Combine Header Performance in Lodged Grain Sorghum

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ABSTRACT

COMBINE header losses during harvesting of standing and lodged grain sorghum were investigated on the Southern Great Plains. A platform header, used as a standard, was compared with a row crop header. The row crop header was more efficient in both standing and lodged grain. The row crop header gathered most lodged seed heads unless they fell parallel to row direction. In a 1979 test with typical conditions, the extra grain saved by the row crop header was 0.6, 2.6, and 5.3 percent, respectively, of the crop yield for standing, moderately, and highly lodged sorghum.

INTRODUCTION

Grain sorghum *(Sorghum bicolor* L. Moench), an important feed grain for the Great Plains, is often grown with limited irrigation or dryland. Under these conditions, moisture stress frequently causes various degrees of lodging, depending on wind and weather. Lodging, an all-inclusive term, refers to bending or breaking of any portion of the stalk that interferes with normal harvest operations and causes grain loss (Rosenow, 1978). Lodging can result from one or more plant, environmental, or pest factors such as root lodging, charcoal rot, and after-freeze stalk breakage. Charcoal rot, induced by moisture stress, is the most common cause of lodging on the Southern Great Plains.

Grain sorghum has traditionally been combine harvested with platform headers. When lodging is severe, row pickup units may be attached to the combine, but moderate lodging tends to be ignored.

In South Dakota, Waelti et al. (1971) investigated the use of special heading attachments. Header losses ranged from 4 percent of the total yield in a standing crop to 52 percent in a lodged crop during one year. In another year, the use of a row pickup attachment on a platform header reduced header losses from 11 to 4 percent in standing sorghum and from 35 to 10 percent in severely lodged sorghum.

In Kansas, Fairbanks et al. (1979) studied grain sorghum harvesting losses in primarily standing grain, with special emphasis on threshing and separation losses at various moisture contents and different machine settings. A conventional platform header was used and header losses ranged from 2.5 percent of the total grain yield for standing sorghum to 10.5 percent for sorghum with some lodging. Threshing losses ranged from about 3 percent with 15 percent grain moisture to 17 percent with grain moisture at 28 percent.

FIG. 1 Optional sorghum guards attached to cutter bar of a platform header. Guards extend 40 cm ahead of cutter bar.

OBJECTIVES

Our objectives were to focus on combine header gathering losses by comparing a conventional platform header with a row crop header in both standing and lodged crop.

PROCEDURE

We conducted a three-year study from 1977 through 1979 at the USDA Conservation and Production Research Laboratory, Bushland, TX. A medium-maturity grain sorghum hybrid was planted each May in 0.75 m spaced rows on a 3 ha area. Atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine] was applied post emergence for weed control. Furrow irrigation was applied as needed to one-half of the area so that the crop was not moisture stressed. The remainder of the area was not irrigated after the boot stage of plant growth so that moisture stress would induce plant lodging. In 1977, harvest was delayed until the combination of weather and crop stress produced the desired various degrees of lodging. In 1978 and 1979, all tests were made within 2-day periods, because the degree of lodging varied considerably over this test field.

A John Deere 4400* combine was used by interchanging platform and row crop headers as needed. The conventional 4.5 m platform header with a 5-slat variable speed reel had sorghum guards that extended 40 cm ahead of the cutter bar (Fig. 1). The optional guards are

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*Use of a proprietary brand name is for information only and does not imply preferential treatment or endorsement.

FIG. 2 Row header operating in lodged crop.

universally used on platform headers for harvesting grain sorghum in the Southern Great Plains. They help to prevent cut sorghum heads from dropping to the ground before the reel forces them into the platform. The John Deere Model 453 row crop header had four 0.75 m spaced head-gathering units (Fig. 2). Each unit had a rotary knife to cut the seed heads and rubber gathering belts to convey the cut material into the auger. Pointed snouts on each unit lifted and guided the stalks toward the cutting knives and gathering belt.

Tests began each year when grain had dried to 13 to 14 percent moisture content. Before each test, the machine was operated and checked outside of the test area. To measure header loss in standing crops, drop cloths 1.6 m^2 were placed ahead of the combine before each run. During each run, the combine was stopped at a point where the cutter unit had passed over the drop cloth but the drive wheels had not. The machine was then backed up about 2 m for access to the sample.

The drop cloths could not be used on most of the tests in lodged crops, because there was not room to place them under lodged stalks or the row crop header snouts were too low to clear the drop cloth. In those instances, missed sorghum heads were gathered from 2.75 m^2 areas on the ground. Four replicates were conducted for each test. Grain losses measured were preharvest shatter and the following components of header loss: (a) header shatter, (b) cutter loss, and (c) cut and dropped heads. With the platform header, cut and dropped heads could also be considered "reel loss."

