
9	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	76	68	91	81	13	8
9	b	Outlook+Betamix+Stinger+Upbeet+MSO	12 oz+8 oz.+1.25 oz.+1/8 oz+2%						
9	c	Outlook+Betamix+Stinger+Upbeet+MSO	9 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
9	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
10	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	48	39	84	69	40	24
10	b	Outlook+Betamix+Stinger+Upbeet+MSO	21 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
10	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
10									
11	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	71	66	91	79	15	4
11	b	Outlook+Betamix+Stinger+Upbeet+MSO	12 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
11	c	Outlook+Betamix+Stinger+Upbeet+MSO	9 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
11									
12	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	83	64	96	78	40	24
12	b	Outlook+Betamix+Stinger+Upbeet **(no oil)**	21 oz+8 oz.+1.25 oz.+1/8 oz **(no oil)**						
12	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
12	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						

Table 8. Hebicide program influence on weed control efficacy in sugar beets ***(Continued)***
Experiment number 0223

Trt #	Appl. Time	Treatment Description	Herbicide rate	Eval 1 Amaranth	Eval 2 Amaranth	Eval 1 Lambs Quarter	Eval 2 Lambs Quarter	Eval 1 Sugar Beet Injury	Eval 2 Sugar Beet Injury
13	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	81	66	96	86	23	10
13	b	Outlook+Betamix+Stinger+Upbeet **(no oil)**	12 oz+8 oz.+1.25 oz.+1/8 oz **(no oil)**						
13	c	Outlook+Betamix+Stinger+Upbeet **(no oil)**	9 oz+8 oz.+1.25 oz.+1/8 oz+1.5% **(no oil)**						
13	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
14	p	Dual	32 oz.						
14	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	30	29	71	63	9	1
14	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
14	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
15	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%	72	54	78	64	55	34
15	b	Dual+Betamix+Stinger+Upbeet+MSO	32 oz.+8 oz.+1.25 oz.+1/8 oz+2%						
15	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
15									
16	p	Nortron	4.5 pt.	34	29	69	61	15	6
16	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
16	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
16									
17	p	Nortron	6 pt.	33	30	60	51	8	0
17	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
17	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
17									
18	P	Dual	32 oz.	84	74	58	49	24	8
18	a	Betamix	16 oz.						
18	b	Betamix	20 oz.						
18	c	Outlook	21 oz.						
19	P	Eptam+Roneet	2+2	58	50	68	58	11	3
19	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
19	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
19	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+2%						
20	p	Nortron	6 pt.	29	26	66	59	8	0
20	b	Betamix	16 oz.						
20	c	Betamix	20 oz.						
21	a	Betamix	16 oz.	84	75	86	81	16	4
21	b	Betamix+Outlook	16 oz.+12 oz.						
21	c	Betamix+Outlook	16 oz.+ 9 oz						
21	d	Betamix	20 oz.						
			LSD (0.05)	23	22	19	19	24	16

Sugar Beet Weed Control Product Comparison Testing

Introduction

Product diversity has been significant over the past year in the weed control arena of sugar beets. The diversity has mainly come in the area of off-patent products we have been using for many years. The concern pertaining to the influence on potential weed control efficacy and sugar beet production for these products is significant. One may say "The products have the same active ingredient, so what difference could there be between these products". The fact of the matter is, that testing to find a different carrier for phenmedipham and/or desmedipham in Betanex and Betamix has shown that a change in the formulation can have a significant effect on product performance. Generic Products with active ingredients desmedipham, phenmedipham, ethofumesate, clopyralid, and clethodim may be available in the market in 2003, thus the SMBSC Agricultural research staff tested all of these products except generic clethodim in 2002.

Summary of Methods

Experiments were established to evaluate weed control products in sugar beets. The products tested were products with the same active ingredients but different formulations. Two sites were selected in the area's of Raymond (experiment 0228), and Maynard (experiment 0227) for this trial and established in a randomized complete block design with four replications. Plots were six rows wide and 30 ft long, with the treatment applied to the middle 4 rows. Sugar beets were planted at a four inch spacing with a J.D. 7000 planter at the Raymond location and at six inch spacing at the Maynard location. Trial specifics are presented in tables 2 and 3.

Treatments were initiated at the cotyledon stage of weeds (A), and sequential treatments were made on seven day spray intervals. Treatment B was applied 7 days after treatment A or approximately at the 2 leaf stage of sugar beet, treatment C was applied 7 days after treatment B or approximately at the 4 leaf stage of sugar beet, treatment D was applied 7 days after C or approximately at the 6 leaf stage of sugar beet. Fungicide applications for cercospora leaf spot were made in accordance with normal production practices.

