CORN PLANTER ATTACHMENT EFFECTS ON SOIL AND RESIDUE

Mark Hanna, Extension Ag Engineer, Ag & Biosystems Engineering Dept.
Don Erbach, Ag Engineer & Research Leader, USDA-ARS Natl. Soil Dynamics Lab, Auburn, AL
Tom Kaspar, Plant Physiologist, USDA-ARS Natl. Soil Tilth Lab, Ames, IA
Muhammad Iqbal, former Research Assistant, Ag & Biosystems Engineering Dept.
Stephen Marley, Professor Emeritus, Ag & Biosystems Engineering Dept.

Introduction

In recent years, an increasing amount of Iowa row crops have been planted into soil left undisturbed from the prior year's harvest. In 1994, one of five Iowa row crop acres was planted in a no-till system (NRCS, 1994). Various planter modifications and attachments are marketed to assist planting into undisturbed soil. The attachments are sometimes used also after full-width tillage such as a field cultivation or disking. Planter operators use the attachments to improve planting by moving residue or uneven soil clods from the row area or to assist seed placement in wetter than ideal soil conditions.

Row cleaners and strip tillage devices impact the amount of residue cover left over the row after planting. Coulters that till soil in the seed zone affect soil around the seed. Decisions on the use and management of corn planter attachments can be made by considering their effect on residue cover over the row area and soil conditions in the seed placement zone within the row.

Residue cover

Removing residue cover over the row generally improves corn growth and yield, particularly if large amounts of residue are present (such as from a preceding corn crop) and soil conditions at planting are cold and wet. Kaspar and Erbach (1990) showed the beneficial effect on corn yield of leaving some type of residue-free area directly over the row (figure 1). The amount of residue left on the soil surface in this experiment was similar to planting corn-after-corn and was equivalent to that produced from a preceding corn crop of 125 bu/a. A conclusion from this three-year research was that if residue cover is left for erosion protection or as a consequence of minimizing inputs by reducing field operations, then a six-inch wide residue-free band over the row provides most of the yield potential without excessive residue removal.

Later research, also done in central Iowa, supports the conclusions from figure 1. Rather consistently, when corn is planted into the greater amounts of residue cover present with a no-till system, some type of row-cleaning operation tends to increase emergence and yield potential. Corn plants emerge from the soil more quickly when row cleaners are used than when only a coulter is used as the planter attachment (Erbach and Kaspar, 1993; Erbach and Kaspar, 1994). The effect of row cleaners in speeding corn emergence is greater in heavier corn residue than in soybean residue (Erbach and Kaspar, 1993). Besides warming the soil, as row cleaners push residue away from the path of planter depth-gaging wheels, they help the planter maintain a more uniform depth of seed placement. The four row-cleaning devices at the bottom of table 1 all resulted in less than or equal variation in seed depth than did the two coulters.

Figure 1. Corn yield versus the width of a residue-free band over the row (Kaspar and Erbach, 1990).

