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Plant phenology as an indicator of developmental events in weed-feeding insects

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Leafy spurge, *Euphorbia esula* (Euphorbiaceae), is an exotic weed infesting grassland habitats in the United States and Canada. Phenology models describing the seasonal abundance of insects utilized as leafy spurge biocontrol agents have been developed for the US, based on accumulated degree-days. These agents are employed across a large area of the western and midwestern US, an area characterized by considerable latitudinal and elevational variability. In addition, recording weather stations are often widely scattered, especially over large areas of the western states. Thus, local land managers rarely have access to real-time degree-day data. Air or soil temperatures appear to have a controlling influence on plant as well as insect phenology in the Northern Hemisphere. If plant and biocontrol agent phenologies respond similarly to a common degree-day regime, plants could serve as "proxy weather instruments" that could be used to predict biocontrol agent phenology. Thus, the objective of this study was to determine if phenological patterns exhibited by various plant species can be used to forecast seasonal abundance patterns among collectable life stages of leafy spurge biological control agents.

The relationships among flowering, fruiting, and vegetative phenology for 12 perennial plant species and accumulated degree-days (LDT = 0°C) were examined at two Montana sites. These relationships were well described by linear regression models ($r^2 > 0.70$). Plant phenology was compared to spurge biocontrol agent phenology on a common degree-day basis. Phenological events in several plant species may serve as reasonably accurate indicators of peak agent abundance in the field. For the peak abundance of leafy spurge flea beetle (*Aphthona* spp., Coleoptera: Chrysomelidae) adults, such relationships include: (1) *A. czwalinae*/*A. lacertosa* (mixed populations) and *A. nigriscutis* – peak flowering of the native plants *Lupinus argenteus*, *Rosa woodsii*, or *Achillea millefolium*; and (2) *A. cyparissiae* and *A. flava* – peak flowering of the exotic weed *Hypericum perforatum* and peak ripeness of fruits of the native shrub *Amelanchier alnifolia*. The completion of flowering by the introduced shrub *Syringa vulgaris* can be an indicator of peak first-generation pupal abundance for the leafy spurge bud gall midge *Spurgia esulae* (Diptera: Cecidomyiidae).