Weed control of amaranth species was evaluated as a group. The amaranth species group in Southern Minnesota Beet Sugar Cooperative growers fields typically includes Redroot pigweed (Ameranthus retroflexus), powell amaranth (Amaranthus powellii), common and tall Waterhemp (Amaranthus radus and Amaranthus tuberculatus, respectively)
.
Sugar beets at the Maynard site were mowed to a six inch height to reduce potential weed seed population. This defoliation of sugar beets was conducted equally to all experimental units. Ten feet of sugar beets were harvested from each of the middle two rows for yield and quality analysis at Maynard and Raymond.. Sugar beets were analyzed for yield and quality through data collected from the SMBSC quality lab.

Summary of Results

Maynard

Sugar beet injury (Table 4) ranged from 0 to 24 at the July 7 evaluation and decreased to a range of 0 to 8 by the August 13 evaluation. The addition of ethofumesate to Betamix gave the highest sugar injury of all treatments. Sugar beet injury evaluations on July 7 showed AgValue des/phen and des tended to give higher sugar beet injury than the similar active ingredient counterpart of Betamix and Betanex, respectively. However, by the second evaluation on August 13 sugar beet injury had reduced to insignificant levels.

Betamix, Betanex, and Betamix Progress controlled amaranth species similarly. The addition of ethofumesate only tended to increase amaranth species control by Betanex, but did effect amaranth species control by Betamix or Betamix Progress. Products with the same active ingredient (Table 1) performed similarly in reference to amaranth species control at this location, whether applied alone or as part of the microrate.

Yield and sugar production for all treatments were statistically similar (Table 5).

Raymond

Sugar beet injury at the Raymond location as at the Maynard location decreased by the August evaluation to insignificant levels (Table 6). At the Raymond location there did not seem to be a difference between AgValue and Bayer products.

All treatments except those consisting of clopyralid alone, gave similar lambsquarter control. Betamix gave significantly lower amaranth species control than Betamix Progress or Betamix plus ethofumesate. Bayer products compared to AgValue products, with similar active ingredients applied alone, tended to give better amaranth species control. All products applied in microrate mix performed similarly for control of amaranth species. Stinger and AgValue clopyralid performed statistically similar within rates.

Yield and sugar per acre was similar with all treatment except with the active ingredient clopyralid applied alone. There was no trend toward any given companies products(table 7).

Table 1. Comparison of active ingredient for products used in testing

Active Ingredient	Tested Product	Producing Company	Lbs.Active Ingredient
Desmedipham	Betanex	Bayer	1.3
	Des	Ag Value	1.3
Desmedipham + Phenmedipham	Betamix	Bayer	1.3
	D-P Mix	Ag Value	1.3
Desmedipahm + Phenmedipahm + Ethofumesate	Betamix Progress	Bayer	1.8
	AgValue D-P Mix+Etho SC*	Ag Value	1.196 + .195
Ethofumesate	Notron SC	Bayer	4
	Etho SC	Ag Value	4
Clopyralid	Stinger	Dow Agri Sciences	3
	ClopyrAg	Ag Value	3

* Betamix Progress made with two Ag Value products mixed which were D-P Mix and Etho SC

Table 2. Experiment specifics for Maynard location, Experiment number 0227.

Variables	Experiment Number	Planting Dates	1 st appl. Post	2 nd appl. Post	3 rd appl. Post	4 th appl. Post
Dates	0227	5/8/2002	5/23/2002	5/30/2002	6/6/2002	6/13/2002
Crop Stage			Cotyl.	Cotyl.-2 lf	2lf-4lf	4lf-6lf
Weed stage						
Amaranth			Cotyl.	Cotyl.-1/2 in.	Cotyl.-2 in.	Cotyl.-4 in.
Lambs Quarter			Cotyl.	Cotyl.-1/2 in.	Cotyl.-1.5 in.	Cotyl.-3 in.
Wind Mph			5	0-5	15	5-10
PSI			40	40	40	40
Temp.			72	82	89	86
Finish time			12:00 p.m.	2:30 p.m.	3:30 p.m.	4:00 p.m.
Variety			ACH 999			

Evaluation 1 date	7/10/2002
Evaluation 2 date	8/15/2002
Harvest date	9/13/2002

Table 3. Experiment specifics for Raymond location, Experiment number 0228.

