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Effects of Twin-Row Spacing on Corn Silage Growth Development and Yield in the Shenandoah Valley

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Corn grown for grain and silage in the Shenandoah Valley of Virginia has traditionally been planted in 30" wide rows. More recently, many producers have been experimenting with narrow or twin-row spacing configurations. There exists a growing body of literature documenting the potential yield and agronomic benefits from corn spaced in either 15" wide rows, or twin-rows, which are 7.5" wide on 30" centers (Cox et al., 2006; Cox and Cherney, 2002; Widdicombe and Thelen, 2002; Cox and Cherney, 2001). The twin-row spacing has particular appeal for many of our dairy operations who often make the decision to harvest forage or grain at or very near to the time of harvest, depending on their storage and use requirements. The appeal of the twin-row spacing is the flexibility to either harvest corn for forage or grain without the investment in specialized harvesting equipment, while at the same time taking advantage of potential yield benefits from the narrow row system. Furthermore, a twin-row system would allow typical in-season crop inputs (side-dress fertilizer, post-emergence herbicide applications) to occur without the danger of crop damage.

Recent advances in planter technology have the potential for very precise seed placement within a twin-row system. This is critical for these systems, because the affect on yield resulting from inaccurate plant spacing within narrow rows is amplified by skips or misplaced seed. A two year study was established in the central Shenandoah Valley to compare the effects of twin-row spacing with conventional row spacing on corn silage yield and growth characteristics using a Great Plains GP1520 precision seeder. Specifically, the objectives of this project were to: 1) Compare the stand establishment between a Great Plains GP1520 precision seeder planting twin-rows with a Great Plains GP6030 corn planter in 30" wide rows and 2) Evaluate the effects of twin-row spacing on corn silage yield and forage quality, plant growth and development, and pest pressure.

MATERIALS AND METHODS

Replicated strip trials were conducted in 2006 and 2007 on a Sequoia silt loam (Typic Hapludult) and an Edom silt loam (Typic Hapludalf) respectively in Augusta County, Virginia. Because of the cropping system on this 500 cow dairy farm, different sites were required in the two study years. In 2006, the field selected was irrigated with a traveling gun system. In 2007, both irrigated and non-irrigated sites were chosen. Plots were arranged in a strip plot design with six replications. Each strip was 60' wide x 1000' long. The corn hybrids selected for this project were Pioneer Brand 31R87 (irrigated sites in 2006 and 2007) and Pioneer Brand 31G71 (non-irrigated site in 2007). Respective relative maturity ratings on these hybrids are

120 and 118 days. Hybrids were planted in early May to achieve target plant density levels of 31,000 plants acre^{-1}. Strips in both study years were planted no-till into killed barley cover crop with either a 6-row Great Plains GP1520 precision drill or a 6-row Great Plains GP6030 corn planter at two row spacings (7.5" twins centered at 30" and 30" respectively).

Plant population was determined in all plots after corn emergence. In 2006 and 2007 stand counts were taken at 21 and 52 DAP (V2 and V8 development stage) and 61 DAP (V9 stage) respectively. Plant height was measured at the V8 growth stage in 2006 and the V9 growth stage in 2007. Visual ratings of disease and insect damage were taken from the plants at various times throughout the growing season. The corn silage was harvested in mid-September with a New Holland (New Holland, PA) pull-type three-row harvester equipped with a kernel processor. The center six rows from each plot were harvested, leaving six rows on either side of each row spacing treatment for a buffer. Forage was blown directly from the harvester into a box-style forage wagon which had been previously tared for weight. After each pass, the wagon was weighed on a set of platform scales. During harvest, grab-samples were collected and compiled for forage analysis to estimate dry matter content, digestibility and nutrient content. Harvest samples were immediately frozen and sent to Cumberland Valley Analytical Services for wet chemistry analysis.

All data were analyzed with the analysis of variance (ANOVA) procedure in SAS Statistical Software Package version 9.1.3 (SAS Inst., 2005). Combined analysis across years and separate analyses within years were conducted for plant densities, plant heights, DM content at harvest, DM yield, and nutritional parameters. Effects were considered significant in all statistical calculations if P-values < 0.05.

