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Assessing Frost/Freeze Damage in Corn

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Introduction

Planting corn at the earliest practical date in the spring is usually the single most important factor for optimum yields in the warm climates of the south. Reasons for this include: the vegetative period of development occurs when temperatures are cooler, the tasseling and silking period is ahead of soil moisture and heat stress, and root systems are more likely to be more extensive and deeper in the soil thus enabling the plant to extract subsoil water available to them when summer droughts occur.

However, risks of planting too early might expose the corn plant to frost or freeze damage. The following paragraphs will discuss when a frost or freeze event may occur, the impact of the developmental stage of the corn plant, how to assess the damage, and the factors that affect replant decisions.

Minimum air temperature and duration of low temperatures will impact the amount of damage to young corn plants. Temperatures and guidelines used by the National Weather Service (NWS) to issue frost and freeze advisories do not necessary align with conditions that are damaging to corn plants. The NWS will issue a frost advisory when wide spread frost formation is expected over a given area. Surface temperatures will usually reach the low to mid 30's. A freeze warning is issued by the NWS when surface temperatures are expected to drop below 32°F over a large area for an extended period of time. Corn plants are generally tolerant of simple frost events and light freezes. The critical temperature for corn is around 28°F. A light freeze event (surface temperatures above 28°F) is usually not damaging to young corn plants provided the duration of sub-freezing temperatures is short. Exposure to temperatures below 28°F for even a short period of time can be damaging to corn plants at any stage of development.

Edaphic (soil) and topographical (physical or natural features of the field) factors may also affect the potential for freezing conditions to occur. Dry soil exchanges heat faster and will cool much quicker than moist soil. Moist soils will generate higher night-time dew points, which will limit evaporative cooling once the dew point is reached. Higher dew points result in higher minimum temperatures. In addition, cool air is heavier than warm air and tends to sink into lower landscape positions. The combination of these two factors will impact the spatial distribution of freeze damage within a field or region.

Stage of Growth

The stage of development will impact which plant tissues are damaged. Damage to leaf tissue will not kill the plant and in most cases will not result in yield loss. Top leaves that are damaged soon become the bottom leaves which are destined to be shaded by later developing leaves. Damage to the meristematic tissue, or the growing point, could be lethal to the plant. The growing point is below the soil surface from emergence through about stage V-5 (5 visible leaf collars) and is less likely to be damaged when protected by the soil. Beyond stage V-5, the growing point is above the soil surface and plants likely will not survive if exposed to a freeze event (Figure 2).

Figure 1. Corn plant in the V2, early V3 stage of growth (left) and the location of the growing point in relation to the soil surface.

Figure 2. *Location of the growing point on corn in the V5 growth stage.*

Assessing the Damage

Leaf tissue is likely to show symptoms of injury during any frost-freeze event. Damaged leaf tissue will be discolored, turning gray to greenish-black within a few hours and eventually drying up and turning brown. More importantly, the status of the growing point should be evaluated. A healthy growing point should be a light cream-color and tissues remain firm. Damaged growing points will be discolored and have a water soaked or mushy appearance. This is a clear indication that the plant is unlikely to recover. However, the best method for determining the extent of damage on a whole field basis will be to wait 3 to 5 days or more to evaluate tissue damage and regrowth.

Regrowth following freeze damage will be evident as new leaf tissue emerges from the whorl. Regrowth will be slower if cool conditions persist following the freeze event. Several days with temperatures above 70 °F is needed for regrowth. The key is to be patient. Yield loss for plants exposed to freezing temperatures earlier than the V-5 stage will result from stand loss, not the extent of damage to aerial plant parts. Up to 50% defoliation at the V10 stage can reduce yield about 6%, with insignificant yield losses at earlier growth stages. Frost damaged leaf tissue can sometimes develop a restrictive knot around the whorl which is disruptive to regrowth but the plant usually recovers without incident. If stand losses are not severe, the original planting will likely out-yield later plantings.

Follow the steps below to determine if stand loss justifies replanting:

1. Wait 3-5 days (+70 °F) or until conditions favor growth following the freeze event to allow regrowth to occur.
2. Count the number of healthy plants remaining for a predetermined feet of row (1 row) based on row spacing (Table 1).
3. Multiply the healthy plant count by 1000 to determine plant population (Table 2).
4. Repeat steps 2 and 3 for several areas across the field.
5. Take the average plant population for the field.