Variables	Experiment Number	Planting Dates	1 st appl. PPI	2 nd appl. Post	3 rd appl. Post	4 th appl. Post
Dates	0228	5/9/2002	5/27/2002	6/4/2002	6/11/2002	6/18/2002
Crop Stage			Cotyl.	Cotyl.-2 lf	2lf-4lf	4lf-6lf
Weed stage						
Amaranth			Cotyl.	Cotyl.-1/2 in.	Cotyl.-1.5 in.	Cotyl.-3.5 in.
Lambs Quarter			Cotyl.	Cotyl.-1/2 in.	Cotyl.-2 in.	Cotyl.-4 in.
Wind Mph			0-5	0-5	10	5-10
PSI			40	40	40	40
Temp.			82	78	77	89
Finish time			2:00 p.m.	6:00 p.m.	8:30 p.m.	3:50 p.m.
Variety			Beta 4930			

Evaluation 1 date	7/9/2002
Evaluation 2 date	8/16/2002
Harvest date	9/12/2002

Table 4. Hebicide program influence on weed control efficacy in sugar beets
Experiment number 0227

Trt #	Appl. Time	Treatment description	Herbicide rate	Eval 1 Sugar Beet Injury	Eval 2 Sugar Beet Injury	Eval 1 Amaranth	Eval 2 Amaranth
1	a	Weed Free check	--	0	0	99	99
1	b	Weed Free check	--				
1	c	Weed Free check	--				
1	d	Weed Free check	--				
2	a	Betamix	16 oz.	9	1	86	75
2	b	Betamix	20 oz.				
2	c	Betamix	20 oz.				
2	d	Betamix	24 oz.				
3	a	Betanex	16 oz.	1	0	87	80
3	b	Betanex	20 oz.				
3	c	Betanex	20 oz.				
3	d	Betanex	24 oz.				
4	a	Betamix Progress	11 oz	14	5	88	78
4	b	Betamix Progress	14 oz.				
4	c	Betamix Progress	14 oz.				
4	d	Betamix Progress	17 oz.				
5	a	Betamix+Ethofumesate(Nortron)	16 oz+4 oz.	24	8	84	74
5	b	Betamix+Ethofumesate(Nortron)	20 oz+4 oz..				
5	c	Betamix	20 oz.				
5	d	Betamix	24 oz.				
6	a	Betanex+Ethofumesate(Nortron)	16 oz+4 oz.	6	0	97	86
6	b	Betanex+Ethofumesate(Nortron)	20 oz+4 oz..				
6	c	Betanex	20 oz.				
6	d	Betanex	24 oz.				
7	a	AgValue D-P Mix	16 oz.	15	3	81	70
7	b	AgValue D-P Mix	20 oz.				
7	c	AgValue D-P Mix	20 oz.				
7	d	AgValue D-P Mix	24 oz.				
8	a	AgValue des	16 oz.	10	1	88	76
8	b	AgValue des	20 oz.				
8	c	AgValue des	20 oz.				
8	d	AgValue des	24 oz.				
9	a	AgValue D-P Mix+Etho SC	9.46 oz +1.54 oz.	13	4	91	83
9	b	AgValue D-P Mix+Etho SC	12.04 oz + 1.96 oz.				
9	c	AgValue D-P Mix+Etho SC	12.04 oz + 1.96 oz.				
9	d	AgValue D-P Mix+Etho SC	14.63 oz + 2.37 oz.				
10	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	11	1	75	65
10	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%				
10	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%				
10	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%				
11	a	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	9	0	90	81
11	b	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%				
11	c	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%				
11	d	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%				
12	a	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	11	3	78	71
12	b	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%				
12	c	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%				
12	d	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%				

Table 4. Hebicide program influence on weed control efficacy in sugar beets ***(Continued)***
Experiment number 0227

Trt #	Appl. Time	Treatment description	Herbicide rate	Eval 1 Sugar Beet Injury	Eval 2 Sugar Beet Injury	Eval 1 Amaranth	Eval 2 Amaranth
13	a	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	6	0	85	78
13	b	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%				
13	c	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%				
13	d	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%				
14	a	ClopyrAg	2 oz	0	0	40	35
14	b	ClopyrAg	2 oz				
14	c	ClopyrAg	2 oz				
14	d	ClopyrAg	2 oz				
15	a	Stinger	2 oz	5	1	39	31
15	b	Stinger	2 oz				
15	c	Stinger	2 oz				
15	d	Stinger	2 oz				
16	a	ClopyrAg	4 oz	3	0	39	35
16	b	ClopyrAg	4 oz				
16	c	ClopyrAg	4 oz				
16	d	ClopyrAg	4 oz				
17	a	Stinger	4 oz	10	1	51	41
17	b	Stinger	4 oz				
17	c	Stinger	4 oz				
17	d	Stinger	4 oz				
			LSD (0.05)	17	7	15	15

