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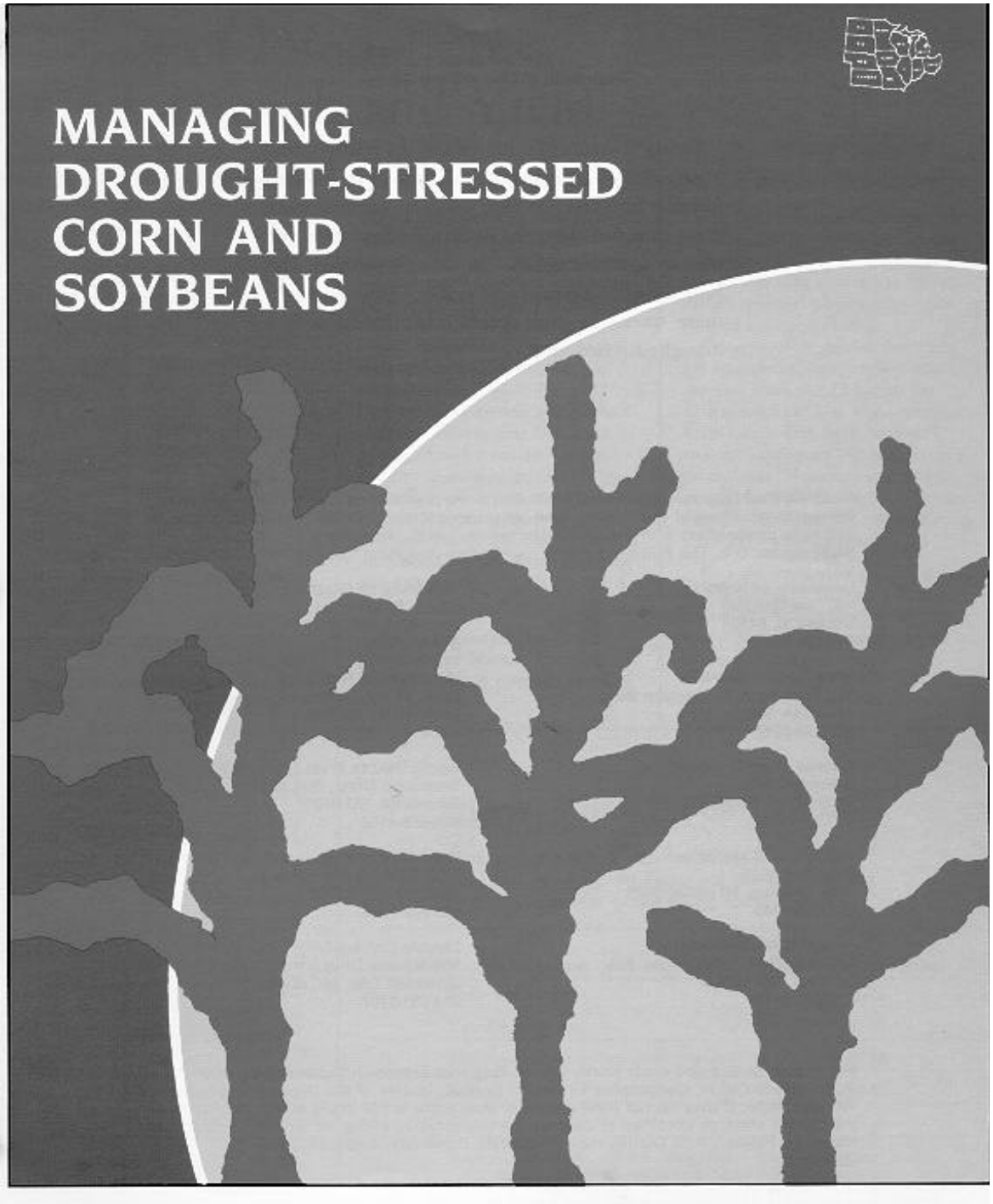

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Drought occurs in some area of the north central region almost every growing season. Farmers need to know how severely their crops are stressed when drought occurs, how the stress will affect yield and what to do with crops that are drought-stressed. This bulletin will help corn and soybean growers answer these questions and decide what to do with a drought-stressed crop.

