Seed spacing for nonthinned sugarbeet production

Sugarbeets planted to stand in 4- or 6-inch seed spacings generally resulted in higher gross sucrose yields and estimated sucrose yields than sugarbeets planted at 7.6- or 9-inch spacings.

By Joyce L. A. Eckhoff, Jerald W. Bergman,* Michael J. Weiss,** and Ardel D. Halvorson****

Introduction

Montana sugarbeet growers traditionally plant beets at high densities to insure adequate emergence, then use hand labor to thin to desired plant populations. This practice significantly increases the cost of sugarbeet production.

Reports on optimum harvest stand for root yield and sucrose yield are conflicting. (2, 3, 6, 8, 9, 10, 11, 12) Conservation of seedbed moisture is important for uniform seed germination, especially with lower seeding rates. Soil water content of sugarbeet seedbeds can be increased by the use of fall irrigation and the fall-ridging/spring-deridging process (7). Ridges are established in the fall that correspond with the sugarbeet rows to be planted the following spring. Before planting, the ridges are scraped into interrow furrows, resulting in a flat seedbed with exposed moist soil. Seed are planted as soon as the seedbed is dry enough to allow equipment into the field. Fall irrigation before ridge establishment can assure favorable seedbed moisture at planting time and increase the chance of adequate sugarbeet populations with reduced seeding rates.

Research to evaluate seed spacings for nonthinned sugarbeets on fall-ridged/spring-deridged beds has not been reported. The objective of this study was to determine optimum intrarow seed spacings for maximum sucrose harvest of nonthinned sugarbeets using fall-ridged/spring-deridged seedbeds.

Materials and Methods

The experiment was conducted from 1984 through 1987 at the Montana State University Eastern Agricultural Research Center in Sidney, on a silty clay soil. Each year, experimental sites were sampled to a 4-foot depth and soil samples were analyzed for nitrogen, phosphorous and potassium. Ammonium nitrate (34-0-0) was applied so that applied nitrogen, residual nitrogen, and nitrogen expected to be mineralized from organic matter totaled 250 lb per acre, for a root yield goal of 25 tons per acre (4,5). Residual phosphorous and potassium were adequate in all years. Sites were disked, irrigated, fertilized, plowed, and leveled prior to fall ridging. Ethofumesate at 3.5 lb AI per acre was applied in 7-inch bands and soil was immediately ridged over the herbicide. Experimental sites were deridged prior to planting.

'AC-102' sugarbeet was planted at 4-, 6-, 7.6-, and 9-inch seed spacings on 24-inch rows using a Heath vacuum air planter. Experimental design was a randomized complete block with six replications. Seed lots were large, noncoated seeds with 95 percent germination. Seed were

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treated with the fungicide pentachloronitrobenzene. Carbofuran insecticide at 2 lb AI per acre was applied in 7-inch bands and incorporated over the seed. Plots consisted of six 100-ft rows with 24-inch spacing between rows. Seedlings in the center two rows of each plot were counted three to four weeks after emergence. Plots were mechanically cultivated and furrow irrigated as needed.

Sugarbeets were defoliated at harvest and beets in the center two rows of each plot were counted to determine final plant populations. A single-row harvester was used to harvest 30 feet from one of the center two rows of each plot. Root yield (RY) and sucrose content (SC) were determined by the Imperial Holly Sugar Corporation, Sidney, Montana. Gross sucrose was calculated by multiplying root yield by sucrose content. Sodium (Na), potassium (K), and amino-N contents were determined by Inter-Mountain Laboratories, Inc., Sheridan, Wyoming, and used to calculate impurity index (II), clear juice purity (CJP), estimated extractable sucrose content (EESC), and estimated sucrose yield (ESY), using these equations (1):

