TEXAS A&M AGRILIFE EXTENSION

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Assessing Hail and Freeze Damage to Field Corn and Sorghum

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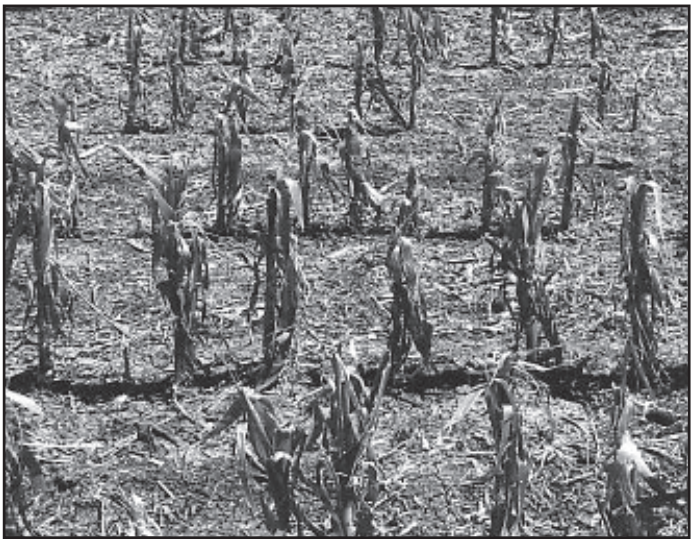
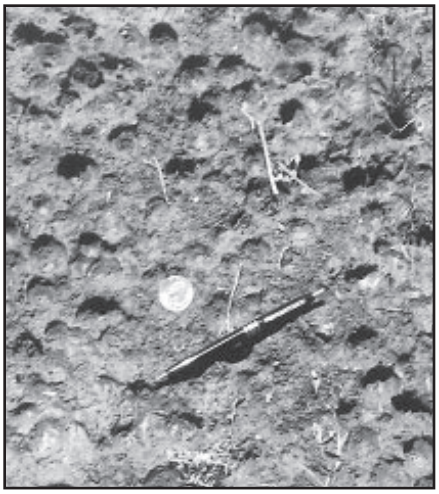
There are belts of hail damage to corn and sorghum almost every year in Texas. The decision to replant, to accept the damage, or to salvage older corn does not have to be made the same day as the event. Usually a few days of evaluation results in the best options being identified. If no alternative crop can be established in the same field at that time of year, the only acceptable solution may be to collect insurance and to salvage whatever is allowed. In assessing damage, it is important to be able to gauge the extent and type of damage, the potential for recovery of the damaged crop, and what actions might be necessary to maximize that recovery process.

Corn Leaf Area and Growth Stage. Like many other crop plants, corn does not need all of the leaf surface area that it produces. Corn fields may look ugly and ragged and still be capable of producing an almost normal corn crop. Even shredded and broken leaves are capable of some photosynthesis if they are still connected (conductive) to the main plant. All of the early damage is to what will ultimately be the lower leaves of the corn plant. Extensive damage to leaf area has also been observed in severe corn earworm and/or fall armyworm infestations, but corn yields were not effected. A strong healthy root system, good soil moisture, and favorable, sunny weather are most important to a rapid recovery.



Ragged, hail-damaged corn plants exhibit various degrees and types of damage. Considerable leaf loss may be sustained with minimal loss of yield potential if corn is very young or is almost mature. Shredded leaves become wrapped around the remaining plant and initially restrict the emergence of new growth.

The growth stage of the corn plant and the percent defoliation are important. Hail that is received later in the growing season can be increasingly destructive. Damage tables constructed by University of Minnesota (Table 1) indicate the percent yield reduction observed with various percents of defoliation at defined growth stages. Notice that a near-50 percent leaf loss at the 10th leaf stage results in only a 6 percent yield reduction. Hail stone size, duration of the hail shower, and the number of stones received per unit area all affect the amount of damage sustained. Fields receiving heavy rain are often crusted or compacted from the hail. If you



If the field is wet, quarter-sized hail can compact soil as well as shredding corn stands. It may be warranted to cultivate compacted fields to breakup compaction and to eliminate any surging weed competition.

