

Influence of Pre-Emergence Irrigation, Planting Date, and Planting Method on the Production of Sugar Beets in Western Nebraska.¹

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Insufficient early spring precipitation sometimes reduces the effective growing season for sugar beets in western Nebraska by delaying germination of sugar beet seed and emergence of the seedlings. Pre-emergence irrigation and moisture conserving planting methods may achieve germination and emergence of seedlings independent of precipitation. These methods might increase the value of early planting, particularly when temperatures are favorable for plant growth.

Nuckols (1)⁴ found that early planted sugar beets yielded two to four tons more per acre than those planted at medium or late dates. He concluded that frost damage to early planted beets was less hazardous than insufficient moisture for germination of late planted beets.

Experiments dealing with pre-emergence irrigation, a moisture conserving planting method, and planting date were conducted from 1948 to 1953 at the Scotts Bluff Experiment Station. The results of experiments conducted in 1948 and 1949 were reported previously (2). The results from the six-year study are reported here.

Experimental Procedure

This study was conducted on Tripp very fine sandy loam maintained in a high state of productivity. Alfalfa was plowed under as green manure two to three years previous to the sugar beet crop, and a 15-ton per acre application of manure was made on each experimental area before planting.

The treatments studied were as follows: Three planting dates (early, medium, late); two planting methods (surface and ridge-cover); and two pre-emergence irrigation practices (no irrigation and irrigation after planting). The treatments were arranged in a split plot design with six replications of each treatment during the first four years, and four replications during the last two years. The smallest plot unit was four rows spaced 20 inches apart and 150 feet long (1948-51) and 100 feet long (1952-53).

The mean dates of early, medium and late planting and standard deviations were, respectively, as follows: April 2 \pm 4 days, April 16 \pm 3, and May 2 \pm 1.

Surface planting is the method used commonly by sugar beet growers. The ridge-cover planting method consisted of surface planting with a ridge or mound thrown over the row with cultivator disks. The ridges were

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⁴ Numbers in parentheses refer to literature cited.

removed with a harrow or cultivator blade following germination of the sugar beet seed. The purpose of the ridge was to conserve moisture near the sugar beet seed. Surface planting was studied six years (1948-1953) and ridge-cover planting four years (1948-1951).

Water for pre-emergence irrigation was applied between every other row of beets in the surface planting method, and between each row in the ridge-cover planting (Figure 1). In each case sufficient water was applied within two days of planting to provide adequate soil moisture for germination of beet seed.

The seed bed for the experimental area was spring plowed and uniformly prepared previous to the early planting date. After the beets were thinned, all plots received the same cultural practices for the remainder of the season.



Figure 1.—Pre-emergence irrigation of surface and ridge-cover planted sugar beets is shown on the immediate left and right, respectively.

Experimental Results and Discussion

Analyses of variance were made on each year's data. Statistically significant effects of single factors based on these analyses were as follows: (A) Planting date influenced yield of roots and harvest stand each year. (B) Pre-emergence irrigation occasionally affected yield of roots and harvest stand. (C) Planting method influenced yield of roots and harvest stand more frequently than irrigation for emergence. (D) Sucrose content was not affected by any single treatment studied. The two-factor interactions of planting date by pre-emergence irrigation and planting method by pre-emergence irrigation were significant more frequently than other interactions. Therefore, pre-emergence irrigation and planting date are discussed under, (a) the surface, and (b) ridge-cover methods of planting.

Six-year treatment means did not differ significantly due to the large mean square for treatment by year interaction. The standard error of the difference between six-year treatment means ("Students' " test of significance

for paired variates (3), was used to show that there are no significant differences between these means. This method eliminates correlation between values in any one year.

Surface Planted Sugar Beets.

Influence of Planting Date: Sugar beets planted May 2 produced approximately two tons less roots per acre than beets planted in early or mid-April (Table 1). This trend prevailed during most of the individual years.

Stands of early planted beets were the poorest, while stands from the late planting were slightly lower than those of beets planted April 16. Soil crusting was a greater problem with late than early or medium planted sugar beets.

Value of Pre-emergence Irrigation: Irrigation for emergence did not influence the yield of sugar beets during the six-year period as a whole. The six-year mean yields were essentially the same at any one planting date whether or not the beets received an early pre-emergence irrigation (Table 1). During individual years, however, the crop benefited or suffered significantly from the early irrigation. For example, in 1948 sugar beets planted early and irrigated for emergence yielded 4.8 tons more per acre than those planted the same day and not irrigated, but in 1949 and 1951 yields were respectively 2.2 and 3.8 tons per acre lower where irrigated for emergence. In 1948, the early planted and early irrigated beets emerged ahead of those not irrigated and did not suffer frost damage, whereas in 1949 and 1951 frost severely damaged sugar beet seedlings in this treatment. The non-irrigated beets escaped frost damage in 1949 and 1951 because of slower germination and emergence.

