BULL THISTLE: THE FORGOTTEN RANGELAND WEED

JAMES A. YOUNG. CHARLIE D. CLEMENTS, AND DAN HARMON

USDA-ARS, 920 VALLEY ROAD, RENO, NV 89512
jayoung@scs.unr.edu

INTRODUCTION

BULL THISTLE (*CIRSIUM VULGARE*) IS ONE OF THE MOST WIDELY DISTRIBUTED EXOTIC WEED SPECIES ON WESTERN RANGELANDS. NATIVE TO EASTERN EUROPE AND ASIA, THIS INVASIVE SPECIES HAS SPREAD TO MANY PARTS OF THE WORLD. THERE ARE SOME 200 SPECIES OF *CIRSIUM* INCLUDING MANY SPECIES NATIVE TO NORTH AMERICA. ON HEAVILY GRAZED MEADOWS BULL CAN BE THE DOMINANT SPECIES. ON MEADOWS THIS WEED FORMS DENSE PARCHES OF PLANTS WITH STIFF STEMS AND SPINE TIPPED LEAVES. THESE PATCHES GREATLY DEPRESS PRODUCTION OF DESIRABLE FORAGE SPECIES AND CREATE BARRIERS FOR THE MOVEMENT OF HUMANS AND LIVESTOCK.

BULL THISTLE IS A BIENNIAL SPECIES. THE FIRST YEAR A ROSETTE OF OVER-LAPPING LEAVES FORMS ON THE SOIL SURFACE. THIS ROSETTE EFFECTIVELY ELIMINATES COMPETING VEGETATION (FIGURE 1). THE SECOND YEAR THE PLANT BOLTS AND PRODUCES FLOWERING STALKS 0.5 TO 1.25 M IN HEIGHT (FIGURE 2). THE CENTRAL STEM ENDS IN A FLOWER HEAD (INVOLUCRE) THAT IS SUBTENDED BY BRACT-LIKE LEAVES. THE INVOLUCRE IS HEMISPHERIC TO BELL SHAPED (FIGURE 3). THE SMALL, TIGHTLY PACKED FLOWERS ARE PURPLE IN COLOR (FIGURE 4). THE FRUIT (ACHENE) IS LIGHT-BROWN TO TAN AND COLOR AND ONLY 3.5 TO 4.5 MM IN LENGTH. THE ABUNDANT PAPPUS IS 20 TO 30 MM IN LENGTH (FIGURE 5) THE SEEDS READILY DISPERSE BY THE SMALLEST OF WIND CURRENTS.

ESTABLISHMENT OF BULL THISTLE PLANTS IS ENTIRELY BY SEED. THIS MAKES AN UNDERSTANDING OF SEED AND SEEDBANK ECOLOGY ESSENTIAL IN THE DESIGN OF BULL THISTLE SUPPRESSION PROGRAMS. GERMINATION IN RELATION TO INCUBATION TEMPERATURE IS AN IMPORTANT FIRST STEP IN THIS UNDERSTANDING.

PURPOSE

TO INVESTIGATE THE GERMINATION OF BULL THISTLE SEEDS AT A WIDE RANGE OF CONSTANT OR ALTERNATING TEMPERATURES.

METHODS

Seeds were collected from numerous stands in the northern Great Basin over a period of several years. Seed from numerous plants at each location were pooled for testing.

In all experiments 4 replications of 25 seeds each were used in a randomized block design. Seeds were placed on top of non-toxic commercial germination paper in closed Petri dishes and kept wet with tap water. Germination trials were conducted in the dark. Incidental light was received during initial wetting and germination counts. Seeds were considered germinated when the radical emerged 1 mm. Germination counts were made after 1, 2, and 4 weeks. Constant incubation temperatures were 0, 2, and 5 C and at 5 degree increments through 40 C. Alternating regimes included 16 hours at each constant temperature, plus 8 hours at each possible higher temperature per 24 hours. For example, 35 C alternated with 40 C only, while 0 C alternated with 2, 5, 10, 15, 20, 25, 30, 35, and 40 C. This made a total of 55 constant and alternating temperature regimes (Young et al. 1991).

The germination responses of the accessions of Cirsium vulgare were compared using the following seedbed temperature regime definitions (Young and Evans 1982):

a. Very cold: 0/0 (constant 0 C), 0/2 (0 C for 16 hours and 2 C for 8 hours in each 24 hour), 0/5 and 2/2 C.
b. Cold: 0/10, 0/15, 2/5, 2/10, 2/15, 5/5, and 5/10 C.
c. Cold fluctuating: 0/20 through 0/40 C and 2/20 through 2/40 C.
d. Fluctuating: 5/35 through 5/40 C, 10/35, 10/40, an 15/40 C.
e. Moderate: 5/20 through 5/30, 10/10 through 10/30 C, 15/15 through 15/35 C, 20/20 through 30/35 C, and 25/25 through 25/30 C.
f. Warm: 20/40, 25/35, and 25/40 C, 30/30 through 30/40 C, 35/35, 35/40, and 40/40 C.

