AGR-194

UK COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY — COLLEGE OF AGRICULTURE

Estimating Hail Damage in Corn

Chad Lee, Plant and Soil Sciences

Hail is precipitation in the form of irregular shapes of ice. Hail can shred leaves off corn plants, bruise stalks, and turn a beautiful field of corn into bare stalks with a few ragged leaves. The initial sight of hail damage is sickening to any farmer.

Small corn, with the growing point below the soil surface (see corn staging below) is highly tolerant to hail damage. As the growing point moves above the soil surface and the corn plant gets closer to tasseling, corn becomes more susceptible to hail damage. Corn is most susceptible to hail damage from the period just prior to tasseling through early milk. Once corn passes the early milk stage, it becomes more tolerant to hail damage.

When to Evaluate

The initial impulse is to evaluate the corn immediately after the hail event. However, waiting about two days will provide an indication of the growing point condition, and about five days are needed to determine if new growth is occurring. To evaluate the growing point, cut the corn stalk to expose the growing point. Healthy growing points will be white or cream-colored; dead points will be dark and/or flaccid. If the growing point is dead on a majority of the plants, replanting options can be considered. If the growing point is healthy on most plants, wait three more days (five days after the hail event) to evaluate new growth (Figure 1).

The amount of leaf area destroyed should be estimated by the amount of leaf area that is either missing or is no longer green. Any green leaf material, even that which is shredded, should not be counted as destroyed. Estimated defoliation is then used in Table 1 to determine potential yield loss. Table 1 provides an estimate of yield loss from defoliation. The entire table can be found in "Assessing Hail Damage to Corn" (G86-803-A), University of Nebraska-Lincoln.

Table 1. Estimated yield loss percentage due to extent of defoliation at a given corn growth stage.

Growth Stage*	% Leaf Area Destroyed									
	10	20	30	40	50	60	70	80	90	100
	Estimated Yield Loss (%)									
7-leaf	0	0	0	1	2	4	5	6	8	9
8-leaf	0	0	0	1	3	5	6	7	9	11
9-leaf	0	0	1	2	4	6	7	9	11	13
10-leaf	0	0	2	4	6	8	9	11	14	16
11-leaf	0	1	2	5	7	9	11	14	18	22
12-leaf	0	1	3	5	9	11	15	18	23	28
13-leaf	0	1	3	6	10	13	17	22	28	34
15-leaf	1	2	5	9	15	20	26	34	42	51
18-leaf	2	5	9	15	24	33	44	56	69	84
Tassel	3	7	13	21	31	42	55	68	83	100
Silked	3	7	12	20	29	39	51	65	80	97
Blister	2	5	10	16	22	30	39	50	60	73
Milk	1	3	7	12	18	24	32	41	49	59
Dough	1	2	4	8	12	17	23	29	35	41
Dent	0	0	2	4	7	10	14	17	20	23
Mature	0	0	0	0	0	0	0	0	0	0

* Hail adjusters' method for staging corn. (8-leaf stage is usually similar to V6 corn, where 6 leaf collars are visible.)
Source: Adapted from the National Crop Insurance Association's "Corn Loss Instructions" (Rev. 1984).

Hail rarely damages the growing point on small corn with the growing point at or below the soil surface. Corn plants damaged by hail early in the season (before V7) usually recover from tied whorls and bruised stalks. The corn will usually grow through tied whorls within 3 or 4 weeks. Stalk bruising has little impact on lodging. Silking will be delayed on severely damaged corn plants. For example, corn at V5 through V7 with complete leaf loss from hail will be delayed in silking by 7 to 10 days compared with plants that received 80 to 90 percent defoliation.

Figure 1. Hail caused nearly 90 percent leaf loss in this cornfield. If bruising is not severe and good weather follows, then yield losses will be about 15 percent.

Determining Growth Stages and Surviving Stand

Knowing the growth stage of corn at the time of a hail is critical to understanding the potential yield impact. Two methods are used to determine vegetative growth stages in corn. These staging methods are used by different disciplines and often found on different herbicide labels. One method determines growth stages by the number of visible leaf collars, and the other uses the number of visible leaves that are bent over.

Leaves and Leaf Stages

Hail adjusters determine vegetative stages by counting the number of leaves that are bending over. The last leaf to bend over is referred to as the indicator leaf. The first leaf of a corn plant likely will not be long enough to bend over, but each subsequent leaf up the stalk will start to bend over. For example, a corn plant with the first (bottom) leaf pointing upward and the second leaf bending over is at the 2-leaf stage. Corn at the 2-leaf stage will have at least two more leaves that are visible. The third and fourth leaves will be pointing upward.

Once the corn plant reaches about 8-leaf stage, the stalk grows rapidly and often tears some lower leaves and collars off the plant, making staging more difficult. These later vegetative stages can be determined by digging up a plant and splitting the lower stalk lengthwise through the roots. The first elongated internode is usually 0.4 inches in length. The first node above this internode is often connected to the fifth leaf (fifth collar). Once this "reference" node has been determined, the remaining leaves can be counted.

