SUGARBEET PLANT POPULATION X NITROGEN FERTILIZER RATE EXPERIMENTS IN MANITOBA

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Introduction

There has been a significant shift toward aiming for higher sugarbeet emergence populations in Manitoba. One of the questions to arise from this shift is whether higher populations require more nitrogen than is currently being recommended. The current nitrogen recommendations in Manitoba consider a substantial number of nitrogen rate studies, each having its own plant population level. The more recent nitrogen rate studies tend to have higher established populations than some of the older nitrogen rate studies.

The intent of the study reported here was to compare nitrogen response at different population levels within the same test. The results would indicate the presence or absence of population x nitrogen interactions and could be used to assess the current nitrogen recommendations.

Methods

Five population x nitrogen experiments were conducted between 1990 and 1992. The experiments were designed as modified latin squares with 12 treatments and 6 replications, statistical differences being determined using a 2 factor factorial analysis. Soil samples were taken at all test sites to a depth of 4 feet, in the fall prior to growing sugarbeets. Sites which were moderate to low in soil nitrate nitrogen were selected.

Nitrogen fertilizer rates of 0, 45, 90 and 135 lbs actual N/acre as urea were applied the fall prior to growing sugarbeets for the 1990 and 1991 tests. Nitrogen was applied in spring, prior to seeding sugarbeets in 1992. Fertilizer was banded at 6 inch spacing, to a 3 inch depth. Nutrients other than nitrogen were applied according to soil tests. Hilleshög HMI 1254 sugarbeet seed was planted at about a 3 inch spacing for the lone experiment in 1990. Betaseed Beta 1996 and Betaseed Beta 2259 sugarbeet seed were used in the 2 tests in each of 1991 and 1992, respectively. Final plot dimensions at all locations were 7.5 x 30 feet, each plot consisting of 4 rows, 22 inches apart. All four rows of each individual plot were hand thinned to one of three populations: low (75 beets/100ft), optimum (125 beets/100ft) and high (175 beets/100ft). These populations equate to 17820, 29700 and 41580 plants/acre, respectively. Thinning was conducted when sugarbeets were from 4 to 8-10 leaves, depending on the location.

A 0-9 rating was conducted in July to compare the extent to which adjacent rows were closed in different treatments. In this rating higher numbers indicated greater inter-row leaf cover. A leaf color rating was also conducted for all tests in mid August. This rating compared the degree to which leaves in different treatments were green or yellow. In this rating higher numbers indicated leaves which were increasingly yellow. Sugarbeet petioles were sampled for nitrate nitrogen analysis at the same time that leaf color was rated. Harvestability evaluations were carried out after defoliation and scalping operations, prior to lifting the sugarbeets. Higher numbers indicated a higher growth habit in this evaluation.

The center 2 rows of each plot were harvested and bagged for analysis in their entirety. Sugarbeets from each bag were washed, counted, weighed and passed through a multi-saw rasp to obtain brei for sugar and impurity analysis. After harvesting was complete, harvester losses for each treatment were evaluated by counting and weighing sugarbeets which had fallen through the harvester. Stand loss over the growing season was calculated by subtracting the harvested stand and harvester loss from the emergence stand and dividing this number by the emergence stand.

Results

Soil testing results for the 5 experiments are reported in Table 1. Soil nitrate nitrogen levels from 0 to 2 feet were considered moderate in 1990 and 1992 and low in 1991. Nitrate nitrogen levels from 2 to 4 feet were considered normal for Manitoba. Nitrogen recommendations are not affected when nitrate levels are below 40 lbs N/acre from 2 to 4 feet. The average 0 to 2 foot soil nitrate nitrogen level for the 5 experiments was 42 lbs/acre. This soil nitrate level resulted in an average nitrogen recommendation of 81 lbs N/acre for the 5 tests.

Table 1. Soil testing results for 5 population x nitrogen tests.

	1990	1991A	1991B	1992A	1992B
Depth	Soil nitrate nitrogen (lbs/acre)				
0-2 feet	51	29	24	53	51
2-4 feet	16	25	16	34	25
Nitrogen recommendation (lbs N/ac)	65	103	110	61	65
Soil textural class	Sandy clay loam	Clay loam	Very fine sandy loam	Clay loam	Very fine sandy loam

Highly significant differences were observed in yield and extractable sugar when different populations were compared (Table 2). Yield was highest at a population of 125 beets/100ft. Yields were not significantly different when 75 and 175 beets/100ft were compared. Extractable sugar/acre and extractable sugar/tonne were significantly better for both the optimum and high populations, when they were compared to a population of 75 beets/100ft.

Highly significant differences were also observed in yield and extractable sugar when different nitrogen rates were compared. Ninety pounds N/acre was the rate which maximized extractable sugar /acre. At this rate yield was also close to maximum, while quality was midway between the highest and lowest values. The average soil test recommendation of 81 lb N/acre for the 5 tests, was close to the 90 lb fertilizer level which maximized extractable sugar/acre. It is noted here that soil test recommendations for individual tests were generally close to the fertilizer levels which maximized extractable sugar/acre in those tests. Individual tests had yields ranging from 14.2 to 21.1 tonnes/acre and averaging 17.5 tonnes/acre.

