THE EFFECTS OF DATE OF PLANTING AND PLANT POPULATION ON YIELD AND SUGAR PRODUCTION IN SUGAR BEET CULTURE IN SOUTHERN IDAHO PRODUCTION AREAS.

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Introduction:

It is a known response to early sugar beet plant establishment that the vegetative growth and establishment of the canopy responsible for sugars formation is also established earlier and therefore there is more time for root growth and sugar depositing in root cells before the harvest date. It is also known that even though the sugar beet plant has great ability to produce greater root growth in individual plants when stands are poor, plant populations of greater numbers and more uniformity can contribute to increased production of over-all sugar on a per acre basis. To a sugar beet grower, the questions regarding, "How much plant population do I need to optimally produce pounds sugar per acre" and "When do I plant to accomplish that" are intrinsic to the production process. When weather difficulties forestall planting and early crop establishment, or in many cases reduce the intended established plant population from emerging or establishing, then questions arise regarding the need to re-seed and start over. When such situations occur, a re-plant guideline would be helpful to use in making such decisions if it was based on known criterion of potential results compared to what should be expected if no replanting actions were taken.

Objectives:

Thus it was determined that a study to assess the results of planting over a staggered schedule from the first of April through the end of May should be conducted and that plant populations ranging from 50-250 plants per 100 feet of row should be looked at and evaluated for their production capabilities.

With the incidence of Round-up Ready® seed technology and the added costs associated with it, the questions regarding "need to replant or not?" have become even more critical when weather induced difficulties result in less stand established than anticipated or desired. Another associated question that has also subsequently arisen is, that with less early season stress on the emerged seedlings resultant from not inducing chemical stress as was formerly the case with the herbicides used before Roundup-Ready seed, there is quicker establishment, and potentially better numbers of emerged seedlings, so- what is the upper optimal plant population which should be retained without hindering production? Studies had been conducted prior to Round-up Ready seed availability to answer these questions and have been used to an advantage by consultants and growers. None had been conducted in Idaho production areas though. It was thought that in order to address these questions and assess the need for possible changes to

customize this information to the Idaho production areas, that a study to determine such should be conducted. A multiple year study (2012-2014) was therefore conducted to determine optimal planting dates, and plant populations. Because of the diversity of the Snake River Sugar Coop growing area, it was decided that the studies should be conducted on both sides of the state, since the production occurs along the whole of the Snake River Plain in Southern Idaho. One study was conducted the first year in the eastern (E.ID) side in the Aberdeen area, and two years in the Minidoka area. Another study was conducted for three years in the western side (W.ID) in an area south of Nampa.

Materials and Methods:

Each experiment was arranged in a split-plot, randomized complete block factorial design with six (6) replications. The main plot factor was planting date and the other, sub plot factor was plant population. There were 6 planting dates and 6 plant populations. The planting dates were spaced 10-14 days apart starting as close to the first of April as possible in the given study year, and ending the end of May or early June. The plant populations which were assessed in the W.ID location started with 55 beets/100' of row and were increased in 40 beet increments to 95, 135, 175, 215, ending with 255 beets/100' row. (representing approximately 13,000, 22,500, 32,000, 41,500, 51,000, and 60,500 plants per acre). In E.ID the planting populations started with 55-65 beets/100' row, increasing to 85-95, 125-135, 165-175, 195-205, and ending with 215-235 beets/100' row. (representing approximately 13,000-15,000, 20,000-22,500, 30,000-32,000, 39,000-41,500, 46,000-48,700, 51,000-55,800 plants/100' of row). The reason for lower figures for the high end of population in the eastern half of the state correspond with the shorter growing season there, compared to the western half.

All plot sites were located in a Grower/Cooperators' commercial field. Uniform soil type, drainage, slope, etc. were looked at to eliminate as many variables as possible when choosing the study area inside the fields boundaries. The study area was soil sampled to a depth of three feet and recommended fertilizer rates were applied if necessary in accordance with sugar company guidelines.

Because of the nature of the study and the fact that most grower fields were irrigated with overhead irrigation, (sprinkler or pivot) with a wider throw pattern than the plot run widths, or with furrow irrigation with headland and tail-land furrows which would be destroyed by the successive tractor work as we made multiple plantings, we chose to irrigate with a drip irrigation system instead of the growers system. This worked very well, allowing us to irrigate, in most cases, within the next day or soon after a treatment was planted. This allowed us to plant when needed in the replication runs without getting stuck or needing to wait for soil drying. It also facilitated the starting process for getting germination and emergence going as close to the planting date as possible so as to show any potential separations of results basis of the dates.

