PLANTING SUGARBEETS TO STAND IN WYOMING*

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Overplanting and then thinning to establish a stand of sugarbeets are traditionally performed to compensate for variable emergence rates and to provide excess plants which are unavoidably removed when the beets are hand hoed for weed control. Elimination of thinning requires top quality precision graded seed, correct seeding rate, proper planting, good herbicidal weed control, emergence rates of 40 percent or more and grower confidence that planting-to-stand will work.

Although no single application of a herbicide has provided consistently good weed control, several combinations have shown excellent results. Complementary preplant-postemergence herbicide demonstration plots of Alley and Humburg (1, 17) consistently indicate 95-100 percent weed control. Labor requirements as low as two hours per acre have been recorded when preplant and postemergence herbicides have been applied. With the knowledge that excellent weed control can be obtained with herbicides, this study was concerned with determining seeding rates and methods of improving field emergence rates.

SEED SPACING STUDIES

Several studies have shown the effect of plant spacing upon sugarbeet yield (e.g., 3, 5, 14, 15, 16, 18, 19, 20). The majority of the studies were conducted using uniform plant spacing and clearly show the loss of yield with under-population. Plant spacing is dependent upon emergence rate, which is quite variable for beets, as well as the seed spacing. Potential yield curves

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were derived by Fornstrom (5) from the uniform spacing studies to infer the potential yields of beets planted-to-stand with different seed spacings and emergence rates.

Field studies were conducted in Wyoming to compare sugarbeets planted-to-stand with beets planted according to the conventional practice of over-planting and then thinning (7, 8, 9, 10, 11). Beets planted-to-stand with seeding rates of approximately 4, 5, 6, 7, and 8-inches per seed were compared with beets which were planted at the rate of 4-inches per seed and then hand-thinned. This experiment was carried out at thirteen locations during 1976, 1977, and 1978. In all of the field studies 22-inch row spacing was used. Average emergence, stands and yields of beets planted at different seeding rates for the three years of study are shown in Table 1. An average emergence of 51 percent was obtained. No significant differences in percent sugar were observed. Tonnage yield began to drop off for the 6-inch or larger seed spacings. The initial stand counts for these seed spacings were less than 100 beets per 100 ft. of row, i.e., a population of less than 24,000 plants per acre.

In order to compare sugarbeets planted-to-stand at all locations with beets overplanted and then thinned, the term "ratio of yields" was defined as the ratio of the yield at a given plant-to-stand seed spacing to the yield obtained at that location when beets were overplanted and then thinned. Ratios of yield as a function of initial stand counts (stand counts taken approximately two weeks after application of post-emergence herbicide, when the beets were in the 4 to 8-leaf stage of growth) are shown in Figure 1. The regression curve shown is significant at the 0.01 level and indicates that initial stand counts in the range of 100-170 beets/100 ft. of row (24-40,000 plants per acre) would produce yields comparable to those obtained by over-planting and then thinning. Although not enough data is available to fully define the ends of the curve, it is evident that under-population is more damaging than over-population. Initial stands of less than 100 beets per 100 ft. of row show lower yield although a yield ratio of 0.8 can still be obtained with 60 beets per 100 ft. of row. In higher density seedings a dominance was observed whereby equally spaced sugar beets did not attain equal size. Harvest stands

Table 1. Emergence, stands and yields of sugar beets planted at different planting rates, all locations, 1976, 1977, 1978.

Planting Rate[a] (inches/seed)	Emergence Rate (%)	Stands (beets/100 ft.) Initial	Stands (beets/100 ft.) Harvest	Yield Tons/A	Yield % Sugar
4--thinned	50	96^{cb}	86^{b}	19.6^{a}	16.2
4--p.t.s.	50	150^{a}	112^{a}	19.6^{a}	16.1
5--p.t.s.	53	133^{b}	103^{a}	19.8^{a}	16.2
6--p.t.s.	49	99^{b}	83^{bc}	18.0^{ab}	16.3
7--p.t.s.	51	89^{cd}	75^{cd}	17.9^{ab}	16.1
8--p.t.s.	51	77^{d}	68^{d}	16.7^{b}	16.3
Average	51	107	88	18.6	16.2

[a] p.t.s.--plants-to-stand seeding rate, hoed for weed control only.

[b] Means followed by different letters are significantly different at the 0.05 level. Means with no superscript letters are not significantly different.

