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EXTENSION

Irrigating Tobacco

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Irrigation is an important component for the production of quality tobacco in Georgia. Rainfall is unpredictable and generally unreliable during the critical growth period. Irrigation is typically used to supplement water needs during periods of rainfall deficit. Too often, water is applied in a haphazard manner with little regard to the water needs of the crop. Research has indicated that both under-watering and overwatering can significantly reduce both tobacco yield and quality; therefore, it is important to apply water at the proper times and in the appropriate amounts.

Tobacco is generally considered a drought-tolerant plant and produces better yields with less than desirable moisture than with excessive soil moisture. Under conditions of inadequate soil moisture, tobacco can benefit from timely application of water in amounts to bring the soil moisture level up to or close to field capacity. The root system is susceptible to water saturated soil conditions, and over-application of irrigation should be avoided. Over-irrigation wastes water and can negatively affect yield and quality of the cured leaf by causing damage to the root system. Excessive water can also leach needed nutrients below the root zone and out of reach of the roots.

Benefits and Risks of Irrigation

The benefits of irrigating tobacco are well documented and include improvements in both the physical and chemical nature of the cured leaf, such as a lighter colored, thinner leaf that is lower in oils, total alkaloids and total nitrogen than tobacco grown with insufficient moisture. Irrigation also increases the sugar content of tobacco leaf and decreases the nicotine content when applied in needed amounts.

Yields are generally expected to increase when irrigation is applied during periods of dry weather. In a series of tests in North Carolina, irrigation resulted in 15 percent more yield and 10 percent higher price than for non-irrigated tobacco. Increased yield also results from the development of a more extensive root system, which produces larger leaves and taller stalks, leaves spaced slightly farther apart on the stalk, and more harvestable leaves per plant.

Irrigation has also been shown to result in less sucker growth per plant and plants that flower earlier than non-irrigated tobacco. Earlier flowering shortens the period for disease and insect infestations and allows for earlier harvesting in areas such as Canada where it is important to avoid frost injury.

Light irrigation at transplanting time will improve survival and early growth by enabling plants to initiate root growth earlier and by reducing potential fertilizer injury when weather conditions are extremely dry following transplanting.

Irrigation during later stages of growth reduces the amount of scalding of upper leaves and “firing” of the lower leaves, which often occurs during dry, hot weather. Faster growth and earlier maturity resulting from timely irrigation may reduce the risk of hail damage and build-up of root diseases, such as black shank, nematodes and insects. Yield and quality losses due to tobacco mosaic virus may also be reduced by timely irrigations.

Curability of the tobacco leaf may be improved by increasing the moisture content of the green leaves when harvesting takes place during extremely hot, dry weather.

However, irrigation also carries a number of risks, including the possibility of getting an extended rainy period immediately after irrigating. Excessive water can cause tobacco to ripen faster as a result of nutrient leaching and/or root injury. Contamination of fields

with disease organisms in irrigation water that may have received runoff from an infested field should be considered a risk of some impounded water sources. Extensive irrigation late in the harvest stage may mobilize remaining soil nitrogen, allowing it to be taken up by the plant and causing a re-greening of leaves that results in lower leaf quality.

Tobacco Growth Stages and Water Needs

The growth of the tobacco plant, as produced for flue-cured tobacco, may be divided into several stages or phases, including transplant production, transplanting until knee-high, rapid growth and harvest. Although tobacco may benefit from irrigation at all stages of growth if soil conditions are dry and rainfall is inadequate to support the growth of the plant, irrigation can significantly affect leaf quality at two stages of growth and development: the rapid growth phase and harvest.

Tobacco may be irrigated any time during the day or night; however, water applied at night is used more efficiently than water applied during the hot part of the day. Irrigation in the early morning may help prevent the spread of diseases such as rhizoctonia, blue mold and brown spot.

Plant beds require a uniform supply of soil moisture. Tobacco seed germination is dependent on temperature, light and soil moisture. When plant beds are covered with porous covers, the soil moisture evaporates rapidly and plant beds require multiple light irrigations to ensure germination and establishment. When nonporous covers are used at the time of seeding, a single irrigation of 0.25 to 0.35 in. after seeding is usually sufficient to meet the needs of the seedlings until temperatures increase to the point that the covers are removed. In moderate climates, irrigation with 0.5 in. of water will normally meet the needs of dry plant beds. Withholding irrigation prior to pulling transplants is a technique used in droughty production areas to harden plants before going to the field and to promote root regeneration.

