Topping Corn and Delaying Harvest for Field Drying

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ABSTRACT

THE tops of corn plants were removed above the ear at physiological maturity to determine if that practice would hasten field grain drying on the Southern Great Plains. Topping lowered the grain moisture content 1.5 percentage points below that of non-topped corn until the grain had dried to about 20 percent moisture. Topping reduced lodging if harvest was delayed but had no significant effect on combine harvested grain yield. Delaying harvest until the grain moisture level had fallen below 20 percent reduced harvestable grain yields, however, the yield reduction was minimized if the Southwestern corn borer was controlled by spraying.

INTRODUCTION

On the Southern Great Plains, harvesting of irrigated corn grown for grain usually begins when the grain moisture content is about 25 percent (wet basis). Heated air drying, an energy intensive process, is used to reduce the moisture content to about 15.5 percent for grain storage without spoilage. The major reason for early harvesting is to reduce losses from plant lodging caused by the Southwestern corn borer (*Diatrea grandiosella* (Dyar)), stalk rot, and exposure to weather. Relatively strong winds, associated with rapidly moving cold fronts, can increase lodging of weakened stalks.

Area growers expressed an interest in mechanically topping corn just above the ear at physiological maturity (32 to 35 percent grain moisture) as a potential method to speed field drying. Earlier work on topping corn in the more humid climate of Iowa (Casselman et al., 1961) showed little or no effect on the rate of field drying regardless of the topping date. In Iowa, topping did not significantly affect grain yield unless it was done relatively early (10 days after pollination). Jones (1961) also found that topping corn in Ohio within a week after pollination, reduced grain yield.

In a 1977 exploratory test, we hand-topped an area of irrigated corn, 10 m by 70 m, when grain moisture was 35 percent. We monitored the grain moisture content and lodging of the corn until the grain reached about 16 percent moisture and was harvested. Five days after topping, the grain moisture in topped corn was 2 percentage points lower than in the control. The two percentage point difference remained constant for about 20 days until the corn was harvested.

OBJECTIVES

The results of the exploratory test prompted the 3-year study on mechanical topping corn from 1978 to 1980 at the USDA Concervation and Production Research Laboratory, Bushland, Texas. Our objectives were to determine if topping at physiological maturity would hasten field drying in a semiarid climate, thus reducing the amount of energy needed for grain drying, and to determine the effect of topping on lodging and harvest losses.

PROCEDURE

The corn was grown after fallow with 180 kg/ha of N applied as anhydrous ammonia. Atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine] was applied for weed control at 3.5 kg/ha. Pioneer* hybrid 3321 was bed-planted on April 11, April 19, and April 22 in 1978, 1979, and 1980, respectively. Plant populations averaged about 60,000 plants/ha. Irrigation water was furrow-applied as needed. Plots for each treatment were twelve 0.75-m spaced rows wide by 200 m long. Treatments were: (C) control, (T) topped, (S) spray treatment for insect control, and (ST) sprayed and topped. Main treatments contained three (4-row) sub-plot treatments consisting of different dates of harvest which coincided with grain moisture contents of 25, 20, and 15 percent. Treatments were replicated twice. The insect spray control treatment was added in 1978 because of damage from the Southwestern corn borer in the 1977 test. The borer causes plant lodging, during the grain drydown phase, from internal girdling of stalks near ground level (Daniels and Chedester, 1977). Carbofuran (2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate) was applied for borer control with a higher clearance sprayer in two 1.1 kg/ha applications as recommended by research entomologists (Daniels and Chedester, 1977). The average occurrences for the spray applications were at pollination and about 10 days later.

Grain moisture content monitoring was started near 50 percent (wet basis) and continued at 4- to 7-day intervals through the harvest test period. On the topped plots, the plant material above the ear was removed at 32 to 35 percent grain moisture by a rotary-bladed topper mounted on a light-weight high clearance 35-kW tractor (Fig. 1). Combine harvest tests were run when grain moisture contents were as close as possible to the 25, 20, and 15 percent moisture levels designated as 25-M, 20-M and 15-M, respectively. A John Deere* 4400 combine with a 4-row corn header was used for the tests.