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Effect of Drought on Crop Growth and Yield

CORN

Inadequate moisture during any period of growth can result in reduced grain yield. Nutrient availability, uptake and transport are impaired without sufficient water. Plants weakened by stress are also more susceptible to disease and insects. Severe moisture stress is indicated by leaf wilting that is alleviated only when the plants receive additional water. The period during which drought will most severely affect yield is silking and pollination (Table 1). Plants under severe moisture stress during silking can lose more than 10 percent of their potential yield per day. Moisture stress during this period can result in a lack of synchronization between pollen shed and silking at pollination because pollen grains may not remain viable and silking may be delayed.

To determine whether corn plants have been pollinated and fertilized, look for small white blisters on the ear 7 to 10 days after pollen shed. To identify the blisters, take ears from several areas in the field and break them in half. Using a knife, dig out several kernels on each ear and compare them with the pictures in Fig. 1. If you find blisters on the ears that look like View 2 in Fig. 1, you can assume that your corn plants were pollinated and kernel fertilization occurred. If you observe the kernels after pollen shed and are unsure whether pollination has occurred, observe the kernels again in five to seven days. If the kernels were pollinated and fertilized, the blisters will rapidly increase in size. If pollination and kernel fertilization did not occur, the kernels will not increase in size . It is also possible to tell if pollination and fertilization occurred by slicing the kernels longitudinally through the embryo side and looking for the young embryo (Fig. 1, View 3). Only fertilized kernels will produce embryos. Kernels that have been pollinated and fertilized will continue to develop to maturity if the plants get water. Fig. 2 displays kernels from normally developing ears that were (from left to right) 7, 10, 12 and 18 days after silking. In each column, kernels are displayed in the same manner as in Fig. 1.

If a plant tasseled and shed pollen but no blisters appeared, it will be barren. A common result of moderate moisture stress during pollination is the production of ears with barren tips. This occurs because the silks attached to the tip kernels were not pollinated or were aborted after pollination.

Drought stress prior to tassel and silk appearance may result in small ear size. From the 12-leaf to the 17-leaf stage (V12 to V17), moisture stress may reduce both ear length and the number of potential kernels on each ear. If ear size is reduced during this period, it cannot be corrected by relieving the moisture stress later in the season.

Drought stress after pollination and fertilization will result in poor kernel fill, causing low test weight and reduced yield. It may also increase stalk rot problems.

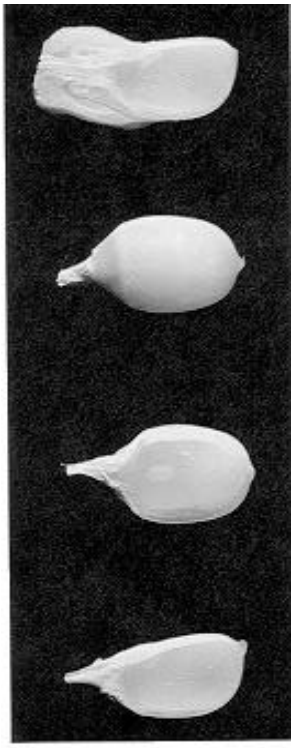
Table 1.

Effects of drought on corn yield.

Four days of visible wilting can reduce potential corn yield by 5 to 10 percent during vegetative growth, and by 40 to 50 percent during silking and pollination.

Stage development	Percent yield reduction from four consecutive days of visible wilting
Early vegetative	5-10
Tassel emergence	10-25
Silk emergence, pollen shedding	40-50
Blister	30-40
Dough	20-30

Source: Classen, M.M., and R.H. Shaw. 1970 Water deficit effects on corn. II. Grain components. Agron. J. 62:652-655.



Kernels at blister stage. From top to bottom: (1) with surrounding materials, (2) intact as viewed from the side opposite the embryo, (3) embryo side sliced longitudinally to reveal the front of the young embryo, and (4) sliced longitudinally through the center. Source: Iowa State University Spec. Rep. No. 48.

