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The Effect of Row Spacing on the Yield and Plant Growth of Popcorn (*Zea mays*)

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ABSTRACT

Narrow row corn production has the potential for increased yields. Calmer Ag Research found a 15.5 bushel per acre advantage in 15-inch row corn over 30-inch row corn. Narrow corn rows will canopy more quickly and will have reduced weed pressures. The purpose of this study was to determine the yield potential and plant growth characteristics in 15-inch row popcorn as compared to 30-inch row popcorn. Popcorn was grown in 2007 in southwest Nebraska on 134 acres of irrigated farmland. The crop was planted in a strip-plot design, alternating 30-inch and 15-inch rows. Plant characteristics were measured at 12 sites in the four inner strips biweekly through the growing season. No significant difference was found in plant height, stalk diameter, ear length, ear to plant ratio, 1,000 kernel weight, or yield. There was a tendency for greater stalk diameter and number of ears in 15-inch rows, and a tendency for longer ears in 30-inch rows. The narrow rows canopied more quickly which reduced weed pressure.

Keywords: *popcorn, narrow row, 15-inch rows, weed control*

INTRODUCTION

Agriculture is an ever-changing industry. Producers are always looking to improve their production practices to make the most efficient use of inputs and resources in order to increase production and maximize profit.

Corn is one of the most widely produced and high yielding crops in the United States. Because of this, corn production technology is always improving. Row spacing has changed over the years as producers try to find the most efficient and economical spacing. Today, the most common corn row spacing is 30 inches. New innovations in corn production have brought about the use of 20-inch and 15-inch row spacings. These new row spacings have been collectively termed ‘narrow-row corn production.’

Narrow-row corn production is more efficient in its use of the soil (Turgut, et al). The corn plants are more evenly spaced, allowing for more equal distribution of nutrients and water. Corn plants will canopy more quickly, meaning that the leaves grow together to shade the soil. This results in better weed control (Stalcup). A Kansas State University study found a 25 to 45 percent reduction of weed emergence in narrow-row corn (Staggenborg, et al). Mechanical cultivation is impossible as modern tractors and tillage equipment are not designed for narrow rows, but conventional herbicide control is equally effective in 30- and 15-inch row corn.

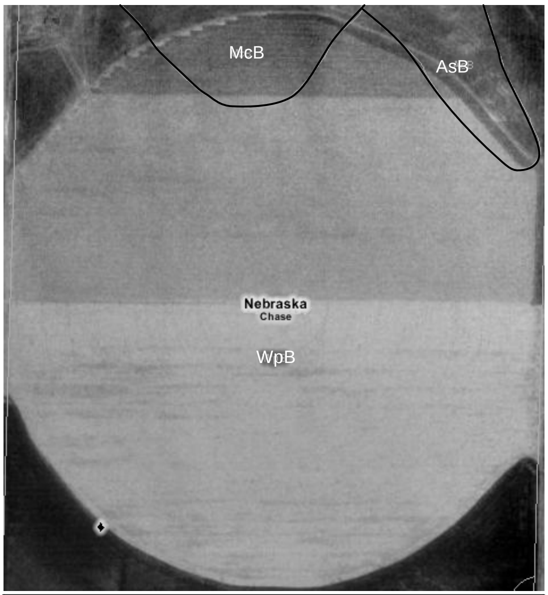
Narrow-row corn production may also affect plant growth. Row spacing has been shown to have little effect on plant height (Liu, et al). Turgut, et al found thicker stems and no difference in the number of ears per plant in narrow rows.

The most important benefit of narrow-row corn production is its potential for increased yield. Turgut, et. al. found a higher yield in narrow-row corn in a 2005 published study. Calmer Ag Research of Alpha, Illinois found a 15.6 bushel per acre advantage in 15-inch corn rows. The greatest yield advantage may be found in areas of high yield potential (Staggenborg, et al).