RESULTS AND DISCUSSION

Row spacing did not affect plant densities and final plant densities were within 90% of target densities (Table 1). Final plant densities were nearly optimum for corn silage yield and quality under growing conditions in our region (Cox et al., 1998). No difference was observed in plant densities measured at the V2 and V8 growth stage in 2006, indicating that plant survival during the growing season was excellent. Row spacing did not affect plant height measured at the V8 growth stage in either year (Table 1). While not significant, height differences were observed as the corn matured and individual row spacing treatments could be picked out (Figure 1). While DM accumulation was not measured in this study, other researchers have confirmed that row spacing had no affect on DM accumulation at the V8 stage, and that the yield advantage observed with twin-row corn compared with conventional corn row spacing is not associated with more rapid early growth (Ma et al., 2003; Cox et al., 2006).

Visual ratings of insect and disease pressure between row spacing treatments were not different. Minor fungal disease (gray leaf spot, northern corn leaf blight, rust) was observed in the irrigated corn treatments in both 2006 and 2007. No significant insect damage was observed at any site/year combination. Row spacing did appear to affect weed infestation, although this was not quantified. Anecdotal evidence indicated that weed pressure was greater in the conventional row spacing treatments (Figure 2). The herbicide regiment for this study was quite robust, with both PRE applications of contact and residual herbicides (Lumax + Aatrex + Princep + Gramoxone) and concurrent POST applications (Prowl H2O + Roundup Original Max). And although weed control was very acceptable between treatments, there were visible and striking differences in weed density observable at harvest. Canopy closure was more rapid and sustained within the twin-row treatments, and thus less light interception was available to germinate weed seed. This is an interesting phenomenon that should be explored further.

Row spacing did not affect DM content at harvest (Table 2). Other studies have reported a response in DM content to row spacing (Cox et al., 2006) but this was not observed in either year or site of this study. Not surprisingly, DM content at harvest was greater in the non-irrigated treatments than the irrigated (P<0.05), but row spacing had no affect on this response (data not shown).

Twin-row corn yielded 12.5% greater than conventional-row corn (Table 2). This significant yield advantage was consistent across years and sites in this study. While somewhat higher than other studies have observed (Cox et al., 2006), these yield responses tended to be enhanced in the irrigated trials. 2007 was exceptionally dry in the Shenandoah Valley and corn yield differences between twin-row and conventional row spacing were amplified. In the non-irrigated trial in 2007, visual observations of water use efficiency between row spacing treatments were quite revealing, but were not quantified. For example, on 18 June corn in the conventional row spacing treatments were exhibiting rolled leaves and were under obvious drought stress, however corn in the adjacent twin-row strips had not yet rolled (Figure 3). Future research will attempt to quantify this phenomenon. Cox et al. (2006) performed their research under non-irrigated conditions and they also observed significant hybrid differences in response to row spacing. In this study, there were no differences observed between the two corn hybrids selected.

Forage quality is also a very important consideration for dairy producers when selecting corn hybrids or implementing production practice changes. In this study, row spacing had no affect on CP, TDN, NE_L, ADF or NDF measured from sub-samples collected at harvest (Table 2). Interestingly, the irrigated site in 2007 did have a greater CP level than either of the other site/year combinations, but row spacing did not influence this response (data not shown). These findings are consistent with other studies reporting similar values in forage quality between narrow row and conventional row spaced corn (Cox et al., 1998, Cox and Cherney, 2001, Cox and Cherney 2002, Widdicombe and Thelen, 2002; Cox et al., 2006).

CONCLUSIONS

Twin-row spacing as an alternative planting practice for corn silage production in the Shenandoah Valley leads to greater corn silage yields through greater water use efficiency and faster canopy development. Forage quality and DM content at harvest were not impacted by row spacing. In this study, the Great Plains GP1520 precision drill was able to consistently and precisely achieve uniform plant spacing within rows, which led to fewer skips and a very desirable “picket-fence stand” (Figure 4). Although standard deviation was not determined in this study, observations of plant spacing with the precision drill appeared more consistent than the conventional corn planter. Future work will attempt to determine precision of planting as a potential factor. Both planters in this study were able to achieve 90% of the targeted plant densities. In this study, plant density was not a factor. Future work will examine the possibilities of increasing plant population in a narrow-row system. Partial budget analysis of conventional, 15” and twin-row spacing by researchers at Cornell University (Cox et al., 2006) determined that the added expense of the precision drill could be justified with as little as 600 acres of corn silage. While only a handful of dairies in the Valley grow this much corn silage, the cost of the planter could easily be justified by the many custom operators who plant corn in the region.

REFERENCES

Cox, W.J., and D.J.R. Cherney. 2001. Row spacing, plant density and nitrogen effects on corn silage. Agron. J. 93:597-602.

