Published May, 1979

Uniform Stage Descriptions in Upland Cotton[1]

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ABSTRACT

A systematic method of defining the developmental stages of upland cotton (*Gossypium hirsutum* L.) is described. The stages of growth are divided into two groups: vegetative and reproductive. The stage of growth of an individual plant is determined by the number of main stem nodes. The uppermost node immediately preceded by a 1.25-cm internode is considered the latest developed node for staging purposes.

Use of these systematic growth stages should lead to more uniform application of agronomic research treatments, cultural practices, and the like.

Additional index words: Development stages, Growth stages, *Gossypium hirsutum* L.

FOR years, plant scientists have desired uniform descriptions for developmental stages of crop plants. Uniform descriptions of growth stages, if widely accepted, lead to better communications among plant scientists and between scientists and the agricultural community. Uniform descriptions are accepted by the scientific community for some crop plants already. This paper provides stage descriptions for upland cotton (*Gossypium hirsutum* L.).

Burmood (1) based a comprehensive method of staging corn (*Zea mays* L.) plant development on the identification and numbering of lower internodes. Stages of growth are advanced as the uppermost leaf becomes fully expanded from the whorl and the collar is visible. Fehr et at. (2) published a method for staging soybean (*Glycine max* (L.) Merr.) plant development based on the degree of expansion of the uppermost trifoliate leaf, time of flower initiation, pod development, and plant senescence.

Today, cotton plants are defined as being in the vegetative, square, bloom, or boll stage of growth. Also, days of growth after emergence and the number of fully expanded leaves have been used for specific stages of development. Obviously, such descriptions are subjective and overlapping.

The cotton plant has, like corn and soybeans, a predictable habit of growth. Once the first true leaf has expanded, and assuming favorable growing condition, approximately 4 days are required between successive vegetative nodes along the main stem. After fruiting begins intervals average 2.5 to 3.0 days. These time intervals are less under optimum growth conditions and become progressively longer as lower night temperatures develop (5).

Growth Stages

We have divided the growth stage descriptions for upland cotton into two groups: vegetative and reproductive. The vegetative stages encompass the period of growth from the time the hypocotyl crook has straightened until the appearance of the first reproductive bud or square.

The first defined growth stage is the vegetative cotyledon (VC), and is the growth period from the time the hypocotyl crook has straightened until a 1.25-cm internode has lengthened above the cotyledonary node (Fig. 1A). The time required for plant development from the VC to the next stage is one of the most variable time intervals in the growth of the cotton plant. Temperature appears to be the primary factor affecting growth of main stem primodia. As the plant develops, the uppermost node on the main stem is considered for staging if the internode immediately below has lengthened 1.25 cm or more.

The first vegetative stage of growth (V1) begins when the internode above the cotyledons, or below the first true leaf node, has elongated 1.25 cm or more (Fig. 1B). The plant is considered in vegetative stage two, (V2) (Fig. 1C) when the internode below the second true leaf node has elongated at least 1.25 cm. Succeeding V stages are likewise determined. The stage of growth of a population is based on 50% of the plants at or beyond a given stage.

The reproductive stages of development begin with the appearance of the first fruiting limb or sympodium (Fig. 2A), and continue for the remainder of the growing season. For example, if the first sympodium appears at the fifth true leaf node on the main stem and is preceded by a 1.25-cm internode, then the plant is in the first reproductive stage (R1) of development. The stage immediately prior was the V4 stage. Normally, the first sympodium occurs immediately following the V5 or V6 stage, however, the plant may have as few as three or as many as 10 V stages before progressing to the R1 stage. The second reproductive stage (R2) begins when the main stem internode immediately above the R1 node has elongated 1.25 cm (Fig. 2B). Succeeding R stages are determined likewise.

The proper stage of development can be determined even if climatic conditions, insects, or diseases cause fruit and leaf loss. This is possible because of the difference between a vegetative branch, or monopodium, and a sympodium. A monopodium produces leaves in a three-eighths phyllotaxy at successive nodes until some stress causes cessation of growth; while the sympodium apical meristem terminates in a fruit form, including a peduncle, and a true leaf (4). Lateral development of the sympodium continues as each node terminates in a fruit and leaf and axilaries develop to produce the next internode. This sequence of axilary bud break to produce the next internode results in the typical zig zag appearance of fruiting branches.

[1] Published with the approval of the Director of the Univ. of Arkansas Agric. Exp. Stn. Received 7 Aug. 1978.

