LAMB, JOHN A.[1*], RYAN KOWTA[2], ISRAEL SANTIAGO[2], and MARK W. BLOOMQUIST[3]. [1]Univ. of Minnesota, 2182 Woodbridge Way, Woodbury, MN 55125, [2]Spreckels Sugar Company, 95 West Keystone Rd. Brawley, CA 92227, and [3]Southern Minnesota Beet Sugar Cooperative, 83550 County Road 21, Renville, MN 56284. **At What Plant Stand is Replanting Needed in the Imperial Valley of California?**

Justification: Establishing an optimum sugar beet plant stand is important to maximizing extractable sucrose yield in the Imperial Valley of California. If conditions are right at planting, then an optimum stand is the result. If there are problems such as seed quality, hot weather, or crusting soil, the stand will be reduced. Currently, the growers in the Imperial Valley aim for a plant stand of 30 sugar beet plants per ten feet of row for optimum production. At what plant stand should a grower decide to replant when the emergence is sub-optimal? The current answer to the question is 15 to 16 sugar beet plants per 10 feet of row. Since the advent of glyphosate resistant sugar beet varieties, there has been no research information from the Imperial Valley about replanting thresholds.

Objective: Determine the threshold plant stand that requires replanting in early and late harvested sugar beet production.

Methods and Materials: The treatments are listed in Table 1. The study was a randomized complete block design with 4 replications. There were seven plant stand treatments to represent different plant population thresholds. Stands were thinned after emergence. Treatments 1, 2, 3, and 4 were thinned to an even stand while treatments 5, 6, and 7 were thinned unequally simulating an uneven stand that would occur with poor emergence (gappy). Treatment 8 was planted later at a plant stand of 30 plants per 10 feet of row, similar to when a replant decision was made. Seven sites were established during the study from Fall 2017 to Summer 2020. Two of those sites were abandoned because of poor stands, Table 2. There were two early harvest and three late harvest sites. Sugar beet for early harvest in the Imperial Valley are usually planted in September and harvested between April 1 and early June. Late harvest sugar beet fields are usually planted in October and harvested in late June through the end of July. The planting, thinning, and harvest dates are listed in Table 2. All locations were planted with Beta 5460. Root yield was determined on the dates reported in Table 2. Root quality was determined by the Spreckels Sugar Tare Laboratory.

Table 1. Treatments for the proposed reduced stand study.

Treatment	Sugar beet per 10 feet of row
1.	34
2.	30
3.	26
4.	22
5.	18 gaps
6.	14 gaps
7.	10 gaps
8.	30 replant – planted at 4-5 weeks after original planting.

Table 2. Planting, thinning, and harvest dates for the replanting study.

Site	Planting date	Thinning date	Replant	Harvest date
Site 1 2017-2018	Oct. 2, 2017	Oct. 30, 2017	Nov. 15, 2017*	June 5, 2018 (early)
Site 2 2017-2018	Oct. 6, 2017	Nov. 9, 2017	Nov. 13, 2017	July 17 and 18, 2018 (late)
Site 1 2018-2019	Oct. 19, 2018	Nov. 27, 2018	Dec. 12, 2018	July 15, 2019 (late)
Site 1 2019-2020	Sept 14, 2019	Oct 17, 2019	Nov. 1, 2019	April 06, 2020 (early)
Site 3 2019-2020	Oct. 12, 2019	Nov. 11-12, 2019	Dec. 6, 2019	June 17, 2020 (late)

* birds ate seed from the previous planting in early November.

Results: Root yield Sugar beet root yield ranged from 36.8 to 92.4 ton per acre at the five sites, Table 3. The root yield was significantly affected by the plant stand treatments at three of the five sites, Table 3. The optimum yield at two sites, Late 17-18 and Late 19-20 were at 14 and 22 plants per 10 feet of row. The response at the Late 18-19 site was linear and the optimum was not obtained. The greatest root yield at the Late 18-19 site occurred at 34 plants per 10 feet of row.

Table 3. Sugar beet root yield as affected by plant stand from 2017 to 2020 in the Imperial Valley of California.

Stand	Early 17-18	Late 17-18	Late 18-19	Early 19-20	Late 19-20
Plants/10 ft. of row	Root yield (ton/A)				
10	61.2	94.4	70.2	36.1	48.2
14	63.9	96.6	77.3	35.8	53.9
18	63.3	92.3	72.9	38.2	56.2
22	64.5	95.1	77.2	35.2	58.5
26	65.2	92.4	74.4	38.6	56.4
30	63.6	90.7	77.7	37.2	55.1
34	61.4	85.9	78.9	36.7	57.3
Grand mean	63.3	92.4	75.5	36.8	55.1
Trt	NS*	0.02	0.03	NS	0.01
C.V. (%)	5.4	3.6	4.6	7.7	5.9

* NS = Not significant at the $P > 0.05$.

Extractable sucrose per ton Extractable sucrose per ton was only affected by the plant stand at one site, Late 18-19, Table 4. The significance for the Late 18-19 was caused by the increased extractable sucrose per ton at 26 plants per 10 feet of row. In most cases, quality as measured by extractable sucrose per ton is not affected by plant stand.

Table 4. Extractable sucrose per ton as affected by plant stand from 2017 to 2020 in the Imperial Valley of California.