The challenge with the leaf method is that if hail is severe, the upper leaves may be missing from the plant, leaving you to guess what upper leaves were bending over. Leaves with any visible collars would have been bent over, which leads into the other staging method.

Collars and V-Stages

The collar is at the junction of the leaf blade and the leaf sheath, which wraps around the stalk of the plant. A corn plant with one visible collar is at growth stage V1. The first leaf of the corn plant is usually oval-shaped; all subsequent leaves will be longer and come to a sharper point. The V1 corn plant may have three or four visible leaves; however, only one collar is visible. Similarly, a corn plant at V6 will have six visible collars, but eight or nine leaves may be visible.

Once the corn plant reaches V6, the stalk grows rapidly and often tears some lower leaves and collars off the plant, making staging more difficult. Follow the guidelines above to find the "reference" node and then find the remaining visible collars.

Comparing the Methods

Both staging systems are based on number of leaves. The difference is determining which leaves to count. Because one method uses collars and the other uses an indicator leaf, the two stages do not equal each other. For example, V1 corn (one visible collar) is usually equal to 2-leaf corn (the bottom leaf plus one leaf bending over) and V6 corn (six visible collars) is usually equal to 8-leaf corn (one bottom leaf with seven more leaves bending over), while V12 corn is typically equal to 14-leaf corn.

Corn Development

The growing point on most corn hybrids will remain below ground until the V6 growth stage (8-leaf stage). Tassel and ear shoot development have both started by V6. Once corn reaches V6, the stalk will begin to grow rapidly. When corn reaches V12 (usually 14- or 15-leaf stage), kernel number and size are being determined. When corn reaches V15, it is passing through the most critical stage for yield determination. Corn is typically more tolerant of hail early and late in development and less tolerant as it approaches tasseling and pollination. In other words, hail damage during tasseling (VT) likely will be more detrimental than hail damage during V6.

Estimating Surviving Corn Stand

Multiple stand counts should be made in both injured and non-injured areas of the field. Use Table 2 to determine the length of row to count to estimate plant stand. Count the plants within a row and multiply that number by 1,000. The product is the estimated number of plants per acre. This process should be repeated throughout the field in injured and non-injured areas. If stands are erratic, counting 50 feet of a row may be a better way to estimate corn stands. Compare the estimated stand to the population numbers in Table 3 to help determine the remaining yield potential in the field.

Table 3 contains older data from the Midwest but is still the best general guide available. Current research indicates that corn populations closer to 30,000 plants/A will provide maximum yield on better soils. When assessing corn stands on better soils, keep this factor in mind.

Example (refer to Table 3):

A full stand of corn (25,000 plants/A) was planted on May 6 in a field that normally yields 150 bu/A.

- If the yield potential for a plant population of 25,000 planted on May 6 is 100%, the anticipated yield at harvest is 150 bu/A:

  150 bu/A x 100% = 150 bu/A

- Frost damage on May 21 reduced stands to 16,000 plants/A.

- Since the yield potential for a plant population of 16,000 planted on May 6 is 88%, the anticipated yield at harvest is reduced from 150 bu/A to 132 bu/A:

  150 bu/A x 88% = 132 bu/A

Re-planting a full stand of corn on May 31 would result in 87% yield potential or 130.5 bu/A.

References

Mangen, T., and P. Thomison, 2002. Early season hail damage in corn: effects of stalk bruising and tied whorls. Agronomic Crops Team On-Farm Research Projects 2000. Special Circular 179-01. http://ohioline.osu.edu/sc179/sc179_16.html

Vorst, J. J. 1986. Assessing Hail Damage to Corn, G86-803-A. University of Nebraska-Lincoln.

Table 2. Estimating corn stand.

Row		Plants in Row	Multiply by:	Estimated Plants/A
Width	**Length**			
Uninjured areas of the field:				
15	34′ 10″		1,000	
20	26′ 2″		1,000	
30	17′ 5″		1,000	
36	14′ 6″		1,000	
38	13′ 9″		1,000	
Injured areas of the field:				
15	50′		696.96	
20	50′		522.72	
30	50′		348.48	
36	50′		290.40	
38	50′		275.12	

Table 3. Relative grain yields for various planting dates and plant populations.*

Planting Date	Thousand Plants/A						
	25+	**22.5**	**20**	**18**	**16**	**14**	**12**
	Yield Potential (%)						
May 6	100	98	95	92	88	83	78
May 11	99	98	95	92	88	83	77
May 16	98	96	93	90	86	81	75
May 21	95	94	91	87	83	78	73
May 26	92	90	87	84	80	75	69
May 31	87	85	82	79	75	70	64
June 5	81	80	77	73	69	64	59
June 10	75	73	70	67	63	58	52

* Expressed as a percent of the yield considered optimal for a given planting date and plant population. Plants are assumed to be uniformly spaced within the row.

Source: Adapted from the National Corn Handbook (NCH-30), "Guidelines for Making Corn Replanting Decisions." Also appears as Table 5 in *A Comprehensive Guide to Corn Management in Kentucky* (ID-139).

Issued 10-2007