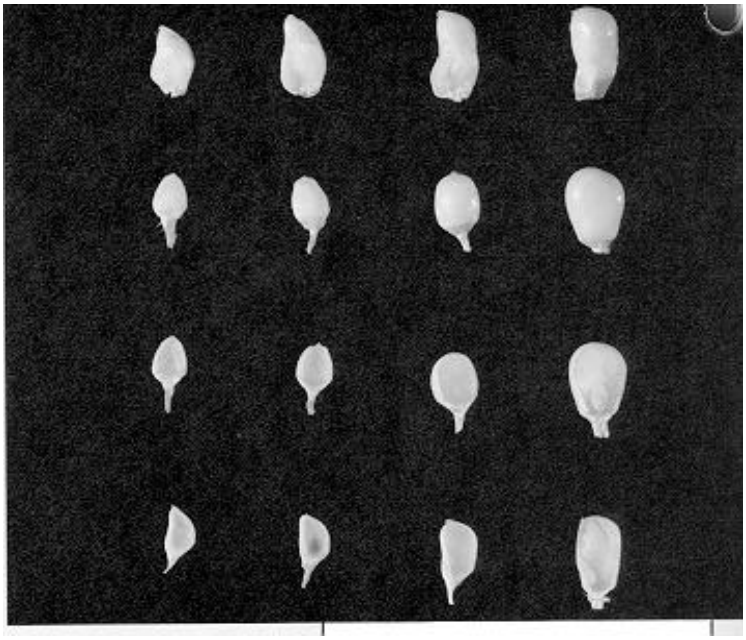


Figure 2. Kernels at (left to right). 7, 10, 12 and 18 Days after silking. Kernels are displayed here as in Fig. 1. Source: Iowa State University Spec. Rep. No.48

SOYBEANS

In general, soybeans are less sensitive than corn to moisture stress during any particular phase of growth, for several reasons.

Soybeans grown in the northern United States are indeterminate and they continue to develop vegetatively during flowering and podding stages. Because flowering and pollination occur over a longer period of time, soybeans are more likely than corn to escape serious damage from relatively short periods of moisture stress.

Soybeans can branch and thus compensate for delayed vegetative growth during a particularly dry period, as long as adequate moisture is subsequently available.

Soybeans are self-pollinated and so do not encounter severe pollination problems due to moisture stress.

Overproduction of flowers and pods also offers a degree of escape from short periods of stress.

Soybeans that are moisture stressed early in the season may still produce good yields if subsequent water is available. With soybeans, the most critical period for adequate moisture is during pod filling.

Salvaging Drought-Stressed Corn and Soybeans

CORN

If you determine that plants have not been pollinated and kernels have not been fertilized (no blisters) and therefore no grain will be produced, two alternatives are either to prepare for winter wheat planting using tillage equipment appropriate to your system or to feed the stalks to livestock.

Prepare to Plant Winter Wheat

Your herbicide program must permit wheat planting. With most corn herbicides, except atrazine or simazine, there should be no problem with planting wheat as long as recommended rates were applied. If the corn crop was adequately fertilized with nitrogen, there will be sufficient nitrogen available to eliminate a fall application to wheat. Nitrogen from corn residue will be converted to nitrate and may be lost by leaching, so spring nitrogen application to wheat should not be reduced.

Feed Stalks to Livestock

Ensiling is preferred to chopping or grazing because of the potential for nitrate toxicity. When drought conditions prevent normal plant growth, the plant stalk may contain abnormally high levels of nitrate, which, if fed in excessive amounts, can cause animals to go off-feed or even die. Under most feeding situations, the nitrate level in feed must be over 2 percent N03 to cause a problem. The following management practices will reduce the chance of nitrate toxicity:

Ensile the corn forage. The potential for nitrate toxicity is usually eliminated during the fermentation process. If nitrate toxicity is a concern, testing for nitrate should be done after the forage has gone through the ensiling process.
Dilute high-nitrate feeds with low-nitrate feeds, such as grain or legume hay.
Raise the cutter bar to leave 10 to 12 inches of the stalk in the field. Nitrate tends to accumulate in the lower portion of the stalks of drought- stressed corn.
Introduce drought- stressed corn forage slowly so the rumen bacteria can adapt to it.