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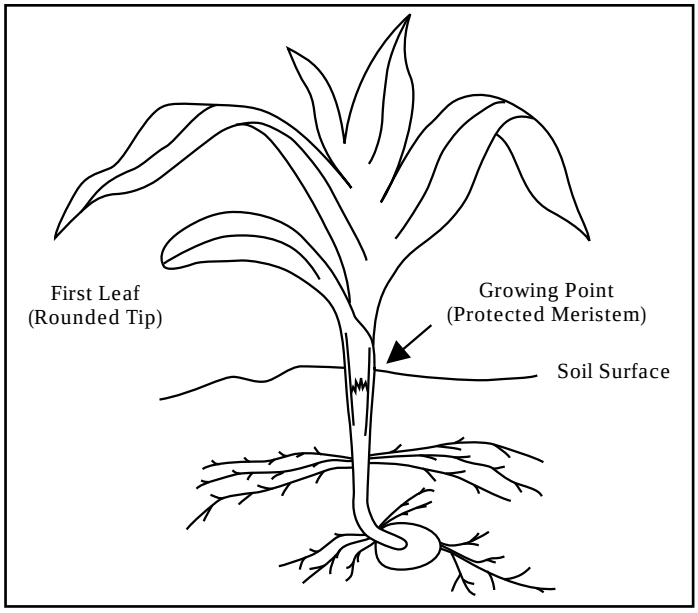
Table 1. Estimating corn yield reduction due to various amounts of leaf removal at several stages of plant development (taken from tables prepared by Hail Insurance Adjustment and Research Association and Crop Insurance Research Bureau as listed in Crop News Bulletin No. 23, Extension Service, University of Minnesota).

Stage of Growth	Percent Leaf Area Destroyed																		
	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
7 leaf							1	1	2	3	4	4	5	5	6	7	8	9	9
8 leaf							1	2	3	4	5	5	6	6	7	8	9	10	11
9 leaf				1	1	2	2	3	4	5	6	6	7	7	9	10	11	12	13
10 leaf				1	2	3	4	5	6	7	8	8	9	9	11	13	14	15	16
11 leaf			1	1	2	3	5	6	7	8	9	10	11	12	14	16	18	20	22
12 leaf			1	2	3	4	5	7	9	10	11	13	15	16	18	20	23	26	28
13 leaf		1	1	2	3	4	6	8	10	11	13	15	17	19	22	25	28	31	34
14 leaf		1	2	3	4	6	8	10	13	15	17	20	22	25	28	32	36	40	44
15 leaf	1	1	2	3	5	7	9	12	15	17	20	23	26	30	34	38	42	46	51
16 leaf	1	2	3	4	6	8	11	14	18	20	23	27	31	36	40	44	49	55	61
17 leaf	2	3	4	5	7	9	12	16	20	23	27	31	35	40	45	50	56	62	69
18-21 leaf	3	4	5	7	10	13	17	21	26	30	34	39	44	50	56	62	69	76	84
Tasseled	3	5	7	9	13	17	21	26	31	36	42	48	55	62	68	75	83	91	100
Silked	2	4	6	8	11	15	19	23	38	33	38	44	50	57	63	70	78	86	95
Silks Brown	2	4	6	8	11	14	18	22	26	31	36	41	47	53	58	64	71	79	88
Pre-Blister	2	3	5	7	10	13	16	20	24	28	32	37	43	49	54	60	66	73	81
Blister	2	3	5	7	10	13	17	21	26	31	36	42	48	55	50	55	60	66	73
Early Milk	2	3	4	6	8	11	14	17	20	24	28	32	36	41	45	50	55	60	66
Milk	1	2	3	5	7	9	12	15	18	21	24	28	32	37	41	45	49	54	59
Late Milk	1	2	3	4	6	8	10	12	15	18	21	24	28	32	35	38	42	46	50
Soft Dough	1	1	2	2	4	6	8	10	12	14	17	20	23	26	29	32	35	38	41
Early Dent			1	1	2	3	5	7	9	11	13	15	18	21	23	25	27	29	32
Dented					1	2	3	5	7	8	10	12	14	16	17	18	20	22	24
Nearly Mature					1	2	3	5	6	7	8	9	10	12	13	14	15	16	
Mature																			

intend to keep the stand, loosening soil next to the plants (if large enough) and throwing some soil to the plant bases is effective in getting air to these important root systems.

Small Corn's High Recovery Potential.

Hail or freeze damage to small corn can be almost insignificant when the corn is less than 6 inches in height. At this early growth stage, the growing point



Corn that has only been emerged 2 to 3 weeks (4 to 5 leaf stage) will still have its growing point positioned below the soil surface. If undamaged, the growing point remains capable of producing new leaves and extending present leaves. Corn in this growth stage is relatively safe from freezing temperatures and is to a lesser degree insulated from hail damage.

is still protected beneath the soil surface. Small corn may be broken-over or partially shredded or may experience the loss of almost all of its above ground growth. Large or high-density hail can completely defoliate corn or increase breakage to the point that only a thumb-size stub of whorled leaves remains. In spite of what appears to be a total loss, small corn plants that are firmly anchored and receive favorable growing conditions will immediately begin to push new leaves. Unless a subsequent freeze or other damage occurs, the chances for recovery are quite good. New growth will be a lighter green than observed in undamaged plants. Expect a 9 to 15 percent yield reduction if the entire top is lost.