During some years precipitation occurred shortly after planting and obliterated any effects pre-emergence irrigation might have shown. This was particularly significant at the late planting date where the yields indicate no influence of irrigation for emergence. Each year during the six-year period, adequate precipitation to germinate beet seed occurred within five days after the late planting date.

Pre-emergence irrigation for beets planted in mid-April improved yields slightly in 1948, 1949, 1950, and 1952. This circumstance may be associated with a slight improvement in stands and a slight increase in growing season during these years as a result of irrigation for emergence. The differences, however, were not statistically significant.

Irrigation for emergence at the early planting date was detrimental to stands five years in six. Irrigation hastened emergence about ten days, but this circumstance was not always advantageous. In several instances, particularly 1949 and 1951, this irrigation hastened emergence only to have many of the beet seedlings killed by frost.

The best stands were obtained with beets planted April 16 and irrigated for emergence. The positive effects of irrigation for emergence for all years except 1953 were related to a deficiency of rainfall after the medium planting date. Pre-emergence irrigation was not beneficial to stands in 1953 because of unfavorable temperatures during the emergence period. In 1952, pre-emergence irrigation was the most beneficial due to the absence of rainfall during the emergence period.

Table 1.—Influence of Pre-emergence Irrigation and Planting Date on Yield of Roots, Harvest Stand and Sucrose Concentration in Surface Planted Sugar Beets (1948-1953). Scotts Bluff Experiment Station.

Year	Pre-emergence irrigation practice	Mean Planting Date								
		April 2	April 16	May 2	April 2	April 16	May 2	April 2	April 16	May 2
		Yield of Roots (tons/A)			Harvest Stand (%) ¹			Sucrose Concentration (%)		
1948	Irrigation	24.1	22.1	19.6	88	89	82	14.4	15.2	15.2
	No irrigation	19.3	21.3	19.1	82	86	77	14.9	15.0	15.1
1949	Irrigation	19.5	23.4	22.0	50	90	86	16.8	17.2	17.5
	No irrigation	21.7	22.7	22.5	62	86	89	16.9	17.3	17.4
1950	Irrigation	26.5	24.7	23.1	70	82	77	18.0	17.7	18.4
	No irrigation	25.6	23.3	23.6	62	80	78	18.5	18.1	18.2
1951	Irrigation	14.9	17.5	16.6	45	75	69	16.2	17.0	16.8
	No irrigation	18.7	18.0	16.2	75	71	67	16.8	16.5	16.6
1952	Irrigation	23.9	23.8	19.7	87	100	96	15.7	15.0	15.7
	No irrigation	21.7	22.8	18.5	93	89	92	15.6	15.4	15.6
1953	Irrigation	20.2	20.2	20.4	72	96	93	16.2	17.6	16.6
	No irrigation	20.8	22.4	19.1	82	102	81	16.9	17.3	17.7
Mean (6 years)	Irrigation	21.5	21.9	20.2	69	89	81	16.2	16.6	16.7
	No irrigation	21.8	21.8	19.8	76	86	81	16.6	16.6	16.8
Standard Error of the difference between means ("Students' " paired variates)		1.20	0.56	0.37	6.6	2.7	6.3	0.22	0.14	0.20

¹ 100 percent stand = one beet plant per foot of row in 20-inch rows.

Despite the fact that poorest stands occurred with beets planted early, yields were the same as for beets planted the middle of April, and were two tons per acre higher than yields from the late planting. In 1949 early planted pre-emergence irrigated beets yielded 19.5 tons per acre with a stand of only 50 percent, and in 1950 the yield was 26.5 tons with a stand of 70 percent. Apparently early planting and early emergence compensated to some extent for loss in stand.

Neither planting date nor pre-emergence irrigation influenced the sucrose percentage of sugar beets in any one year or during the six-year period (Table 1). Growing conditions prevailing during different years had a much greater effect on sucrose content than the treatments studied. Favorable or unfavorable conditions for sucrose accumulation affected all treatments approximately the same in any one year. In 1948 the beets contained approximately 15 percent sugar, and in 1950, 18 percent. Apparently 1950 was a favorable year for the production of high yields of beets which contained a high percentage of sugar. High or low sucrose concentration was not significantly associated with good or poor stands in these tests.

Ridge-Cover Planting.

Influence of Planting Date and Pre-emergence Irrigation: Yield trends under the ridge-cover method of planting were similar to those under the surface method of planting where beets were pre-emergence irrigated. Planting date had little influence on the mean yields of ridge-cover planted beets not irrigated for emergence (Table 2). Irrigation for emergence at the early and medium planting dates increased yields slightly over beets not irrigated.

Inferior and generally more erratic stands were associated with ridge-cover planting more than with surface planting. This circumstance was related to difficulties encountered in removing ridges satisfactorily. In some instances rain delayed removal of the ridges at the proper time, and in others, hot weather following removal produced heavy crusts over the beet seedlings. The implements used—spike tooth harrow and cultivator blade—did not perform the operation as desired. Too much or too little soil was removed in some situations. The difficulties encountered in removing ridges influenced stands and the distribution of plants within a particular stand of sugar beet plants.

