DRYLAND CORN YIELD AND WATER USE AFFECTED BY SEEDING RATE AND ROW CONFIGURATION

B.L. Allen
USDA-ARS, Sidney, MT
brett.allen@ars.usda.gov (406) 433-9402

ABSTRACT

An established cattle market in the Northern Great Plains (NGP) creates a demand for feed grains including corn grain and silage. However, dryland corn production is hampered by the risk of crop failure due to drought conditions. Altering the row configuration and seeding rate have reduced the risk of yield loss in other areas, but these typically receive greater rainfall than the average 12-14 in annual precipitation of the NGP. A study was initiated in 2007 to determine the impact of seeding rate and row configuration on dryland corn yield and water use in the NGP. Two sites in north eastern Montana were planted to corn at four rates (10, 15, 20, and 25k plants/ac) in conventional 24 in rows or in a skip row configuration with every third row skipped. Soil water content in skip row plots was monitored during the growing season via neutron probe access tubes. At all seeding rates, total biomass yield was greater in conventional than in skip row corn. However, trends for unshelled ear yield were inconsistent and any differences between conventional and skip row configurations were small. Yield (biomass and unshelled ear) showed an inverse relationship with seeding rate. Furthermore, a greater proportion of total biomass was made up of grain (unshelled ears) as planting rates decreased. Soil moisture monitored at a depth of 36 in in the skipped row during the growing season indicated little difference between 10k and 25k seeding rates. Conversely, readings taken at 18 in depth suggested the 25k seeding rate depleted available soil moisture earlier in the season, limiting grain fill potential. Data from the first year of this study suggests that for areas with low rainfall, potential improvements in corn yield and yield quality can be made by adjusting seeding rates to 10k plants/ac or lower.

INTRODUCTION

The leading factor that reduces crop yield potential in the NGP is lack of plant-available water. Planting crops in a skip row configuration is one management practice that has shown potential to improve yield in dry climates for cotton, sorghum, and corn. Klein et al. (2005) reported a 17% grain yield improvement when every third row of corn was skipped (compared to a control where corn was planted in every row). However, this yield improvement also could be attributed (in whole or part) to the difference in plant population, which was lower in the skip row treatment (13.8k plants/ac) compared to the control (19.5k plants/ac). The rationale for yield improvement in skip row planting involves a reserve of soil moisture located a greater distance from the row (for plant development and grain fill later in the growing season) that would otherwise be utilized too early in the season in a conventional row space configuration. Nielsen et al. (2007) suggested that sorghum and sunflower were able to extract stored soil water in the skipped row, but reported results for corn were inconsistent. The objective of this study was to measure the impact of row space configuration (skip row versus conventional) and seeding rate on corn yield. A secondary objective was to measure soil water during the growing season in skip row corn.

MATERIALS AND METHODS

A complete factorial randomized complete block design with four seeding rates (10k, 15k, 20k, and 25k seeds/ac) planted in conventional 24 in row spacing or in a skip row configuration (every third row skipped) was initiated at two sites during 2007. Each treatment combination was replicated five times. Pioneer 39T67 RR2 Poncho 250 treated-seed was planted on May 11 and 12 at USDA-ARS dryland research farms near Froid and Sidney, MT, respectively. The previous crop was spring wheat at Froid and hay barley at Sidney. At both sites a pre-emergent application of glyphosate was made in addition to an application on Jun 27. Fertilizer was broadcast May 4, 2007 at rates of 72, 38, and 61 lb/ac N, P_2O_5, and K_2O, respectively. Soil samples taken to a depth of four ft were obtained about one mo prior to planting and one mo after harvest. Soil organic C measured in the surface eight in was 11.3% (Sidney) and 8.4% (Froid). Soil pH was 7.2 at both sites. Two twelve-foot length sections were hand harvested in each plot on September 10 (Sidney) and 14 (Froid). Following above ground biomass collection, samples were placed in cloth bags, oven-dried at 140 deg F for one week, and weighed.

Soil water was monitored during the growing season in all skip row plots via neutron probe access tubes. A five-foot length of metal pipe (1½ in inside diameter) was placed vertically into the soil to a depth of 4.5 ft in the row that was skipped during planting, so that the nearest row of corn was 24 in to either side of the access tube. Neutron probe readings at five depths (4, 9, 18, 24, 36 in) were taken on Jun 8 and 19, Jul 2, 19, and 31, and Aug 16 and 27 at each site. An additional post harvest reading was taken on Sep 17 (Sidney) and 21 (Froid).

