Extension Folder 263
Revised 1977

Irrigated Corn Production

James B. Swan
Dale R. Hicks

AGRICULTURAL EXTENSION SERVICE
UNIVERSITY OF MINNESOTA

Irrigated Corn Production

In parts of Minnesota, drought seriously depresses corn yields; for example, drought frequently occurs on sandy or shallow soils with low water holding capacity. Irrigation assures adequate water for crop production, but as in nonirrigated corn production, other production practices must be at an optimum level for maximum corn profits.

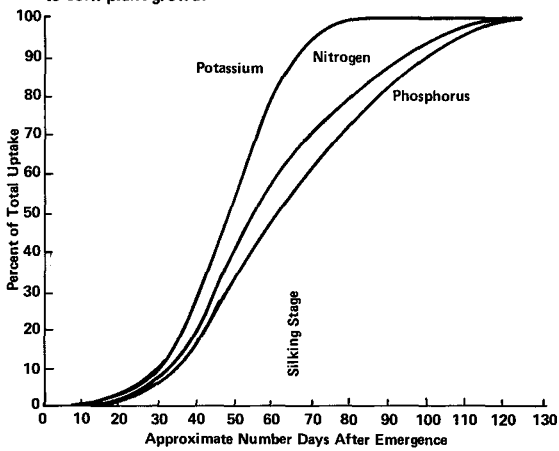
It is essential to use excellent production practices to obtain sufficient returns to pay the substantially increased costs of irrigation. These practices include soil fertility; hybrid selection; seedbed preparation; row width; planting date; plant population; insect, disease, and weed control; harvesting; artificial drying; storage and market. Information on some of these practices is given in various publications listed at the end of this folder.

Except for nitrogen fertilizer application, information on other production practices applies equally to irrigated and to nonirrigated corn production. This pamphlet's emphasis is fertilizer application differences, the effect of moisture stress at various growth stages on the development and yield of corn grain, and the effect of the irrigation termination date on ear moisture and grain yield.

Fertilization

Amounts and methods of fertilization should be made according to soil test results to guarantee adequate available nutrients necessary for corn growth throughout the entire growing season. Rate of nutrient uptake becomes rapid about 30 days after emergence (figure 1). Soon after silking (about 75 days after emergence), potassium uptake is completed. However, the uptake of nitrogen and phosphorus continues essentially to maturity. A single annual application of nitrogen on shallow sandy soils is not desirable, since nitrates are readily lost due to leaching from both rain and irrigation waters. Since nitrogen uptake continues to near maturity of the corn plant, deficiencies due to excessive leaching can limit corn yields on irrigated fields. Fertilizer nitrogen leaching can be greatly reduced by split nitrogen applications throughout the growing season. This is readily done by applying nitrogen through the irrigation system.

Figure 1. Uptake of nitrogen, phosphorus and potassium in relation to corn plant growth

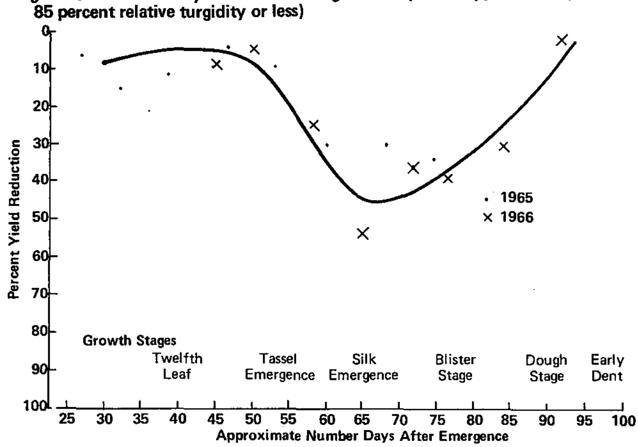


Moisture Stress

During the first 4 to 6 weeks of growth after emergence, loss of soil water is small and primarily through evaporation from the soil surface. When the corn plants attain 3½ feet in height, they approach effective full cover and evapotranspiration occurs near the maximum rate for that time of year. Evapotranspiration is the combined loss of water by evaporation from the soil surface and transpiration from the crop. Irrigation would normally be underway by this time.