The purpose of this study was to determine the yield potential and plant characteristics in narrow-row popcorn production. Popcorn was used because there is interest in using narrow-row technology for popcorn production in southwest Nebraska where this study took place. Popcorn is a direct human food crop, and the current public apprehension to genetically modified foods has prevented the use of genetic engineering to add genetic resistance to herbicides in popcorn hybrids. Since narrow popcorn rows may canopy more quickly, some weed control should be expected that might normally be controlled by herbicides or mechanical cultivation.

MATERIALS AND METHODS

Research was conducted at Grosbach Farms, Inc in the summer growing season of 2007. Popcorn was planted in Chase County, Nebraska (SW1/4 of sec 25, T7N, R38W, 6th PM). The soil type at this field is predominantly Woodly fine sandy loam, with Alliance silt loams on the north edge and Ascalon fine sandy loam on the northeast edge (NRCS) (Figure 1). Average rainfall is 22.5 inches (NRCS). The field was circular in shape, covering 134 acres. It was irrigated with a Zimmatic center-pivot irrigation system with low-pressure drop nozzles and equipped with fertilizer injection equipment (Lindsay Manufacturing, Omaha, Nebraska).



Chase County, NE Section 25 Township 7N Range 38W	
Map Unit Symbol	*Map Unit Name*
AsB	Ascalon fine sandy loam
McB	Mace-Alliance silt loams
WpB	Woodly fine sandy loam

Figure 1: Soil map of research field

The previous crop in the field was soybeans. A fertilizer of 8% nitrogen, 9% phosphorus, 4.2% potassium, 5% sulfur, and 0.5% zinc was applied at 15 gallons per acre with Bicep II MagnumLite herbicide (S-metolachlor + atrazine) at a rate of 1.5 quarts per acre. The field was then conditioned in a north-south direction with a 24-foot Sunflower Land Finisher just prior to planting.

The field was divided into eight strips running the length the field in an east-west direction (Figure 2). Each strip was approximately 330 feet wide. The strips alternated 30-inch and 15-inch row widths. Planting was performed with two planters, a John Deere 1790 front-fold planter (15-inch rows) and a John Deere 1720 stacker-fold planter (30-inch rows).

The tractor used to plant the 15-inch rows was equipped with Global Positioning System (GPS) auto-steer equipment, which allowed for accurate strip layout. Hybrid popcorn seed (Vogel VYP 321) was planted at a population of 30,000 seeds per acre in both row spacings. Planting occurred on May 10 and 11.

Within 48 hours of planting, twenty gallons per acre of 42% nitrogen, 15% phosphorus fertilizer was applied with Bicep II MagnumLite herbicide (S-metolachlor + atrazine) at 1.5 qt/acre. Thirty days after planting, Dual II herbicide (S-metolachlor) was applied through the irrigation system at 0.75 pt/acre.

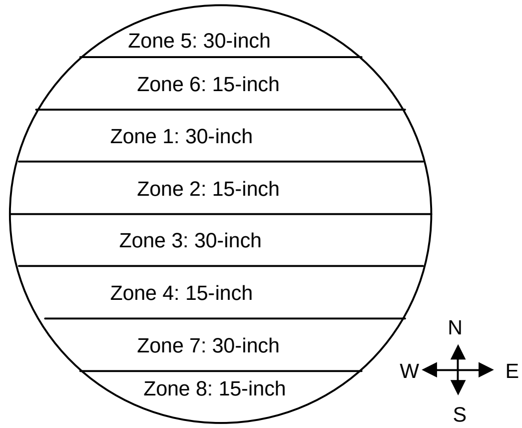


Figure 2 : Layout of strip-plots and row spacings

Twenty gallons per acre of 32% nitrogen fertilizer was applied through the irrigation system later in the growing season. A total of thirteen inches of irrigation water was applied during the growing season.

