Temperature and Crop Development

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The state of a plant is determined by both growth and developmental processes. In modeling crop systems, separating the two processes is important because they are affected by different environmental variables. Development refers to the timing of critical events in the life cycle of a plant. Growth refers to the increase in weight, volume, length, or area of some part or all of the plant. In more mechanistic crop modeling, considerably more research and emphasis has been placed on plant growth through the photosynthesis process than on development.

The potential biomass yield of a crop can be thought of as the product of the rate of mass accumulation multiplied by the duration of growth. The rate of biomass accumulation is principally influenced by the amount of light intercepted by plants over a fairly wide optimum temperature range. However, the duration of growth for a particular cultivar is usually almost directly proportional to temperature, over a wide range of temperatures. Highest potential yields of a particular annual crop are obtained in regions where the season duration is maximized because of relatively low temperatures. In regions such as the tropics, where the temperature is usually relatively high, potential yield levels can reach those of cooler temperature regions only by combining yields from two or more crops in sequence so that the duration of the total growth periods is about the same in both regions. This suggests that the potential rate of biomass growth is relatively constant over space and time when the temperatures are within the range for growth, whereas the duration of growth is more variable in space and time. Thus, the modeling of crop duration is critical in order to predict crop potential productivity.

Predicting crop growth duration is necessary to find genotypes with a desired growth period that enables farmers to optimize yields. These yields are produced within the constraints of a soil water supply or a favorable thermal environment. Also, the ability to predict the stage of crop development is important for such management decisions as timing of pesticide application, scheduling the orderly harvest of crops, or synchronizing the flowering of cross-pollination crops for hybrid seed production.

Reaumur first suggested in 1735 that the duration of particular stages of growth was directly related to temperature and that this duration for a particular species could be predicted using the sum of mean daily air tem-