If drought- stressed corn is green chopped, it should be tested for nitrate concentration prior to feeding. This practice is especially important if high rates of nitrogen fertilizer or manure were applied or if the soil has a high organic matter content. A return to non-stressed conditions following substantial rainfall should decrease nitrate accumulation, but chopping should be delayed for 3 to 5 days.

Ensiling high-nitrate forage can result in production of various nitrogen oxide gases. These gases are highly toxic to humans and livestock. The danger of silo gas can exist from ensiling time to four weeks later. During this period, do not enter a silo without first running the blower for 15 to 30 minutes. It is also recommended that a hatch door be opened just above the level of the forage when running the blower and that a self-contained breathing apparatus be worn if you must enter any silo during the first four weeks after filling it. Any person exposed to silo gas should seek immediate medical attention to combat delayed poisoning symptoms.

For silage, moisture concentration should be between 55 and 70 percent. Green barren stalks contain between 75 and 90 percent moisture but will dry down rapidly if weather remains hot and dry. Most states have Extension bulletins available on the subject of corn silage, and farmers can refer to these for more information.

If the plants pollinated but you expect low grain yields because of a continued lack of moisture, either harvest low-yield grain or feed whole-plant corn silage to livestock.

Harvest Low-Yield Grain

The decision to harvest low-yield grain should be based partly on whether the value of the harvested grain covers the harvest cost. If only a localized area is stricken by drought-even an area as large as a single state-you cannot expect a higher price for corn to offset low yields. If the drought is widespread-that is, if it affects the major corn producing areas in the United States-then harvesting a low-yield crop may be profitable because the price will likely increase.

Because the ears on moisture stressed plants will probably be small, some combine adjustments will be necessary. Consider the following:
Review the operator's manual for suggestions on harvesting a light crop.
With short or lodged corn, run the gathering snouts and chains low. Watch for stones, and be sure stone -protective devices are working.
Drive carefully and at normal

speeds to avoid excessive harvest loss and machine damage from stones.

For small ears, set stalk rolls and snapping plates closer than normal to snap off a higher percentage of ears. Don't attempt to snap off barren cobs.

If clean shelling is a problem, increase cylinder speed slightly and, if necessary, decrease cylinder concave clearance. With a rotary machine, check rotary -concave clearance. Avoid excessive damage to kernels from good ears.

If cleaning losses are high, open the chaffer and chaffer extension slightly.

Initially decrease the amount of air from the cleaning fan. If cleaning becomes a problem, increase the fan blast and close the lower sieve slightly.

Be alert to changes in weather and crop conditions and make adjustments as necessary.

Feed Corn Silage To Livestock

Before making and feeding silage, be sure that all pesticides applied to the crop are cleared for silage use. The interval between final application and allowable harvest may differ for silage and grain. Be sure to check the label of any chemical that was applied.

Before drought-stressed corn is chopped for silage, test moisture percentage. Even though lower leaves may be brown, plants can contain 75 to 90 percent water, which is too wet for acceptable silage fermentation. If drought stressed corn has pollinated, it is best to delay harvest as long as some green leaf and stalk tissue remains and the black layer has not formed on kernels. Rainfall and subsequent relief of moisture stress can increase grain dry matter and silage quality.

The feed value of silage made from drought-stressed corn is between 90 and 100 percent of that of silage made from well-eared corn, based on equal dry weights of the two feeds. Crude fiber and crude protein will be somewhat higher and TDN lower than with normal silage because ears from drought stressed corn may contain 50 percent or more cob compared to 20 percent

Table 2.

Drought-stressed corn silage value (A)

Maximum and minimum prices for drought-stressed corn silage based on prices for alfalfa hay and corn grain.

Use this table to look up the maximum and minimum values of drought-stressed corn silage. Find the column and row that represent today's prices for corn grain and alfalfa hay, respectively. Find the value of silage at the intersection of these prices. The variable cost of harvesting would be subtracted from these values, if harvested by the buyer, to determine the net price paid to the seller.