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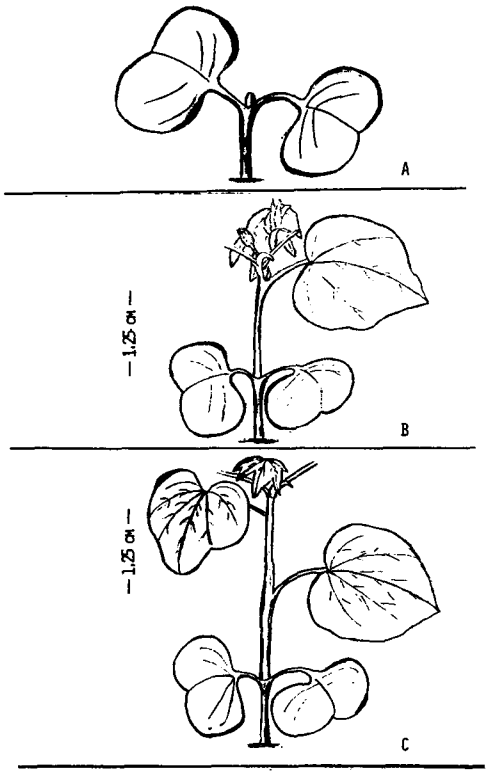

Fig. 1. Initial vegetative stages of cotton development. A) VC, B) VI, and C) V2.

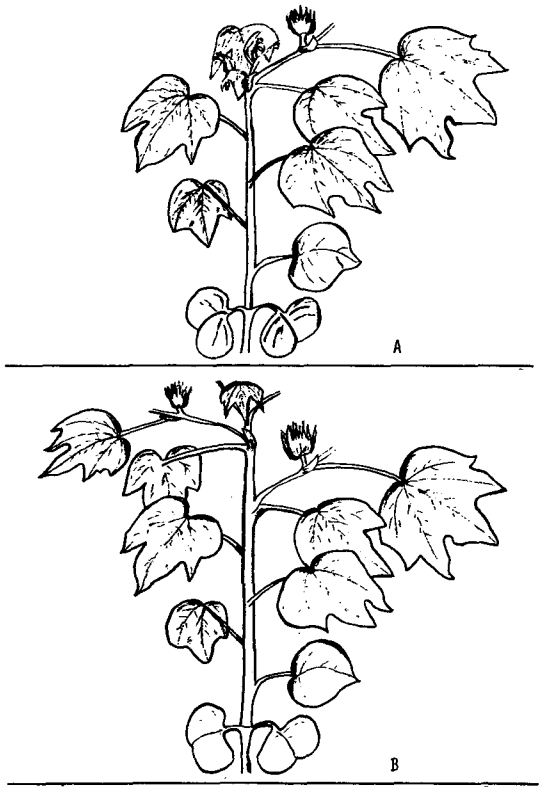

Fig. 2. Initial reproductive stages of cotton development. A) R1 and B) R2.

If some environmental condition or insect attack has resulted in the loss of fruit and/or leaves, the position of the R1 node can be determined since prominent scars will remain (Fig. 3). Therefore, the lowest branch with opposite scars will be the first sympodium and the main stem node from which it arises will be the R1 node. Again, the uppermost node preceded by a 1.25-cm internode will be utilized in determining the stage of growth.

The internode length was an arbitrary selection in order to define when a main stem node should be counted for staging purposes. The procedure loses its continuity during environmental conditions such as cool spring temperatures, severe drought, and cool night temperatures late in the growing season. Minimum experience will allow one to determine if the uppermost node should be considered established for staging purposes. Once the uppermost node is determined, all nodes below are considered established regardless of the length of the internode associated with that node.

Once the plant is considered mature, further stage descriptions are of no practical value. Unfortunately, maturity of a perennial plant such as cotton, which is forced by climate and cropping practices to produce as an annual, is difficult to define. Therefore, we recommend that the last stage; i.e. the uppermost main stem node expected to produce a harvestable boll; be followed by a "+" to indicate maturity. For example, if a plant had 12 R stages and the likelihood of harvestable bolls at additional main stem nodes was slight, that R12 stage would be designated R12+ and no other stage determinations would be made.

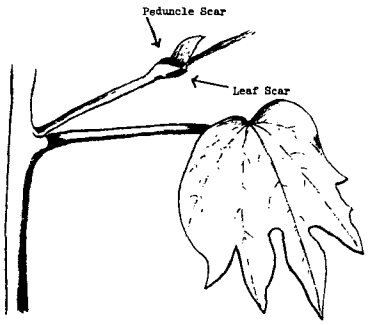

Fig. 3. Diagrammatic representation of sympodium showing opposite scars.

Plants with opposite leaves arising from a single node or with at least one short internode have been reported (3, 6). The plants with opposite leaves would fit this procedure with no apparent problems; however, plants with the genetically controlled short internode would be staged incorrectly by one stage until a normal length internode had developed above.

This procedure has been used successfully across the cotton belt by crop insurance industry adjustors for approximately 3 years. We feel that the procedure has merit for widespread use because it clearly defines morphological development and arbitrary defines nodal advance.

ACKNOWLEDGMENT

Work leading to the development of this procedure was financed in part by the National Crop Insurance Association and the Crop Insurance Research Bureau, Inc.

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