$II = ((3.5 \times Na) + (2.5 \times K) + (9.5 \times amino\text{-}N))/SC$

$CJP = 97.09 - (II \times 0.00208)$

$EESC = (SC - 0.3)\{1 - [1.667 \times (100 - CJP)/CJP]\}$

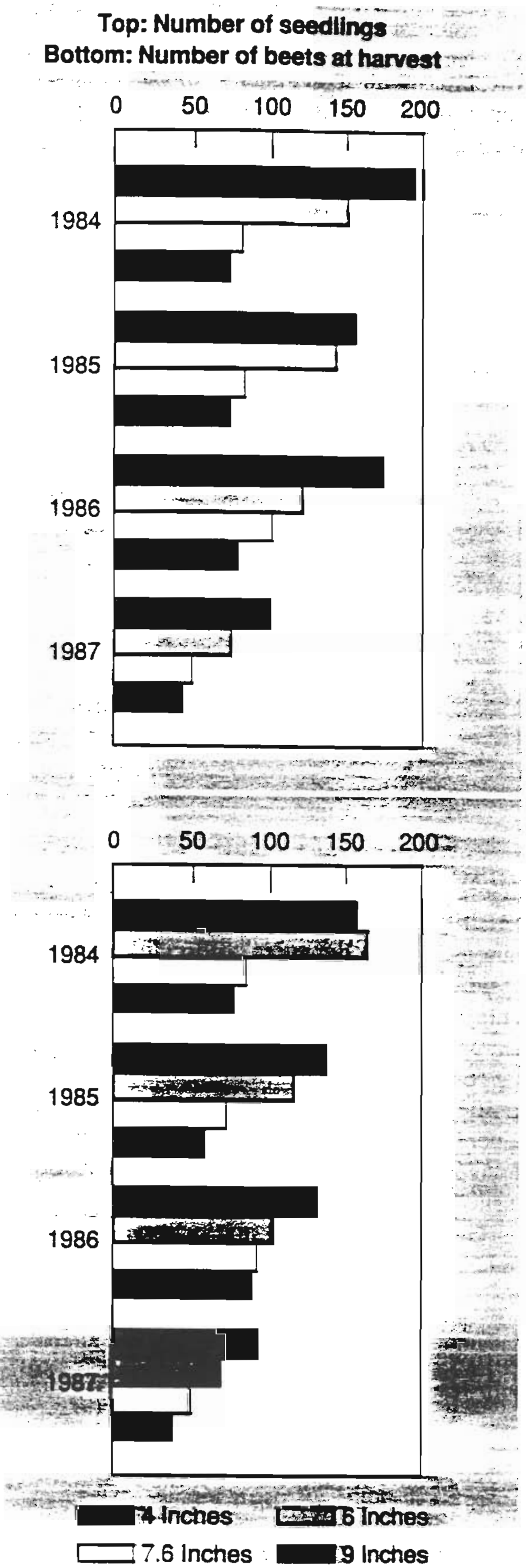
$ESY = (EESC/100) \times RY \times 2000$

Statistics were computed using MSUSTAT, ver. 4.10, developed by Dr. Richard Lund, Montana State University at Bozeman.

Results and Discussion

Spring seedling stands and harvest stands decreased as seed spacing increased in all years, with significant negative correlations. Harvest stands were positively correlated with seedling stands (Figure 1). Sugarbeet densities at harvest were generally less than seedlings densities, especially at narrower seed spacings. This reduction in beet numbers was attributed to plant competition and loss to disease. Seedling and harvest stands for the four seed spacings were similar in 1984, 1985, and 1986. Heavy rain between planting and emergence in 1987 resulted in severe crusting of the soil surface, which reduced emergence and stands at all seed spacings.

Figure 1. Number of seedlings and sugarbeets at harvest at four seed spacings per 100-foot row



Seed spacing did not affect root yield when analyzed across years (Table 1), but root yield among the different seed spacings varied within years. Root yield was positively correlated with seed spacings in 1984 and 1986, and negatively correlated with seed spacing in 1985 and 1987. Harvest stands of the wider seed spacings were lower in 1985 and harvest stands of all seed spacings were lower in 1987 than in 1984 and 1986, so that gaps in the rows were great enough at the 7.6- and 9-inch spacings that increased beet size did not compensate completely for the lower stands. Root yields in the 7.6- and 9-inch spacings were apparently compensated for by larger roots in 1984 and 1986, the years with the greater harvest densities at the wider seed spacings.

Table 1. Four-year average sugarbeet yields at four in-row seed spacings

Seed spacing, inches	*Root yield T/acre*	*Sucrose content percent*	*Gross Sucrose yield lb/acre*	*Impurity index*	*Estimated Sucrose yield lb/acre*
4	23.0a	18.07a	8312a	697.1a	7558a
6	22.8a	17.83ab	8130ab	721.5ab	7378ab
7.6	22.0a	17.59bc	7740b	759.1b	7014b
9	22.5a	17.17c	7726b	816.1c	7020b

Different letters in columns indicate differences among treatments at probability of 0.05%, using Least Significant Difference.