Determine Condition of Growing Point. Hail often strikes the corn plants at an angle and will damage one side of the plant more than the other.

Hail may fall at an angle, resulting in greater damage to one side of the plant than another. Some of these plants should be split open with a knife 3 to 4 days after the damage, to examine the condition of the growing points.

Bruises or lesions may develop on sides of knee-high corn. Although no nodes (stalk) have been formed yet, several wraps of leaves are protecting the growing point. This protection works for a while, but after multiple hail stones the plant begins to fragment. Sometimes all that is left is a stub. After 4 to 5 days have lapsed since the hail storm, inspect the surviving plants. Some of these plants should be split open to see at what height and condition the growing point is found. If the growing tip is black or brown, the damage is severe and the plant may soon die. Undamaged growing points will be pushing new leaves, and corn will increase in height and leaf area if sunshine and favorable soil moisture are present. Often, if the growing point is not damaged or bruised, the plant will recover. Plants fully broken-over will not. These should be considered as lost plants.

Old Damage May Entangle New Growth.

Physical damage to young corn can be experienced from a freeze or heavy frost, from blowing sand and whipping in high winds, and from hail. Sometimes it may be a combination of several events. With each of these the growing point has the immediate task of pushing and breaking through the damaged leaves (trash) and pulling itself erect. Most damaged plants will usually do this successfully, although some buggy-whipping and distortion of the plant may last for days or even weeks following the hail event. In 2 to 4 weeks, most of the surviving plants will have broken through the older damaged tissue. Rarely,

the growth stage and type of damage is such that a large percentage of plants will have difficulty growing through the old damage. In this situation some producers have gone over the field with a forage chopper set on a higher setting, to remove the buggywhips and restrictive trash materials.

New growth may have trouble emerging through old damaged tissue (trash). Buggy-whipping may occur temporarily, but 85 to 90 percent of these plants break through and resume normal growth.

Determine Plant Density. The density of surviving plants should be determined as a basis for assessing the need for replanting. Corn plants are not very efficient when growing at temperatures above 90°F. Late-planted corn will produce lower yields if it has to grow through extended periods of high temperature and stress at pollination. Often, when hail damage occurs, it is too late to replant corn and may be too late for the planting of sorghum, without providing protection against heavy sorghum midge pressures. The surviving density may be adequate to return costs to the producer, or the hail insurance may be based on what reductions occur as opposed to your normal production year.

Plants broken-over are considered as lost. When making stand counts, exclude broken plants and those which are known to have bruised or damaged growing points. If field counts do not exceed 13,000 plants per acre, skips and population gaps cannot be offset through flexing in ear size.

As plant densities diminish to less than 13,000 plants per acre, potential yields also fall and late-season weed control is harder to maintain because of less shading and canopy. With most hybrids, corn ears will flex longer and fatter with lower populations. Some compensation occurs in this way, but yields fall-off rapidly below 13,000 plants per acre. Further, skips result in un-utilized surface, and an almost linear reduction in yields occurs. If the weather turns droughty, the impact will be less because the lighter stand will survive longer into the growing season without moisture stress (see fact sheet MP-1369 for information on planting dates and corn population management).

Plant density (plants per acre) can be determined by multiplying the number of surviving plants in the appropriate row length for 0.001 acre (Table 2) times 1,000. Several counts should be taken in different parts of the field to provide a representative average for the field.

Potential for Disease. What sometimes occurs is that a damaged stand is a future target for disease, insects, and harvesting problems. Lodging may be greater if stalks were damaged by hail. Leaf and ear smut may increase in certain years because of wounds being opened for infection. Other leaf diseases may increase. Spores and inoculum must be airborne (present) at the time of damage for infections to be successful. The use of foliar sulfur or fungicides has not been warranted following hail damage in the Texas Coastal Bend, but is commonly used in Northern Texas.

Low Temperature Damage (33 to 45°F). Prolonged low temperatures just above freezing can adversely affect young corn plants. This chilling type of damage should be distinguished from normal phosphorous deficiency or zinc deficiency which is also influenced by low soil temperature, but is the result of a root system that is too small to access enough nutrients to feed the plant. Low-temperature

Table 2. Row length segments necessary to calculate plant populations for twelve different row spacings.