Price of alfalfa hay ($/ton)	**Price of corn grain ($/bu)**													
	2.20		**2.40**		**2.60**		**2.80**		**3.00**		**3.20**		**3.40**	
	Value of Corn Silage ($/ton)													
	max	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**
40.00	13.30	11.00	13.30	12.00	13.30	13.00	14.00	13.30	15.00	13.30	16.00	13.30	17.00	13.30
50.00	16.65	11.00	16.65	12.00	16.65	13.00	16.65	14.00	16.65	15.00	16.65	16.00	17.00	16.65
60.00	20.00	11.00	20.00	12.00	20.00	13.00	20.00	14.00	20.00	15.00	20.00	16.00	20.00	17.00
70.00	23.30	11.00	23.30	12.00	23.30	13.00	23.30	14.00	23.30	15.00	23.30	16.00	23.30	17.00
80.00	26.65	11.00	26.65	12.00	26.65	13.00	26.65	14.00	26.65	15.00	26.65	16.00	26.65	17.00
90.00	30.00	11.00	30.00	12.00	30.00	13.00	30.00	14.00	30.00	15.00	30-00	16.00	30.00	17.00
100.00	33.30	11.00	33.30	12.00	33.30	13.00	33.30	14.00	33.30	15.00	33.30	16.00	33.30	17.00
110.00	36.60	11.00	36.60	12.00	36.60	13.00	36.60	14.00	36.60	15.00	36.60	16.00	36.60	17.00
120.00	40.00	11.00	40.00	12.00	40.00	13.00	40.00	14.00	40.00	15.00	40.00	16.00	40.00	17.00

cob on normal ears. Drought stressed silage should be tested for percent moisture and feed value. Shelled corn from drought -stressed plants contains between 90 and 100 percent of the feed value of normal shelled corn. Test weight will be lower. Market discounts on low test weight corn are often greater than the reduced feeding value, so this shelled corn is a good buy for a livestock producer.

Selling Drought-Stressed Silage

Yields. For moisture-stressed corn, you can expect to harvest one ton of silage per acre for each five bushels of corn grain per acre that could be harvested. For example, if you expect a grain yield of 50 bushels/ acre, you can expect 10 tons/acre of 30 percent dry matter silage. If very little or no grain is expected, a rough preharvest estimate of yield can be made by assuming that 1 ton of 30 percent dry matter silage can be obtained for each 1 foot of height of plant material, excluding the tassel.

Value. The dollar value of corn silage depends on the value of harvestable grain, the cost of purchasing other feed substitutes and the cost of harvesting. Well-eared, high-yielding corn will have six to seven bushels of No. 2 dry shelled corn per ton of 30 percent dry matter corn silage. Drought-stressed corn may have about five bushels of corn grain per ton of silage. At the minimum,
each ton of silage is worth about five times the current price per bushel of shelled corn plus 50 cents to cover the added cost of harvesting and storing corn silage rather than grain. If the buyer harvests and stores the silage, $2 to $2.50 per ton should be subtracted because the seller will pay nothing to harvest the crop. Another way to value the silage is based on feed value. On this basis, one ton of 30 percent dry matter corn silage will substitute for about one-third of a ton of alfalfa hay.

Price. Table 2 presents the minimum and maximum prices calculated for drought-stressed corn silage over a range of corn grain and alfalfa hay prices. If selling silage from a drought-stressed corn crop, you should receive at least the minimum price listed in the table or you might as well harvest and market it as grain. The maximum bid price listed in Table 2 is the price of one-third of a ton of alfalfa hay. This maximum is a rough approximation based on energy with no adjustment for protein differences. Table 3 lists prices for drought-stressed corn silage based on both energy (total digestible nutrients, TDN) and crude protein (CP) content for a range of corn grain and soybean meal prices. These prices were calculated assuming 30 percent dry matter corn silage with 65 percent TDN and 10 percent CP. The actual exchange price for drought-stressed corn silage will vary by area, depending on the relative supply and demand.