To determine plant growth data, three sampling sites were selected in each of the four inner strips using Stratus software from SST Development Group, Stillwater, Oklahoma. A hand-held GPS unit was used to locate each site. At each site a length of row was selected representing 1/1000th of an acre (17 ft 5 in. for the 30-inch rows, 35 ft 10 in. for the 15-inch rows).

Plant height and stalk diameter were measured bi-weekly at each site. The date of canopy coverage was recorded and weed pressures were observed. Ear lengths were measured at plant maturity. A thousand-kernel weight measurement was taken to gauge seed size

Harvest occurred when the grain reached 15% moisture using two Case IH 2388 combines on October 6 and 7. One combine used a standard 8-row 30-inch corn head, while the other used a 16-row 15-inch corn head from Clarke Machine, Inc of Howard, South Dakota. Each combine was equipped with Advanced Farming Systems GPS yield mapping equipment and yield data was collected.

The data was analyzed using a standard t-test. Yield data from the combines was analyzed using SSToolbox (SST Development Group).

RESULTS

Very little difference was found in any of the measured variables between the 30-inch and 15-inch rows.

Plant heights and stalk diameters throughout the growing season showed no difference between row spacings (Figures 3 and 4). Stalk diameters decreased in both treatments late in the growing season.

Table 1: Average Plant Measurements for 30-inch and 15-inch rows

Measurement	30-inch rows	15-inch rows	P-value
Plant Height (in)	101.3	102.6	0.517
Stalk Diameter (in)	0.94	1.02	0.065
Ear Length (in)	7.8	7.5	0.135
Ear/Plant ratio	1.31	1.46	0.117
1,000 Kernel Weight (g)	166.2	168.0	0.093
Actual Yield (lbs/acre)	6439	6723	0.327

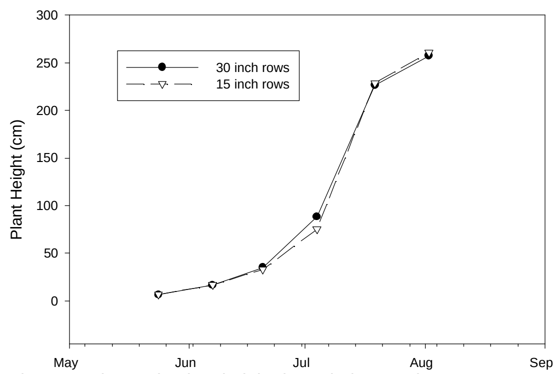


Figure 3: Change in plant height through the growing season

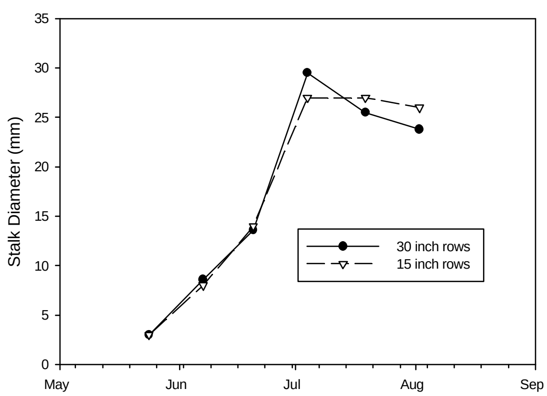


Figure 4: Change in stalk diameter through the growing season

Canopy coverage was established by week four in the 15-inch rows and by week six in the 30-inch rows. Weed pressure was significant throughout most of the field, but appeared to be less of a problem in the 15-inch rows.

At plant maturity, no statistical difference was found between plant heights. There was a strong tendency for stalk diameter to be greater in the 15-inch rows (P=0.065). Ear length tended to be slightly longer in the 30-inch rows (P=0.135). The number of ears per plant tended to be greater in the 15-inch rows (P=0.117). The thousand kernel weight of the 15-inch rows tended to be greater than that of the 30-inch rows (P=0.093). (Table 1)

Average yields were 6439 lb/acre and 6723 lb/acre in the 30- and 15-inch rows, respectively. The difference was not significant (Table 1).