Cox, W.J., and D.J.R. Cherney. 2002. Evaluation of narrow-row corn forage in field-scale studies. Agron. J. 94:321-325.

Cox, W.J., D.J.R. Cherney, and J.J. Hanchar. 1998. Row spacing, hybrid, and plant density effects on corn silage yield and quality. J. Prod. Agric. 11:128-134.

Cox, W.J., J.J. Hanchar, W.A. Knoblauch, and J.H. Cherney. 2006. Growth, yield, quality, and economics of corn silage under different row spacings. Agron. J. 98:163-167.

Ma, B.L., L.M. Dwyer, and C. Costa. 2003. Row spacing and fertilizer nitrogen effects on plant growth and grain yield of maize. Can. J. Plant Sci. 83:241-247.

Widdicombe, W.D., and K.D. Thelen. 2002. Row width and plant density effect on corn forage hybrids. Agron. J. 94:326-330.

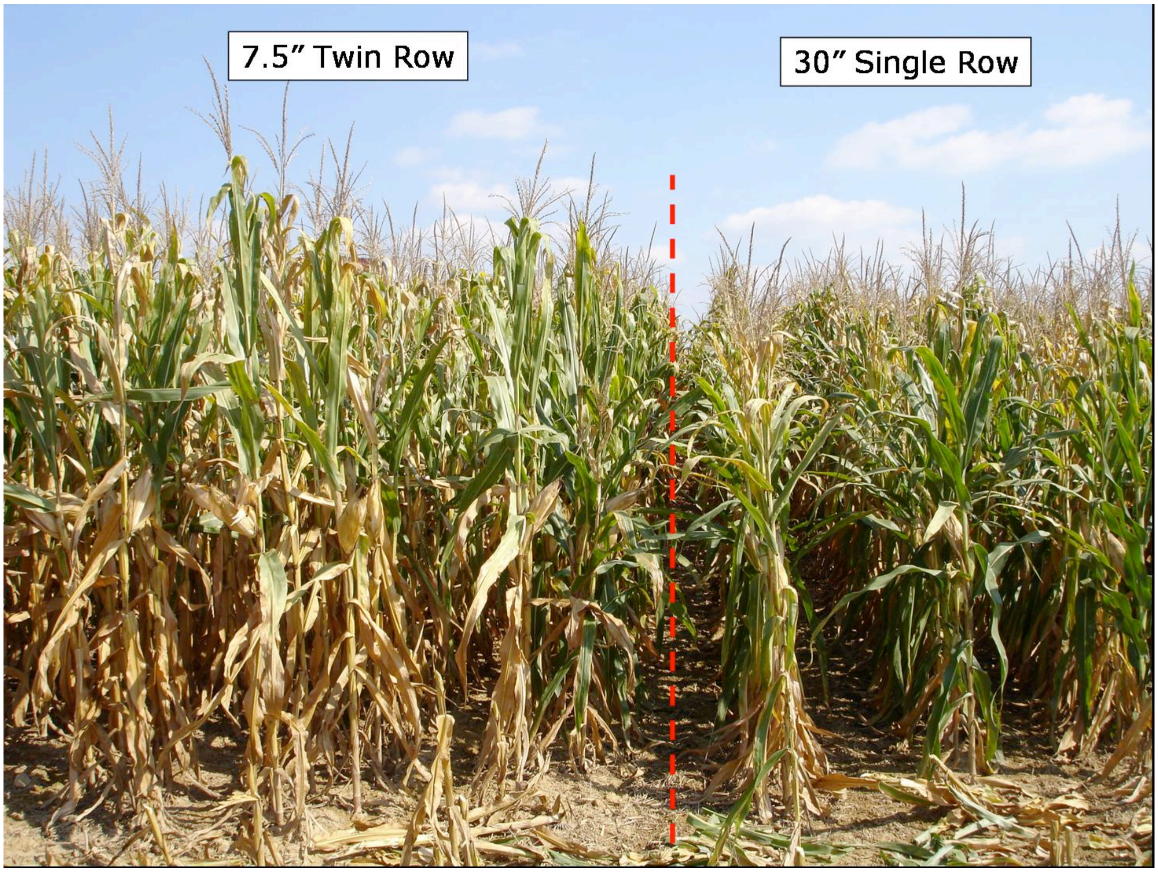

Figure 1. Observed plant height differences between row spacing treatments.

Figure 2. Typical effect of row spacing on weed control.

