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HARVEST DELAY EFFECTS ON MACHINE STRIPPED COTTON YIELD AND QUALITY

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Abstract

Acres of cotton (*Gossypium hirsutum* L.) planted in Kansas have outpaced the purchase or availability of custom machinery for timely harvest of the crop. The normally open Kansas falls have led cooperators to believe that the yield and quality losses associated delayed harvest do not place the purchase of their own harvest machinery at a high priority. A study was conducted in 2001 and 2002 near Hutchinson, Kansas to quantify the effects of delayed harvest on cotton lint yields and fiber qualities. Lint yield losses did not occur between the first three date(s) of harvest (DOH) of 2001, but 18% yield losses were recorded between DOH 3 and DOH 4. Weathering did not significantly reduce lint yields after DOH 4. No differences in ginouts were recorded as harvest was delayed. Reflectance (Rd) increased and yellowness (+b) decreased as harvest was delayed, but no other fiber qualities were influenced by field exposure. The 2002 growing season was very favorable for dryland cotton production and resulted in excellent yields and high quality fiber. No yield reductions were noted between DOH 1 and DOH 2. A snowfall event prior to DOH 3 contributed to a 33% reduction in lint, but measurable losses did not occur in subsequent harvests. The highest percentage of lint was produced in DOH 1 plots. Ginouts from DOH 2 through DOH 5 were significantly lower than those from DOH 1, but no lint percentage reductions between the later harvests were recorded. Micronaire decreased significantly between the first two harvests in 2002, but no other lint quality determining factors were influenced. Cotton fiber losses increased significantly once, when harvest was delayed past optimum timing. Weathering effects on crop value were influenced only by lint losses in the field.

Introduction

Kansas farmers have increased cotton plantings from about 2,000 acres in 1996 to over 60,000 acres in 2002. Three gins are now operating in counties bordering Oklahoma. Custom operators do the bulk of the harvesting, and occasionally harvest is delayed by weather events and the availability of equipment.

Ray and Minton (1973) reported lint yield losses of up to 18, 12 and 6.5 pounds per week if cotton was left in the field up to one, four or 11 weeks, respectively, after the crop reached harvestable condition. Micronaire was not significantly affected, but fiber length, strength and reflectance were all reduced by extended field exposure. Yellowness decreased as exposure to the elements lengthened. Kelley et al., (2002) reported similar negative effects on fiber quality as field exposure time increased. Based on the USDA loan value, these reductions in quality translated into approximate losses of $0.06/lb (Kelley et al.) in 2002 or up to $9.50/acre (Ray and Minton) in the first week of harvest in 1973. The objective of this study was to quantify potential cotton yield, quality and income losses due to delayed harvest.

Materials and Methods

Date(s) of harvest (DOH) and the subsequent effects of weathering on machine-harvested cotton were evaluated in small plots at the Kansas State University South Central Experiment Field near Hutchinson, KS, in the 2001 and 2002 growing seasons. In both years the plots were established on a Clark-Ost (fine, loamy, mixed, superactive, mesic Udic Calciustolls-fine, loamy, mixed, superactive, mesic Udic Argiustolls) complex. Four row plots were planted in 30-in. rows on June 13, 2001, and May 28, 2002. Approximately 66,200 seeds acre^{-1} were dropped both years. Plots were trimmed to 75 ft and 30 ft, respectively in 2001 and 2002. The cotton variety planted was Delta and Pine Land 'PM2156RR', which had produced acceptable yields in Kansas State University variety performance tests and was commonly grown in Kansas. This variety also has one of the lowest storm-proof ratings of cotton varieties commonly grown in Kansas, therefore representing a worst-case scenario for weather related losses. Fifty lb acre^{-1} nitrogen (N) was applied each year to the plot area. In 2001, the N was top dressed at the three-leaf stage, and in 2002, the fertilizer was pre-plant incorporated. A preemerge herbicide combination of 1.3 pt acre^{-1} Dual II Magnum® plus 3 pt acre^{-1} Cotoran® plus 0.6 oz acre^{-1} Staple® was applied after planting for weed control in 2001. In 2002, 1.0 pt acre^{-1} Dual II Magnum® plus 0.6 oz acre^{-1} Staple® was applied preemerge. Roundup Ultra Max® at 26 oz acre^{-1} was applied post emergence when cotton seedlings reached the four leaf stage, and hand weeding was used for late season weed control. Harvest aids were applied each year to the plots. Aim® (1.0 oz acre^{-1}) plus crop oil concentrate, and Prep (16 oz acre^{-1}) plus Defol 6 (16 oz acre^{-1}) were applied October 10, 2001 and October 14, 2002, respectively in 20 gallons acre^{-1} of water. In this study, the center two rows of each plot were machine harvested and yields were calculated similar to the methodology of Kelley et al. (2002). Lint that had fallen on the ground was not retrieved and included in the final yields as in the Ray and Minton (1973) study. Harvest dates (Table 1) were set at 14-day intervals, weather dependant, or as soon as possible after significant precipitation events. Precipitation between harvests is summarized in Table 1. A sub-sample was taken from each plot, ginned and the fiber submitted to the International Textile Center at Texas Tech Univ., Lubbock, TX, for fiber quality analysis. Results were analyzed using the analysis of variance procedure of SAS. Lint values were calculated using the Cotton Loan Value calculator developed by Kelley (2000).