Table 1. *Feet of row needed to equal 1/1000 of an acre based on row spacing.*

Row Spacing (inches)	Feet of Row (1/1000 acre)
30	17' 5"
36	14' 6"
38	13' 9"
40	13' 1"

Table 2. *Plant population worksheet.*

Healthy Plant Count		Plant Population
1.	x 1000	=
2.	x 1000	=
3.	x 1000	=
4.	x 1000	=
5.	x 1000	=
6.	x 1000	=
Average		

Factors Affecting Replant Decisions

As previously mentioned, reductions in plant populations will have a greater impact on yield than damage to leaf tissue. Yield of irrigated corn drops significantly at populations below 25,000 plants per acre (Figure 3). For example, if the target plant population was reduced from 31,000 to 17,000 plants per acre, yield will be about 80% of optimum yield. Small reductions in plant populations from target plant populations do not reduce yield significantly. Most corn hybrids are capable of "ear flex" or increasing the length and girth of ears in response to lower plant populations. Stand uniformity should also be considered. Large skips (4 to 6 ft) can reduce yield up to 5%.

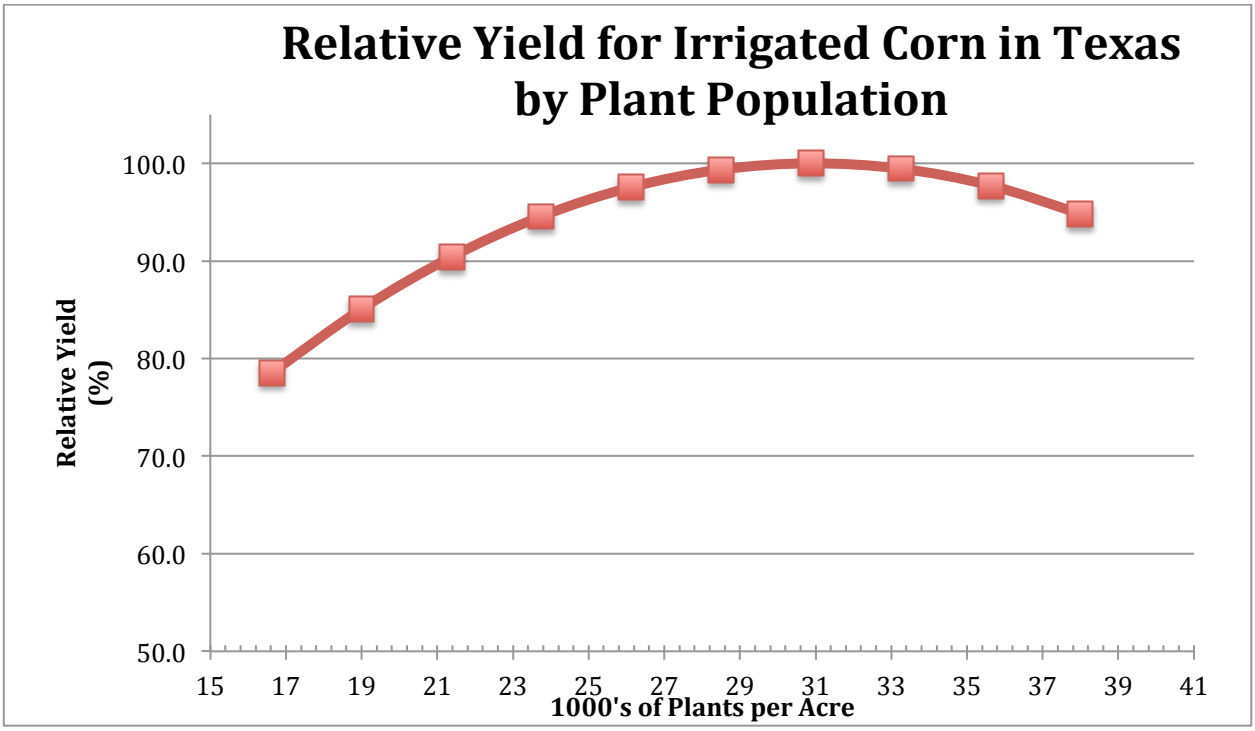

Figure 3. *Relative yield of irrigated corn in response to seeding rate/plant population.*

Yield reductions due to stand loss and uniformity must be weighed against yield reductions due to later planting dates. In central Texas, it is estimated that corn planted on April 7 will yield about 77% of corn planted on March 7 (Figure 4). The last week in February through the first week in March is considered optimum in central Texas. Earlier plantings avoid heat and moisture stress during pollination periods often encountered for later plantings.

