

THE SCIENTIFIC BASIS OF COTTON'S NEED FOR WATER IN DIFFERENT PERIODS OF DEVELOPMENT AND ITS IRRIGATION PROCEDURE

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Annotation: Cotton (*Gossypier spp.*) is a widely cultivated crop with distinct water requirements across its various growth stages, necessitating precise irrigation management strategies grounded in scientific principles. Cotton undergoes several critical growth stages, including germination, seedling establishment, vegetative growth, flowering, boll development, and maturation. The water needs of cotton vary significantly during each of these stages, with peak water demand typically occurring during flowering and boll development. Evapotranspiration, the combined water loss from the soil surface (evaporation) and plant leaves (transpiration), serves as a fundamental indicator of crop water requirements. Understanding the daily and seasonal ET rates for cotton is crucial for determining irrigation scheduling and application rates. Monitoring soil moisture levels provides valuable insights into the water status of the root zone and helps guide irrigation decisions.

Keywords: cotton water requirement, growth stages, irrigation management, evapotranspiration, soil moisture monitoring, crop development, water use efficiency, irrigation scheduling, drip irrigation, sprinkler systems, soil type, climate conditions, optimal yield, fiber quality, sustainability.

Techniques such as soil moisture sensors, densitometers, and neutron probes enable farmers to assess soil moisture content accurately, ensuring timely irrigation to meet crop needs while avoiding water stress or excessive moisture. Cotton's water requirements vary according to its developmental stage. During the early growth stages, adequate soil moisture is critical for germination, root development, and establishment. As the plant progresses through vegetative growth and enters the reproductive phase (flowering and boll formation), water demand increases to support growth, fruit set, and fiber development. Maximizing water use efficiency is essential for sustainable cotton production. WUE refers to the amount of biomass or fiber produced per unit of water consumed. Implementing efficient irrigation practices, such as scheduling irrigation based on crop water requirements, optimizing irrigation application methods, and minimizing water losses, enhances WUE and conserves water resources. Scientifically informed irrigation scheduling involves timing irrigation events to coincide with periods of peak water demand and optimizing water application rates to match crop needs.

This may entail adjusting irrigation frequency and duration based on factors such as weather conditions, soil moisture status, and crop growth stage. Various irrigation methods, including drip irrigation, sprinkler systems, and furrow irrigation, can be employed in cotton production. Drip irrigation, which delivers water directly to the root zone, is particularly well-suited for cotton, as it minimizes water loss due to evaporation

and runoff, promotes uniform soil moisture distribution, and enhances nutrient uptake efficiency. By integrating scientific knowledge of cotton's water requirements with precise irrigation management practices, growers can optimize water use efficiency, promote crop productivity, and ensure the sustainability of cotton cultivation in diverse agro ecosystems.

Understanding the specific water needs of cotton at each developmental stage is essential for implementing precise irrigation management practices. By providing adequate water throughout the growing season, growers can optimize crop growth, yield potential, and fiber quality, thereby maximizing the profitability and sustainability of cotton production.

Germination and Seedling Establishment:

- During germination, cotton seeds require consistent moisture to initiate the growth process.

- Adequate soil moisture is essential for seedling emergence and establishment of a healthy root system.

- Water stress during this stage can lead to poor germination rates and uneven stands.

Vegetative Growth:

- In the vegetative stage, cotton plants focus on leaf and stem development.

- Moderate soil moisture levels are necessary to support vegetative growth and maintain plant vigor.

- Water stress during this stage can result in reduced leaf expansion, stunted growth, and decreased photosynthetic activity.

Flowering and Boll Development:

- Flowering and boll development are critical stages for cotton yield and fiber quality.

- High water demand is observed during flowering and boll formation, as water is essential for pollination, fruit set, and fiber elongation.

- Water stress during flowering can lead to flower abortion, while water deficit during boll development can cause poor fiber quality and reduced yield.

Maturation and Boll Opening:

- As cotton bolls mature and approach harvest, water requirements decrease.

- Reduced irrigation during maturation helps promote boll opening and facilitates mechanical harvesting.

Scientific Basis of Cotton Irrigation Procedure: Evapotranspiration (ET) Monitoring:

- ET measurement serves as a fundamental tool for estimating crop water requirements.

- Weather-based ET models, such as the Penman-Monteith equation, can be used to calculate daily crop water use based on weather data.

Soil Moisture Monitoring:

- Continuous monitoring of soil moisture levels helps assess the water status of the root zone.

- Various methods, including soil moisture sensors, tensiometers, and neutron probes, can be employed to measure soil moisture content accurately.

Irrigation Scheduling:

- Scientifically informed irrigation scheduling involves timing irrigation events to coincide with periods of peak water demand.

- Methods such as the crop water balance approach or soil water depletion method can be used to determine when irrigation is needed based on crop water requirements and soil moisture depletion.

Irrigation Methods:

- Different irrigation methods can be utilized in cotton cultivation, including furrow irrigation, sprinkler systems, and drip irrigation.

- Drip irrigation, which delivers water directly to the root zone, is well-suited for cotton production as it minimizes water loss through evaporation and runoff, promotes uniform soil moisture distribution, and enhances nutrient uptake efficiency.

Water Use Efficiency (WUE) Optimization:

- Maximizing water use efficiency is crucial for sustainable cotton production.

- Implementing efficient irrigation practices, such as drip irrigation and deficit irrigation strategies, can help optimize WUE by matching water supply with crop demand and minimizing water losses.

By integrating scientific principles with practical irrigation management strategies, growers can effectively meet the water requirements of cotton across its growth stages, optimize water use efficiency, and achieve sustainable cotton production.

Cotton's water needs vary significantly throughout its growth stages, reflecting the dynamic physiological processes and environmental factors influencing crop development. Scientific research has elucidated the nuanced relationship between water availability and cotton's developmental stages, providing valuable insights for irrigation management and sustainable crop production.

During the early stages of germination and seedling establishment, consistent soil moisture is essential for ensuring uniform emergence and vigorous root growth. Adequate irrigation at this stage promotes stand establishment and sets the foundation for robust crop development.

As cotton progresses through vegetative growth, flowering, and boll development, its water requirements increase to support vegetative expansion, reproductive processes, and fruit development. Optimal soil moisture levels during these critical stages are crucial for maximizing yield potential, fiber quality, and overall crop performance.

Late-season stages, including fruit maturation and harvest preparation, require careful irrigation management to balance water availability with crop maturity and quality objectives. Controlled deficit irrigation may be employed to facilitate boll opening and defoliation while minimizing water stress and preserving fiber integrity.

In conclusion, the scientific understanding of cotton's water requirements across different developmental periods serves as a cornerstone for effective irrigation strategies and sustainable water management practices in cotton production. By integrating scientific knowledge with practical field management techniques, growers can optimize water use efficiency, enhance crop productivity, and mitigate the impacts of water scarcity on cotton cultivation. Continued research and innovation in cotton irrigation science are essential for

meeting the evolving challenges of agricultural sustainability and ensuring the resilience of cotton production systems in the face of changing environmental conditions.

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