Maximum ear development requires an adequate water supply at all times during the period of growth from just before tasseling until maturity. Therefore, corn yield may be seriously reduced by drought, especially if deficiency of water, called moisture stress, occurs during the reproductive stage. Two days of moisture stress during silking and tasseling can decrease corn yields more than 20 percent and 4 to 8 days can decrease yields more than 50 percent. When short periods of moisture stress are imposed on growing corn plants, those occurring during the interval from tasseling through the dough stage cause the greatest yield reductions (figure 2). Moisture stress at earlier or later growth stages has less effect on yield. The effect of short moisture stress periods for each of the stated growth periods is as follows:

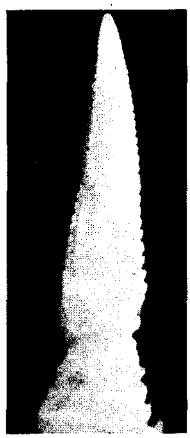
Figure 2. Effect of 4 days of visible wilting on corn yield *(approximately 85 percent relative turgidity or less)

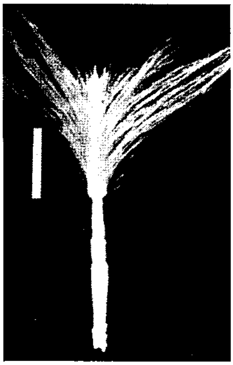


* From Claassen, M. M. and R. H. Shaw. 1970. Water Deficit Effects on Corn. II Grain Components. Agron. J. 62:652-655.

Early Vegetative Growth

This is the period of rapid leaf formation and root development. Moisture deficiency can severely restrict vegetative growth. If rainfall is insufficient, irrigation may be necessary to insure germination. Ground cover is quickly achieved; effective full cover is usually provided about six weeks after emergence and irrigation is normally underway. The top ear is about one inch long. Moisture or nutrient deficiency may reduce the potential ear size and number and the quantity of kernels since the number of ovules which develop silks is being determined. Four days of moisture stress at this stage decreases grain yield about 10 percent.

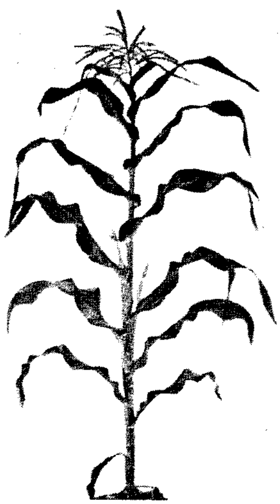




Tassel emergence

The tip of the tassel has emerged from the whorl and the top one or two ears are undergoing rapid enlargement and elongation.

Silks from the base of the ears are elongating rapidly. Measurements show 4 days of moisture stress at this stage reduce yields from 10 to 25 percent.



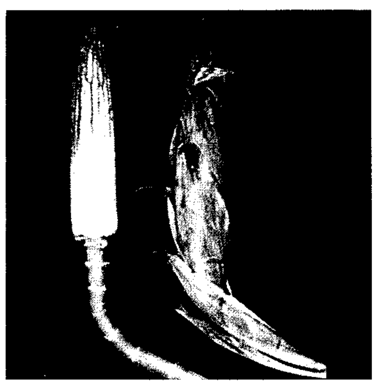
Silk emergence, pollen shedding

Leaves and tassel have fully emerged. The cob and silks are growing rapidly, but have not emerged from the husk. The ovules are enlarging. Potassium uptake is essentially complete and nitrogen and phosphorus uptake are rapid.

Kernel number is determined by those ovules fertilized. Moisture stress or nutrient deficiency may result in poor pollination and few kernels. Yields are reduced up to 50 percent by 4 days of moisture stress at this growth stage.

Blister stage

Cob and husks are fully developed and the kernels are rapidly increasing in weight. Unfavorable conditions such as moisture stress will cause unfilled kernels, usually at the tip of the ear. During this period yields were reduced from 30 to 40 percent by 4 days of drought.