Table 5. Hebicide program influence on yield of sugar beets
Experiment number 0227

Trt #	Appl. Time	Treatment description	Herbicide rate	Tons/ Acre	Sucrose Percent	Loss to Molasses	Recoverable Sucrose per Ton	Recoverable Sucrose per Ace
1	a	Weed Free check	--	13.86	12.47	1.37	222	3017
1	b	Weed Free check	--					
1	c	Weed Free check	--					
1	d	Weed Free check	--					
2	a	Betamix	16 oz.	11.43	13.43	1.34	242	2791
2	b	Betamix	20 oz.					
2	c	Betamix	20 oz.					
2	d	Betamix	24 oz.					
3	a	Betanex	16 oz.	14.88	13.32	1.34	239	3560
3	b	Betanex	20 oz.					
3	c	Betanex	20 oz.					
3	d	Betanex	24 oz.					
4	a	Betamix Progress	11 oz	14.83	12.87	1.37	230	3411
4	b	Betamix Progress	14 oz.					
4	c	Betamix Progress	14 oz.					
4	d	Betamix Progress	17 oz.					
5	a	Betamix+Ethofumesate(Nortron)	16 oz+4 oz.	12.91	13.01	1.36	233	3026
5	b	Betamix+Ethofumesate(Nortron)	20 oz+4 oz..					
5	c	Betamix	20 oz.					
5	d	Betamix	24 oz.					
6	a	Betanex+Ethofumesate(Nortron)	16 oz+4 oz.	11.22	13.10	1.36	235	2669
6	b	Betanex+Ethofumesate(Nortron)	20 oz+4 oz..					
6	c	Betanex	20 oz.					
6	d	Betanex	24 oz.					
7	a	AgValue D-P Mix	16 oz.	12.00	12.69	1.38	226	2772
7	b	AgValue D-P Mix	20 oz.					
7	c	AgValue D-P Mix	20 oz.					
7	d	AgValue D-P Mix	24 oz.					
8	a	AgValue des	16 oz.	11.52	13.02	1.36	233	2691
8	b	AgValue des	20 oz.					
8	c	AgValue des	20 oz.					
8	d	AgValue des	24 oz.					
9	a	AgValue D-P Mix+Etho SC	9.46 oz +1.54 oz.	11.15	13.15	1.35	236	2635
9	b	AgValue D-P Mix+Etho SC	12.04 oz + 1.96 oz.					
9	c	AgValue D-P Mix+Etho SC	12.04 oz + 1.96 oz.					
9	d	AgValue D-P Mix+Etho SC	14.63 oz + 2.37 oz.					
10	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	10.98	13.12	1.36	235	2571
10	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
10	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
10	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
11	a	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	15.13	12.11	1.37	223	3749
11	b	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
11	c	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
11	d	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
12	a	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	13.15	12.92	1.36	231	3074
12	b	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
12	c	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
12	d	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					

Table 5. Hebicide program influence on yield of sugar beets ***(Continued)***
Experiment number 0227

Trt #	Appl. Time	Treatment description	Herbicide rate	Tons/ Acre	Sucrose Percent	Loss to Molasses	Recoverable Sucrose per Ton	Recoverable Sucrose per Ace
13	a	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	12.97	12.78	1.37	228	2964
13	b	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
13	c	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
13	d	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
14	a	ClopyrAg	2 oz	13.01	12.78	1.37	228	2980
14	b	ClopyrAg	2 oz					
14	c	ClopyrAg	2 oz					
14	d	ClopyrAg	2 oz					
15	a	Stinger	2 oz	12.40	12.68	1.37	226	2799
15	b	Stinger	2 oz					
15	c	Stinger	2 oz					
15	d	Stinger	2 oz					
16	a	ClopyrAg	4 oz	11.45	12.63	1.37	225	2555
16	b	ClopyrAg	4 oz					
16	c	ClopyrAg	4 oz					
16	d	ClopyrAg	4 oz					
17	a	Stinger	4 oz	12.36	12.56	1.37	224	2752
17	b	Stinger	4 oz					
17	c	Stinger	4 oz					
17	d	Stinger	4 oz					
			LSD (0.05)	5	1	0.04	20	1336