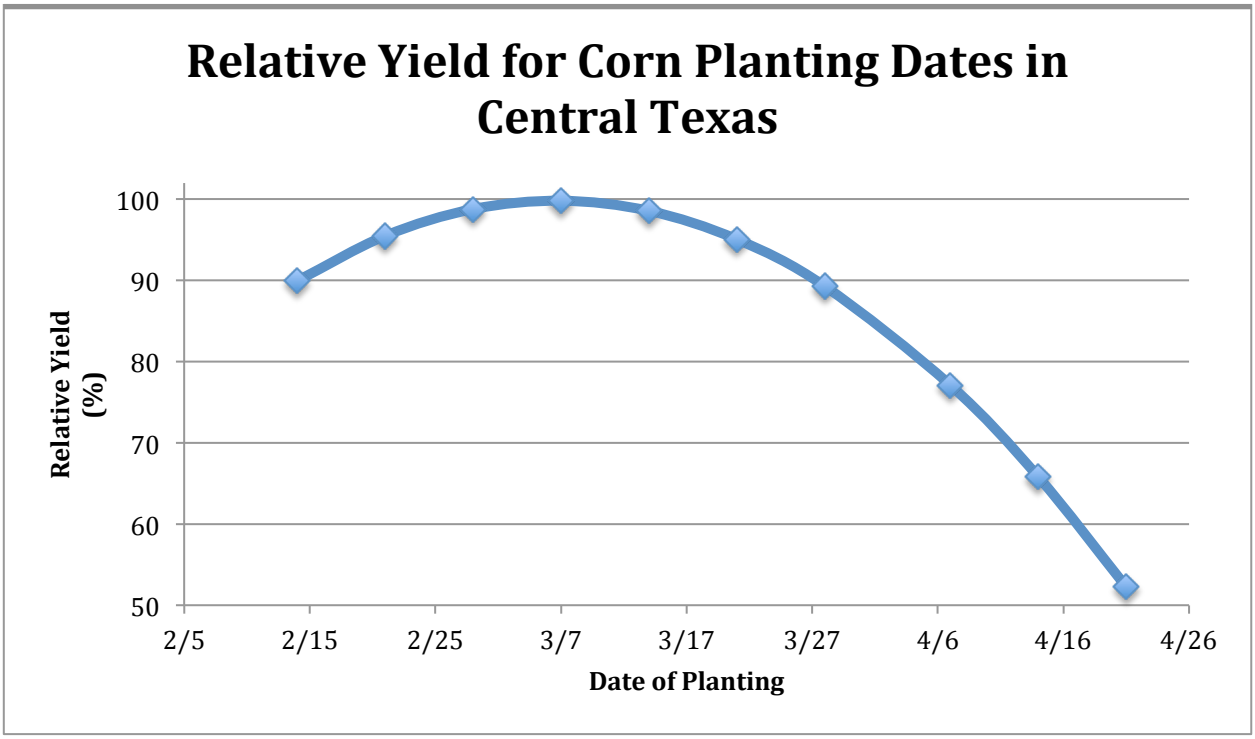

Figure 4*. Relative corn yields by planting date.*

In addition to potential yield reductions due to later plantings, cost of replanting should be considered. Yield for a given replant date must justify added input cost associated with replanting in addition to normal input cost. Replant cost is estimated to be from $75 to 80 per acre (seed, equipment, labor). If replanting is not economically favorable, alternative crops should be considered.

Summary

Minimum air temperature and duration of low temperatures will impact the degree of damage to young corn plants. Also, soil and the physical or natural features of the field may affect the potential for frost or freeze damage to occur. The growing point of the corn plant is below the soil surface from emergence through about the V-5 stage and is less likely to be damaged when protected by the soil. When assessing the damage, the status of the growing point should be evaluated. A healthy growing point should be a light cream-color and tissues remain firm. Damaged growing points will be discolored and have a water soaked or mushy appearance. Be patient, wait 3 to 5 days to evaluate growth. Factors that affect replant decisions include plant population/stand uniformity, time of the season, and the cost of replanting. If remaining plant stand is inadequate and it is too late in the season to replant, consider planting an alternative crop.

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