Significant population x nitrogen interactions were not observed in either yield or extractable sugar/acre. There was no indication that high populations (175 beets/100ft) required more nitrogen fertilizer than is currently being recommended. Based on the maximum value for extractable sugar/acre, it might be suggested that low populations may require somewhat less nitrogen fertilizer than what was recommended; however, the response curve was not significantly different than for the optimum and high populations.

There was a trend for quality to decrease somewhat more when nitrogen fertilizer was applied to lower populations as compared to optimum and high populations. This interaction was significant at the 10 percent level. At low to moderate soil nitrate levels this could again suggest that low populations require somewhat less nitrogen. It cannot be assumed that this interaction would be evident at higher soil nitrate levels.

Observations over the growing season showed that rows closed sooner when populations were optimum to high and fertilizer was applied at recommended to high rates (Table 3). Leaf color was significantly yellower in August, with increased populations and decreased fertilizer rates.

Petiole nitrate levels in mid August increased as fertilizer nitrogen rates were increased. It is noted that although values increased in all tests when fertilizer was added, the mean petiole nitrate was at a different level at each individual location. Mean petiole nitrate values were 5273, 2709, 104, 4689 and 1507 ppm for the 1990, 1991A, 1991B, 1992A and 1992B tests, respectively. Petiole nitrate levels generally did not change with different populations. This was consistent with amino nitrogen levels in the sugarbeet roots, which did not significantly change with different populations. Different populations did have a significant effect on the sodium and potassium

levels in the beet roots.

The growth habit of sugarbeets (harvestability) was lower with higher populations and with lower nitrogen rates (Table 4). Population level had a much larger effect on this factor than nitrogen rate. Stand loss over the growing season and harvester loss increased with higher populations. Harvester losses were 0.45 tonnes/acre higher for the high versus the low populations. It is noted that although the losses were higher when populations were high, yields were not significantly different when the high and low populations were compared. Populations of 125 beets/100ft produced the optimum balance between harvester loss and maximum yield. Fertilizer addition had a minimal effect on losses during the season or at harvest. Unharvestable beets which were lost through the harvester averaged 0.36 pounds in weight, 19.5% sugar, 2.3% LTM and 162.5 kg/tonne extractable sugar for the 5 tests. The quality of unharvestable sugarbeets compared favorably with harvestable beets in all individual tests. In all cases quality was measured on beets which had all the petioles removed in the processing lab.

Summary

Achieving what was considered an optimum emergence population (125 beets/100ft) and applying fertilizer according to current soil test recommendations (90 lb N/ac rate) resulted in the maximum production of extractable sugar.

The effect of nitrogen fertilizer on extractable sugar/acre was not influenced significantly by population. There was no indication that any of the three emergence populations tested required more nitrogen fertilizer than is currently being recommended. There was some indication that lower than recommended nitrogen rates would be adequate if a low population (75 beets/100ft) of sugarbeets was established.

Table 2. Population * nitrogen tests (1990-1992) - 5 test average.

TREATMENT	EXTRACTABLE SUGAR kg/ac	kg/ tonne	SUGAR %	LOSS TO MOLASSES %	YIELD tonnes /ac
POPULATION (beets/100ft)					
75	2561	148.28	18.21	2.38	17.19
125	2715	151.85	18.36	2.18	17.82
175	2661	152.23	18.34	2.13	17.41
LSD (.05)	53	1.45	0.12	0.05	0.35
LSD (.01)	70	1.90	NS	0.06	0.46
NITROGEN APPLICATION (lb N/ac)					
0	2472	153.07	18.44	2.14	16.07
45	2698	152.18	18.43	2.20	17.66
90	2725	150.54	18.29	2.25	18.02
135	2687	147.36	18.07	2.34	18.15
LSD (.05)	61	1.67	0.14	0.06	0.40
LSD (.01)	81	2.20	0.18	0.07	0.53
75 BEETS/100ft, 0N	2344	152.16	18.45	2.24	15.32
75 BEETS/100ft, 45N	2658	149.80	18.35	2.33	17.64
75 BEETS/100ft, 90N	2654	147.51	18.17	2.43	17.90
75 BEETS/100ft, 135N	2588	143.67	17.88	2.53	17.91
125 BEETS/100ft, 0N	2568	152.59	18.38	2.14	16.75
125 BEETS/100ft, 45N	2743	152.55	18.41	2.17	17.92
125 BEETS/100ft, 90N	2781	153.20	18.46	2.15	18.09
125 BEETS/100ft, 135N	2770	149.08	18.17	2.27	18.51
175 BEETS/100ft, 0N	2504	154.45	18.47	2.04	16.14
175 BEETS/100ft, 45N	2694	154.20	18.51	2.10	17.41
175 BEETS/100ft, 90N	2740	150.93	18.25	2.17	18.08
175 BEETS/100ft, 135N	2704	149.33	18.15	2.22	18.03
Interactions					
Population x nitrogen	NS	NS	NS	NS	NS
Location x population	*	**	*	NS	**
Location x nitrogen	**	NS	**	NS	**
Location x pop. x N	NS	NS	NS	NS	NS
MEAN	2646	150.79	18.30	2.23	17.47
C.V.(%)	8	3.80	2.53	8.62	7.87

** and * are statistically significant at the 1% and 5% levels, respectively.

Table 3. Population * nitrogen tests (1990-1992) - 5 test average.

