1988

Surface Cover from Corn Residue on Sandy Soils

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This article is reprinted from APPLIED ENGINEERING IN AGRICULTURE (Vol. 4, No. 3, pp. 234-236, 1988)
Published by the American Society of Agricultural Engineers, St. Joseph, Michigan

ABSTRACT

CORN residue left as surface cover after land preparation and planting by various combinations of tillage implements and surface planters, respectively, was measured on four research/demonstration sites with sandy soils in Nebraska. Surface cover ranged from 51 to 80% for the no-till treatments to 14 to 53% for the twice-disked treatments. The wide range in cover was due to the amount of antecedent residues from the previous crop and the soil type which ranged from sandy loam to fine sands. Other tillage implements included a rolling-cultivator, sweep-plow, and mulch-treader.

INTRODUCTION

Row crop acreage in the Sandhills and Sandplains regions of Nebraska has increased during the past 15 years with the introduction of center pivot sprinkler irrigation. The potential for wind erosion has also increased because the permanent cover has been removed from the sandy soils that are highly susceptible to erosion. The most important management technique for reducing erosion potential is leaving the previous crop's residue on the soil surface. However, crop residue management on sandy soils is sometimes compromised when soil incorporated herbicides are used to control weeds such as field sandbur.

Several tillage implements are available for herbicide incorporation (Bode et al., 1969; Sloneker and Moldenhauer, 1977; Todd et al., 1985) but they differ in their effect on incorporation of crop residues. The standard tillage implement in the Sandhills is the tandem disk-harrow. Disks usually are used once or twice before planting with no primary tillage before disking. However, one-way and tandem disks bury from 30 to 70% of corn residue per tillage pass (Dickey and Havlin, 1985; Fenster, 1977; Kimberlin et al. 1977). Sweep-plows reduce wheat residue from 10 to 20% per tillage pass (Dickey et al., 1983; Fenster, 1977; Unger et al., 1971). A powered strip rotary tiller and planting unit may bury 75% of corn residue (Dickey et al., 1984). Other tillage implements such as rolling-cultivators and mulch-treaders have not been fully evaluated for their effect on crop residue incorporation. Little information exists on the effect of tillage implements on corn residue on sandy soils.

OBJECTIVE

The objective of this research/demonstration project was to measure the corn residue cover remaining after corn planting when several different tillage implements were used for weed control and herbicide incorporation on sandy soils. The goal was to measure the differences in residue cover at the time when the soil was most vulnerable to erosion, especially wind erosion.

EQUIPMENT AND PROCEDURES

The study was conducted on four different fields in two different areas of the Sandhills region of Nebraska. The first area included gently rolling fine sands (mesic typic ustipsamments) at the University of Nebraska Sandhills Agricultural Laboratory (SAL) 64 km northwest of North Platte, NE from 1982 through 1985. The second area included sandy loam soils (mesic udic haplustolls) with nearly level topography. The fields in the second area were on two farmer-cooperator farms near Ainsworth (AINS), located in north-central Nebraska, in 1983 and 1984; and at the Brown-Rock-Keya Paha County extension demonstration plots near Ainsworth in 1985. These two areas were selected because they represent the range of soils used for row crops in the Sandhills region.

The study was conducted as a research/demonstration project. Experimental design at each of the seven field locations was a randomized complete block. The treatments were replicated at least three times and as many as six times in some locations. Since some of the plots were on private land, the number of replications was not uniform from site to site. All statistical comparisons among treatments were made for a given site. Irrigated corn was the previous crop at all locations, but corn yields were not available. The plots (3 to 6-m by 30 to 37-m) were tilled parallel to the old rows 1 to 10 days before planting. Field speed for all tillage and planting operations was 6.4 km/h, except for the rolling cultivator which was operated at 8 km/h.

Tillage implements used included tandem disk-harrows, a mulch-treader, rolling-cultivator, and sweep-plow. The disk-harrow and mulch-treader implements are described in Table 1. All the tandem disk-harrows had four gangs of disks with the two front gangs set as a single disk-harrow and the two rear gangs in tandem to those in front. The rear gangs threw the soil in the

Article was submitted for publication in November, 1987; reviewed and approved for publication by the Soil and Water Div. of ASAE in June, 1988.

This manuscript has been assigned Journal Series No. 8487, Agricultural Research Division, University of Nebraska-Lincoln.

Partial support for this research was obtained from Stauffer Chemical Company.

