Using Degree Days to Predict Weed Growth.

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Scheduling weed control measures to phenological stages is important for control of most species. Critical stages of plant development for several important weed species are often missed, rendering control less effective. Critical stages for control include delaying control of yellow nutsedge past the 5 leaf stage will allow plants to produce new tubers. Cultivating later than the 2 leaf stage with flex-tined cultivators will reduce control of many species. Our ability to predict emergence and development of weed species can improve our efficacy of weed control.

Increasing our understanding of species that emerge and growth during similar time periods would allow us to time our control to a phenological stage of the last member of a species assembly. Identifying species assemblies would allow us to time postemergent berm sprays to a specific leaf stage of the last species of the assembly, allowing for control of all species and precluding the need for a second application. Degree day models also allow us to schedule control activities by providing us a greater understanding of how fast weeds attain the same phenological stage during different time periods. Intuitively we know that common lambsquarters will grow slower in March than it will in June. Knowing the speed of development allows planning to make sure that labor shortages or irrigation schedules do not prevent control of weeds during the control window. Our ability to identify species assemblies and to identify control windows can improve the efficiency of weed control.

Methods

Weed species were planted at 4 equal intervals through out the year. Each species emergence and growth were recorded up until fruit maturation. Emergence and growth of each species were related to degree day accumulation using regression analysis. Historical air temperature weather data were acquired from UCIPM and two years from a ten year selection of temperature data were selected because of the difference in temperature patterns between the two years. Degree day models were run for each of those two years to find differences between years in plant development and to find differences in plant development with selected emergence dates with each year.

Results

Weed species did grow predictably according to accumulated degree days. Some species such as common lambsquarters did not grow at the same accumulated degree rate in each season (Figure 1). Different models may be required for some seasons but part of the difference in models may be a result of fewer stages of growth achieved in winter versus summer.