Sucrose percentage was not influenced by the ridge-cover method of planting or treatments associated with ridge-cover. However, sucrose percentages of beets varied more under the ridge-cover than under the surface method of planting.

Comparison of Surface and Ridge-Cover Methods of Planting Sugar Beets.

Differences in the yields of beets from the two methods of planting were small at each planting date (Table 3). The yields under the ridge-cover planting method were lower in each instance. Stands were lower under the ridge-cover than under the surface method of planting at each planting date. Under the conditions of these experiments, the lower yields and stands reflect the inability to satisfactorily remove the ridges.

Table 2.—Influence of Pre-emergence Irrigation and Planting Date on Yields of Roots, Harvest Stand, and Sucrose Concentration of Ridge-Cover Planted Sugar Beets. 1948-1951, Scotts Bluff Experiment Station.

Year	Pre-emergence irrigation practice	Mean Planting Date								
		April 2	April 16	May 2	April 2	April 16	May 2	April 2	April 16	May 2
		Yield of Roots (tons/A)			Harvest Stand (%) ¹			Sucrose Concentration (%)		
1948	Irrigation	24.6	22.1	18.5	75	82	66	14.6	15.1	14.6
	No irrigation	19.4	21.7	21.9	48	86	86	15.1	14.9	14.5
1949	Irrigation	20.6	23.2	21.6	54	86	84	16.6	17.5	17.2
	No irrigation	20.6	20.8	19.3	82	79	70	17.0	14.7	17.3
1950	Irrigation	24.0	22.9	21.5	58	50	66	17.7	17.8	18.3
	No irrigation	21.8	23.4	23.2	57	42	68	18.0	17.4	18.4
1951	Irrigation	16.6	18.4	16.3	56	73	67	16.1	16.7	16.6
	No irrigation	18.5	17.3	15.9	70	69	66	17.1	17.3	16.3
Mean (4 years)	Irrigation	21.5	21.7	19.5	61	73	71	16.3	16.8	16.7
	No irrigation	20.1	20.8	20.1	64	69	72	16.8	16.1	16.6
Standard Error of the difference between means ("Students" paired variates)		1.71	0.79	1.27	12.1	3.6	7.1	0.28	0.83	0.10

¹ 100 percent stand -- One beet plant per foot of row in 20-inch rows.

Table 3.—Comparison of the Surface and Ridge-Cover Methods of Planting Sugar Beets, 1948-1951.

Planting Date	Planting Method	Yield of Roots (tons per acre)	Harvest stand (percent)
Mean Four Year Period (1948-1951) ¹			
Early	Surface	21.3	67
	Ridge-cover	20.8	62
	Standard Error ²	0.94	8.1
Medium	Surface	21.6	82
	Ridge cover	21.2	71
	Standard Error ²	0.39	10.3
Late	Surface	20.4	78
	Ridge-cover	19.8	72
	Standard Error ²	0.65	4.5

¹ Data represents mean yields of combined plots irrigated and not irrigated for emergence.

² Standard Error of the difference between the two means by method of "Students" paired variates.

Summary

Experiments dealing with planting date, pre-emergence irrigation and planting method were conducted during a six-year period (1948-1953) at the Scouts Bluff Experiment Station in western Nebraska.

Sugar beets planted April 2 and April 16 produced about the same mean yields over the six-year period, but a two ton per acre reduction in yield occurred where planting was delayed until May 2.

During the six-year period as a whole, yields on plots irrigated for emergence were the same as on plots not irrigated at any one planting date. During individual years, however, the crop benefited or suffered significantly from the early irrigation. Irrigated beets emerged earlier than non-irrigated beets, and the occurrence or absence of severe frost at time of emergence influenced stands and yields accordingly.

Poorest stands in the tests were associated most often with early planting and irrigation for emergence. The yields obtained, however, indicate that early planting compensated to some extent for loss in stand.

Sucrose percentage was not affected by the treatments used.

Yield trends under the ridge-cover method of planting were similar to those under the surface method, but inferior stands were associated with ridge-cover planting. Climatic conditions, physical structure of ridges, and techniques used in removing them were problems associated with ridge-cover planting of sugar beets.

References

- (1) NUCKOLS, S. B. 1946. Summary of date of planting experiments with sugar beets in Nebraska and Wyoming. Proc. Amer. Soc. Sugar Beet Tech. 185-189.
- (2) HARRIS, I., PUMPIREY, F. V. and RHOADES, H. F. 1950. Cultural experiments with sugar beets in western Nebraska. Proc. Amer. Soc. Sugar Beet Tech. 261-269.
- (3) GOULDEN, C. H. 1952. Methods of statistical analysis. 2nd ed., page 55. John Wiley and Sons, Inc., New York, N.Y.