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TABLE 1. CONFIGURATION OF DISK-HARROWS AND MULCH-TREADER

Item	Implement: Disk 1	Disk 2	Disk 3	Mulch-Treader
Disk blade diameter				
Front, mm	432	432	508	381
Rear, mm	483	508	508	381
Disk blade spacing, mm	184	216	190	152
Number of blades/gang				
Front	8	8	16	12
Rear	9	8	16	11
Angle of gangs, deg	20	20	20	22
Cutting width, m	3.05	3.35	6.02	3.66
Weight/cutting width, kg/m	261	313	384	384
Location & years used	SAL 82 SAL 83 AINS 83	SAL 84 SAL 85 AINS 84	AINS 85	ALL

TABLE 2. PERCENT RESIDUE COVER AFTER TILLAGE AND PLANTING, SANDHILLS AG LAB AND AINSWORTH, 1982 TO 1985

Treatment	Sandhills Ag Lab 82	83	84	85	Ainsworth 83*	84	85††
	%						
No till, plant	66a†	63a†	51a†	56a†	80a†	75a†	57a†
Rolling cultivator, plant	56ab	-	-	-	75ab	67ab	-
Sweep plow, plant	48bc	-	-	-	70ab	67ab	-
Sweep plow, rolling cult., plant	48bc	-	-	-	65bc	60ab	-
Mulch treader, plant	-	61ab	32b	52a	66ab	56b	52a
Mulch treader, mulch treader, plant	-	-	-	-	-	59b	39b
Disk, plant	39bc	43bc	16bc	28b	52d	30c	30b
Disk, disk, plant	34c	37c	14c	20b	53cd	20c	30b

* No planting operation
† Means with different letters within a column are significantly different at the p=0.05 level, according to the Ryan-Einot-Gabriel-Welsch multiple F test.
†† Rolling stalk chopper was used prior to the application of tillage and planting.

opposite direction from the front gangs. The disk-harrow normally used at the particular field location was used for the field study. Depth of disking was approximately 7 to 10 cm. The second pass with the disk was in the same direction and occurred on the same day as the first pass. The mulch-treader is a rolling tillage implement with four gangs of finger wheels arranged and angled like a tandem disk-harrow. The 3-m-wide mulch treader was operated at a depth of 7 to 8 cm. The rolling-cultivator had rotary ground-driven gangs of finger wheels. Each of the 12, 20-cm-wide rolling gangs had four finger wheels arranged for full-width tillage between and over the old rows. The 3-m-wide rolling-cultivator was operated at a depth of 2 to 3 cm. The sweep-plow was a single 1.5-m-wide V-shaped blade and was operated at a depth of 12 to 15 cm. The sweep-plow plus rolling-cultivator combination treatment was a sweep-plow operation followed by a rolling-cultivator operation to simulate a rolling cultivator-type gang attached directly to and following the sweep plow. A no-till, plant only treatment was also included.

The corn was planted with the farmer-cooperator's equipment. All planters were equipped with straight rolling coulters and either runner or disk type furrow openers. These planters caused minimal disturbance to the surface.

Residue cover at SAL was measured shortly after corn emergence using a method similar to the line-transect method described by Laflen et al., 1981. Three, 3.3-m-long line-transects were selected randomly and placed diagonally across each plot. Each line was read every 10 cm and the presence or absence of residue recorded for a total of 100 points per plot. Residue cover at Ainsworth was estimated similarly with 100-m transects placed diagonally across the plot. One hundred points were read for the presence or absence of residue.

Data from each trial were analyzed with analysis of variance and differences between means at the $p=0.05$ level were investigated using the Ryan-Einot-Gabriel-Welsch multiple F test (SAS, 1982). T-tests were used to determine if residue cover means for each treatment were different from 40% residue cover.

RESULTS

The percent residue cover remaining after tillage and planting for each treatment is given in Table 2. All statistical comparisons were made among tillage implement treatments at a particular site. The antecedent residue varied from site to site and from season to season, as indicated by the range in residue cover on the no-till treatment. This range in beginning cover amounts was largely due to the stover production from the prior corn crop. The soils in the study sites ranged from loamy sands to fine sands with 1.5 to 0.75% organic matter which produced a range in grain and stover production potential. However, the range of residue cover in Table 2 gives a more realistic indication of values for sandy soils than would a single value for each treatment.

These procedures did not directly measure soil erosion. Rather, residue cover was used as an indicator of soil erosion protection. The residue cover measurements were taken soon after planting when the soil on continuous corn acreage in the region is most susceptible to erosion. A residue cover of 40% has been suggested as the minimum cover for wind erosion protection of sandy soils (Dickey and Havlin, 1985). The mean residue cover of each treatment at each location was compared to the 40% minimum cover to determine if its residue cover differed significantly from 40%.