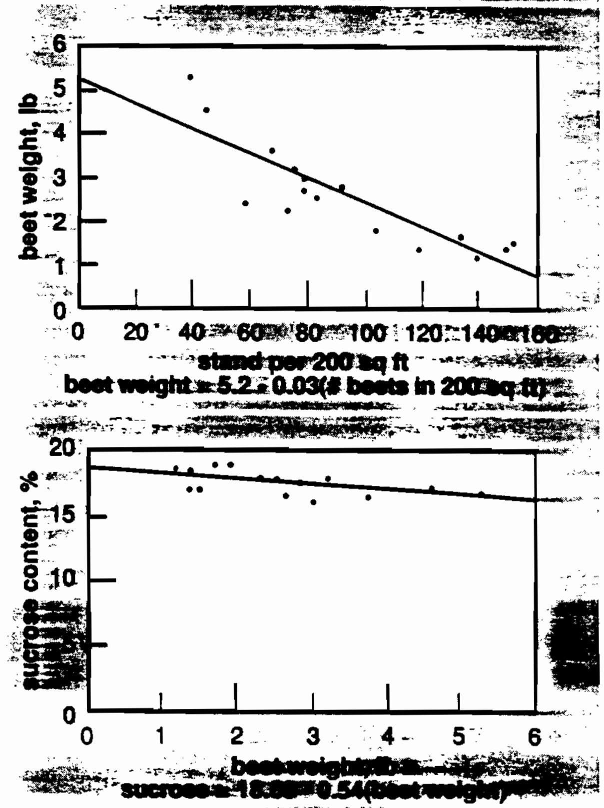
Sugarbeet sucrose contents responded to different seed spacings and their resulting plant densities. The narrower seed spacings resulted in increased plant densities. Individual sugarbeet weights decreased as plant density increased, while sucrose contents increased as the beet size decreased (Figure 2). Thus, narrower seed spacing resulted in greater plant densities, causing smaller beets with greater sucrose. Large beets generally develop more crown tissue, which has lower sucrose and more impurities than root tissue (4).

Gross sucrose yield and estimated sucrose yield increased as seed spacing decreased as a result of the increased sucrose content (Table 1). Greater harvest stands were achieved with the narrower seed spacings, resulting in smaller beets with less crown tissue and higher sucrose contents. Wide seed spacings resulted in lower harvest densities, which generally produced larger beets with more crown tissue and lower sucrose contents, resulting in lower gross and estimated sucrose yields than narrower intrarow seed spacings. Sucrose contents, gross sucrose yields, and estimated sucrose yields at the 4- and 6-inch seed spacings were greater than at the 7.6- and 9-inch seed spacings when analyzed across years.

Sodium content of the sugarbeets was not affected by seed spacing or harvest stand. Potassium and amino-N were negatively correlated with seed spacing and with harvest stand when analyzed within years and across years. The increased potassium and amino-N content along with the reduced sucrose content of the more widely spaced sugarbeets caused impurity indices to increase as harvest stands decreased.

Root yield, gross sucrose yield and estimated sucrose yield showed significant seed spacing by year interactions. Variation in root yield apparently was not due to differences in plant population, because no correlation was indicated when root yield was regressed against seed and harvest stands within years or across years. The negative relationship between stand density and root size also suggests that stand density was not a factor

Figure 2. Individual sugarbeet weights regressed against harvest densities and sucrose contents regressed against individual sugarbeet weights



in root yield. Root yield was used to calculate gross sucrose yield and estimated sucrose yield, so as root yield varied across years, so did gross sucrose yield and estimated sucrose yield.

This study and previous reports indicate that factors such as length of growing season influence root yield more than seed spacing and harvest stand (3, 9). Sugarbeet stands were lower in 1987 than in other years, but average root yield in 1987 was greatest. Seeding occurred about two weeks earlier in 1987 than other years, and a long frost-free season allowed the beets to continue to grow and accumulate sucrose to a later date than other years. The long growing season contributed to the higher yields in 1987. Early planting dates for sugarbeets planted to stand would probably result in greater compensation for lower stands.

Sugarbeets were successfully planted to stand without supplemental spring irrigation using the fall-ridging/ spring-deridging process with fall irrigation. Average root yields achieved by commercial growers in the lower Yellowstone River valley were 16.7, 19.2, 21.6 and 24.5 tons per acre in 1984 through 1987 respectively, and the average sucrose contents of commercial sugarbeets for those years were 16.84, 16.93, 18.17, and 18.83 percent, for harvested gross sucrose yields of 5,625; 6,500; 7,850; and 9,225 lb/acre (D. Melin, Imperial Holly Sugar Corp, 1990, personal communication). Gross sucrose yields achieved at the 4- and 6-inch seed spacings were similar to or greater than those achieved by commercial growers in all years. Sucrose yields were generally greater at the 4-inch and 6-inch seed spacings than at the wider spacings, while impurities were generally lower.