TREATMENT	ROW CLOSING (0-9)	LEAF COLOR (0-9)	PETIOLE NITRATE (ppm)	AMINO NITROGEN	SODIUM	POTASSIUM
				(ppm fresh weight)		
POPULATION (beets/100ft)						
75	5.26	2.53	2863	303	456	2040
125	5.88	3.28	2864	288	400	1919
175	6.15	3.55	2842	289	392	1874
LSD (.05)	0.14	0.16		NS	23	31
LSD (.01)	0.18	0.22		NS	30	43
NITROGEN APPLICATION (lb N/ac)						
0	4.72	4.18	1060	231	365	1973
45	5.73	3.45	2295	270	401	1952
90	6.13	2.74	3298	312	433	1920
135	6.45	2.11	4772	362	466	1931
LSD (.05)	0.16	0.19		18	28	35
LSD (.01)	0.21	0.25		24	34	NS
75 BEETS/100ft, 0N	4.38	3.57	1092	232	386	2054
75 BEETS/100ft, 45N	5.13	2.93	2450	268	427	2058
75 BEETS/100ft, 90N	5.65	2.13	2543	325	495	2010
75 BEETS/100ft, 135N	5.87	1.50	5368	386	517	2036
125 BEETS/100ft, 0N	4.95	4.30	1289	221	367	1973
125 BEETS/100ft, 45N	5.82	3.50	2098	275	395	1921
125 BEETS/100ft, 90N	6.17	2.93	3501	301	402	1869
125 BEETS/100ft, 135N	6.57	2.37	4567	356	435	1912
175 BEETS/100ft, 0N	4.83	4.67	799	238	343	1892
175 BEETS/100ft, 45N	6.25	3.92	2336	266	379	1877
175 BEETS/100ft, 90N	6.58	3.15	3851	311	401	1880
175 BEETS/100ft, 135N	6.92	2.47	4381	343	446	1847
Interactions						
Population x nitrogen	*	NS		NS	NS	NS
Location x population	**	**		NS	**	NS
Location x nitrogen	**	**		**	**	NS
Location x pop. x N	NS	NS		NS	NS	NS
MEAN	5.76	3.12	2856	293	416	1944
C.V.(%)	9.47	20.87		21.63	21.72	6.29

** and * are statistically significant at the 1% and 5% levels, respectively.

Table 4. Population * nitrogen tests (1990-1992) - 5 test average.

TREATMENT	HARVESTED STAND pl/100'	%STAND LOSS season	WEIGHT/ BEET (lb)	HARVESTER LOSSES pl/100'	HARVESTER LOSSES t/ac	HARVEST-ABILITY (1-5)
POPULATION (beets/100ft)						
75	76	0	2.10	3.4	0.12	3.24
125	110	9	1.51	5.8	0.22	2.47
175	128	19	1.27	15.7	0.57	1.86
LSD (.05)	2		0.04	1.1	0.05	0.10
LSD (.01)	3		0.07	1.5	0.06	0.13
NITROGEN APPLICATION (lb N/ac)						
0	103	10	1.50	9.6	0.35	2.34
45	106	9	1.63	8.1	0.29	2.49
90	105	9	1.68	7.7	0.30	2.59
135	105	9	1.69	7.6	0.28	2.67
LSD (.05)	NS		0.04	1.3	0.06	0.12
LSD (.01)	NS		0.07	1.7	NS	0.15
75 BEETS/100ft, 0N	76	0	1.87	4	0.14	3.10
75 BEETS/100ft, 45N	77	0	2.12	4	0.12	3.17
75 BEETS/100ft, 90N	76	0	2.20	4	0.13	3.32
75 BEETS/100ft, 135N	75	0	2.20	2	0.09	3.38
125 BEETS/100ft, 0N	109	10	1.44	6	0.27	2.38
125 BEETS/100ft, 45N	110	9	1.51	5	0.17	2.48
125 BEETS/100ft, 90N	111	8	1.52	6	0.24	2.48
125 BEETS/100ft, 135N	110	9	1.56	5	0.20	2.53
175 BEETS/100ft, 0N	124	20	1.21	19	0.65	1.55
175 BEETS/100ft, 45N	130	18	1.25	16	0.57	1.82
175 BEETS/100ft, 90N	128	20	1.32	14	0.52	1.98
175 BEETS/100ft, 135N	130	18	1.31	15	0.54	2.10
Interactions						
Population x nitrogen	NS		**	NS	NS	NS
Location x population	**		**	**	**	NS
Location x nitrogen	NS		**	*	**	**
Location x pop. x N	*		NS	**	**	NS
MEAN	105	9	1.63	8	0.30	2.53
C.V.(%)	9		10.11	53	63.52	15.87

** and * are statistically significant at the 1% and 5% levels, respectively.