Table 6. Hebicide program influence on weed control efficacy in sugar beets
Experiment number 0228

Trt #	Appl. Time	Treatment description	Herbicide rate	Eval 1 S. Beet Injury	Eval 2 S. Beet Injury	Eval 1 Amar.	Eval 2 Amar.	Eval 1 Lambs Quarter	Eval 2 Lambs Quarter
1	a	Weed Free check	--	0	0	99	99	97	99
1	b	Weed Free check	--						
1	c	Weed Free check	--						
1	d	Weed Free check	--						
2	a	Betamix	16 oz.	6.25	1.25	76	69	98	91
2	b	Betamix	20 oz.						
2	c	Betamix	20 oz.						
2	d	Betamix	24 oz.						
3	a	Betanex	16 oz.	7.5	1.25	87	79	94	86
3	b	Betanex	20 oz.						
3	c	Betanex	20 oz.						
3	d	Betanex	24 oz.						
4	a	Betamix Progress	11 oz	2.5	0	91	84	98	88
4	b	Betamix Progress	14 oz.						
4	c	Betamix Progress	14 oz.						
4	d	Betamix Progress	17 oz.						
5	a	Betamix+Ethofumesate(Nortron)	16 oz+4 oz.	3.75	0	91	83	97	89
5	b	Betamix+Ethofumesate(Nortron)	20 oz+4 oz..						
5	c	Betamix	20 oz.						
5	d	Betamix	24 oz.						
6	a	Betanex+Ethofumesate(Nortron)	16 oz+4 oz.	5	0	90	83	99	93
6	b	Betanex+Ethofumesate(Nortron)	20 oz+4 oz..						
6	c	Betanex	20 oz.						
6	d	Betanex	24 oz.						
7	a	AgValue D-P Mix	16 oz.	6.25	1.25	86	79	98	90
7	b	AgValue D-P Mix	20 oz.						
7	c	AgValue D-P Mix	20 oz.						
7	d	AgValue D-P Mix	24 oz.						
8	a	AgValue des	16 oz.	5	0	74	68	96	88
8	b	AgValue des	20 oz.						
8	c	AgValue des	20 oz.						
8	d	AgValue des	24 oz.						
9	a	AgValue D-P Mix+Etho SC	9.46 oz +1.54 oz.	5	1.25	85	76	96	86
9	b	AgValue D-P Mix+Etho SC	12.04 oz + 1.96 oz.						
9	c	AgValue D-P Mix+Etho SC	12.04 oz + 1.96 oz.						
9	d	AgValue D-P Mix+Etho SC	14.63 oz + 2.37 oz.						
10	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	3.75	0	91	83	98	92
10	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%						
10	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%						
10	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%						
11	a	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	8.75	0	88	81	99	94
11	b	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%						
11	c	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%						
11	d	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%						
12	a	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	8.75	2.5	92	84	98	91
12	b	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%						
12	c	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%						
12	d	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%						

Table 6. Hebicide program influence on weed control efficacy in sugar beets ***(Continued)***
Experiment number 0228

Trt #	Appl. Time	Treatment description	Herbicide rate	Eval 1 S. Beet Injury	Eval 2 S. Beet Injury	Eval 1 Amar.	Eval 2 Amar.	Eval 1 Lambs Quarter	Eval 2 Lambs Quarter
13	a	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	3.75	0	93	84	93	85
13	b	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%						
13	c	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%						
13	d	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%						
14	a	ClopyrAg	2 oz	1.25	0	43	35	43	38
14	b	ClopyrAg	2 oz						
14	c	ClopyrAg	2 oz						
14	d	ClopyrAg	2 oz						
15	a	Stinger	2 oz	1.25	0	38	25	35	28
15	b	Stinger	2 oz						
15	c	Stinger	2 oz						
15	d	Stinger	2 oz						
16	a	ClopyrAg	4 oz	13.75	5	38	34	53	40
16	b	ClopyrAg	4 oz						
16	c	ClopyrAg	4 oz						
16	d	ClopyrAg	4 oz						
17	a	Stinger	4 oz	21.25	8.75	43	35	66	45
17	b	Stinger	4 oz						
17	c	Stinger	4 oz						
17	d	Stinger	4 oz						
			LSD (0.05)	12.78	4.68	15.824	12.026	12.501	8.8496

