NO-TILLAGE COULTER, RESIDUE FINGER AND CLOSING WHEEL EFFECTS ON PLANT STAND AND YIELD

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Abstract

Producers in south Texas are adopting conservation tillage practices but at times have difficulty establishing cotton in heavy crop residue from the previous crop. The objective of this study was to evaluate the effects of six different residue finger/coulter combinations over a two year period and 10 different closing wheel combinations on plant population and crop yield. Studies were conducted in 1998 and 1999 with six different coulter/residue finger combinations to aid in seed placement in heavy crop residue conditions and in 1999 with 10 different closing wheel types and configurations in no-tillage corn residue for both corn and cotton. Although one type of residue fingers reduced total plant population in no-tillage corn residue, cotton plant height, leaf stage, lint percentage, or lint yield was not affected. The closing wheel configurations affected crop yield. When a Dawn closing wheel was used without a depth wheel cover plus one conventional rubber wheel, no-tillage cotton yield was reduced 24% compared with using two May-Wes poly closing wheels or one May-Wes poly closing wheel plus one rubber closing wheel.

Introduction

Use of conservation tillage production practices has increased greatly in south Texas over the past few years primarily due to the savings in production costs and tillage trips over the field needed for successful stand establishment and crop maintenance. Several researchers have found that conservation tillage cotton production is more profitable (Patterson et al., 1993; Paxton et al., 1993; Segarra et al., 1991; and Wiese et al., 1994) primarily due to reductions in production inputs and increases in soil water infiltration and storage. Retaining crop residue on the soil surface decreases wind (Hagen and Armbrust, 1994) and water erosion (Mcgregor and Mutchler, 1992; Mutchler et al., 1985; Savabi and Stott, 1994), decreases water runoff after moderate to heavy rainfall events (Koraddi et al., 1992; Yoo et al., 1989) and increases water infiltration rates and soil water retention (Baumhardt et al., 1993; Bordovsky et al., 1994; Radford et al., 1995). Producers are aware of the many benefits of using conservation tillage for cotton production but are reluctant to adopt conservation tillage practices because of real or perceived problems with seed placement and crop stand establishment when planting through crop residue including old root crowns from the previous crop of corn or grain sorghum. Producers also face problems with closing the seed trench after planting with traditional rubber closing wheels. If the seed trench is not firmly closed, the germinating seed may dry out before becoming an established plant. Side wall compaction of the seed trench can inhibit cotton seedling emergence. If down-pressure is increased to close the seed trench, sometimes the cotton seedling is unable to emerge due to excessive firmness of the soil which covers the seed. Cotton may have trouble emerging through a surface crust with clay soils especially if the seed trench was wet when closed and the soil surface bakes due to high temperature and winds prior to seedling emergence. The objective of this study was to evaluate the effects of six different residue finger/coulter combinations over a two year period and 10 different closing wheel combinations on plant population and crop yield.

Materials and Methods

Cotton was planted into untilled corn residue which had not been shredded in March 1998 and 1999 on a Hidalgo silty clay loam soil that was firm and dry at planting times for all treatments. The field site had been a fall corn crop each year and was harvested in January so residue decomposed very little and exceeded 10,000 lbs/acre on the soil surface both years. In 1999 the field was split and one half of the field of corn residue was moldboard plowed, disked three times, and beds were formed. One-half of the field was left no-till. Tillage had dried the soil so much that the moldboard plow portion of the field had to have an irrigation after planting for seed germination while the no-till block had adequate water for seedling germination. All cotton was furrow irrigated about 45 days after planting and again about 70 days after planting. The same treatments as 1998 were applied in 1999 on both the tilled and no-till fields. Six different attachments were mounted on a John Deere 7200 Maxemerge planter. The attachments consisted of 1) “Dawn” (Dawn Equipment Inc. Sycamore, IL) attachment with both residue fingers and a ripple coulter; 2) 25 wave coulter without residue fingers; 3) “Yetter” (Yetter Manufacturing o., Colchester, IL) residue finger/25 wave coulter combination; 4) “Dawn” residue fingers overlapped with no coulter; 5) “Martin” (Martin & Co. Elkton, KY) residue fingers overlapped; and 6) Accra residue fingers. A randomized complete block design was used with four replications of each treatment. Plot size was six 30-inch wide rows by 120' long. Measurements were collected from the two center rows of each plot. Crop yield data was collected by hand harvesting two sub-samples from each plot, each from the two center rows (2 rows by 26.2' row length). Seed cotton was weighed, ginned with a lab scale saw gin and percent lint was weighed to calculated percent lint. Cotton plant population, plant height, leaf stage, percent lint, and lint yield were measured for each treatment.