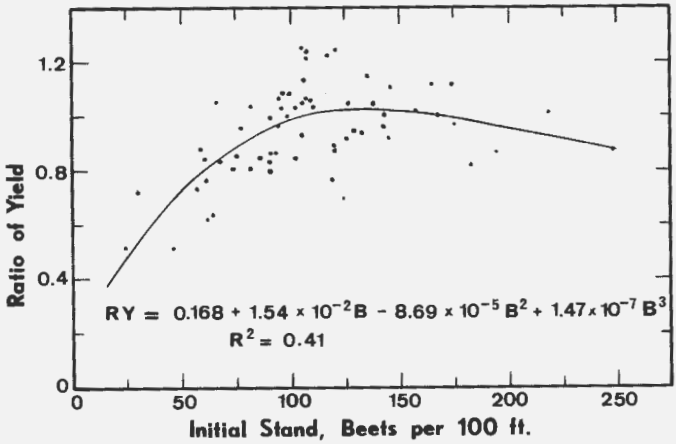

Figure 1. Ratio of yields (plant-to-stand yield/overplanted-thinned yield) as a function of initial stand count.

were considerably lower than the initial stands. The regression curve for harvest stands, H, as a function of initial stand, I, was as follows:

$$H = 22.7 + 0.600\ I$$

Lower harvest stands were due to atrition when hoeing and cultivating for weeds and due to non-machine-harvestable small roots. In order to more nearly simulate mechanical harvesting, beets with crown diameters of 2 inches or less were not included in the harvest samples. With high plant populations, there were

a larger number of these non-machine-harvestable roots but they did not contribute much to the total yield. The non-harvestable roots amounted to more than one ton per acre for only one treatment at one location. For the 4-inch seed spacing at Torrington in 1976, 72 non-harvestable roots yielded 1.5 tons per acre while 143 harvestable roots yielded 17.4 tons per acre as compared to 19.8 tons per acre from the thinned treatment.

These seeding rate studies have suggested that for optimum root yield, initial plant densities should be in the range of 100 to 170 beets per 100 ft. of row. Translated into terms of seed spacing and emergence, the seed spacing for 22-inch rows should be equal to about 9 times the expected emergence rate, e.g., an expected emergence rate of 0.6 (60 percent) would indicate a seed spacing of 5-6 inches per seed. A yield ratio of 0.96 or better could then be obtained with an emergence range of 0.4 to 0.8. Obtaining a predictable emergence rate would allow a more quantitative prediction of the proper seed spacing.

EMERGENCE

Sugar beet emergence rate affects the variability of plant spacing as well as the average plant spacing. The average spacing after emergence, $\bar{x}$, is given by:

$$\bar{x} = \frac{S}{E}$$

where,

S = average seed spacing, and

E = emergence rate.

The standard deviation, σ, i.e., concentration of plant spacings about the mean spacing, as reported by Fornstrom (6), is given by:

$$\sigma = \bar{x} \sqrt{1 - E}.$$

A large standard deviation implies a large variation in plant spacings. A completely uniform spacing would result if the emergence rate was 1.0 (100 percent) and would have a standard deviation of zero. A good emergence rate is desirable from both the standpoint of obtaining the desired stand as well as keeping the variation in plant spacings to a minimum.

Temperature, moisture, physical impedance and aeration are recognized as the basic soil environmental factors which influence

germination and seedling emergence (4).

Temperature is uncontrollable, and limiting, particularly in Wyoming where maximum utilization of the available growing season is necessary for beet production. A model has been developed describing the emergence of beets as a function of soil heat (13). Air temperature is also limiting in that freezes may, and do, occur after the plants have emerged. Applying the model with soil and air temperature data for Powell, Wyoming, no planting criteria for this area was found to be advantageous to planting according to the calendar, i.e., according to average temperatures from year to year.

Physical impedance is occasionally a problem when crusts are formed which prevent emergence. Anticrustant materials intended to stabilize the soil particles so that a crust is not formed were applied over-the-row at several locations. The anticrustant applications were not beneficial for the soil conditions encountered in the three years of study (7, 8, 9).

Soil moisture appears to be the key to obtaining satisfactory emergence. Adequate soil moisture not only provides the necessary moisture for germination and emergence but also enhances herbicidal weed control and prevents crust formation. Laboratory emergence studies indicate that emergence is affected very little when the water potential is 5 bars or less, but emergence ceases somewhere in the range of 12 to 15 bars of tension (2, 10), which corresponds to the tensions at which permanent wilting of plants occurs.