Table 7. Hebicide program influence on yield of sugar beets.
Experiment number 0228

Trt #	Appl. Time	Treatment description	Herbicide rate	Tons/ Acre	Sucrose percent	Loss to Molasses	Recoverable Sucrose per Ton	Recoverable Sucrose per Ace
1	a	Weed Free check	--	18.04	15.16	1.23	279	5049
1	b	Weed Free check	--					
1	c	Weed Free check	--					
1	d	Weed Free check	--					
2	a	Betamix	16 oz.	18.44	15.37	1.21	283	5210
2	b	Betamix	20 oz.					
2	c	Betamix	20 oz.					
2	d	Betamix	24 oz.					
3	a	Betanex	16 oz.	18.15	15.22	1.22	280	5079
3	b	Betanex	20 oz.					
3	c	Betanex	20 oz.					
3	d	Betanex	24 oz.					
4	a	Betamix Progress	11 oz	18.42	16.28	1.17	302	5286
4	b	Betamix Progress	14 oz.					
4	c	Betamix Progress	14 oz.					
4	d	Betamix Progress	17 oz.					
5	a	Betamix+Ethofumesate(Nortron)	16 oz+4 oz.	17.66	15.40	1.21	284	5003
5	b	Betamix+Ethofumesate(Nortron)	20 oz+4 oz..					
5	c	Betamix	20 oz.					
5	d	Betamix	24 oz.					
6	a	Betanex+Ethofumesate(Nortron)	16 oz+4 oz.	15.98	15.70	1.19	290	4507
6	b	Betanex+Ethofumesate(Nortron)	20 oz+4 oz..					
6	c	Betanex	20 oz.					
6	d	Betanex	24 oz.					
7	a	AgValue D-P Mix	16 oz.	19.51	15.32	1.22	282	5456
7	b	AgValue D-P Mix	20 oz.					
7	c	AgValue D-P Mix	20 oz.					
7	d	AgValue D-P Mix	24 oz.					
8	a	AgValue des	16 oz.	15.75	15.42	1.21	284	4552
8	b	AgValue des	20 oz.					
8	c	AgValue des	20 oz.					
8	d	AgValue des	24 oz.					
9	a	AgValue D-P Mix+Etho SC	9.46 oz +1.54 oz.	15.50	14.98	1.24	275	4285
9	b	AgValue D-P Mix+Etho SC	12.04 oz + 1.96 oz.					
9	c	AgValue D-P Mix+Etho SC	12.04 oz + 1.96 oz.					
9	d	AgValue D-P Mix+Etho SC	14.63 oz + 2.37 oz.					
10	a	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	20.84	15.44	1.21	285	5931
10	b	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
10	c	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
10	d	Betamix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
11	a	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	16.51	15.09	1.24	277	4578
11	b	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
11	c	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
11	d	Betamix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
12	a	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	20.65	15.49	1.20	286	5911
12	b	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
12	c	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
12	d	Avalue D-P Mix+Stinger+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					

Table 7. Hebicide program influence on yield of sugar beets. ***(Continued)***
Experiment number 0228

Trt #	Appl. Time	Treatment description	Herbicide rate	Tons/ Acre	Sucrose percent	Loss to Molasses	Recoverable Sucrose per Ton	Recoverable Sucrose per Ace
13	a	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%	18.55	15.20	1.23	280	5166
13	b	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
13	c	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
13	d	Agvalue D-P Mix+ClopyrAg+Upbeet+MSO	8 oz.+1.25 oz.+1/8 oz+1.5%					
14	a	ClopyrAg	2 oz	17.83	14.58	1.28	266	4729
14	b	ClopyrAg	2 oz					
14	c	ClopyrAg	2 oz					
14	d	ClopyrAg	2 oz					
15	a	Stinger	2 oz	11.23	15.30	1.22	282	3164
15	b	Stinger	2 oz					
15	c	Stinger	2 oz					
15	d	Stinger	2 oz					
16	a	ClopyrAg	4 oz	11.29	14.77	1.26	270	2986
16	b	ClopyrAg	4 oz					
16	c	ClopyrAg	4 oz					
16	d	ClopyrAg	4 oz					
17	a	Stinger	4 oz	14.57	15.06	1.24	276	4056
17	b	Stinger	4 oz					
17	c	Stinger	4 oz					
17	d	Stinger	4 oz					
			LSD (0.05)	5.4068	1.4197	0.1033	30.518	1500.1