Rainfall data was collected from weather stations located at each research farm, and for the 12 month period from September 2006 to August 2007 total precipitation was 13.2 and 15.0 in at Sidney and Froid sites, respectively.

RESULTS AND DISCUSSION

Yield

<u>Row Configuration</u>

Total biomass was consistently greater in corn where every row was planted (conventional 24 in spacing) than for corn planted in a skip row configuration (every third row skipped) at Sidney (Fig. 1) and Froid (Fig. 2). Average total biomass yield across all planting rates was 0.2 and 0.3 tons/ac greater for conventional versus skip row spacing at Sidney and Froid, respectively. The decreased yield at Sidney across all treatments was likely due in part to less rainfall (Table 1) than Froid and to a severe hail storm with 40 mph winds Jul 9 that perforated most leaves.

Unlike total biomass, unshelled ear yield was similar in conventional and skip row plots at both sites (Figs. 1 and 2). Across all planting rates, average unshelled ear yield for both conventional and skip row spacing was 1.15 and 1.24 tons/ac at Sidney and Froid, respectively. Other research has reported similar or greater yield in conventional row spacing compared to skip row. Vigil et al. (2006) reported that corn yield was similar in conventional 30 in rows and in corn planted with every third row skipped, though skip row corn did show a yield advantage over conventional corn when planted in skip-two-rows-plant-two-rows and skip-one-row-plant-one-row configurations.

Planting Rate

Total biomass yield generally increased as planting rates decreased at both sites (Figs. 1 and 2) and ranged from 2.9 tons/ac (25k seeding rate) to 3.2 tons/ac (10k seeding rate) at Sidney. At Froid the total biomass yield ranged from 3.5 tons/ac (25k seeding rate) to 3.8 tons/ac (10k seeding rate).

There was a greater response with seeding rate for unshelled ear yield than with total biomass yield. For every 5k decrease in seeding rate, there was roughly a 0.5 ton/ac yield increase at Froid. At Sidney, the yield increase with decreasing seeding rate was slightly less pronounced.

These results suggest that not only does overall biomass increase with lower seeding rates, but that other quality indicators such as feed value and harvest index increase at a disproportionate rate. Future research should also include seeding rates lower than those represented in this study in order to identify optimal planting rates for overall yield and yield quality.

Water Use

Soil Depth

Volumetric soil moisture decreased in the skipped row (not measured in conventional row spacing) at 18 and 36 in depths as the growing season progressed at Sidney (Fig. 3) and Froid (Fig. 4). The period of time corresponding to the greatest decrease in soil moisture at the 18 in depth was between 50 and 80 days after planting (Jul 1 to 31) at both sites. Temporal decreases in soil moisture measured at the 36 in depth were delayed slightly at both sites compared to shallower depths, and the magnitude of decrease was less pronounced at both sites. This observation should be expected as the growing roots utilize available moisture closest to the plant and accesses water further away (lateral and vertical) from the plant as the growing season progresses.

The cumulative soil moisture decrease was greater at Sidney than Froid at 18 in and 36 in depths (Figs. 3 and 4). At the 18 in depth, volumetric moisture at Sidney decreased from approximately 35% to 20% (15% deficit), while at Froid measurements were 30% to 18% (12% deficit). Analogous measurements at the 36 in depth were 34% to 27% (7% deficit) at Sidney and 32% to 28% (4% deficit). Incidentally, both sites received 4.99 in total precipitation between September 2006 and April 2007. Soil moisture differences between sites could be explained in part by greater clay content at Sidney (31%) than Froid (18%) measured in cores taken from 2-8 in depth. Another contributing factor likely was the previous year's crop of hay barley removed less soil water at Sidney than the spring wheat crop at Froid.

Planting Rate

Soil moisture differences between planting rates were apparent when measured during the latter portion of the growing season at the 18 in depth (Figs. 3 and 4). Measurements taken at both sites approximately seventy and eighty days after planting indicated lower soil moisture in the 25k than the 10k plant/ac rate. The timing of these readings coincides with rapid growth and explains in part the higher proportion of grain to biomass with lower planting rates (Figs 1 and 2). Similar moisture content between 10k and 25k rates on Aug 16 and 27 (just before and after

100 days following planting) also suggests that corn planted at 25k used up available moisture earlier in the season (than the 10k rate) to produce vegetative growth at the expense of reduced grain fill.

Little difference in volumetric soil moisture during the growing season was apparent between the highest (25k) and lowest (10k) planting rates when measured at a depth of 36 in at Sidney (Fig. 3). At Froid, the average soil moisture was consistently greater in 25k than the 10k plants/ac treatment when measured at the 36 in depth. This was most likely not related to any experimental treatment, as three of five replications consistently had an approximately 5% greater volumetric moisture reading at all sampling dates. The author has no supported explanation for this observation.