Two distinct climatological areas exist in Wyoming where sugar beets are grown. The Big Horn Basin has an arid climate and all farmers irrigate their beets for emergence. The eastern area of production centered around Torrington receives an average of 4.19 inches of precipitation in April and May and the farmers in the area depend upon this precipitation for emergence moisture.

In the Big Horn Basin area near Powell, monitoring studies were conducted in 1977, 1978, and 1979 (10, 11, 12). Ten cooperator fields were monitored for soil moisture over the emergence period and the final emergence rate was observed. Final emergence as a function of the high soil moisture tension reached

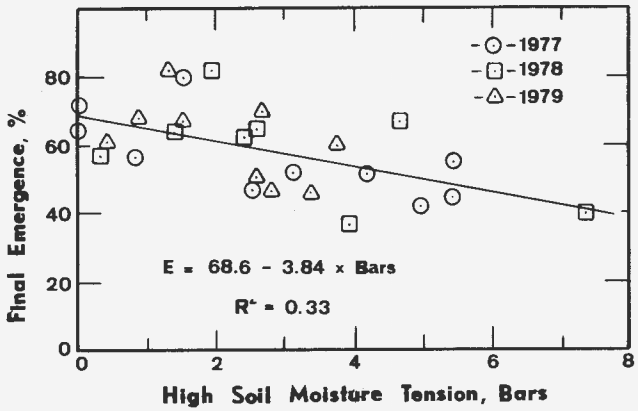

Figure 2. Final emergence rate as a function of high soil moisture tension during the emergence period, Powell area, 1977, 1978 and 1979.

during the emergence period is shown in Figure 2. The linear relationship is significant at the 0.05 level and indicates that a final emergence of 60 percent or more would be attained with soil moisture tensions of less than about 5 bars. Thus, a second irrigation may be necessary in this area to assure adequate emergence.

In the Torrington area, a study was conducted for five years to compare irrigation for emergence with no irrigation (7, 9, 10, 11, 12). Precipitation was adequate for emergence and herbicidal weed control in four out of the five years of study. The emergence rate for the non-irrigated treatment was lower but satisfactory (61 percent vs. 65 percent) and herbicidal weed control was poorer in one year. In the 1977 non-irrigated treatment, beets emerged unevenly and about two weeks later than those in the irrigated treatment. This prevented a postemergence herbicide application and resulted in an average weed control of 77 percent as compared to 100 percent in the irrigated treatment.

Stand loss due to herbicide damage, in effect, reduces the emergence rate. Average stands in 1977, 1978, and 1979 when compared to non-treatment checks were 13 percent less with preplant treatments and 17 percent less with complementary preplant-postemergence treatments (10, 11, 12). If this were a consistent

stand loss, it could be compensated for. However, the stand loss is not always consistent. In 1979, complementary treatment with herbicides at five locations resulted in stand losses of 0, 0, 84, 51, and 32 percent, respectively. Although not a common occurance, such inconsistency is of concern when planting beets to stand.

SUMMARY

Planting sugar beets to stand requires good herbicidal weed control, proper seeding rates and consistent emergence rates. This study has been concerned with planting and emergence rates for planting-to-stand in Wyoming.

This study shows that planting-to-stand is a very feasible method of planting beets. Planting rate studies indicate that if the initial stand counts are in the range of 100-170 sugar beets per 100 ft. of row spaced 22 inches, (24-40,000 plants per acre) yields will generally equal those attained when the sugar beets are over-planted and then thinned. Although there was a tendency for lower yields when stands were below 100 beets per 100 ft., initial stands as low as 60 beets per 100 ft. can probably be tolerated when the time, labor, fuel, and costs of either hand or machine thinning the crop are considered.

A good emergence rate is most desirable from both the standpoint of obtaining the desired stand as well as keeping the variation in plant spacings to a minimum. Soil moisture is the key soil environmental factor in obtaining adequate emergence. Maintaining soil tension at less than 5 atmospheres appears to be a realistic management criteria to insure an emergence rate of 60 percent or more. Adequate soil moisture is beneficial not only for seedling emergence but also for insuring adequate herbicidal weed control. Occasional stand losses with complementary herbicide treatment are a concern when planting sugar beets to stand.

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