Figure 3. Example of improved water use efficiency in twin-row corn versus conventional row spacing. Note rolled leaves.

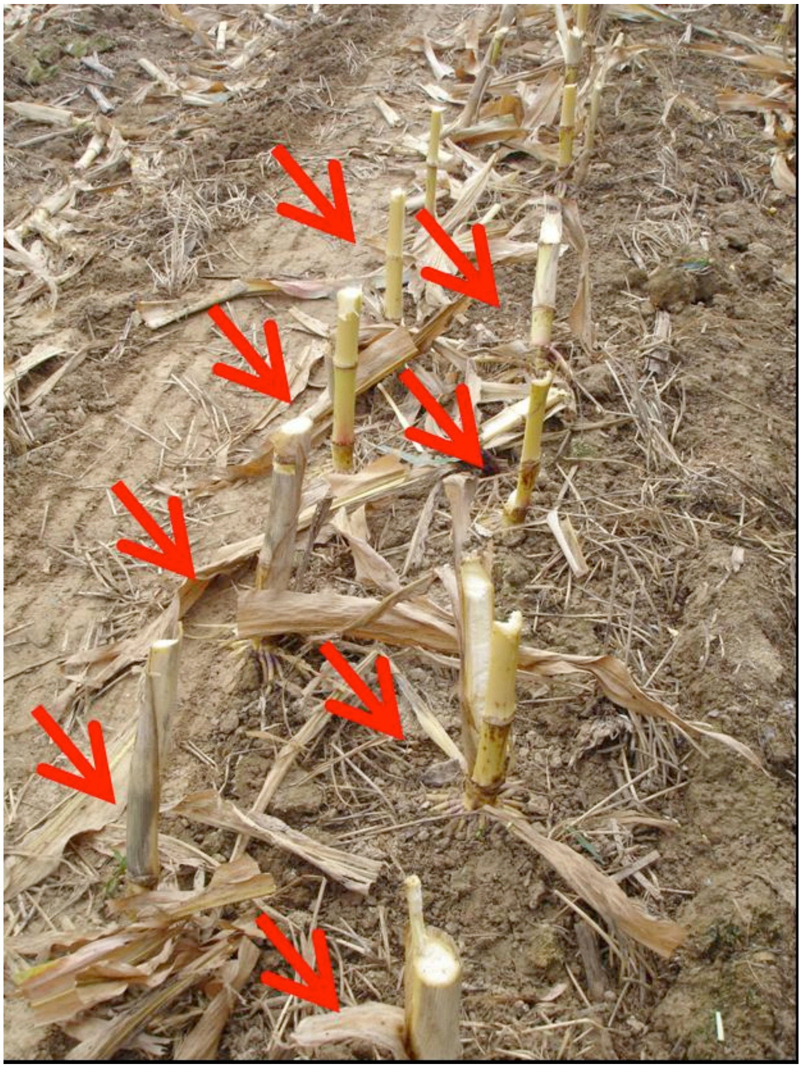

Figure 4. Precise plant placement achieved from the Great Plains GP1520 precision drill.

Table 1. Plant density at the second and eighth leaf stages (2006) and ninth leaf stage (2007) under conventional- (30") and twin- (7.5" on 30" centers) row spacings; and plant height measured at the eighth leaf stage in 2006.

	Plant Population				Plant Height
	2006		2007		2006
Row spacing	V2 Irr†	V8 Irr	V9 Irr	V9 Non	V8 Irr
	----------------------------plants ac^{-1}---------------------------				inches
Twin	28000	28000	28670	29250	21.6
Conventional	28000	27000	27580	27630	19.8
Average	28000	27500	28125	28440	20.7
LSD (0.05)	NS	NS	NS	NS	NS

† Growth stage and irrigation treatments where Irr = irrigated and Non = non-irrigated

Table 2. Dry matter (DM) content, DM yield, crude protein (CP), total digestible nutrients (TDN), net energy for lactation (NE_L), acid detergent fiber (ADF) and neutral detergent fiber (NDF) for two row spacings averaged across the 2006 and 2007 growing seasons.

Row spacing	DM content	DM Yield	CP	TDN	NE_L	ADF	NDF
	%	ton ac^{-1}	----------------------------------%--------------------------------------				
Twin	38.7a	22.4a	7.3a	71.4a	0.8a	23.7a	42.2a
Conventional	40.5a	19.9b	7.6a	70.5a	0.7a	25.0a	44.0a

* Means followed by a common letter are not significantly different at the 0.07 level of probability.