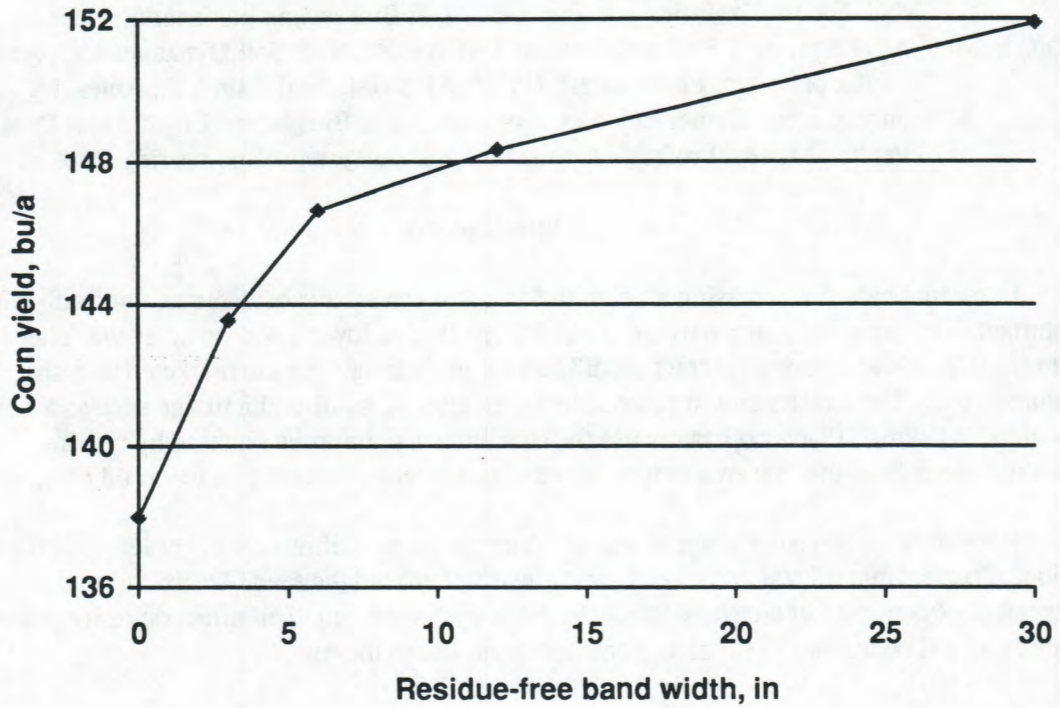

Table 1. Variation in seed placement depth (one standard deviation) for various planter attachments (Erbach and Kaspar, 1994).

Attachment	Standard deviation, in.
Bubble coulter	0.26
Fluted coulter	0.29
Disc row cleaner	0.24
Spoke row cleaner	0.26
Sweep	0.25
Powered horizontal disc	0.22

Adjustment and management of these planter attachments also impacts early corn growth. Corn emerges most rapidly when row cleaners are adjusted to move primarily residue and little soil (Erbach and Kaspar, 1994). Coulter depth has a lesser effect on emergence than does row cleaner depth, however, emergence is generally more rapid when the bottom of the coulter operates at or 1/2 inch above seed depth (Erbach and Kaspar, 1994). This research also showed that stalk-chopping before planting generally does not speed emergence unless corn is planted directly into last year's row without using row cleaners.

Soil conditions

Soil moisture conditions have been wetter than normal during planting in parts of Iowa for the period 1991-96. This has increased grower interest in some type of tillage during planting to ameliorate packed soil conditions in the seed zone. Some growers have been concerned by two-dimensional corn seedling root systems that follow along the furrow and do not adequately proliferate through the soil. Others have been frustrated by seed furrows that never close completely or re-open after a few days,

leaving exposed furrow walls to dry and harden. Growers forced to plant when soil is in a wet, plastic state increase the potential for smearing of seed-furrow sidewalls.

A recent research experiment by Iqbal (1995) was conducted to measure the effects of coulters on soil conditions in the seed furrow and on early corn growth. Planter treatments were the use of three fluted coulters, one bubble coulter, or no coulter immediately ahead of the planter's double-disc seed opener. Soil measurements were bulk density and vertical and horizontal soil penetration resistance in the seed zone. In addition, air permeability was measured in the seed zone as an indicator of smearing and of the ability for air to move to and from the germinating seed and initial roots. The speed of corn emergence was measured as an emergence rate index (ERI). ERI is measured by counting the number of emerged corn plants each day in a specific length of row. The earlier plants emerge, the more heavily they are weighted in the index. A greater ERI value for a treatment indicates that corn plants emerged more quickly. Plants were harvested at the end of six weeks and dried to determine plant dry matter accumulation.

To determine effects of the coulter treatments over a wider range of soil moisture contents, planting was done during three time periods, from late April until early August, during both 1994 and 1995. Seeds were planted into a loam soil at the ISU Agricultural Engineering Research Center near Boone, IA. Results from 1995 are summarized in table 2.

Table 2. Soil and corn growth measurements after using various coulter attachments ahead of planter seed openers during late spring through mid-summer planting periods in 1995 (Iqbal, 1995).*

Measurement	Coulters	Planting period		
Soil bulk density, Mg/m^3		1	2	3
	None	1.01 b	0.99ab	0.99a
	Single	1.03a	1.01a	0.99a
	Triple	0.94 c	0.96 b	0.98a
Vertical penetration resistance, kPa				
	None	637 b	960 b	984 b
	Single	842a	1180a	1109a
	Triple	437 c	640 c	672 c
Horizontal penetration resistance, kPa				
	None	553 b	735 b	867 b
	Single	684a	860a	944ab
	Triple	344 c	571 c	564 c
Air permeability, x $10^{-11}m^2$				
	None	3.3 c	4.3 c	6.8 c
	Single	6.4 b	8.6 b	10.9 b
	Triple	14.5a	16.3a	22.1a
Emergence rate index				
	None	12.0 b	23.3a	24.0a
	Single	12.2ab	24.0a	24.5a
	Triple	12.4a	23.5a	24.6a
Plant dry matter, g/plant				
	None	13.5 b	31.2 b	25.1 b
	Single	14.2 b	34.1a	25.2 b
	Triple	16.8a	34.5a	26.0a

*Within the same column, measurements followed by the same letter are not statistically different (α = 0.05).