Dough stage

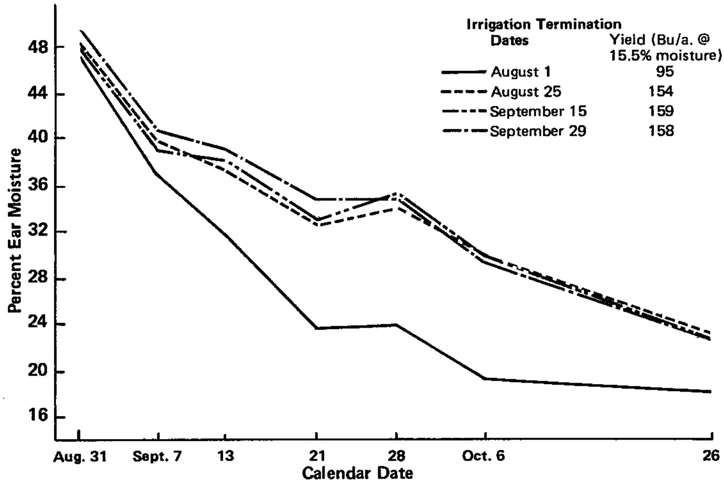
Kernels are growing rapidly and increasing in weight. Moisture stress will cause unfilled and "chaffy" ears. At this stage moisture stress of 4 days reduced yield about 30 percent.

Terminating Irrigation

For maximum yield, corn plants should have adequate water until the kernels have reached maximum dry weight (physiological maturity). Maximum dry weight of corn kernels is reached when "black layer" forms in the tip (cob end) of the kernel. The black layer is easily seen by removing the tip (pedicel) from the kernel. Black layer forms in the kernels on the tip end of the ear first and progresses to the butt. The black layer will have formed in butt kernels 3-5 days after forming in tip kernels: this formation in the kernels on the tip of the ear can be used as a guide to terminate irrigation. If the last irrigation occurs at or near the time the tip kernels form the black layer, moisture stress should not occur before the butt kernels have reached physiological maturity.

The rate of kernel moisture loss (dry-down) after physiological maturity is a simple drying process affected by weather conditions (primarily air temperature). Irrigation studies at Elk River, Minnesota, show that neither ear moisture content nor rate of moisture loss was affected by addition of water after plants had reached physiological maturity (figure 3). However, premature killing by terminating irrigation before plants had reached physiological maturity resulted in faster drying and lower moisture content than for plants receiving irrigation water until maturity. In addition, yields were substantially reduced by moisture stress.

Figure 3. Effect of irrigation termination date on corn ear moisture and dry-down rate, Elk River, Minnesota, 1971



Summary

1. Producing maximum corn grain yield under irrigation is not greatly different from corn production without irrigation except that increased costs necessitate using good production practices. Several bulletins are available with information on corn production subjects.

2. Nitrogen is more subject to leaching on shallow sandy soils where corn is grown under irrigation. Leaching and loss of nitrogen can be reduced by reasonable distribution and timing nitrogen applications throughout the growing season rather than one heavy application.

3. For maximum yield, corn plants should have adequate moisture and nutrients until kernels have reached physiological maturity. Yield reductions caused by moisture stress of corn plants at various growth stages are presented. The maximum decrease occurs when plants are stressed during the pollination period.

4. Since kernels have reached physiological maturity when black layer forms, this can be used as a guide to terminate irrigation.

5. Irrigating after physiological maturity had no effect on ear moisture content or dry-down rate.

James B. Swan is professor and extension soils specialist and Dale R. Hicks is professor and extension agronomist, both at the University of Minnesota.

Credits: John J. Hanway, Iowa State University, Special Report 48, *How a Corn Plant Develops,* for photos, figure 1; and a portion of the discussion.

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Norman A. Brown, Director of Agricultural Extension Service, University of Minnesota, St. Paul, Minnesota 55108. The University of Minnesota, including the Agricultural Extension Service, is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, creed, color, sex, national origin, or handicap. 15 cents