The plots were seeded with a Monosem air planter set to 22" row spacing and with a seed drop of 2 inches, set at a depth of approximately ¾ - 1" depth depending on soil type and conditions. The drip tape was installed between every two rows, usually the same day as the planting was done. It was installed with a shanking mechanism which inserted the tape two rows at a time, and placed it 2-5 inches deep in the center of the furrow. The tape had emitters spaced every 8 inches and would usually soak from center of furrow to across each plant row within 24-42 hrs.

depending on soil type and evapotranspiration rate. After each plot run was planted in each replication, each planting was irrigated separately and as needed thereafter until all the planting was accomplished and each planting date emerged and established. From then on they were irrigated on the same schedule.

The 6 different plant populations were established by hand thinning each plot to the prescribed number of beets at approximately the 4-6 leaf stage of growth. Each individual sub plot was 6-4 rows wide, (6 rows in 2012, and 4 rows in 2013, 2014), by 27.5 feet – 35 feet in length depending on the site and the year. During the growing period, the plots were scouted for any disease or insect problems and the appropriate treatments were made, i.e. leaf miners, root maggots, powdery mildew, black bean aphids, etc.

The center 2 rows of each plot was harvested and the data collected, i.e. the weight of each as well as 3 samples (approximately 25 lbs. each) collected and sent to the company's quality lab for sugar content analysis as well as other quality factors. The plots were first defoliated with a two row double or triple drum defoliator, and then each individual plot was harvested using a 2 row research harvester equipped with a scale and bagging equipment.

Results for Eastern Idaho:

For Eastern Idaho (E. ID) the earliest planting dates produced the best yields of tons/acre. This was expected. Each of the succeeding planting dates delineated a reduced tonnage. There were approximately 10 days between planting dates and almost without exception there was statistically, significant differences in the yields between each planting date. The difference on tonnage from the first date of around April 10 and the last date of the first of June was 17.04 t/a in 2012, 17.82 t/a in 2013, and 15.81 t/a in 2014. This amounted to an average tonnage drop of around 2.8 t/a for every 10 days delay in planting date.

In 2012 the sugar percentage between the first date of planting in April and the last date in June ranged from 17.64-18.21 % with a .57% difference between them. Statistically, in 2012 there was some separation on sugar percentage between the first two planting dates of April 9 and April 20 and the rest of the planting dates. In 2013 the range was from 15.51-16.61 % with only .10 % difference between them which was not statistically significant. In 2014, there was separation between the first four planting dates extending from April 10 to May 12 and the later two planting dates. In 2014 the range was from 16.17-16.55 % with .38 % between them. The two years that there was a difference were both very productive growth years and the sugar percentage difference most probably reflected a maturation of plant growth difference. Estimated recoverable sugar per acre which would be a reflection of the combined contributions of tonnage and sugar percent of the crop, basically followed the same distinct separation as tons per acre for all three years. The earlier the plant date, the more sugar per acre produced.

Plant populations, (plants per 100 foot of row), for all three years showed that the least tonnage was produced by the lowest two populations. For 2012, 55-65 plants/100' row produced 36.15 t/a and 85-90 plants/100' row produced 38.39. In 2013 55-65 plants/100' row produced 31.6 t/a and 85-95 plants produced 35.04 t/a. In 2014 it was 55-65 plants/100' row producing 40.48 t/a and 85-95 plants/100' row with 41.3 t/a. These tonnages were statistically the lowest productivity of tons per acre and estimated recoverable sugar per acre. For the next gradations of population

however, there was a wider range of being able to produce similar tonnage and ERS/acre without showing any significant difference. In 2012, the rest of the populations above 90 plants/100'row were not statistically different and had tonnages ranging from 39.16- 41.11 t/a which is only a difference of 1.95 t/a from lowest to highest tonnage over that span of plant population differences. In 2013, there were two more separations above the 85-95 plants/100' row of significance. One ranged from 85-205 plants/100' row with tonnages ranging from 35.04-36.45 t/a and the next from 195-235 plants/100' row with tonnages ranging from 36.45- 38.03 t/a. This essentially shows that there was some compensating growth in the 85 and up plant populations. This was again reflected in 2014, when the next, and only significant separation above the low end ranged from 125-235 plants/ 100' row with tonnages ranging only from 42.34-43.5 t/a.

Percent sugar relevant to plant population difference showed no significance for any of the three years. It was fairly scattered and the percentages throughout all of the plant populations were similar.

Of interest though was that the tare for the varying plant populations delineated with significance statistically with the highest populations having the highest tares down to the least stands having the lowest.

Overall, the highest variability year was 2013 and the lowest was 2014 which also reflects the kind of growth years they were relevant to weather conditions.

Conclusions for Eastern Idaho:

As far as tons per acre are concerned, around 125-235 plants per 100 feet of row will, year for year, produce similar tonnages. The date of planting effected the tonnages and showed that for most years the earlier one plants and the crop establishes, the better the yield potential. A date of demarcation around the first 10 days in May, (May 2-12), would be a period for significant separation on expected yield reductions after this period.