Row Width	Row Length	Your Count	Factor	Population
42-inch	12’ 5”	_____	x 1000	_____
40-inch	13’ 1”	_____	x 1000	_____
38-inch	13’ 9”	_____	x 1000	_____
36-inch	14’ 6”	_____	x 1000	_____
34-inch	15’ 5”	_____	x 1000	_____
32-inch	16’ 4”	_____	x 1000	_____
30-inch	17’ 5”	_____	x 1000	_____
28-inch	18’ 8”	_____	x 1000	_____
26-inch	20’ 1”	_____	x 1000	_____
24-inch	21’ 9”	_____	x 1000	_____
22-inch	23’ 9”	_____	x 1000	_____
20-inch	26’ 2”	_____	x 1000	_____

damage is shown as a decline in plant color, near-stoppage of photosynthesis, and insufficient heat units to compensate for stress. Corn leaves appear gray-green, purplish, and red-mottled with increasing yellowing. Growth is so minimal that plants are not able to establish an extended root system. While corn may easily germinate at 50°F, these juvenile plants must have enough sunshine and temperatures above 55°F to support photosynthesis and to grow through any extended stress period once seed stores are depleted.

Frost Damage (27 to 32°F). Tissue loss from frost damage is directly proportional to how low the temperature falls, how long the low temperature is sustained, and the moisture content of the plant and soil at the time of damage. The capability of the soil to hold heat and to initially protect the plants against falling air temperatures is only effective for small temperature fluctuations. Frost damage usually damages only leaves. See Tables 3 and 4 for expected yield reductions.

Freeze Damage (<26°F). All soft tissue actually wilts and desiccates in the few days following a freeze. Small corn may initially have trouble growing through these fused materials. The remaining plant tissue may also begin to “pinch-in” where the freeze damage stops, creating a constrictive collar through which the emerging leaves must pass. There are different views on the merits of removing this restrictive point with a cutterbar. Clipping off these pinched areas may reduce additional stress on the emerging plant tissue, but it may be difficult to remove this tissue without getting too close and damaging the growing point. Shredding has not been demonstrated to improve the recovery of damaged plants. If the damage event is more than 1 month from the optimum planting window, the damaged crop will usually out-yield replanted fields.

Freeze Damage to 6- to 15-Leaf Corn. Corn that is greater than 12 inches in height when subjected to extended freezing temperatures will usually not survive. If the growing point is above the soil level within the plant (no longer insulated by the earth), the meristematic tissue is ultimately damaged. Also a grass plant, sorghum is effected very similarly by hail and frost or freezing temperatures.

Late-Season Frost Damage. During the late-milk or soft-dough stage, a frost or light freeze may catch fall-planted corn. This occurrence essentially terminates the plant before moisture can leave the ear, kernels, and stalk. Several days or weeks may be required before grain will easily shell from the cob. Many ears may mold or become diseased because of the trapped moisture and full shuck cover. Resulting grain will be low in test weight (as

low as 35 lb./bu.). If not moldy, such grain has good feeding value, but it is difficult to sell. Cool nights and low day temperatures extend the time necessary to field dry frost-damaged corn.

Salvaging Older Hail- or Frost-Damaged Corn. If immature or wet, mature corn or sorghum is freeze-killed or severely damaged by hail and there is a use for silage, a silage chopper can be used to harvest the remaining erect plants. The chop can be placed in conventional silos, or it can be blown into commercial plastic silage-bags which are positioned on a smooth surface. The quality and nutritional value of the silage will be best when ears are present and grain has formed. Baseball-sized hail will breakout plant tops, bruise ears, and lodge plants. Most leaning plants can be recovered with a silage chopper.

Table 3. Estimated grain sorghum yield reductions resulting from various amounts of leaf removal at increasing stages of plant development (HIARA).

Leaf Loss	Plant Age (days)			
(%)	17	37	51	71
30	2	4	15	12
60	2	7	38	50
90	5	13	68	55

Because damaged plants tend to have extensive wounds, they will lose large amounts of water. If plants are too dry, it may be necessary to add back some water when filling the silo to correctly prepare the corn chop for the ensiling process. In South Texas, silage from mature, hail-damaged corn was evaluated at 25 percent DM, 8 percent protein, and 66 percent TDN. While corn silage is one of the finest cattle feeds known, it is not feasible to transport it for great distances. Once opened, it becomes a perishable commodity and must be used within a matter of a few days.

Table 4. Mean yield decrease resulting from leaf removal from grain sorghum at late boot and bloom growth stages (*Agron. Journal* Vol 53).

Leaf Loss	Mean Yield Decrease)
(%)	(%)
33	23
50	35
67	43
100	95

Hail damage to sorghum creates almost prostrate plants. Water loss will be extensive from the multiple breaks and bruises. Good soil moisture and sunny weather are important to the recovery of damaged stands.

Another option would be to place an electric fence around the area chosen for salvage and to allow cattle to graze the damaged corn. Cattle will consume the leaves, ears, shucks, and smaller, softer portions of the stalk. This allows a rapid use of the damaged crop with a minimum investment of time and equipment.

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