Before each test, the combine was checked for proper operation outside of the plot area. For loss

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*Mention of a trade name does not constitute a recommendation for use by the U.S. Department of Agriculture, or exclude other products which may be suitable.

FIG. 1 Corn being topped above the ear with rotary cutter mounted on high clearance tractor.

measurements of stalk-roll shellage and missed ears, the combine was stopped, backed up about 5 m, and grain samples gathered from 2.3-m² ground areas. Loose kernels (separator loss), cobs with some kernels remaining (cylinder loss), and total missed ears were gathered from 2.3-m² areas behind the machine. Ears that dropped from the stalk before harvest (preharvest losses) were gathered from 46-m² areas ahead of the combine. Machine ear loss was determined by subtracting preharvest loss from the total ear loss. Harvested yields were determined from three (10-m) combine passes per sub-plot. The travel rate was 3.2 to 4.0 km/h. Lodging counts were made on each harvest date.

RESULTS AND DISCUSSION

Field Grain Drying

The drying patterns during the 1978-80 tests are shown in Fig. 2. In 1978 and 1979, the grain moisture content in topped corn initially dropped 1.5 to 2.0 percentage points lower than the control, then the difference disappeared after about 10 days when the grain had dried to about 20-M. The drying patterns in 1978 and 1979 were similar although the 1979 crop was later because of a cooler than average growing season. In both years, the grain moisture for the topped corn and the control declined about 1 percentage point per day until reaching the 20-M range. In the 1980 season, topping had no effect on grain drying. We attribute this to the extremely hot and windy growing season. June through August temperatures were about 3 °C above average and pan evaporation totaled 780 mm or 10 percent above average. Even through irrigation applications were at

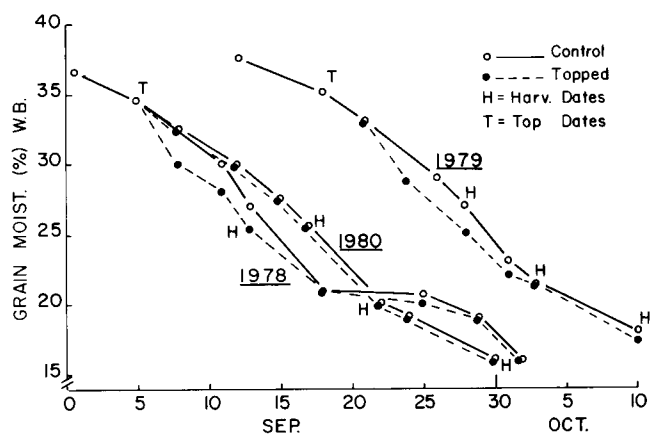

FIG. 2 Grain moisture drying pattern, 1978-1980.

10-to 14-day intervals from late June through August, plants underwent varying moisture stress which caused early plant senescence. In years similar to 1978 and 1979, the faster early drydown of topped corn can reduce energy needs for heated-air drying or it can permit harvesting 1 to 2 days earlier. Spraying for borer control had no measureable effect on corn maturity or the rate of grain drying in any year.

Potential Energy Savings from Topping

To compare the drying energy requirements with and without topping, we assumed that topping reduced grain moisture from 25- to 23.5-M. About 5800 kJ of energy are required to remove one kilogram of water from grain with heated air drying (Lane et al., 1973). If we assume a corn yield of 9400 kg/ha (150 bu/A), then 1,189,000 kJ/ha of energy is used to reduce the moisture in non-topped corn by 1.5 percentage points. This amount is equal to the energy value in 31 L/ha of diesel fuel. Topping corn uses about 7 L/ha of diesel, so about 24 L/ha (2.6 gal/A) of diesel equivalent can be saved by topping in years with results similar to those in 1978 and 1979. However, the accelerated drying from topping disappeared when the grain moisture dropped to about 20-M (Fig. 2). The difference between 25- and 23.5-M corn seems rather small, but it amounts to about 200 L/ha (22 gal/A) of water that must be removed from the grain.