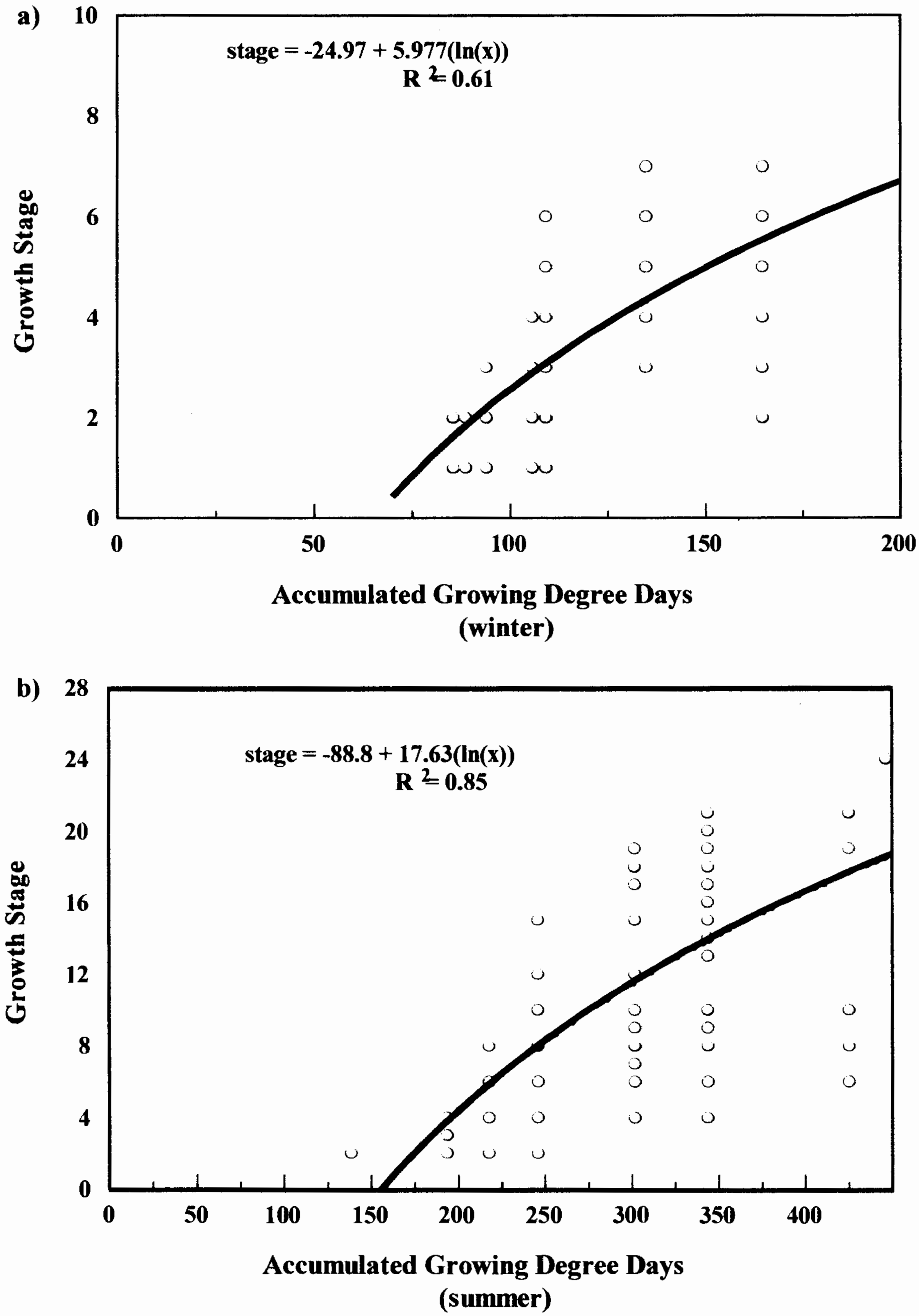

Figure 1. Accumulated growing degree day models for common lambsquarters grown in winter and summer. Growth in winter stopped at stage 10 (9 leaf stage) by frost.

Models may change with season but their utility for predicting phenological development is apparent when looking at how plant development changes with different germination and emergence dates through the year (Figure 2). Wild radish that initiates growth in October required only 8 calendar days to achieve the 2 leaf stage but a wild radish that initiated growth in January required 56 days to achieve the 2 leaf stage (Figure 2). Seasonal differences in phenological development could be manipulated when timing cover crop plantings to minimize competitiveness of weedy species. Understanding the seasonal differences in phenological development also allows the farmer or PCA to allocate labor efficiently to control weeds within a reasonable control window.

Weed species may respond differently to temperature between species but some species will have similar emergence and phenological development. Grouping of species into species assemblies requires that the most developed species must still be at a controllable stage at the time when the last species in the assembly emerges. If a technique such as flame cultivation requires flaming prior to the 12 leaf stage for a particular weed species (for example common lambsquarters) then the last member of that assembly must emerge prior to the 12 leaf stage of common lambsquarters. The assemblies also must reflect irrigation schedules. If control is delayed for a newly emerged member of an assembly and the field is too wet, then the oldest species may be past the phenological stage for control.