Results and Discussion

2001

Consistent, untimely rainfall in 2001 delayed planting until June 13. Once planted, the crop emerged rapidly and uniformly. Temperatures during the growing season allowed for greater than normal heat unit (HU) accumulation. Timely rains kept the crop alive, but the crop was heat and moisture stressed throughout the fruiting and filling periods. Yields (Table 1 and Fig. 1) were unaffected for the first three harvest dates, but did decline significantly between DOH 3 and 4. Field losses were obvious (Fig. 2). No differences existed between lint yields from DOH 4 and 5 even though 2.48 in. of precipitation accumulated, including 1.22 in. as sleet and 0.68 in. as a heavy, wet snow. In the 26-day period between DOH 3 and DOH 4, only a trace of precipitation fell. High winds (wind speeds of at least 15 miles hour^{-1}) were recorded on 20 of 26 days between DOH 3 and DOH 4, and may be the cause for the field losses of this variety. The only significantly affected fiber qualities were Rd and +b (Table 2), which increased and decreased, respectively, as one would expect. The effect of delayed harvest on lint yields was similar to results reported by Ray and Minton (1973) in the lowest yielding year (1969) of their study. Kelley et al., (2002) however, reported that field weathering significantly reduced staple length, uniformity and strength on the High Plains of Texas. In this study, strengths were not significantly reduced, but were numerically reduced by 15-25 points after DOH 1, depending on harvest date (Table 2), according to the Plains Cotton Cooperative Association loan rate chart. The USDA loan value fluctuated only about \$0.01 lb^{-1} through the harvest season (Table 3). The value of lint lost from weathering was from \$28.42-\$39.95 acre^{-1} from the first three DOH, to DOH 4. Delaying harvest another 43 days cost reduced revenue another \$9.26 acre^{-1}. The lint and monetary loss trends are similar to those reported by Ray and Minton (1973). When value was lost, the biggest loss was the first loss. The magnitude of yield and revenue reductions declining with delayed harvest(s) after the first big loss.

2002

In excess of six inches of precipitation was received in the first 19 days after planting, resulting in slow emergence and slow early growth of seedlings. In addition, a hailstorm hit the plots at the two to three leaf stages. Final plant stands averaged about 31,700 plants acre^{-1}, barely half the targeted populations. However, above normal HU accumulation through the rest of the growing season and timely precipitation, especially from peak bloom through the rest of the season, resulted in exceptional lint yields (Fig. 1). Gross returns from the 2002 crop (Table 3) are higher than those of 2001. Lint yields trended up, but not significantly, in the eight days between DOH 1 and 2, probably as the result of a greater number of later maturing bolls being more open. However, the \$36.60 acre^{-1} increase in value between harvest dates is certainly appealing, and in a year with a late, heavy boll set, one might consider whether or not to delay harvest and allow those upper bolls to fully open. The supposition that DOH 2 yields were supplemented by later maturing bolls is supported by the corresponding drop in micronaire (Table 2) as harvest was delayed. These results clearly illustrate the impact of a weather event on yield losses as a wet snow fell between DOH 2 and DOH 3 and contributed to the 33% harvested lint reductions. But, no differences existed between DOH 3 and DOH 4 even though an intense, but brief, rainfall event occurred. Two wet snows fell between DOH 4 and DOH 5, but lint yields were not adversely affected. Though the time period between harvests was shorter in 2002 vs 2001, the trend of the first significant harvest losses resulting from the first weather event and lower if no yield losses from subsequent weathering events was consistent. Ray and Minton (1973) reported similar results, especially in the year of highest yields in their study. Only the first two DOH fiber quality characteristics have been received, but will be discussed. The favorable weather during fiber development, vs that in 2001, is obvious (Table 2) with the 2002 fiber having premium micronaire, length and strength values. Micronaire values decreased significantly with delayed harvest, in contrast to the results of previous investigators [Ray and Minton (1973) and Kelley et al. (2002)], who found no change in micronaire after field weathering. Both Ray and Minton (1973) and Kelley et al. (2002) reported reduced fiber length and strength as a result of field weathering. However, neither of those trends was reported in the two harvests of 2002.

Results indicate that when harvest date is delayed past optimum, lint yields and gross income will be significantly reduced. The higher the yield levels, the greater the magnitude of yield loss from weathering. The first major weather event had the greatest impact on yield losses with subsequent weather contributing little to the overall yield reductions. Perhaps yield reductions would be different with a variety rated as more storm-proof, similar to those in the Texas studies. Kansas harvest season precipitation amounts were less than those in studies of other investigators, which may result in "less" field weathering of fiber grown in Kansas. Consequently, fiber quality of Kansas cotton has not been reduced when harvest was delayed, contrary to the findings from Texas.