Sugar accumulation can vary year to year basis of plant date, but most years only slightly, with earlier dates of crop establishment showing a potential for better sugar because of more time for plant maturity and sugar accumulation by harvest, as was shown in 2012 and 2014. The 2014 study for a fact, showed separation of sugar accumulation basis of planting date with dates prior to May 12 being better than later dates, and the last date, (end of May), being least.

Results for Western Idaho:

For Western Idaho, (W. ID), the earliest planting dates also produced the best tonnages. The difference on tonnage from the first date in 2012 of April 5 and the last date of planting on May 30 was 15.04 t/a. In 2013 there was 19.23 t/a difference between the first and last planting dates and in 2014, 21.22 t/a difference. The average tonnage drop for every 10 days delay in planting averaged 3.24 t/a for all three years. This was very similar to the results in (E. ID). In all three years the differences in tonnages between the first and second planting dates was independently significantly different and those tonnage differences were as high as 8.92 t/a in 2012 to only 4.15 t/a in 2013 and then up to 7.17 t/a in 2014. The difference between the next two planting dates in April for each of the years showed the least drop in tonnage for delay and then the yields dropped more after each 10 days delay in May.

Differences ranges from as low as .15 t/a between April 23 and May 1, to as much as 5.84 t/a difference between May 1 and May 13. In 2014 the yields also delineated from start to finish significantly with each successive date.

There were no significant differences of sugar percentages pertaining to date of planting in 2012 or 2013. However, in 2014 the sugar dropped consistently with time, with a difference of .72 % sugar from the first date of April 8 to the last date of June 2. The first planting dates sugar was significantly different from the last three planting dates. The next four planting dates were mixed on separation but significantly different from the last planting date of June 2, which was the very lowest sugar. These differences of significance for this year could possibly be contributed to a generous growth season relevant to heat units resulting in a difference in maturation of the crop at time of harvest.

Estimated recoverable sugar per acre, (ERS/acre), delineated in significance in the same way which root yield, (t/a) did.

Plant populations effects resulted in two distinct statistical separations on yield. The 55 plants/100' row stood alone as the lowest yielding separation and the tonnages were different year to year. The next 5 plant population ranges, however, showed no significant difference in their ability to produce similar tonnages. These ranged from 95- 255 plants/ 100' row and the tonnages in 2012 ranged from 39.65-40.57 t/a; in 2013 from 53.22-54.69 t/a; and in 2014 42.69-44.84 t/a. As stated above, this production area, (W. ID), is an area of longer growing season relevant to heat units availability which facilitates yield 'catch up' in stands of lower plant population.

Conclusions for Western Idaho:

As concerning tons per acre production capability, 95-255 plants/100' row will, year for year, produce similar tonnages. The date of planting affected the tonnages and showed that for most years, the earlier one plants and the crop establishes, (emerges), the better the yield potential. A date of demarcation; the period of April 25 through the first week in May, is a period of significant separation on expected yield reductions after this period.

Replanting guide for producers to determine need for replanting:

A replanting guide chart for each production area is in process of being formulated. The charts will be delineated based on an increase in yield potential basis of the combined data for yield and population for each area. Beets/ 100'row is the common methodology for producers to talk about plant population because of ease of actually measuring or determining such in practicality on an in-field basis. Therefore, for the six ranges of plant population, starting with 60 beets/100' row, then 90 beets, 170, 200, and 220 and above, the potential increase for earlier planting dates vs. later planting dates for each population, point in time, will be compared to a greater population for the same point in time. If a greater population would result in a better yield outcome, for instance a 2 t/a increase, then it might be useful to consider replanting and trying to achieve a thicker stand. If much less than this it would probably be just as advisable to keep the lesser stand, if fairly evenly distributed, and continue to grow it to harvest because of the costs involved diminishing the value of any potential increase in yield from replanting.