RESULTS AND DISCUSSION

The form of plant lodging varied, as did the percentage. Depending on wind strength and direction, lodged stalks were either partially supported by adjacent plants or broken and lying flat on the ground. Stalks broke at ground level or at various positions up the stalk. When lodged stalks broke above ground and fell at approximate right angles to row direction, the row crop header snouts usually lifted the stalk and saved the attached seed head. If lodged stalks and seed heads lay on the ground parallel to the row, then it was difficult to gather them with the row crop header. With moderate lodging, the row crop header snouts were operated from 0 to 10 cm above ground; with severe lodging, the snouts remained on the ground.

1977 Tests

The data obtained in 1977 are presented in Table 1. Header losses are presented as a percentage of the grain yield. The yellow endosperm sorghum hybrid used in 1977 was very tall, reaching a 1.5 m height. The distance from the lower heads to the higher heads was great enough (0.80 m) to make optimum reel height adjustment on the platform header difficult. The headers were adjusted to cut 45 to 50 cm above ground in the standing crop (1-2 percent lodging). Total losses for the platform header were relatively high (2.6 percent) because plants were tall and varied widely in head height. Row crop header losses were only 0.3 percent. Preharvest shatter loss was about 3.6 percent.

With moderate lodging (20 to 25 percent), some lodged heads were leaning on adjacent plants so the platform header could gather most of them. Losses were only 5 percent compared to 2.4 percent for the row crop header. The row crop header operated just above ground level at the 5 to 10 cm height.

Heavy lodging (60 to 75 percent) occurred after a wind-driven snow, and some seed heads were touching ground. As a result, the row crop header had relatively high losses (12 percent) because the rotary knives cut the

TABLE 1. HEADER LOSSES FOR 1977 TESTS. LOSSES ARE PRESENTED AS A PERCENTAGE OF THE TOTAL GRAIN YIELD.

Plant ht. and yield	Lodging percentage and (harvest date)	Header	Grain loss: Header shatter	Cutter loss	Cut and drop	Total loss	Grain* saved
	%		%	%	%	%	%
1.5 m	1-2	Row	0.12	0.07	0.11	0.30†	2.30
6300 kg/ha	(10-18-77)	Platform	0.81	0.85	0.94	2.60	
1.35 m	20-25	Row	0.84	1.00	0.60	2.44	2.56
5550 kg/ha	(11-2-77)	Platform	1.00	2.30	1.70	5.00	
1.35 m	60-75	Row		12.40		12.40	
3000 kg/ha	(11-14-77)						
1.2-1.25 m‡	0	Row	0.05		0.14	0.19	0.22
8000 kg/ha	(10-20-77)	Platform	0.13	0.10	0.18	0.41	
0.75-0.9 m§	2-5	Row	0.27			0.27	3.08
1250 kg/ha	(10-20-77)	Platform	0.36	0.27	2.72	3.35	

*Additional grain recovered by row crop header as compared to platform header.
†An analysis of variance revealed no significant differences in types of header losses, but the harvest dates and headers were significantly different at the 1 percent level.
‡Separate test in standing grain.
§Nonirrigated test.

TABLE 2. HEADER LOSSES FOR 1978 AND 1979 TESTS. LOSSES ARE PRESENTED AS A PERCENTAGE OF THE TOTAL GRAIN YIELD.

Plant ht. and yield	Lodge rate and (harvest date)	Header	Grain loss				
			Header shatter	Cutter loss	Cut and drop	Total loss	Grain* saved
	%		%	%	%	%	%
1978							
1.25	0	Row	0.11	0.10	-	0.21†	0.55
5400 kg/ha	(10-10-78)	Platform	0.32	0.44	-	0.76	
1.25 m	40-50	Row	-	2.10	-	2.10	36.90
3900 kg/ha	(10-11-78)	Platform	-	-	39.00	39.00	
1.25 m	60-70	Row	-	8.00	-	8.00	45.00
3900 kg/ha	(10-11-78)	Platform	-	-	53.00	53.00	
1979							
1.25 m	0-2	Row	0.03	0.03	0.14	0.20†	0.60
8850 kg/ha	(10-17-79)	Platform	0.11	0.09	0.60	0.80	
1.25 m	20-30	Row	-	1.90	-	1.90	2.60
6800 kg/ha	(10-18-79)	Platform‡	-	-	3.90	3.90	
		Platform§	-	-	7.60	7.60	
1.25 m	50-60	Row	-	4.50	-	4.50	5.30
5600 kg/ha	(10-18-79)	Platform‡	-	-	9.80	9.80	
		Platform§	-	-	22.00	22.00	