At transplanting, a small amount of water (approximately 100 to 200 gallons/acre) is applied as each plant is placed in the soil. This water creates a hospitable environment for new root development and provides good soil contact with existing plant roots.

After transplanting and before severe wilting occurs, an application of approximately 0.5 in. of irrigation is recommended to wet the soil slightly deeper than the roots. Irrigation after transplanting is better than irrigation before transplanting because drier soils compact less with the movement of tractors and equipment across the field. Application of additional water after transplanting also helps settle the soil around the roots of the plants and provides adequate moisture to encourage faster root development. Uniform wetting of the soil following transplanting helps to minimize fertilizer salts injury, which is usually worse in soils that start with adequate moisture but dry after transplanting.

During the early growth stage, from the time of transplant establishment until the tobacco plants are knee-high, approximately four to six weeks after transplanting, water is withheld to create moderate moisture stress. This moderate stress is considered beneficial to the tobacco plants as deeper root development is encouraged in preparation for the rapid growth phase and may result in increases in yield and quality of the cured leaf. During the early growth phase, irrigation is recommended only during extended drought.

The rapid growth stage occurs from the time the tobacco plants are knee-high to early bloom, approximately between weeks four and six after transplanting. During this time moisture is extremely important to the tobacco plant and is needed to ensure good leaf spread and improve yield and quality. Although an adequate supply of soil moisture is required during the rapid growth phase, water use curves indicate that tobacco should only be irrigated often enough to keep the moisture level sufficiently high to ensure rapid growth, not to exceed 2 in. per week. Excessive irrigation during this critical period may cause damage to the root system.

During harvest, irrigation is not generally required. Water loss from the plant is reduced as it approaches maturity compared to the rapid growth phase. The need for water for cell expansion decreases as leaves reach their full size and as the ripening process changes the color from green to yellow in flue-cured tobacco. Leaf cuticle and waxes increase with maturity, further reducing the rate of transpiration. The transpiring surface of flue-cured tobacco is continually being reduced by individual harvests. Slight moisture stress may be beneficial by helping to reduce the

severity of brown spot and slow down the harvest rate.

In extreme drought conditions irrigation during the harvest stage will increase the maturity rate of tobacco, improve curability of the leaf by allowing better yellowing, and reduce burning of leaf margins, which lowers leaf quality and indicates an imbalance of chemical components.

Tobacco may ripen faster after heavy rains or heavy irrigation because part of the nitrogen is leached from the root zone, water damage occurs to the root system, or physiological reactions within the leaf were made favorable by higher moisture content.

Drowning is perhaps more likely to damage tobacco than most other crops. Drowning results from damage to roots by water saturation of soils in the root zone.

The potential for drowning can be reduced by planting flue-cured tobacco on well-drained soils and on high, wide row ridges to enhance drainage and raise the root system up above the saturated soils. Younger tobacco (12th leaf stage) is more susceptible to drowning than tobacco at a later growth stage (17th leaf stage). Wilting after conditions of excess soil moisture is a direct result of lack of water being transported to the shoot. Under anaerobic conditions roots are injured primarily by lack of oxygen. Water uptake by dead roots is only 40 percent of healthy roots.

Determining When to Irrigate

Immediately after transplanting, tobacco should be irrigated with about 0.5 in. of water. This helps to settle the soil around the roots and provides moisture to stimulate fast root development. After the stand is established and until tobacco is 2 ft high, irrigate only after an extended dry period. It is generally accepted that slightly dry soil during this period helps to stimulate deeper root development, which benefits the plant during the later rapid growth stage. Moisture levels should be maintained near field capacity during the rapid growth stage (2 ft high to early bloom). Leaf expansion and internode elongation are often severely restricted if adequate water is not available during this period. During the harvest period, irrigate tobacco only during extreme drought. The plant requires less water as it approaches maturity; however, adequate water is required for proper maturing and curability.

The need for irrigation can often be determined by simply observing the appearance of the crop and soil. If tobacco shows signs of wilting before 1:00 a.m. or if the soil appears ashy in color and void of all moisture, irrigation may be beneficial to the crop. Tobacco produced in areas typically dry during the production season can be irrigated based on a balance sheet approach, which tracks plant water use and moisture application.