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A study was also conducted in 1999 with 10 different combinations of closing wheels in no-till corn residue conditions. A ripple coulter was mounted in front of the Maxemerge planter double disk openers to slice crop residue and all closing wheel combinations were mounted in a "V" formation to close the seed trench. The following closing wheel combinations were mounted behind the seed placement tube: 1) two rubber wheels; 2) one rubber wheel plus one "Martin" metal spike closing wheel; 3) one rubber wheel plus one "Yetter" metal toothed wheel; 4) two "Dawn" metal spike wheels with depth covers; 5) one "Dawn" metal spike wheel with no cover plus one rubber wheel; 6) one "Dawn metal spike wheel with depth wheel cover plus one rubber wheel; 7) two "Martin" metal spike wheels; 8) two Yetter metal wheels; 9) two May-Wes (May-Wes Mfg. Inc. Hutchinson, MN) poly toothed closing wheels; and 10) one May-Wes wheel plus one rubber closing wheel. Measurements taken on cotton population, growth, and yield were similar to those with the residue finger study.

Discussion

Cotton plant population was affected by the type of residue finger/coulter combination used when conventional moldboard tillage was used in 1999. The 25 wave coulter used alone produced the greatest plant population while metal spike wheel residue fingers used alone had lower plant populations than the 25 wave coulter. Plant height was affected very little by the type of coulter/residue finger combination used (Table 1) although in 1999 the "Yetter" residue fingers used in combination with the 25 wave coulter had an average plant height (Table 2) 10% lower than the "Dawn" residue finger plus the ripple coulter combination (71.6 cm vs 61.7 cm at 56 days after planting). Average cotton leaf stage (Table 3) was also reduced with the "Yetter" residue finger plus 25 wave coulter combination when compared with the "Dawn" residue finger plus ripple coulter combination. (15.2 leaves vs. 16.5 leaves at 56 days after planting). Percent lint after ginning the seed cotton (Table 4) was affected very little by the residue fingers and coulter used at planting; however, the Accra Residue fingers had a slightly lower lint percentage than the "Dawn" residue fingers plus the ripple coulter combination (39.8 % vs. 40.6%) and most other treatments. Lint yields in 1998 varied from 636 to 784 kg/ha but were not statistically different at $\propto$ = 0.05 level of significance. Cotton lint yields in 1999 (Table 5) planted in the no-till corn residue varied from 983 to 1067 kg/ha and were not significantly different.

The closing wheel study did not affect plant population of cotton or corn in 1999 (Table 6) with no-till conditions. However, the combination of a "Dawn" spike toothed closing wheel without a depth cover used with a rubber closing wheel in the conventional moldboard tillage treatment reduced the cotton plant population by 28% (111,000 vs 155,00 plants/ha) compared with the standard two rubber wheel treatment. Using 2 MayWes closing wheels produced the largest cotton lint yield with both the traditional moldboard plow system and the no-tillage system (1301 and 1198 kg/ha). These closing wheels also produced the largest corn yield (11905 kg/ha grain) although yield was not statistically greater than many of the other treatments. Toothed closing wheels closed the seed trench without compacting the sidewalls of the seed trench while leaving some loose soil covering the top of the seed trench . Toothed closing wheels except treatment number 4 (Dawn closing wheels with covers) in corn and number 5 (one Dawn closing wheel with cover plus one rubber wheel) produced yields of lint and corn grain at least as good as the double rubber wheel combination.