*Additional grain recovered by row crop header in comparison to platform header.
†There was a significant difference in total losses between headers in both years. Seed heads cut and dropped were significantly higher than either header shatter or cutter loss in 1979.
‡Cutter bar at 30-cm height.
§Cutter bar at 45-cm height.

grounded seed heads in two or more parts and the gathering belts missed some of the fragments. The tall plants were too tangled to attempt a test with the platform header.

An analysis of variance revealed that total header losses were significantly different between types of header and dates of harvest. Types of header losses — header shatter, cutter loss, and cut-dropped seed heads did not differ significantly.

Tests were also made on a high-yielding irrigated field with a normal height (1.25 m) hybrid and on a relatively low-yielding dryland crop with short (0.75 to 0.90 m) plants. In the high-yielding, medium height crop, where conditions were as near ideal as possible, losses for both headers were remarkably low (less than 0.5 percent). In the low-yielding dryland test where some plants were leaning, but the seed heads were not touching the ground, the row crop header was very efficient (0.2 percent loss) and the platform header losses were 3.3 percent.

1978 Tests

The hetero-yellow endosperm (bronze) hybrid used in 1978 reached a height of about 1.25 m. Rainfall during seedling emergence caused some soil crusting and resulted in a relatively low plant population (125,000 ha). This low plant population plus below-average tillering produced a relatively low yield (5400 kg/ha with full irrigation and 3900 kg/ha with plants stressed by limited irrigation). There was no preharvest grain shatter. The standing crop was cut at about the 0.45 m height with both headers. Losses with the row crop header were minimal at 0.2 percent and were only 0.8 percent for the platform unit (Table 2).

In the lodged crop, stalks broke 15 to 20 cm above ground and fell at right angles to row direction with the seed heads touching ground. Thus the row crop header snouts had room to get under the broken, but not separated, stalks and save much of the crop. It was not possible to operate the platform header low enough to retrieve the grounded heads, so losses were high for both the 40 to 50 percent and the 60 to 70 percent lodging. Losses with the platform header were so high mainly because the low plant population provided fewer standing stalks to intercept the fall of lodged stalks.

1979 Tests

The grain sorghum in the test area yielded well above average (5600 to 8800 kg/ha) in 1979 because of a good stand and a relatively cool summer with low evapotranspiration. However, late season warm temperatures in September and October caused plant stress and strong early October winds were conducive to lodging. The hybrid was the same as that used in 1978 and plants averaged 1.25 m in height. Preharvest wind shatter loss was 0.2 percent. Header losses in standing crop were less than 1 percent for both units (Table 2). Platform header losses, though low (0.8 percent), were four times more than with the row crop header. Most of the platform header losses were caused by the reel not forcing cut seed heads into the auger.

At the moderate and high lodging rates, many of the leaning stalks and seed heads were partially supported by adjacent plants. Lodged plants fell both parallel and at right angles to row direction. The row crop header did not retrieve most of the seed heads that fell parallel to the row. Since the leaning heads were not touching ground, a lowered cutting height (30 cm) with the platform header reduced losses to less than one-half of those at the 45 cm cutting height for both the moderate and high lodging rates. Further lowering of the cutting height was not beneficial because we could not adjust the reel to operate below 30 cm without standing seed heads being carried forward and dropped. Total losses were significantly lower with the row crop header for each of the lodging rates. In standing grain, the cut-drop losses were significantly higher than header shatter or cutter loss.

SUMMARY AND CONCLUSIONS

The degree or type of lodging varied widely depending on how much the stalks were weakened by late season moisture stress, and on weather conditions. The row crop

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header was more efficient in both standing and lodged grain. A lowered cutting height reduced losses with the platform header when stalks were leaning, but losses were relatively high if the stalks broke and the seed heads touched ground. The row crop header successfully retrieved most lodged seed heads unless the heads fell parallel to the row direction and were touching the ground. In this case, the rotary knife often cut the seed heads in pieces and the rubber gathering belts missed some of the fragments.

In standing sorghum, the row crop header saved at least 0.5 percent of the total grain yield. In the 1979 tests where lodging conditions were typical, the row crop header saved an additional 0.60, 2.60, and 5.30 percent, respectively, of the crop yield for standing, moderately, and severely lodged sorghum.

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