All observed residue covers were equal to or greater than 40% except for those of the single-disk and double-disk treatments in 1983, 1984 and 1985. Residue covers for those treatments and trials were significantly less than 40% at the $p<0.12$ level.

Residue cover after no-till ranged from 51 to 80%. Residue cover for the no-till treatment was significantly greater than residue cover for both disk treatments at all trials. Residue cover after single and double-disking ranged from 16 to 52%, and 14 to 53%, respectively, and was somewhat dependent on the disk used (Table 1.). The lighter Disk 1, used in 1982 and 1983, tended to reduce residue cover less than the disks used in subsequent years. There was little residue reduction resulting from the second pass of the disk, and no significant differences between single and double-disking were detected in any location. The first pass of the disk buried residue. The second pass, in the same direction as the first pass, tended to stir rather than bury residue. The Ainsworth plots in 1983 had the highest residue covers for single and double-disking, but there was no planting operation at that location.

No significant differences were detected due to the rolling-cultivator, mulch-treader, sweep-plow, or sweep-plow plus rolling-cultivator treatments. Residue cover after the non-disk tillage and planting operations was generally significantly higher than residue cover after single or double disk and plant operations at the Ainsworth locations. However, at SAL during 1982, only the rolling-cultivator resulted in significantly higher residue cover than double-disking, though the other non-disk tillage treatments resulted in consistently higher residue cover than the single or double disk treatments.

Residue cover with the rolling-cultivator, plant treatment was not significantly different from the residue cover with the no-till, plant only treatment. However, residue covers with the rolling-cultivator were consistently lower than with the no-till, plant only treatment. The rolling-cultivator generally tended to bury less residue than the other tillage implements, which agreed with observations that this implement had the least aggressive tillage. In this study, the finger-wheels operated parallel to the direction of travel. Tillage action would be more aggressive if the gangs of finger wheels were angled, but soil ridging would occur. Configuring the rolling-cultivator so that soil moves out from the center may eliminate ridging and allow angled gangs. More aggressive tillage may bury more residue, which would be needed to control existing weeds and/or incorporate herbicide with the rolling cultivator.

Residue cover with the mulch-treader was significantly higher than with the double-disk treatment at SAL in 1983 and 1984, and significantly higher than both the single and double-disk treatments at SAL in 1985. The residue cover after mulch-treader tillage and planting was significantly less than that with the no-till treatment at both SAL and Ainsworth in 1984. There was no significant residue cover difference due to the mulch treader and no-till treatments in the other trials.

The undercutting action of the sweep-plow left corn stalks standing but leaning in the direction of implement travel. Because little soil was turned over, only a very small amount of residue was buried. Residue cover from this treatment ranged from 48 to 70%. However, residue cover measurements for the sweep-plow and no-till treatments may not accurately reflect the total wind erosion control potential because many stalks were left standing. Since standing residue is more effective in controlling wind erosion than flat residue (Lyles and Allison, 1981), the no-till and sweep-plow treatments probably gave better wind erosion control than treatments which flattened residue.

SUMMARY

A wide range in residue cover (51 to 80%) due to the plot locations was evident for the no-till, plant treatment. The soil types, which varied from a fine sand at the Sandhills Agricultural Lab to sandy loams at Ainsworth, probably contributed to this wide range because of differences in dry matter production by the previous crop. The disk-harrow, plant treatments generally resulted in the least residue cover—16 to 52% for one pass and 14 to 53% for two passes. The residue cover with one or two passes of the disk-harrows was statistically the same for all locations. The mulch-treader, plant treatments resulted in 32 to 66% of the surface covered with residue. The finger wheels on the mulch-treader seemed to stir the soil but did not throw as much soil over residue as the disk-harrows. The sweep-plow, plant treatment resulted in 48 to 70% residue cover. The sweep-plow disturbed the residue very little visually, except for the slot left by the V-blade support. The rolling-cultivator, plant treatment resulted in 56 to 75% residue cover. The rolling-cultivator had the "least aggressive" tillage of all the implements when the finger wheels were orientated parallel to the direction of travel.

Surface residue cover can vary on cultivated sandy soils. Differences in residue cover after tillage and planting can also result from the selection of the tillage implement. The tillage implement that is selected and the manner in which it is used can make an important impact on erosion potential, as indicated by surface residue remaining.

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