

Late-Season Frost Damage to Corn Grown for Silage

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Late corn plantings and cool autumn temperatures create a recipe for frost damage on corn grown for silage. The extent of the frost damage on the corn depends on the temperature, duration of the temperature, and corn growth stage at the time of the frost.

Conditions for a Frost

Air temperatures below 32°F for four to five hours will result in frost damage to the stalk, leaf, and husk. Air temperatures that drop to 28°F for a few minutes and return to 32°F can result in similar injury. Air temperatures between 32°F and 40°F typically result in less frost damage.

Frost at temperatures above 32°F usually occurs under conditions of clear skies, low humidity, and no wind. These conditions are ideal for rapid heat loss from the corn leaves. Under these conditions, temperature of the corn leaves can be less than the air temperature. Thin stands of corn and corn stands at the edges of fields are more likely to receive frost damage at temperatures above 32°F than thicker stands and the centers of fields. The uppermost leaves of the corn plant are most susceptible to frost damage at temperatures between 32°F and 40°F.

Growth Stage at Time of Frost

Management of corn damaged by frost will depend on the stage of growth at the time of frost. Several of the growth stages during kernel development are listed in Table 1. Corn will ensile well at moisture levels less than 70% for upright silos and less than 75% moisture for horizontal silos. Corn harvested at 62% to 68% moisture (late-dent stage) is ideal for ensiling. Frost damage prior to the late-dent stage will result in corn that is too moist for silage harvest. Frost at these higher moistures will reduce yields and may reduce quality.

Corn moisture content can be determined with a microwave or forage moisture tester. A simple field technique for determining corn moisture content is to squeeze a ball of chopped corn forage in your hand for 30 seconds. Release the ball of chopped forage and examine its shape. You can gain a rough estimate of moisture content based on the descriptions in Table 2. If you would prefer to not use the silage chopper to help determine whole plant moisture, then you can use a tobacco or corn knife to chop several corn plants. Be careful to chop up the corn plants into pieces that are similar in size to those cut by the silage chopper.

Table 1. Several stages of kernel development.

Crop Stage	Description*	Kernel Moisture** (%)	Whole Plant Moisture*** (%)
R3 Milk	Kernels are becoming yellow and the silks are dry.	80	79
R4 Dough	Fluid in the kernel is becoming a consistency similar to dough.	70	75
R5 Dent	Kernel has dented at the top; starch layer begins at the top of the kernel and progresses down the kernel. This progression is referred to as the milkline.	55	70

* Adapted from Ritchie et al., 1993.

** Kernel moistures are for the start of each growth stage. The kernels will dry down as the crop progresses through each stage of growth.

*** Adapted from Lauer, 1999.

Table 2. Field technique for estimating moisture content of corn forage.

Condition of Forage Ball After Squeezing for 30 Seconds	Approximate Moisture Content
When the ball holds its shape and there is considerable free juice.	Over 75%
When the ball holds its shape but there is very little free juice.	70 to 75%
When the ball falls apart slowly and there is no free juice.	60 to 70%
When the ball falls apart rapidly.	Below 60%

Frost at Milk Stage

When a frost occurs on corn at the milk stage, the moisture content of the plant is too high for proper ensiling. The leaves of the plant will dry very quickly, which causes the entire plant to appear to be drying more quickly. However, the entire plant will dry down similarly to corn that was not injured by frost. If the corn at milk stage is ensiled immediately after frost, then nutrients will leach away, the silage will be sour and wet, and livestock consumption will be low.

Waiting to harvest frost-damaged corn at the milk stage will improve silage quality but will decrease dry matter yield. Up to 10% dry matter losses will occur the first 10 days after the frost, and up to 20% dry matter will be lost 40 days after the frost. In addition, mold may develop in the ears and cause further yield reductions. Because of these factors, a compromise between dry matter yield and ideal ensiling moisture must be made.