Summary

In the no-tillage environment the "Martin" residue fingers had a smaller cotton population in 1999 compared with other treatments. However, the plant height, leaf stage, percent lint, or lint yield was not adversely affected. Furrow closing wheels had little effect on cotton plant population except for the combination of one Dawn closing wheel with a depth cover used in combination with one rubber closing wheel which suppressed plant population when compared with the two rubber closing wheels in the moldboard treatment. Cotton and corn populations under no-till conditions were not different for any of the 10 closing wheel combinations. No-till cotton had only 867 kg/ha of lint with one "Dawn" closing wheel used in combination with one rubber closing wheel compared with 1178 kg/ha with two Yetter closing wheels or 1198 kg/ha with two May-Wes closing wheels. Studies will be continued with coulter/residue finger combinations and closing wheel combination on other soil types to determine the impact of these equipment on sandy soils and heavy clay soils.

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Table 1. Effect of coulter and or residue fingers on average cotton plant population per hectare at Weslaco, TX.

Treatment	Moldboard 1999	-------No-till------- 1998	1999
1. Dawn Res. Fingers + Ripple Coulter	137,974 ab	170,825 a	166,972 ab
2. Dawn 25 Wave Coulter	177,395 a	177,395 a	186,238 a
3. Yetter Res. Fingers + 25 Wave Coulter	78,842 bc	154,128 a	166,972 ab
4. Dawn Res. Fingers Overlap	59,132 c	157,684 a	154,128 ab
5. Martin Res. Fingers	85,413 bc	164,255 a	134,862 b
6. Accra Res. Fingers	105,123 bc	157,685 a	179,816 ab
minimum significant difference	61,009	20,550	4,495

Comparisons made using a Waller-Duncan K-ratio T-test within a column. Values followed by the same letter within a column are not significantly different ($\propto = 0.05$).

Table 2. Effect of coulter and or residue fingers on average cotton plant height (cm) at Weslaco, TX.

Treatment	Moldboard 1999	-------No-till ------- 1998	1999
1. Dawn Res. Fingers + Ripple Coulter	---------- (56 DAP) ---------- 80.1 a	36.2 a	71.6 a
2. Dawn Wave Coulter	78.7 a	35.5 a	64.1 ab
3. Yetter Res. Fingers + Wave Coulter	76.6 a	38.3 a	61.7 b
4. Dawn Res. Fingers Overlap	74.7 a	33.1 a	70.7 a
5. Martin Res. Fingers	75.2 a	35.5 a	65.9 ab
6. Accra Res. Fingers	77.4 a	33.9 a	64.3 ab
minimum significant difference	8.7	6.7	7.0

Comparisons made using a Waller-Duncan K-ratio T-test within a column. Values followed by the same letter within a column are not significantly different ($\propto = 0.05$).

Table 3. Effect of coulter and or residue fingers on average cotton plant leaf stage at Weslaco, TX.

Treatment	Moldboard 1999	------- No-till ------- 1998	1999
1. Dawn Res. Fingers + Ripple Coulter	---------- (56DAP) ---------- 16.9 a	12.3 a	16.5 a
2. Dawn Wave Coulter	16.5 a	11.9 a	15.9 ab
3. Yetter Res. Fingers + Wave Coulter	16.5 a	12.7 a	15.2 b
4. Dawn Res. Fingers Overlap	16.5 a	11.2 a	16.5 a
5. Martin Res. Fingers	16.1 a	11.8 a	16.4 a
6. Accra Res. Fingers	16.8 a	11.6 a	15.7 ab
minimum significant difference	1.3	1.5	0.9

Comparisons made using a Waller-Duncan K-ratio T-test within a column. Values followed by the same letter within a column are not significantly different ($\propto = 0.05$).

Table 4. Effect of coulter and or residue fingers on average cotton percent lint at Weslaco, TX.