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Figure 1. Yield measured as total biomass or unshelled ear (cob) weight for corn planted at four seeding rates under conventional row spacing every 24 in (conv) or with every third row skipped (skiprow) at Sidney, MT.

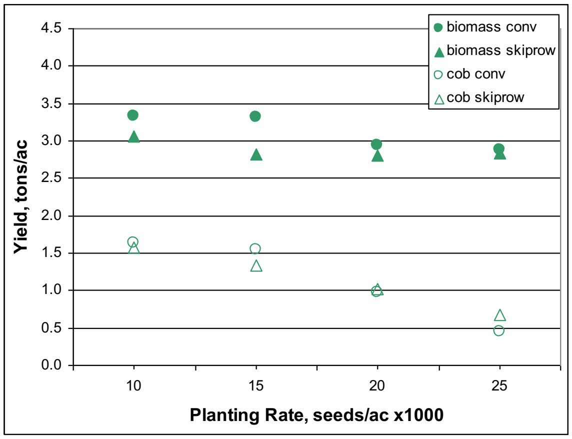

Figure 2. Yield measured as total biomass or unshelled ear (cob) weight for corn planted at four seeding rates under conventional row spacing every 24 in (conv) or with every third row skipped (skiprow) at Froid, MT.

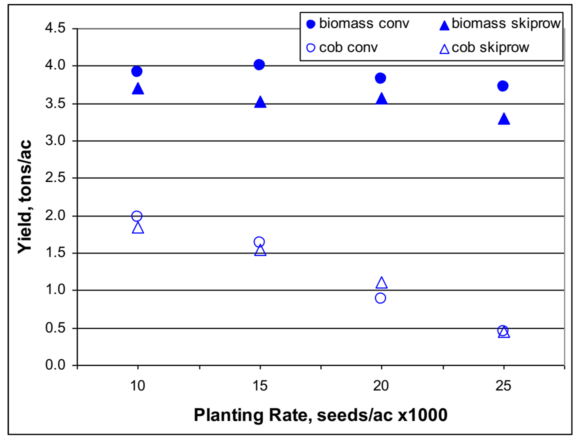

Figure 3. Soil water content during the growing season measured at two depths and at two seeding rates in skip row corn planted on 24 in row spacing with every third row skipped at Sidney, MT.

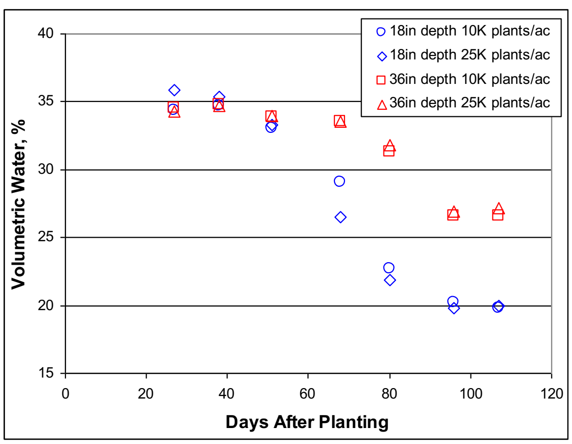

Figure 4. Soil water content during the growing season measured at two depths and at two seeding rates in skip row corn planted on 24 in row spacing with every third row skipped at Froid, MT.

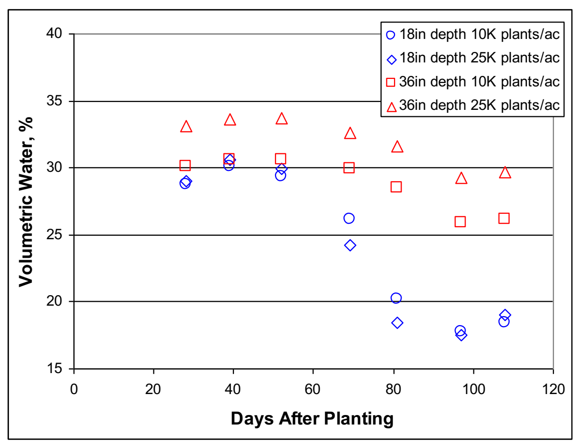

Table 1. Monthly rainfall during the 2007 growing season at Sidney and Froid, MT sites.

Month	Site	
	Sidney	Froid
	Rainfall, in	
May	5.1	5.4
Jun	2.0	3.0
Jul	0.9	0.8
Aug	0.3	0.9
Total	8.3	10.1