SOYBEANS

Forage

If feed is needed, soybean forage can be used for either hay or silage. Soybeans should be harvested for forage at mid- to late podfill but before many of the leaves turn yellow. Wilting is usually necessary to reduce the moisture content to 70 percent for ensiling. Estimated net energy can be increased by adding ground corn grain during ensiling at a suggested rate of 200 lb/ton. Soybean forage can also be mixed with corn forage in a ratio of I part soybean forage to 3 parts corn forage. The mixture has a higher protein content and lower net energy than corn silage.

Grain

Drought-stressed soybeans may be mature and at a harvestable moisture content two to three weeks earlier than normal. Plants will be shorter and a greater portion of the yield will be on the lower section of the stem than on normally developed soybeans. Cutting as close to the ground as possible will be important to minimize harvest losses. Automatic header height control or a flexible floating cutter bar will be especially helpful in harvesting. The reel should be placed as close to the cutter bar as feasible. The teeth on the pickup reel may be spaced too far apart to gather short plants. To alleviate this problem, either install additional teeth on the reel or place belting material between teeth on the pickup bar.

CROP INSURANCE

If you are covered either by the Federal Crop Insurance Program or by a private insurance company, check with your insurance agent before harvesting the crop for either grain or silage. Inspections should be made to determine the difference between actual anticipated yield and the amount covered by the policy. Insurance settlements are based on this difference.

Table 3.

Drought-stressed corn silage value (B)

Value of drought-stressed corn silage at various prices for corn grain and soybean meal.

The value of one ton of corn silage is the cost of an equivalent amount of energy (TDN) and protein if purchased in the form of corn grain and soybean meal, respectively. Find the column and row that represent today's prices for corn grain and soybean meal-the value of silage will be at the intersection of these prices. Values are based on corn silage with 65 percent TDN and 10 percent crude protein.

Price of soybean meal	**Price of corn grain ($/bu)**						
	2.20	**2.40**	**2.60**	**2.80**	**3.00**	**3.20**	**3.40**
($/cwt)	**Value of Corn Silage ($/ton)**						
6.00	20.11	21.68	23.24	24.81	26.38	27.95	29.52
6.50	20-34	21.91	23.48	25.05	26.62	28.19	29.76
7.00	20.58	22.15	23.72	25.29	26.86	28.43	29.99
7.50	20.82	22.39	23.96	25.53	27.09	28.66	30.23
8.00	21.06	22.62	24.19	25.76	27.33	28.90	30.47
8.50	21.29	22.86	24.43	26.00	27.57	29.14	30.71
9.00	21.53	23.10	24.67	26.24	27.81	29.38	30.94
9.50	21.77	23.34	24.91	26.47	28.04	29.61	31.18
10.00	22.01	23.57	25.14	26.71	28.28	29.85	31.42
10.50	22.24	23.81	25.38	26.95	28.52	30.09	31.66
11.00	22.48	24.05	25.62	27.19	28.76	30.32	31.89
11.50	22.72	24.29	25.86	27.42	28.99	30.56	32.13
12.00	22.96	24.52	26.09	27.66	29.23	30.80	32.37
12.50	23.19	24.76	26.33	27.90	29.47	31.04	32.61
13.00	23.43	25.00	26.57	28.14	29.71	31.27	32.84

AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE (ASCS)

If you are expecting severe yield reductions due to drought, report this to your county ASCS office before the crop is harvested. If the drought is widespread, there may be the possibility of emergency or low interest loans.

REDUCING THE RISK OF DROUGHT STRESS

The only sure method to avoid drought-stressed crops is to use irrigation. Some other management practices, however, can help reduce the risk of drought stress in many years. These include:

G Early planting. By planting early, you increase the chance especially with corn-of having pollination completed before the driest part of the season.

G Adequate fertilization. Proper fertilization will promote healthy plant growth. Efficient moisture utilization is essential for high yields in both normal and dry years.

G Plant corn hybrids of varying maturities. Planting a range of hybrid maturities may reduce the risk of moisture stress at pollination.

G Weed control. Weeds compete with crop plants for water, so controlling weeds will provide more water for the crop.

G Residue management. By maintaining a cover of residue through conservation tillage or no-till, you can reduce the amount of evaporation from the soil surface and conserve water for the crop's use.

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