The triple coulter attachment generally lowered soil bulk density, decreased penetration resistance, and increased air exchange. Earlier in the season or with wetter soil conditions, use of the triple coulter tended to increase the speed of emergence, and increase early plant dry matter weight. Results from 1994 were similar (Iqbal et al. 1995), however, corn emergence and plant weight were less in the triple coulter system. An examination of seed depth for 1994 indicated that although planter depths were set identically for all three treatments before planting, seed was placed about 1/2 inch deeper in soil loosened by the triple coulters. This research suggests that if soils are wet or early season soil temperatures are cold, a multi-coulter system properly adjusted for seed depth may help avoid problems. Grain yield may be increased, although other season-long factors may limit yield. Indiana research at a more southern latitude than central Iowa did not find grain yield differences when one and three coulter systems were compared over a three year period (Griffith et al., 1994).

Conclusions

Planting corn into heavy residue cover or undisturbed soil requires increased attention to proper use and adjustment of the planter and its attachments.

Leaving a strip of residue-free soil over the corn row is usually beneficial. The effect of this row cleaning seems to be greater in colder, wetter, more poorly drained soils and/or in latitudes comparable to central Iowa and further north (Griffith et al., 1992). Residue removal over the row is typically not detrimental to plants, unless residue is required to prevent soil crusting, residue is used for erosion control (e.g. heavy rainfall on non-contoured rows), or residue is used to inhibit moisture loss during dry soil conditions. Residue removal over the row does not seem to benefit yield as much when soil is drier, further south, lighter colored or sandy, or following lighter amounts of soybean residue. In a fifteen year yield comparison at ISU's northeast research farm near Nashua, corn yields following soybeans averaged one bushel less in a ridge till system using double-disc row cleaners compared to a no-till system using a single coulter. In general, the use of row cleaners when planting corn into soybean residue, is not as critical unless the soil is particularly cold or wet.

A triple-coulter system ahead of the double-disc seed opener tends to loosen the soil. If soil is wet or cold the triple coulter system gives corn a faster start early in the season than does a single bubble coulter or not using any coulter ahead of the seed opener. Although a good early start does not guarantee an end-of-season yield difference, it may reduce yield risk. Other methods that may reduce furrow smearing include use of a small press wheel which is offset from the seed furrow or heavier, cast-iron press wheels. For some operators habitually planting in wetter than desirable soil or interested in corn appearance during mid-June either for themselves or a landlord, the investment in use of multiple coulters may be beneficial.

References Cited

Erbach, D. C. and T. C. Kaspar. 1994. Row cleaners for no-till planting of corn. ASAE Paper No. 941004. St. Joseph, Mich.: ASAE.

Erbach, D. C. and T. C. Kaspar. 1993. Reducing stand establishment risk in conservation tillage. ASAE Paper No. 931559. St. Joseph, Mich.: ASAE.

Griffith, D.R., J.F. Moncrief, D.J. Eckert, J. B. Swan, and D.D. Breitbach. 1992. Crop response to tillage systems. In Conservation tillage systems and management, 25-33. Ames, IA: Midwest Plan Service.

Griffith, D.R., T.D. West, G.C. Steinhardt, and P.R. Hill. 1994. Strip preparation for no-till corn and soybeans. Purdue Univ. Coop. Ext. Bull. No. CT-4. West Lafayette, Ind.

Iqbal, M., S. J. Marley, D. C. Erbach, and T. C. Kaspar. 1995. Effects of coulter treatments on seed furrow smearing and early crop response. ASAE Paper No. 951322. St. Joseph, Mich.: ASAE.

Iqbal, M. 1995. Seed furrow sidewall smearing by double disk openers. Unpub. Ph.D. diss. Ames, Ag & Biosystems Engr. Dept., Iowa State University.

Kaspar, T. C., D. C. Erbach, and R. M. Cruse. 1990. Corn response to seed-row residue removal. Soil Sci. Soc. Am. J. 54:1112-1117.

Natural Resources Conservation Service. 1994. Forty ways to better land and water. Des Moines, Iowa: NRCS.