Eastern and South Central Idaho study locations

	2012 Aberdeen			2013 Minidoka			2014 Minidoka		
Planting Date	Root yield tons/acre	Sugar % content	Rec. sug. lbs. / acre	**Planting Date**	Root yield tons/acre	Sugar % content	Rec. sug. lbs. / acre	**Planting Date**	Root yield tons/acre	Sugar % content	Rec. sug. lbs. / acre
9-Apr	47.68 a	18.02 a	14956 a	12-Apr	43.99 a	16.61	12705 a	10-Apr	50.24 a	16.50 a	14340 a
20-Apr	45.01 b	18.21 a	14251 b	25-Apr	41.06 b	16.64	11893 b	22-Apr	43.65 b	16.60 a	12553 b
1-May	40.88 c	17.82 bc	12604 c	2-May	37.10 c	16.63	10752 c	30-Apr	44.18 b	16.60 a	12642 b
15-May	37.51 d	17.86 bc	11627 d	14-May	32.12 d	16.54	9206 d	12-May	42.93 b	16.45 ab	12209 b
25-May	34.01 e	17.78 bc	10491 e	21-May	33.79 d	16.62	9756 d	21-May	37.85 c	16.24 bc	10581 c
7-Jun	30.64 f	17.64 c	9351 f	29-May	26.17 e	16.51	7477 e	30-May	34.43 d	16.21 c	9609 d
LSD (0.05)	2.24	0.29	634	LSD (0.5)	2.6	NS	779	LSD (0.5)	1.47	0.23	465
CV %	6.7	2.3	6.6	CV %	9.4	2.1	8.7	CV %	5.7	2.8	6.1
Pr > F	0.0001	0.0097	0.0001	Pr > F	0.0001	0.6261	0.0001	Pr > F	0.0001	0.0018	0.0001

Eastern and South Central Idaho study locations

	2012 Aberdeen		2013 Minidoka		2014 Minidoka	
Plant population	Root yield tons/acre	Sugar % content	Root yield tons/acre	Sugar % content	Root yield tons/acre	Sugar % content
55-65	36.15 d	17.86	31.60 d	16.71	40.48 c	16.47
85-95	38.39 c	17.88	35.04 c	16.64	41.30 bc	16.52
125-135	39.52 bc	17.90	35.54 bc	16.67	42.63 a	16.28
165-175	40.09 ab	17.83	36.89 ab	16.53	42.66 a	16.50
195-205	39.16 bc	17.94	36.45 abc	16.52	42.34 ab	16.40
215-235	41.11 a	17.83	38.03 a	16.47	43.50 a	16.42
LSD (0.05)	1.34	NS	1.7	NS	1.2	NS
CV %	6.7	2.3	9.4	2.1	5.7	2.8
Pr > F	0.0001	0.738	0.0001	0.0856	0.0006	0.1803

Western Idaho study locations

	2012 Nampa				2013 Nampa				2014 Nampa				
Planting Date	Root yield tons/acre		Sugar % content	Rec. sug. lbs. / acre	**Planting Date**	Root yield		Sugar %	Rec. sug.	**Planting Date**	Root yield		Sugar %		Rec. sug.
					28-Mar	61.69	a	13.46	13732 a	8-Apr	54.13	a	15.01	a	13611 a
5-Apr	47.98	a	16.55	13436 a	11-Apr	57.54	b	13.61	13063 b	18-Apr	46.96	b	14.89	ab	11727 b
25-Apr	39.56	b	16.89	11301 bc	23-Apr	54.21	c	13.51	12092 c	29-Apr	46.43	b	14.82	abc	11500 b
7-May	39.44	b	16.68	11081 bc	1-May	54.06	c	13.26	11783 c	12-May	41.91	c	14.63	bcd	10211 c
18-May	38.19	b	16.44	10583 c	13-May	48.22	d	13.17	10451 d	20-May	35.62	d	14.50	cd	8687 d
30-May	32.94	c	16.69	9276 d	23-May	42.46	e	13.41	9412 e	2-Jun	32.91	e	14.29	d	7884 e
LSD (0.05)	2.2		ns	513	LSD (0.05)	2.03		ns	571	CV (%)	1.59		0.36		562
CV(%)	7.1		2.3	7	CV (%)	7.4		3.0	7.9	Pr>F	5.4		2.4		5.6
Pr>F	0.0001		0.0904	0.0001	Pr>F	0.0001		0.0687	0.0001	0	0.0001		0.0220		0.0001

Western Idaho study locations

	2012 Nampa			2013 Nampa			2014 Nampa		
Plant population	Root yield tons/acre		Sugar % content	Root yield tons/acre		Sugar % content	Root yield tons/acre		Sugar % content
55 Plants	36.53	b	16.55	50.17	b	13.39	38.43	d	14.64
95 Plants	39.73	a	16.59	53.33	a	13.51	43.25	bc	14.73
135 Plants	39.65	a	16.83	53.52	a	13.41	44.62	a	14.72
175 Plants	40.46	a	16.67	54.69	a	13.35	42.69	c	14.73
215 plants	41.03	a	16.55	53.79	a	13.38	44.11	ab	14.67
255 Plants	40.57	a	16.65	53.22	a	13.41	44.84	a	14.66
LSD (0.05)	1.61		ns	1.92		ns	1.16		ns
CV (%)	7.1		2.3	7.4		3.0	5.4		2.4
Pr>F	0.0001		0.0681	0.0005		0.6069	0.0001		0.8354