Stand	Early 17-18	Late 17-18	Late 18-19	Early 19-20	Late 19-20
Plants/10 ft. of row	Extractable sucrose (lb/ton)				
10	279	240	279	274	311
14	280	240	286	277	316
18	278	259	285	276	310
22	286	244	284	280	316
26	292	249	297	272	322
30	273	238	285	274	322
34	281	244	286	279	314
Grand mean	281	245	286	276	316
Trt	NS*	NS	0.002	NS	NS
C.V. (%)	2.9	4.2	1.5	2.7	2.1

* NS = Not significant at the P > 0.05.

Extractable sucrose per acre Extractable sucrose per acre was significantly affected by plant stand at four of the five sites, Table 5. The effect of plant stand on extractable sucrose per acre from all sites is shown in Figure 1. In all cases except for the Early 19-20 site, the optimum stand ranged from 18 to 34 plants per 10 ft of row.

Table 5. Extractable sucrose per acre as affected by plant stand from 2017 to 2020 in the Imperial Valley of California.

Stand	Early 17-18	Late 17-18	Late 18-19	Early 19-20	Late 19-20
Plants/10 ft. of row	Extractable sucrose (lb/acre)				
10	17044	22682	19596	9878	15077
14	17893	23162	22086	9882	17034
18	17568	23918	20742	10544	17379
22	18388	23247	21932	9818	18452
26	19031	22975	22050	10597	18154
30	17335	21531	22102	10201	17752
34	17238	21169	22644	10225	17977
Grand mean	17785	22640	21578	10151	17394
Trt	0.04	0.02	0.02	NS*	0.001
C.V. (%)	4.8	4.3	5.0	6.6	5.4
Trt *	9631	17595	7679	5000	9850

* NS = Not significant at the P > 0.05.

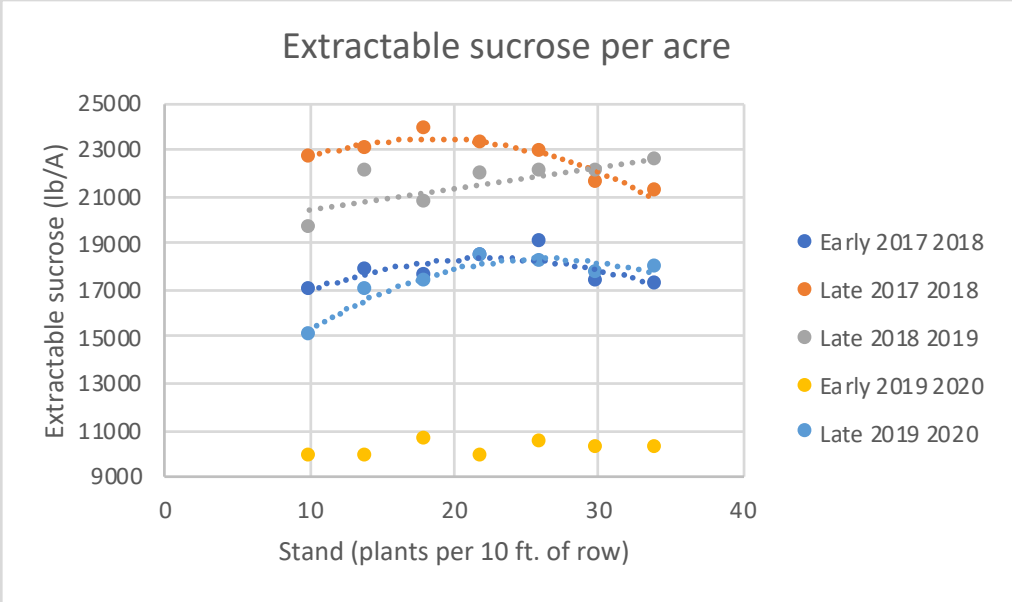

Figure 1. Plant stand effects on extractable sucrose per acre 2017-2020.

The economic effect of whether or not to replant will depend on income loss from later planting date and cost of added inputs. The effect of time between original planting date and the replanting date on extractable sucrose per acre was measured by comparing treatment 2, plant stand of 30 plants per 10 feet of row with the late replant treatment 8, Table 6. The average extractable sucrose per acre loss in this study was 160 lb per acre per day or 1.00% per day.

Table 6. Optimum plant stand for extractable sucrose per acre at five locations in the Imperial Valley from 2017 to 2020.

	Optimum stand	Days after planting	Trt 2 – Trt 8	Replant extractable sucrose per acre losses based on Trt 8.	
Site	Plants/10 feet of row	Days	lb/A	lb extractable sucrose per acre per day	Loss per day of planting delay (%)
Early 17-18	22	44	7704	175	-1.01
Late – 17-18	18	38	3936	104	-0.48
Late – 18-19	34	54	14424	267	-1.21
Early – 19-20	No optimum	48	5201	108	-1.06
Late – 19-20	26	55	7902	144	-0.81

Besides the loss in extractable sucrose per acre, the addition cost of replanting (fuel, seed, time, etc.) needs to be considered. One other factor is the harvestability of sugar beet. The size of the some of the sugar beet roots at harvest in the uneven 10 plants per 10 feet of row treatment (1) were very large and caused significant mechanical harvest issues. This was particularly an issue with the late harvest sites.

Summary: This study would indicate that decision of replanting is not influenced by harvest date. The optimum plant stand in recent studies is around 24 plants per 10 feet of row. Good yields of extractable sucrose per acre can be obtained most of the time with a stand as low as 14 plants per 10 feet of row. The results from this study would not recommend replanting a of stand greater than 14 plants per 10 feet of row. A population of less than 14 on late harvest sugar beet can cause harvest issues because of variable size roots.