In some cases, the corn will need to be harvested when it is too wet for silage. In these situations, chopped grain, hay, or straw can be added to the silage to decrease overall moisture. In general, 30 pounds of dry matter per ton of silage are required to reduce the moisture percentage by one point. For example, if the corn was at 78% moisture and the target moisture was 68%, then 300 pounds of dry matter would be required for each fresh ton of silage.

One concern of frost occurring at the milk stage is high nitrate levels. High nitrate levels are toxic to cattle and will occur most frequently when the corn has been under drought stress prior to the frost. Ensiling will reduce nitrate levels 40% to 60%. To reduce the risk of nitrate toxicity, allow the ensiling process to occur for at least 21 days before feeding. See ID-86, *Using Drought-Stressed Corn: Harvesting, Storage, Feeding, Pricing, and Marketing*, for more information on nitrate levels in corn.

Another option for corn with high moisture content is to feed the corn as green-chop. Cattle will consume less green-chop corn than ensiled corn. However, the quality of the frost-damaged, green-chopped corn is better than the quality of the ensiled corn at milk stage. If the corn is to be fed as green-chop, then check the corn for nitrate levels before feeding. A diagnostic test is available for determining nitrate levels, which is usually available through your county Extension office.

Frost at Dough Stage

If a frost occurs when the corn is at the dough stage, then whole corn is often too wet for silage harvest. Typically, several drying days are necessary before whole corn will be at the proper moisture for silage harvest. The corn should be harvested as soon as it reaches the desired moisture of 70% to 75%. The balance between waiting to harvest corn for silage at the ideal moisture and harvesting to prevent yield loss still must be considered. However, corn damaged by frost during the dough stage will require less time to dry down than corn damaged during the milk stage.

Frost at the Dent Stage

If a frost occurs when corn is at the early dent stage, then whole corn may need to dry a couple days before it is ready to harvest. If a frost occurs when the corn is at the mid- to late-dent stage, whole corn is at or very close to ideal moistures for ensiling. Corn damaged by frost at the mid- to late-dent stage should be harvested for silage immediately because whole plant moisture should be close to ideal for harvest and waiting to harvest could cause yield reductions.

Summary

Management of frost damage to corn grown for silage depends in part on the stage of growth when the frost occurred. Corn in the milk and dough stages is too wet for chopping and ensiling. The corn plants need to dry down before chopping occurs. Waiting to harvest frost-damaged corn will improve silage quality but will decrease dry matter yield. Producers must balance between expected yield losses and quality gains by waiting to harvest.

Additional Questions

For additional questions regarding frost damage on corn grown for silage, contact your county Extension agent.

References

- Amaril-Phillips, D., W. Crist; G. Heersche, J. Johns, M. Bitzer, F. Benson and L. Meyer. 1988. *Using Drought-Stressed Corn: Harvesting, Storage, Feeding, Pricing, and Marketing*: ID-86. University of Kentucky.
- Bitzer, M. J., J.H. Herbek, G.Lacefield, and J. K. Evans. 1979. *Producing Corn for Grain and Silage*: AGR-79. University of Kentucky.
- Carter, P.R. and O.B. Hesterman. 1990. *Handling Corn Damaged by Autumn Frost*. National Corn Handbook: NCH-57. Michigan State University.
- Lauer, J. 1999. *Silage Drydown: How is it Progressing?* Wisconsin Crop Manager: 6:140-141
- Nielsen, R. 1996. *Potential Yield Losses in Corn from Fall Frost Damage*. Purdue Crop and Livestock Update: CL-9. Purdue University.
- Ritchie, S. W., J. J. Hanway and C. O. Benson. 1993. *How a Corn Plant Develops*. Special Report No. 48. Iowa State University Press.
- Steevens, B., R. Belyea and R. Crawford. 1993. *G3151, Using a Microwave Oven to Determine Moisture in Forages*. University of Missouri Extension.
- Taylor, R.W. and R. Barczewski. *Managing Frost-Damaged Silage Corn*. Agronomy Fact Series: AF-10. Delaware Cooperative Extension.