Water-Holding Capacity

The water-holding capacity of soil is extremely important for determining the need for irrigation. Pore spaces between soil particles are either large or small.

The free moisture in the small pore spaces is held by capillary forces. Water is removed from large pore spaces by gravity. Coarse textured soils (sand) have larger pores. Fine textured soils (clay or silt) have smaller pores. Soils are saturated when the pores are completely filled. Soils are at field capacity when water ceases to drain from them by gravity. Drainage from saturation to field capacity for most soils used for tobacco usually requires two to three days. Sandy soils require less time for drainage than clay soils.

Tobacco plants can utilize both the water that drains from the soil by gravity and that which is held against gravity by the soil particles. Some moisture is held so tightly by the soil particles that it is unavailable to plants.

Tobacco roots pull moisture mainly from the top 8 to 12 in. of soil. A majority of the flue-cured tobacco is grown on loamy sand or sandy loam soils with an available water-holding capacity between 0.7 and 1.5 in. of water in the root zone.

Water Loss and Use

Water loss from the soil occurs through the process of evaporation. Water loss from the plant results from transpiration, or moisture loss as vapor through plant leaves. The combined effect of these two processes is alled evapotranspiration. In Georgia, evapotranspiration varies from 0.1 to 0.25 in. per day. Tobacco usually requires an average of 1 in. per week of water for good growth.

Determining How Much Water to Apply

For maximum yields, adequate soil moisture should be maintained in the top 2 ft of soil. Most tobacco-producing soils hold about 1 in. of available water per foot of depth (specific information on soil water holding capacity can be obtained from SCS Soil Surveys.)

In a 2-ft root zone this soil would hold about 2 in. of available water at field capacity. Highest yields are maintained when available moisture remains above 50 percent of field capacity. Therefore, the allowable depletion before irrigation would be only 1 in. The required irrigation amount to replenish the field would be 1 in. plus losses due to evaporation and non-uniform distribution. The standard practice is to add 25% for losses; therefore, the required irrigation amount is 1.25 in. This amount will be less for sandier soils and more for loamier soils. The peak water use for tobacco is about 0.25 in. per day and occurs at about eight weeks after transplanting (see Figure 1). During this period the soil in the previous example would require irrigation every four days. Water consumption earlier and later in the season will be considerably less and therefore irrigation will be less frequent.

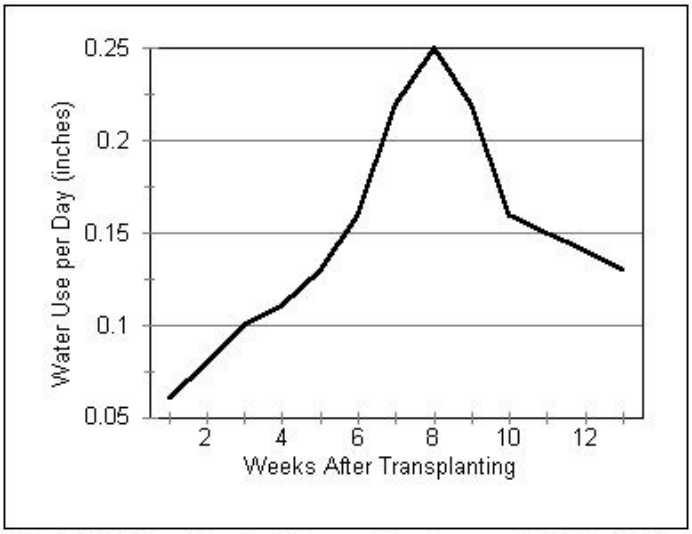

Fig. 1. Moisture Use by Tobacco (Harrison and Whitty, 1971)

Soil moisture sensing devices such as tensiometers and resistance blocks are often used to schedule irrigations. Generally, two of these devices are installed at different depths—one near the middle of the root zone at 8 to 10 in. deep and one near the bottom at 16 to 20 in. deep. The shallow devices are used to determine when to irrigate and the deeper ones are used to ensure that adequate water is maintained near the bottom of the root zone (see Figure 2). A minimum of two to three sensing locations should be maintained in each field. When using tensiometers, readings should be maintained between 5 and 30 centibars during the rapid growth stage. Readings below 5 indicate that the soil is too wet and readings above 30 mean the soil is too dry. Higher readings are acceptable during earlier and later growth stages. Tensiometers are an accurate means of measuring soil moisture, but they do have one drawback. If the soil is allowed to dry out to the point where the tensiometer readings go above 70 or 80 centibars, the tensiometers will "break tension" and must be serviced. They require frequent monitoring to prevent this from occurring.

