Minnesota Crop eNews
Current • Practical • Convenient
University of Minnesota Extension Service

Using Drought-Stressed Corn for Forage

July 26, 2006

D.R. Hicks and P.R. Peterson
Agronomists, University of Minnesota

Corn that is drought stressed can be used for forage, either green chop or as silage. The purpose of this newsletter is to address some of the questions that growers should consider when using drought-stressed corn.

Determining Ear Development

For most of the drought-stressed corn, the ear will have little to no grain. If there is no grain, florets on the ear were either not pollinated or have not started to grow because of lack of moisture. If pollination and fertilization of florets have occurred, there should be evidence of kernel growth, which may have slowed or stopped because of the moisture shortage. These kernels may grow now if the plant is not dead and if rain occurs before the plant dies. If there is no evidence of kernel growth and most plants have tasseled and shed pollen, then those plants will continue to be barren even if it rains. If kernel growth is occurring, one should wait to harvest to allow more dry matter to accumulate in the grain, which will increase the yield and quality of the forage. If the plant is barren and or dead, harvest should occur when the whole plant moisture is appropriate for preservation and storage.

When to Harvest

Because the potential for nitrate toxicity exists, grazing or green chopping should be done only when emergency feed is needed. If ensiling drought-stressed corn, as with normal corn, harvesting should be done at the moisture content that ensures good storage in the silo - 65-70% in horizontal silos (trenches, bunkers, bags), 60-65% in upright stave silos, and 55-60% in upright oxygen limiting silos. Green, barren stalks will contain 75-90 percent water. If weather remains hot and dry, moisture content drops, but if rain occurs before plants lose green color, plants can remain green until frost. Methods to determine percent moisture are discussed below.

NITRATES AND GASES

Accumulation in the Plant

Nitrate can accumulate in drought-stressed barren corn plants. The nitrates taken up by plants are normally reduced and incorporated into amino acids that are used to make proteins. The primary site of nitrate reduction in the corn plant is green leaf tissue. The highest concentrations of nitrates in drought-stressed corn are normally found in the stalks and other conductive tissues. A summary of nitrate levels in drought-stressed corn follows:

Plant part	ppm $N0_3$ N
Leaves	64
Ears	17
Upper 1/3 stalk	153
Middle 1/3 stalk	803
Lower 1/3 stalk	5524
Whole plant	978

Nitrates accumulate in plants only when 1) there is a large amount of nitrate in the soil or 2) some factor interferes with normal plant growth. Higher excessive rates of nitrogen fertilizer and drought conditions are the most important factors contributing to nitrate buildup in corn plants. Highest levels of nitrate accumulation occur where drought occurs during heavy nitrate uptake by the plant. Occurrence of drought during or immediately after pollination could be associated with the highest nitrate accumulations. Extended drought before pollination should not be related to high accumulations of nitrate. Resumption of normal plant growth from heavy rainfall will reduce nitrate accumulation in the plant, but harvesting should be delayed for the first few days after heavy rainfall.

Weeds commonly found in corn which have been reported to accumulate toxic levels of nitrate are: redroot pigweed, common lambsquarters, kochia, wild sunflower, Russian thistle, witchgrass, Canada thistle, and black nightshade. Concentrations of nitrate in these weeds peak at prebud to bud stages of maturity and decrease as they mature.

Ensiling Reduces Nitrate

Cutting drought-stressed corn for silage is a preferred method of utilization because one-third to one-half the nitrate accumulated in the plant material can be dissipated during fermentation. Because fermentation takes 2 to 3 weeks for completion, drought-stressed corn silage should not be fed for at least 3 weeks after the silo has been filled. Percent moisture of the plant material influences the length of fermentation. The optimum is 65 percent moisture, and the minimum for ensiling corn suspected of high nitrate is 55 percent water. Corn ensiled at less than 55 percent moisture results in the reduced fermentation activity, and less breakdown of nitrate. Moisture levels above 70 percent will result in seepage losses and production of a sour smelling silage, which will not be consumed as readily by livestock as normal silage.

Nitrate Toxicity

Since fresh green-chopped corn will vary in nitrate level due to soil fertility, soil moisture, and corn maturity, nitrate testing is recommended. Follow management considerations carefully.

Nitrate-nitrogen levels and corresponding animal responses follow:

Nitrate nitrogen (NO_3N)		Feeding guide
Percent[1]	Parts Per Million (PPM)	
0 to 0.3	3,000	Gradually introduce feed
0.3-0.5	3,000 to 5,000	Limit to ½ of the total ration dry matter
Over 0.5	Over 5,000	Limit to ¼ of the total ration dry matter or lower (depending on level)

[1]*Dry matter basis*

Nitrate analysis may be reported several ways. If the report is not nitrate nitrogen, one can convert to nitrate nitrogen by:

Nitrate (NO_3) x 0.23 = Nitrate nitrogen
Potassium nitrate (KNO_3 x 0.14 = Nitrate nitrogen
Sodium nitrate ($NaNO_3$) x 0.16 **=** Nitrate nitrogen

Symptoms of nitrite toxicity in animals are increased pulse rate, quickened respiration, heavy breathing, muscle tremble, weakness, staggered gait, and blindness. If these symptoms occur, change the feed source.

Sampling The Forage for Moisture and Nitrates

The best way to determine moisture content is to send a representative sample to a commercial forage testing lab. Alternatively, a microwave oven or a rapid 'Grab Test' can be used to estimate percent moisture. With the grab test method, a handful of finely cut plant material is squeezed as tightly as possible for 90 seconds. Release the grip and note the condition of the ball of plant material in the hand.