Treatment	Moldboard 1999	------- No-till ------- 1998	1999
1. Dawn Res. Fingers + Ripple Coulter	40.8 a	37.7 a	40.6 a
2. Dawn Wave Coulter	41.3 a	38.4 a	41.0 a
3. Yetter Res. Fingers + Wave Coulter	41.3 a	37.8 a	39.9 bc
4. Dawn Res. Fingers Overlap	40.7 a	37.3 a	40.5 ab
5. Martin Res. Fingers	41.3 a	36.2 a	40.4 ab
6. Accra Res. Fingers	41.7 a	37.5 a	39.8 c
minimum significant difference	1.6	3.2	0.6

Comparisons made using a Waller-Duncan K-ratio T-test within a column. Values followed by the same letter within a column are not significantly different ($\propto = 0.05$).

Table 5. Effect of coulter and or residue fingers on average cotton yield (kg/ha) at Weslaco, TX.

Treatment	Moldboard 1999	------ No-till ------ 1998	1999
1. Dawn Res. Fingers + Ripple Coulter	1292 a	707 a	1040 a
2. Dawn Wave Coulter	1458 a	784 a	1015 a
3. Yetter Res. Fingers + Wave Coulter	998 ab	720 a	1025 a
4. Dawn Res. Fingers Overlap	701 b	636 a	983 a
5. Martin Res. Fingers	767 b	696 a	1117 a
6. Accra Res. Fingers	1163 ab	646 a	1067 a
minimum significant difference	437	173	139

Comparisons made using a Waller-Duncan K-ratio T-test within a column. Values followed by the same letter within a column are not significantly different ($\propto = 0.05$).

Table 6. Effect of type of seed furrow closing wheels on average cotton and corn plant population per hectare at Weslaco, TX 1999.

Treatment	------- Cotton ------- Moldboard	No-till	Corn No-till
1. 2 Rubber wheels	155,000 a	92,000 a	57,300 a
2. 1 Rubber + 1 Martin	140,000 a	111,000 a	68,200 a
3. 1 Rubber + 1 Yetter	136,000 ab	108,000 a	62,700 a
4. 2 Dawn w/ covers	115,000 ab	92,000 a	62,900 a
5. 1 Dawn no cover + 1 Rubber	115,000 ab	92,000 a	65,800 a
6. 1 Dawn w/ cover + 1 Rubber	111,000 b	88,700 a	71,500 a
7. 2 Martin	131,000 ab	105,000 a	53,900 a
8. 2 Yetter	144,000 a	131,000 a	60,300 a
9. 2 Maywes	119,000 ab	168,000 a	58,600 a
10. 1 Rubber + 1 Maywes	127,000 ab	164,000 a	70,900 a
minimum significant difference	32,800	45,100	14,500

Comparisons made using a Waller-Duncan K-ratio T-test within a column. Values followed by the same letter within a column are not significantly different ($\propto = 0.05$).

Table 7. Effect of type of seed furrow closing wheels on average cotton yield and corn grain yield (kg/ha) at Weslaco, TX 1999.

Treatment	------- Cotton ------- Moldboard	No-till	Corn No-till
1. 2 Rubber wheels	981 a	1006 ab	11768 a
2. 1 Rubber + 1 Martin	1080 a	1158 a	10538 ab
3. 1 Rubber + 1 Yetter	1089 a	1099 ab	10557 ab
4. 2 Dawn w/ covers	1076 a	994 ab	6276 b
5. 1 Dawn no cover + 1 Rubber	946 a	867 b	7993 ab
6. 1 Dawn w/ cover + 1 Rubber	951 a	945 ab	9165 ab
7. 2 Martin	1133 a	1073 ab	8879 ab
8. 2 Yetter	1145 a	1178 a	12118 a
9. 2 Maywes	1301 a	1198 a	11905 a
10. 1 Rubber + 1 May-Wes	974 a	1135 a	10401 ab
minimum significant difference	337	281	3950

Comparisons made using a Waller-Duncan K-ratio T-test within a column. Values followed by the same letter within a column are not significantly different ($\propto = 0.05$).