In order to compare energy use for drying in a farm situation, we assumed 120 ha (300 A) of corn that could be harvested with a 4-row machine in 10 days. By starting harvest at 25-M, the harvest could be completed by the time that the field grain moisture content had lowered to 20-M. During this 10-day harvest interval, the moisture content in topped corn would average about 1.5 percentage points lower than in non-topped corn. The energy savings for the 120 ha (300 A) crop yielding 9400 kg/ha (150 bu/A) would be 2950 L (780 gal) of diesel equivalent.

For a cost comparison in 1980, local drying costs for corn averaged \$0.0002/kg (\$0.053/bu) for each percentage point above 15.5-M which included shrinkage loss. The cost to reduce the grain moisture by 1.5 percentage points totaled \$29.65/ha (\$12.00/A). Custom rates for topping corn averaged \$17.30/ha (\$7.00/A). The cost advantage for topping was \$12.35/ha (\$5.00/A).

Lodging

The lodging percentages for 1978-80 are presented in Table 1. In 1978 and 1979, very little lodging occurred until the grain moisture had dropped to the 15-M level. In 1980, the moisture stress accelerated plant drydown and increased corn borer related lodging in unsprayed corn. Topping reduced lodging by 7 to 14 percent on unsprayed treatments, but had no effect on lodging for sprayed treatments.

The type of lodging can have considerable effect upon the potential of a corn header to retrieve ears on lodged stalks. Lodged, but attached, stalks are more retrievable than those completely detached by corn borer girdling. Stalks that lodge somewhat perpendicular to row direction are more retrievable than those that fall parallel to the row. For example, during the first harvest test (25-M) in 1980, lodging was only 2 percent on sprayed treatments but reached 20 to 30 percent on unsprayed treatments. However, harvested yields were only slightly

TABLE 1. GRAIN YIELD AND STALK LODGING PERCENTAGES FOR CORN TREATMENTS HARVESTED AT VARYING MOISTURE LEVELS

Year	Treat	Grain moisture at harvest					
		---- 25 percent ----		---- 20 percent ----		---- 15 percent ----	
		Yield*	Lodge	Yield	Lodge	Yield	Lodge
		kg/ha	percent	kg/ha	percent	kg/ha	percent
1978	Control	9,720ab	2			9,280 b	16
	Top	9,910a	2			9,220 b	3
	Spray	10,280a	1			9,840a	11
	Spr-Top	10,160a	1			9,720ab	3
1979	Control	10,290ab	1	10,350ab	2	9,470 c	9
	Top	10,350ab	1	10,410ab	2	9,470 c	6
	Spray	10,540ab	1	10,980a	1	10,030 b	3
	Spr-Top	10,600ab	1	10,790a	1	9,910 b	3
1980	Control	9,600ab	30	8,090 c	47	6,710 d	72
	Top	9,780 a	20	8,280 c	40	7,020 d	58
	Spray	9,970 a	2	9,600ab	5	8,910 bc	7
	Spr-Top	9,910 a	2	9,410ab	4	8,720 bc	5

*Means for a specific year followed by a different letter differ significantly at the 5 percent level according to Duncan's multiple range test.

reduced because the lodging was mostly perpendicular to the row and the header retrieved the ears. During the second test (20-M), lodging on the unsprayed treatments had reached near 50 percent with most of the additional lodging being parallel to the row. This lodging significantly reduced the harvested yield.

Grain Yield

In 1978, topping doe not affect harvested yield (Table 1). The spray treatments yielded slightly more than the control when harvested at both 25-M on September 15 and at 15-M on October 2. A 142-mm rain prevented a test at 20-M, after which combine yields were slightly less for all treatments when harvested at 15-M. The slight spray treatment effect resulted from control of both the corn borer and the Banks grass mite, *Oligonychus pratensis* (Banks). The grass mite, discussed by Daniels (1978), did not infest the corn in 1979 or 1980.

In 1979, which had ideal growing conditions, there was no significant yield difference between treatments at either 25-M (Sept. 28) or 20-M (Oct. 3). The average temperatures were 3 °C below normal in 1979 during June through August. Pan evaporation was 20 percent below average during June through August. When harvest was delayed until 15-M on October 12, the harvested yields for all treatments were reduced significantly. The yield decline for the final test (15-M) in 1978 and 1979 can be accounted for in the slight increase in lodging and harvesting losses.