Conclusions

Sugarbeets planted to stand at 4- and 6-inch seed spacings resulted in adequate plant populations so that no loss of root yield or sucrose yield occurred. Sucrose concentration increased and concentrations of the impurities potassium and amino-N decreased as seed spacing decreased. The combination of fall irrigation with fall ridging/ spring deridging provided adequate seedbed moisture for seedling emergence.

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Table of Contents

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On the cover: Photos of sugar beets in paper pots ready for transplanting at the MSU Agricultural Experiment Station's Eastern Agricultural Research Center at Sidney.

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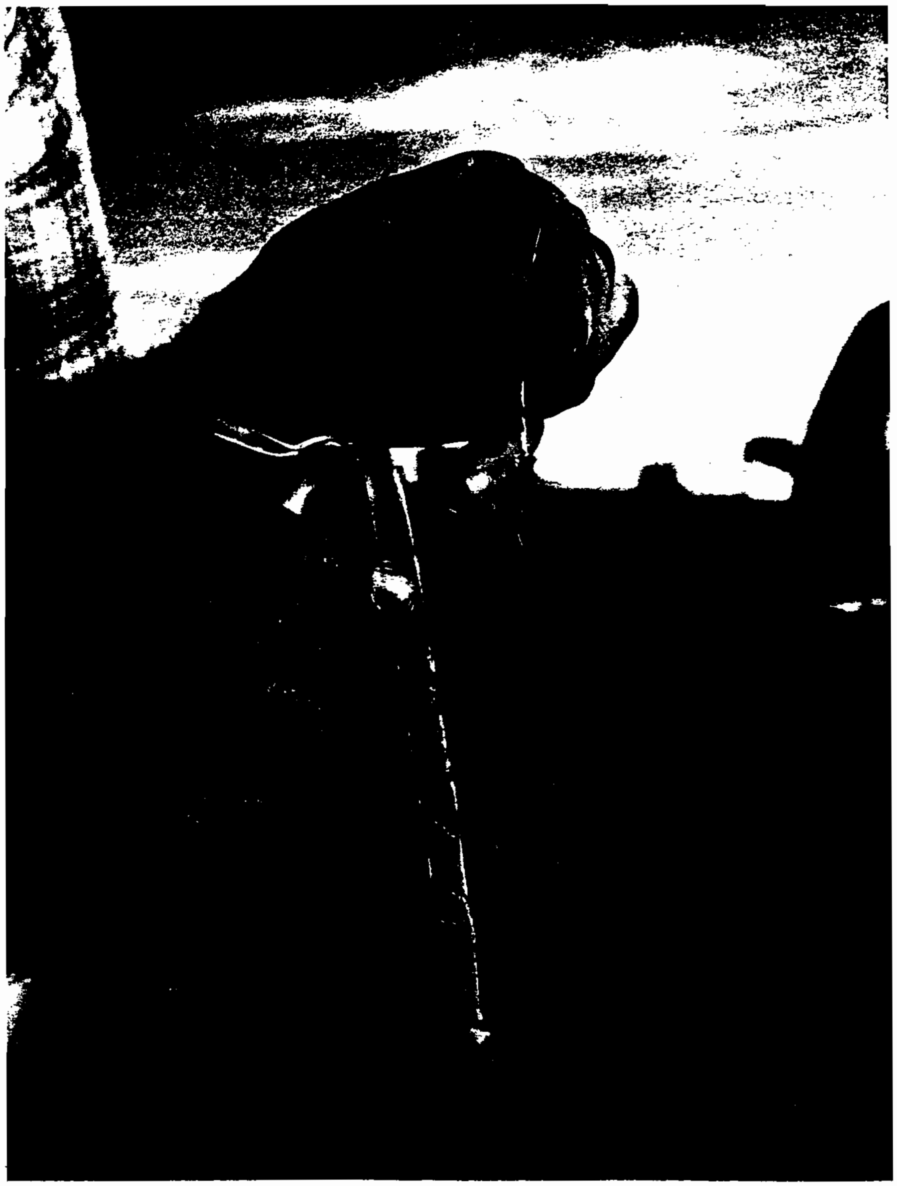

Transplanting sugarbeet seedlings, page 14.

See also:

- *Updates on Montana agricultural research, page 1*
- *Breeding hard red spring wheat, page 31*