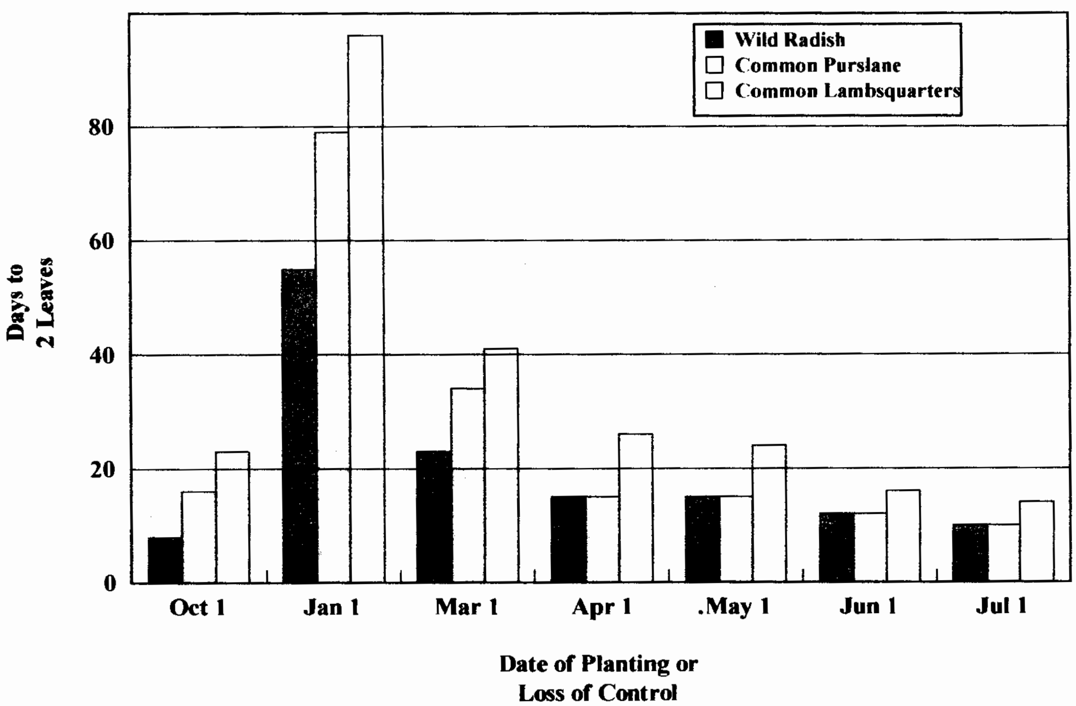

Figure 2. The effect of starting point for plant development for wild radish, common purslane and common lambsquarters on the number of calendar days required to achieve the 2 leaf stage.

Year to year variation in weather will change the calendar date at which a particular growth stage occurs. Accumulated degree day models will still reliably predict phenological development. Using historical temperature data to run the degree day models produced an interesting result. For two years with different temperature patterns, 1989 and 1996, weed species had the greatest calendar day variation in the winter and spring (Figure 3). For a number of species, the summer months were similar between years. The difference in calendar days between seasons is important because it means that once the degree day relationships have been worked out for species emerging in May through September, calendar dates can be used for prediction of growth stage. Degree day models will still need to be run for species emerging in late winter and spring.

Once species assemblies have been formed and the seasonal relationships are well understood, our ability to schedule weed control will be enhanced. Applications for degree day models are already under study. Examples include timing Surflan applications to just prior to common purslane emergence, and timing plantings of tomatoes to avoid severe competition from sheperdspurse. Basing control decisions on degree day models should improve efficiency of control and efficacy as well.

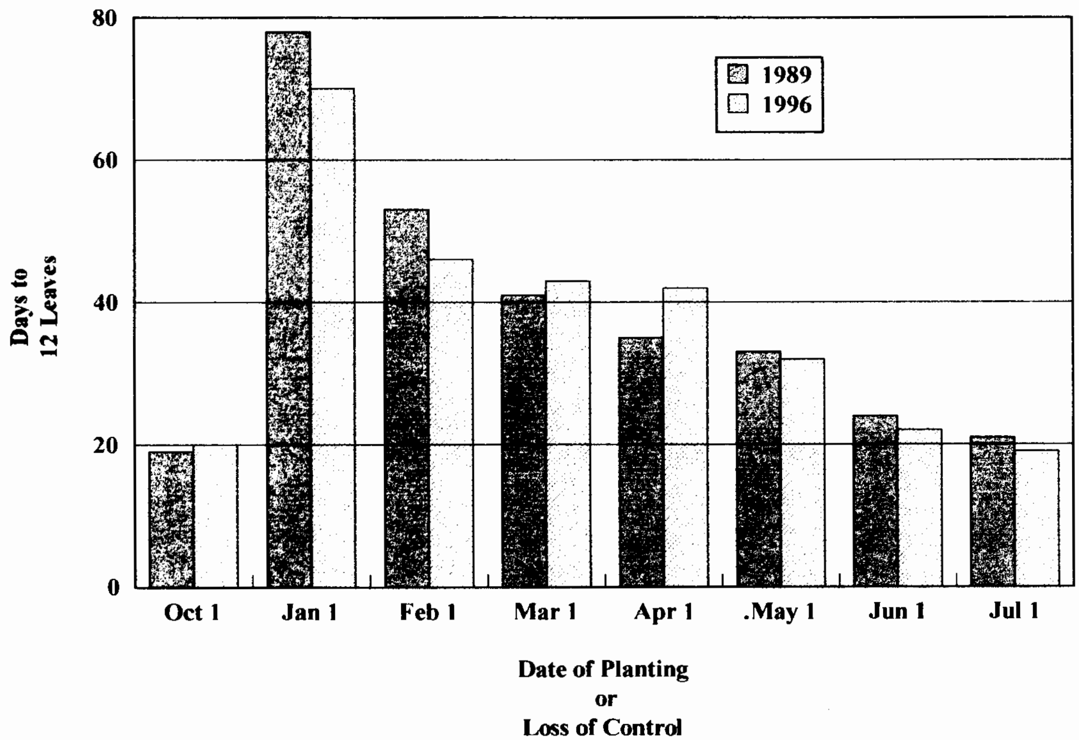

Figure 3. The effect of starting point for plant development for wild radish in two years on the number of calendar days required to achieve the 12 leaf stage.