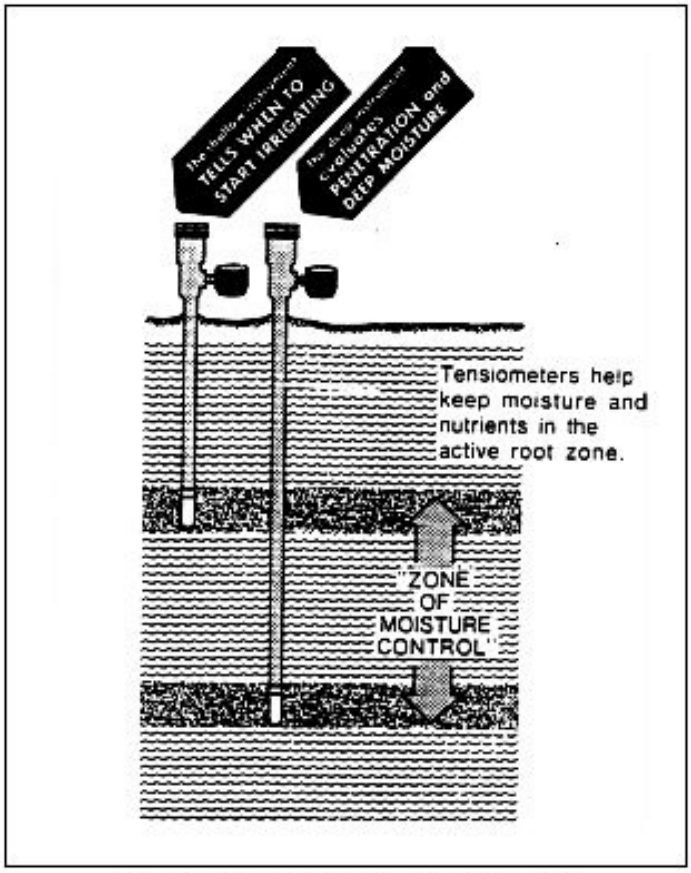

Fig. 2. Proper Use of Tensiometers

Some farmers prefer using electric resistance blocks such as gypsum blocks or Watermark sensors. These are generally not quite as accurate as tensiometers but they do not require regular servicing and are more useful for measuring soil moisture in coarse soils. As a general rule you should read and record soil moisture readings at least three times per week and irrigate accordingly.

Excessive water will leach some fertilizer nutrients below the root zone and may result in lower yield and quality of the crop. Repeated light irrigation of dry soils will encourage growth of roots near the soil

surface. A shallow root system makes the crop more susceptible to injury from dry and hot weather than expected with a normal root system. During the rapid growth stage it is recommended to withhold irrigation until about 40 percent of the available soil water is left and then irrigate to field capacity. Sandy soils need more frequent and lighter irrigation and heavier soils need less frequent and heavier irrigation.

Infiltration Rate of Soils

The infiltration rate of most soils used for the production of tobacco in the southeastern United States varies from 3 in. per hour for coarse textured soils to as little as 0.5 in. or less per hour for the sandy clay loams. Infiltration rate is influenced by soil compactness, soil structure, organic content, presence of plant material on the surface and quantity of water already in the soil.

When water is applied faster than it can soak into the soil, it runs out the end of the row. This is wasteful of water and energy and reduces the accuracy of the estimate of water entering the soil. Infiltration is reduced as tobacco becomes larger, causing water to be shed toward the middle of the rows. The danger of runoff is greater as the tobacco plant grows.

Water Quality

Various water sources may be used to irrigate tobacco, including surface water supplies such as impounded ponds and streams, ground water supplies such as wells, wells plus holding ponds and municipal water systems.

Disease

In most cases the water available for irrigation would be completely suitable for use on tobacco. However, a number of diseases may be spread by contaminated irrigation water. Disease organisms such as black shank and Granville wilt may be spread to uninfested fields by contaminated water, especially from streams and ponds receiving drainage from infested fields. Additionally, diseases such as black shank that normally infect plants through roots, where resistance resides, may directly infect plants through the leaves and stems following irrigation. Brown spot sometimes appears worse following irrigation; however, irrigation alone could provide a suitable environment for infection by brown spot.