In 1980, topping did not affect the combine harvested yield at any harvest moisture content even though topping did reduce lodging. Spraying lessened the yield decline from lodging when harvested at 20-M (Sept. 22) and 15-M (Sept. 30). The decline in harvested yield between 25-M and 15-M is illustrated in Fig. 3. The yield decline was severe on unsprayed treatments. This yield response to spraying shows that control of the Southwestern corn borer is especially critical when weather conditions cause high late season evaporative demand and plant water stress.

The overall yield results indicate that when harvesting early at 25-M, neither topping nor spraying usually had any effect on harvested yield. Spraying had some effect when harvest was delayed until 20-M, except in 1979, and had a significant effect on yield if harvest was further delayed until 15-M. Neither topping nor insect spraying noticeably affected the threshing and cleaning of the grain. Topping did make it easier for the combine operator to see the header function and to steer the machine.

Measured Harvest Losses

Types of measured losses during 1979 and 1980, which included preharvest losses, stalk roll shellage, separator loss, cylinder loss, and machine ear loss, are presented in Table 2. In 1979, measured losses were relatively low totaling about 1 percent or less. The machine ear loss made up the largest portion of the losses. Machine ear loss increased noticeably when harvest was delayed until 15-M. Crop conditions for the 20-M harvest test in 1979 were near ideal. The low overall losses, about 1 percent, are similar to results reported in Iowa tests under optimum conditions (Ayers, 1973).

In 1980, losses were greater than in 1979. Preharvest ear drop was by far the largest portion, reaching 5 percent where it could be measured. Lodging was so severe

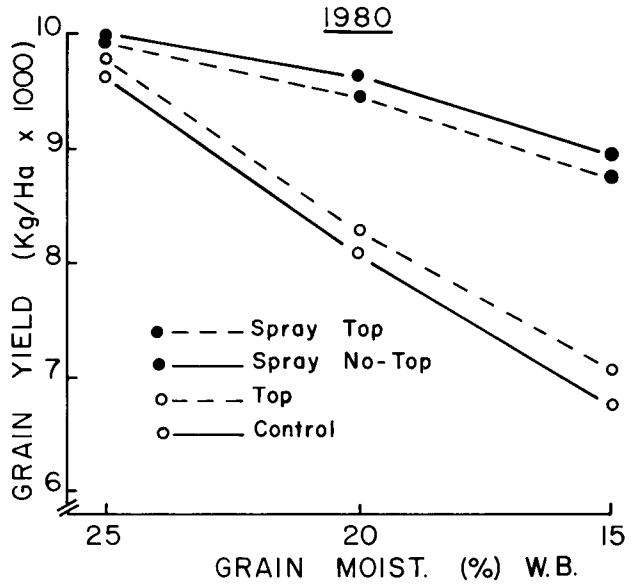

FIG. 3 Harvested grain yield at different harvesting moisture contents in 1980.

TABLE 2. TYPES OF LOSS DURING CORN HARVEST AT DIFFERENT GRAIN MOISTURE LEVELS

Treatment	Loss*	Grain moisture content at harvest, 1979, 25	1979, 20	1979, 15	1980, 25	1980, 20	1980, 15
		percent	percent	percent	percent	percent	percent
Control	Pre	0.04	0.05	0.07	1.70	2.50	†
	SRS	0.15	0.13	0.12	0.14	0.17	
	Sep	0.14	0.16	0.10	0.09	0.12	
	Cyl	0.11	0.01	0.01	0.28	0.09	
	Mach-Ear	0.48	0.58	0.73	‡		
	Total	0.92	0.93	1.03	2.28§	2.88	
Top	Pre	0.04	0.05	0.07	1.80	2.60	
	SRS	0.20	0.16	0.18	0.16	0.20	
	Sep	0.08	0.18	0.16	0.14	0.17	
	Cyl	0.10	0.01	0.01	0.31	0.10	
	Mach-Ear	0.32	0.35	0.68			
	Total	0.74	0.75	1.10	2.49	3.07	
Spray	Pre	0.04	0.05	0.07	1.60	3.10	5.00
	SRS	0.25	0.15	0.10	0.28	0.15	0.13
	Sep	0.07	0.08	0.08	0.19	0.10	0.08
	Cyl	0.06	0.01	0.01	0.08	0.03	0.05
	Mach-Ear	0.29	0.30	0.60			
	Total	0.71	0.59	0.86	2.15	3.38	5.26
Spray-Top	Pre	0.04	0.05	0.07	1.40	2.20	4 80
	SRS	0.30	0.30	0.19	0.15	0.14	0.16
	Sep	0.09	0.10	0.15	0.10	0.11	0.13
	Cyl	0.07	0.01	0.01	0.07	0.07	0.07
	Mach-Ear	0.25	0.28	0.56			
	Total	0.75	0.74	0.98	1.72	2.52	5.16

