Ecological Deception: Pulling the Trigger on Yellow Starthistle Seed Germination.

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There is an increasing body of evidence indicating yellow starthistle seedbanks may be depleted by over 95% with three years of intensive management (DiTomaso et al. 1999; Enloe, unpublished data). With this in mind, current research directives are aimed at developing techniques to facilitate seed germination in the first and second years of management to accelerate the depletion process. A better understanding of the ecology of yellow starthistle seed germination may aid in developing accelerated seedbank depletion techniques.

The phenomenon of field abortion of yellow starthistle following late summer thunderstorms has been documented in Europe (Sobhian 1993) and has been observed in Northern California (Enloe, unpublished data). This may occur when yellow starthistle seeds are induced to germinate following rainfall but subsequently die for a lack of further available moisture. We attempted to apply this idea as a seedbank depletion strategy for yellow starthistle. Studies were conducted on both grazed and ungrazed plots near Davis and at the Sierra Foothills Research and Extension Center (SFREC) near Marysville, California during the month of September 2000. We applied 0, 0.5, 1.0, and 1.5 inches of irrigation to 0.25 m$^2$ circular plots either as a simulated thirty-minute evening rainstorm or in split applications over a twenty-four hour period. We continuously monitored soil temperature within the germination zone (1-2 cm) and soil water potential with a potentiometer for sixty-six to ninety hours following irrigation. Five days after irrigation, we counted and individually marked all emerged yellow starthistle seedlings with colored toothpicks. We monitored seedling survival weekly until either complete seedling mortality or the first sustaining rainfall, after which no further mortality occurred. At the end of the experiment we quantified the soil seedbank by sampling five-1.75 cm diameter cores in each plot. Soil water potential and seedling emergence and survival data were analyzed using repeated measures analysis of variance.

Maximum daily soil temperatures generally exceeded 35° C and minimum nightly temperatures averaged 15° C across locations. Prior to irrigation, baseline soil water potentials were less than –40 MPa at all study sites. With 0.5 and 1.0 inches of irrigation, soil water potential initially increased to greater than –0.5 MPa, but rapidly declined to below –1.0 MPa. Larson and Kiemnec (1997) determined that –1.0 MPa was the low end for yellow starthistle germination. This was reflected in the fact that very few seed germinated in these treatments at either location. Additionally, soil water potential decreased much more rapidly in grazed than ungrazed sites. Irrigation applied at 1.5 inches maintained soil water potentials favorable for germination in both ungrazed sites. Complete mortality of emerged seedlings occurred at both Davis locations within three weeks. However, few seedlings died at SFREC before the first sustaining rains and monitoring was then discontinued. In terms of the seedbank, the best treatment (1.5 inches of irrigation) induced roughly 20% of the seedbank to germinate at SFREC, and less than 15% at Davis. In contrast, the first sustaining rains for germination in mid-October induced 65% and 45% of the seedbank to germinate at Davis and SFREC, respectively.
These results suggest several key points for biology and management. Maintaining adequate soil moisture within the germination zone may be very difficult when temperatures are extremely hot during the early fall. Additionally, applying excessive water to induce germination may also sustain seedling survival until fall precipitation occurs. However, irrigation techniques may be refined to improve the success of this technique. The low percent of the seedbank that was induced to germinate compared to the first fall rains may also suggest some dormancy mechanisms are working to prevent mass field abortions when late summer precipitation does occur. This has been shown for several annual grass species in California (Jain 1982). Laboratory experiments are being initiated to further examine this issue with yellow starthistle.

References


Sobhian, R. Life history and host specificity of Urophora sirunaseva (Hering) (Dipt., Tephritidae), a candidate for biological control of yellow starthistle, with remarks on the host plant. J. Appl. Ent. 116:381-390.