Salts in Irrigation Water

Chlorine is the element of primary concern when irrigating tobacco. Particular attention should be given to the Cl content of irrigation water if the water source at any stage of growth should happen to be a municipal water source that has been treated with Cl. No more than 30 kg Clha-1 should be applied to tobacco from all sources. Most surface water sources in Georgia contain 4–10 mg Cl L-1; thus, 2.5 cm of irrigation water would deliver 126 g of Cl for each mg L-1 determined to be in the irrigation water.

Manure lagoon liquid is not considered suitable for irrigation of tobacco due to excessive chlorine and nitrogen content.

Other Production Practices Related to Irrigation

Choose practices that will give the best results under good growing conditions. Variety selection, plant population and topping height should be selected to produce high quality leaf that is desirable to buyers. Manage irrigation properly and do not irrigate excessively. There is no justification for changing production practices if enough water is used to keep the crop in good condition.

Additional N and K may be needed with excessive irrigation or precipitation following irrigation. In studies in Virginia, irrigation depressed yields at lower and higher rates of N. Medium rates of irrigation and N interacted to increase yields. Excessive irrigation or rainfall may cause leaching of soil N below the root zone. Ripening may begin before maturation has been completed.

Some growers apply extra N at the last cultivation as insurance against leaching in wet weather that may occur during the rapid growth phase. When expected precipitation does not occur, more irrigation is required to leach extra N and maintain leaf quality. This is not an environmentally or economically sound practice.

Irrigation Equipment

A variety of irrigation systems are available and are used for overhead irrigation of tobacco and other crops. Gun sprinkler systems may be solid set, portable pipe sections or self propelled traveling systems. Center pivot systems can cover large, primarily circular areas with a minimum of physical

requirements by the operator. Complete coverage of irregularly-shaped fields by center pivot systems presents some problems. Self-propelled lateral move sprinkler systems have some distinct advantages in that they are able to cover rectangular-shaped fields. Lateral systems require multiple risers along the lateral move path.

A variety of pumps are available that may be run by LP gas, diesel fuel or electric power. Pumps may be installed permanently or remain portable.

Drip Irrigation

Drip irrigation is another system for delivering irrigation water to tobacco. Drip irrigation is termed so because of the slow application of water delivered to plants under low pressure through emitters spaced uniformly along the length of plastic tubing. Drip irrigation has been reported to reduce water use by 30 to 50 percent.

Components of a drip irrigation system include a water source, pump, filters, main line, water meter, check valve, low pressure drain, vacuum breaker, pressure reducer, manifold, injection pump for adding fertilizer, sub mains and drip tube with emitters.

Drip irrigation may be used with or without plastic mulch to cover the row bed into which the tobacco is planted. With plastic mulch, no cultivation is necessary and no application of chemicals or fertilizer is possible except through the irrigation water and the drip system. Without plastic mulch, conventional cultivation and fertilization is still possible.

The minimal pump operating pressure for a drip irrigation system is a distinct advantage. Water is delivered through the drip tubing at 10 to 15 psi. A water supply that is clean of micro flora growth and chemical contaminants is required. Contaminated water sources can clog filters and emitters.

Benefits of utilizing the drip system for irrigating tobacco include efficient water use, the possibility of injecting fertilizer through the system either to supplement or replace the normal dry fertilizer program, possible increases in the quality of the lowest plant leaves without splashing sand on these leaves, and a reduced potential for soil erosion from surface water runoff on rolling terrain.

Problems presented by drip irrigation include the expense of installing the needed wells and system components, a tendency to over-irrigate and leach fertilizer nutrients, a requirement for increased management ability and an understanding of the pumping and delivery system, and disposal of plastic mulch and drip tubing.

In the United States, application of soil fumigant and plastic mulch with drip tube increases the cost of production by as much as $600.00 per acre. Permanent installation of needed wells, pumps, filters and supply lines can add as much as $1,500.00 per acre to the expense of installing a drip system.

For best results, irrigation type and scheduling should be based on the combined use of production experience, crop observation, a water balance sheet and moisture blocks.

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