A yield map revealed some variation across the field, but there was little evidence of variation between treatment strips. (Figure 5)

DISCUSSION

A major rain storm that produced 10 inches of rain reduced the effectiveness of residual herbicide control, resulting in major weed pressure. Although weed pressures were extreme throughout the field, it was observed that there were fewer weeds in the 15-inch rows. This is consistent with previous research showing that narrow-row corn canopies more quickly, reducing weed emergence (Staggenborg, et al). Because popcorn is not genetically modified for herbicide resistance, narrow rows may be an effective cultural weed control option. Even with fewer weeds, harvest conditions were not ideal and the narrow-row corn header did not handle the weeds very well.

No difference was found in plant heights, which is similar to results found by Liu, et. al. Consistent with the Turgut, et al study, the 15-inch rows had thicker stems. Thicker stems should lower the risk of lodging. It is interesting to note the decrease in stem diameter in both 30- and 15-inch rows late in the growing season. This may be a result of high transpiration rates and turgor pressures contracting the lower part of the corn stalk (Frye).

Previous research conducted by Turgut, et al, Calmer Ag Research, and Kansas State University (Staggenborg, et al) does suggest a yield advantage in narrow-row corn production. In this study, no significant difference in yield was found between 15-inch and 30-inch rows. It may not be economical to make an investment in expensive equipment where no yield advantage has been found

No definite conclusions can be made from this study because it only spans one growing season. Repetition of this research would reduce multi-year seasonal variation.

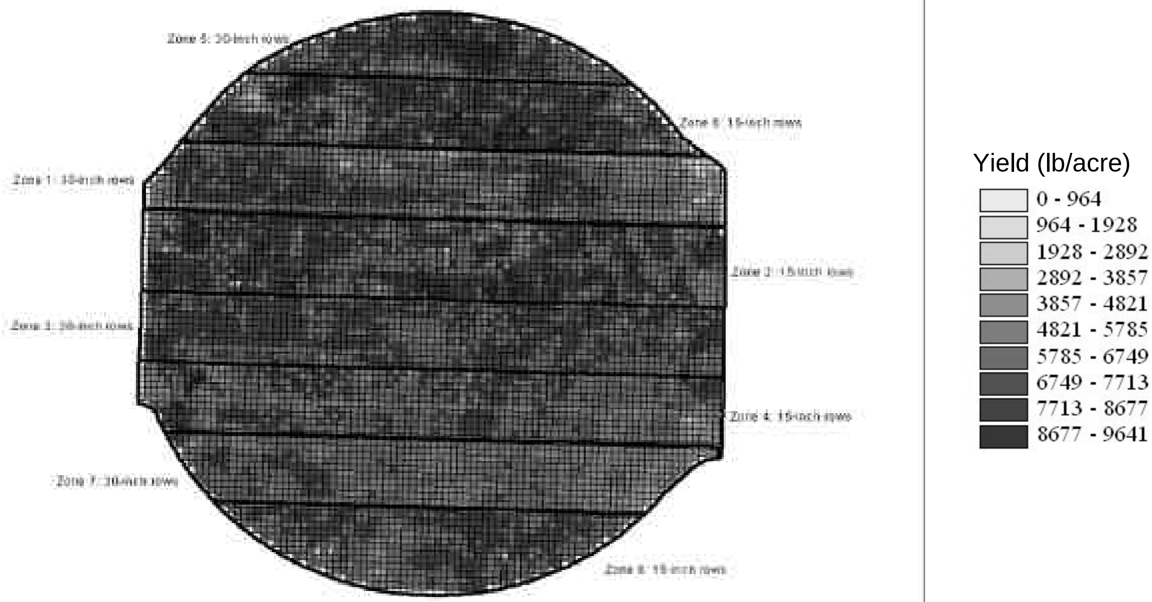


Figure 5: Yield surface showing variation across strip plots in pounds per acre of popcorn

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