- If juice runs freely or shows between the fingers, the crop contains 75 to 85 percent moisture.
- If the ball holds its shape and the hand is moist, the material contains 70 to 75 percent moisture.
- If the ball expands slowly and no dampness appears on the hand, the material contains 60 to 70 percent moisture.
- If the ball springs out in the opening hand, the crop contains less than 60 percent moisture.

Testing for nitrate content of drought-stressed corn should be done before green chopping or grazing. If drought-stressed corn is ensiled at the proper moisture content and other steps are followed to provide good quality silage, testing should not be necessary. Nitrates can be tested at most commercial forage testing laboratories in Minnesota. See your County Extension Director for costs and addresses.

Whether determining percent moisture or nitrate, care must be taken in sampling to ensure a representative sample. Grab samples should be taken from chopped forage from various locations in the field, which represent all levels of plant stress. Mix these samples in a bucket and place approximately one pint of material in a sealed plastic bag. Time between sampling and arrival at the laboratory must be as short as possible. Refrigeration of samples is beneficial, especially when the lag extends beyond one day. Green or wet samples allowed sitting at room temperature or higher temperatures might lose nitrate through action of denitrifying bacteria and enzyme action.

Silo Gases

Forage containing nitrate results in production of various forms of nitrogen oxide gas during fermentation. These gases are lethal, poisonous to humans and livestock, and may occur within 12 to 60 hours after silo filling begins. These gases are heavier than air and will accumulate above the silage in a silo, in the chute, in the silo room, and flow out the silo juice drain. The first lethal gas to form is nitric oxide, which is colorless and odorless. Nitric oxide is then converted to nitrogen dioxide, which is yellowish-green in

color and smells like some laundry bleaches. Further oxidation of nitrogen oxide forms nitrogen tetra oxide, which has a reddish-brown color and carries an odor characteristic of some laundry bleaches. These gases will leave a characteristic yellowish-brown stain on wood, silage or any other material it contacts.

One should not enter the silo without first running the blower for 10 to 15 minutes to completely ventilate the silo, chute, and silo room. It is wise to do this during filling, and whenever anyone enters the silo for 2 to 3 weeks after completion of filling. Also, leave the chute door open at the surface of the silage to prevent accumulation in the silo.

Call a doctor immediately if anyone is exposed to nitrogen oxide gases from silage. Medical treatment may prevent death and minimize injury.

Storing the Silage

If upright silos in good condition that are designed for storing high moisture crops are available, they can be used in the normal way. Because the moisture content of the silage may be higher than normal, leaching of silage juices can be expected unless harvest is delayed until well after a killing frost.

Upright silo storage capacity for more than a normal amount of silage is usually not available. The advisability or even the possibility of providing permanent storage for silage put up on an emergency basis is questionable. As temporary storage, the aboveground stack, the below ground unlined trench, and silage bags are readily available alternatives. Good compaction will reduce storage losses. Better compaction can be obtained with a wheel tractor than with a crawler type. Because of the greater exposed surface, the shallow depth, and the difficulty of packing, storage losses of 30-40 percent or more may result. This is actually a storage cost, but seems justifiable in a circumstance where silage storage may be required for only 1 year and there would be little way of paying for upright silos on the basis of future use.

Select a well-drained site for a stack or trench to exclude surface water and provide best access under wet weather conditions. A tight cover of plastic held down with old automobile tires is effective in reducing storage losses.

FEEDING ASPECTS

Feed Value

The results of several feeding trials showed that corn silage made from plants with no ears or partially filled ears had 90-100 percent of the value of normal corn silage on a dry matter basis when comparing feed efficiency, milk production, and growth rate. Moisture content of silage made from barren stalks is high, which reduces the daily dry matter intake and, in turn animal performance.

A specific example-comparing drought affected with regular corn silage shows:

	% Dry matter	Crude protein	TDN
- - - % of DM - - -			
Non pollinated (barren)	22	10.9	65
Normal (grain formed)	35	8.4	68

Drought-stressed ear corn contains a higher proportion of cob to grain. While normal ear corn is 20 percent cob and 80 percent grain, ears from drought-stressed corn may contain 50 percent or more cob, which reduces the energy value and increases the fiber content.

Shelled corn from drought-stressed plants contains 92-100 percent of the feed value of normal corn on a dry matter basis. Test weight is lower; a larger volume of feed is required for comparable production. However, market discounts on low-test weight corn are greater than the reduced feed value, making this corn a relatively good buy for the livestock feeder.

Management Considerations

1. Limit corn silage initially if it is green chopped or pastured to avoid off-feed or nitrate toxicity. Provide other feeds before pasturing or limit pasturing time.

2. Supplement with other forages to avoid excess intake and dilute potentially dangerous silage.

3. Feed a small number of animals and observe carefully before feeding a large number of animals.

4. Feed poorer quality feed to low producing animals.

5. Add non-protein nitrogen (NPN), such as urea, only if good quality corn silage can be produced. If the silage does not ferment (too dry), losses will occur as ammonia gas. If seepage occurs (too wet), the NPN will leach out since it is water-soluble. Drought-stressed corn should not be supplemented with NPN.

6. Since immature corn is high in nitrates and NPN, limit the amount of urea in the total ration.

7. Additional vitamin A can be added (50,000 International Units [IU] for dairy cows, lower levels for heifers and beef cattle) to compensate for less carotene conversion to vitamin A.

8. Cyanide toxicity from drought-stressed corn is rare.

9. Adding grain (carbohydrates) will improve fermentation and silage quality, but cost must be considered.

10. Well-balanced rations minimize stress on the animals.