*Pre (Preharvest), SRS (Stalk roll shellage), Sep (Separator), Cyl (Cylinder).
†Crop was too tangled to find preharvest ear loss or to measure other losses.
‡Machine ear loss not measured because of the large amount of preharvest ear drop.
§Total loss values are not complete because machine ear loss was not determined.

(60 to 70 percent) on the unsprayed treatments that loss measurements could not be made. The larger losses in 1980 were related to high temperature and water stress associated with the early plant senescence, which contributed to the severe amount of preharvest ear drop. The combine header losses, though extensive in 1980, could not all be separately identified and measured with the severe ear drop and lodging. The harvested yields reflect the combined effect of lodging and harvesting losses with adverse conditions.

The grain yield and harvest loss data indicate that about 20 percent is the optimum grain moisture content for corn harvest where soil moisture is adequate through physiological maturity and the corn borer is controlled. General harvesting observations by the combine operator support this conclusion. In years when the corn is standing well and harvesting can be delayed from 25-M to 20-M, heated air drying, supplied by fossil fuel, may not be needed. Forced air drying without supplemental heat can be used for grain moisture contents below 20 percent in the Great Plains climate area (Lane et al., 1973).

SUMMARY AND CONCLUSIONS

Topping corn at 32 to 35 percent moisture immediately after physiological maturity, on the Southern Great Plains, slightly increased the rate of field grain drying until the grain moisture had declined to about 20 percent. Topping can reduce energy needs for heated air drying when harvesting early or it can permit harvesting 1 to 2 days earlier. The grain moisture decline for both topped corn and the control averaged about 1 percentage point per day from the time of physiological maturity until reaching the 20 percent range. In an abnormally hot-dry season (1980) when plants prematurely senesced due to late season moisture stress, topping had no effect on the rate of field grain drying. Both topping and spraying for corn borer control can reduce lodging, especially if harvest is delayed. Topping did not significantly affect the harvested grain yields; however, spraying for the corn borer did reduce the decline in harvested yields associated with later harvest dates. A combine corn header can retrieve the ears from many of the stalks that lodge perpendicular to the row direction so yield decline was not as great as lodging percentages would indicate. Neither topping nor spraying had a noticeable effect upon the quality of threshing and cleaning of the grain.

References

1 Ayres, G. E. 1973. Profitable corn harvesting. Iowa State Univ. Ext. Bull. Pm-574. 2 p.

2 Casselman, T. W., J. L. Schmidt, and W. G. Lovely. 1961. Corn topping prior to harvest. AGRICULTURAL ENGINEERING 42(10):542-545.

3 Daniels, N. E. 1978. Banks grass mite and Southwestern corn borer control in corn. Southwestern Entomologist 3(2):80-84.

4 Daniels, N. E. and L. D. Chedester. 1977. Insecticidal control and damage evaluation of the Southwestern Corn Borer. Texas Agric. Exp. Sta. Prog. Rept. PR-3431.

5 Lane, D. E., P. E. Fishbach, and N. C. Teter. 1973. Energy uses in Nebraska Agriculture. Univ. of Nebraska. Ext. Pub. CC 255. 35 p.

6 Jones, J. B., Jr. 1961. Effect of date of topping upon corn yields in Ohio. J. Crop Sci. 1(4):303.