References

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Table 1. Dates of harvest and precipitation received prior to and lint yield of each harvest.

	2001			2002	
Harvest Date	Precipitation - - - - in. - - -	Yield - - lb acre^{-1} - -	Harvest Date	Precipitation - - - - in. - - -	Yield - - lb acre^{-1} - -
Nov. 19	0.11†	449	Nov. 13	0.04†	920
Dec. 3	Trace	468	Nov. 21	0.22	1019
Dec. 21	0.16	467	Dec. 6	0.25‡	769
Jan. 16, 2002	Trace	384	Dec. 16	0.36	818
Feb. 28, 2002	2.48‡	357	Dec. 30	0.08‡	798
LSD$_{(0.05)}$		42			99
C.V.		6.4			7.0

† precipitation received the week prior to this harvest.
‡ snow included in the precipitation total.

Table 2. Date of harvest effects on cotton fiber quality characteristics.

Harvest Date	Micronaire	Length - in. -	Uniformity - - - % - - -	Strength g tex^{-1}	Rd	+b
2001						
Nov. 19	4.7	0.96	81.9	30.0	67.5	6.9
Dec. 3	4.7	0.95	81.1	28.7	69.9	7.3
Dec. 21	4.5	0.95	80.4	28.3	70.7	6.7
Jan. 16, 2002	4.8	0.95	81.4	29.1	68.0	6.1
Feb. 28, 2002	4.5	0.95	81.1	28.0	71.5	6.1
LSD$_{(0.05)}$	NS	NS	NS	NS	4.0	1.1
C.V.	5.3	1.3	1.3	6.0	3.1	8.7
2002†						
Nov. 13	4.1	1.04	83.6	29.5	68.4	7.7
Nov. 21	3.7	1.05	83.5	31.1	69.9	6.9
LSD$_{(0.05)}$	0.39	NS	NS	NS	NS	NS
C.V.	4.6	2.2	0.5	4.4	5.2	8.9

† results of the last three harvests have not yet been analyzed.

Table 3. Delayed harvest effects on cotton gross returns acre^{-1}.

	2001			2002	
Harvest Date	Lint Value† - - \$ lb^{-1} - -	Gross Returns‡ - - \$ acre^{-1} - -	Harvest Date	Lint Value† - - \$ lb^{-1} - -	Gross Returns‡ - - \$ acre^{-1} - -
Nov. 19	0.4240	190.43	Nov. 13	0.4435	408.24
Dec. 3	0.4302	201.21	Nov. 21	0.4346	442.84
Dec. 21	0.4325	201.96	Dec. 6		
Jan. 16, 2002	0.4218	162.01	Dec. 16		
Feb. 28, 2002	0.4278	152.75	Dec. 30		

† Lint value determined using Cotton Loan Value calculator.
‡ Gross returns = Yield x Lint value.

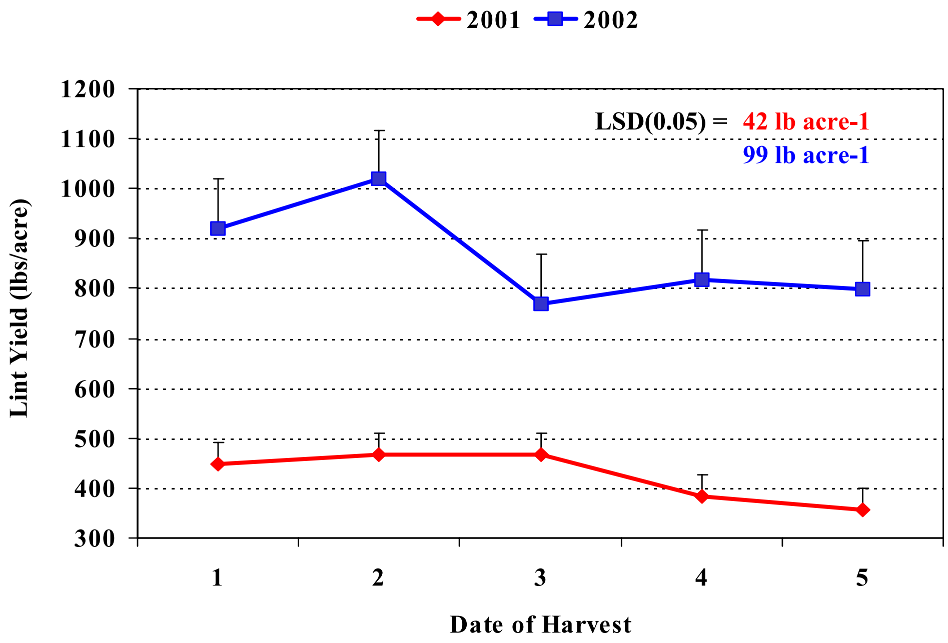

Figure 1. Delayed harvest effects on lint yields at Hutchinson, KS.

Figure 2. Differences in field losses between DOH 3 and DOH 4 when harvest was delayed in 2001 at Hutchinson, KS.