The temperature categories reflect germination environments of field seedbeds based on several years of monitoring in the Great Basin (Evans et al. 1970, Evans and Young 1970, 1972).

Data from each base temperature and its alternating temperature regimes were used to generate a quadratic response surface with estimated means and confidence intervals at the 1% level of probability (Young et al. 1980, Evans et al. 1982, Palmquist et al. 1987). A number of germination parameters were calculated from the quadratic response surfaces (Table 1) (Young and Evans 1982). These germination parameters were individually subjected to analysis of variance and the means separated by Duncan's Multiple Range Test.

Table 1. Quadric response surface with calculated percentage germination and confidence interval (P≤0.01) for seeds of bull thistle incubated at 55 constant or alternating temperatures. Seeds collected at Dana, California in 2001.[1]

Cold period temperature C	Percentage germination, Warm period temperature C (%): 0	2	5	10	15	20	25	30	35	40
0	0±12	0±12	0±12	26±9	34±8	34±8	38±8	15±10	0±12	0±12
2		0±12	4±11	39±8	69±7	61±7	56±7	52±7	0±12	0±12
5			3±11	41±8	67±7	58±7	46±8	37±9	22±9	0±12
10				32±8	77±6*	[79±6*]	76±6*	63±7	59±7	0±12
15					43±8	68±7	68±7	73±6*	62±7	37±10
20						53±7	56±7	60±7	48±8	24±10
25							26±10	53±8	52±8	8±11
30								1±11	2±11	0±12
35									0±12	0±12
40										0±12

[1]Number following the mean is one half of the confidence interval as determined from regression equations used to develop the response surface (Palmquist et al. 1987). The maximum calculated germination is enclosed by brackets [ ]. * indicates means not lower than the maximum germination minus one half of its confidence interval, our definition of optimum germination.

FIGURE 1. BULL THISTLE IS A BIENNIAL WHICH PRODUCES A LARGE ROSETTE THE FIRST SEASON. THIS ROSETTE SMOTHERS COMPETING VEGETATION.

FIGURE 2. BULL THISTLE PLANTS ELONGATE IN THEIR SECOND SEASON TO A HEIGHT OF 0.5 TO 1.2 M. THE STEMS ARE STIFF AND THE LEAVES TIPPED WITH SPINES. SCALE POLE IN DECIMETERS.

FIGURE 3. FLOWER HEAD OF BULL THISTLE WITH SUBTENDING SPINE TIPPED BRACTS.

FIGURE 4. BULL THISTLE SEEDHEAD SHOWING RAY AND DISK FLOWERS.

FIGURE 5. A. BULL THISTLE SEED ON 1 MM GRID. B DISPERSING BULL THISTLE SEEDS SHOWING VERY SMALL ACHENES AND LONG PAPPUS HAIRS. SEEDS FLOAT ON THE BAREST OF WIND CURRENTS.

RESULTS

WE PRESENT A TEMPERATURE-GERMINATION PROFILE FOR SINGLE LOCATION AS AN EXAMPLE OF THE DATA GENERATED BY THIS PROCEDURE (TABLE 1).

COMPARING PROFILE CHARACTERISTICS FOR 3 ACCESSION OF BULL THISTLE SEEDS (TABLE 2), REVEALS GENERAL SIMILARITIES AND SOME VARIATION. MAXIMUM OBSERVED GERMINATION RANGED FROM 79 TO 95% WHICH INDICATES THE SEEDS CAN BE QUITE VIABLE. THE REGIMES WITH OPTIMUM GERMINATION WERE ONLY 7 TO 15% OF THE PROFILE, INDICATING THE HIGHEST GERMINATION ONLY OCCURRED AT A LIMITED NUMBER OF TEMPERATURE REGIMES.

COMPARING THE TEMPERATURE-GERMINATION PROFILES TO CATEGORIES OF SEEDBED TEMPERATURES (TABLE 2) REVEALS THAT NO GERMINATION OCCURRED AT VERY COLD SEEDBED TEMPERATURES WHILE TWO OF THE PROFILES HAD MARKED GERMINATION AT COLD SEEDBED TEMPERATURES. THERE WAS CONSIDERABLE VARIATION AMONG ACCESSION IN GERMINATION, EVEN AT MODERATE SEEDBED TEMPERATURES.

Table 2. Summary table for germination-temperature profiles for 3 accessions of bull thistle.

Germination parameter	Accession (%): Cassell	Dana	Reno
Profile characteristics			
Mean	32	24	21
Regimes with germination	75	78	87
Mean of optima	70	76	81
Regimes with optima	15	7	7
Maximum	95	79	84
Seedbed categories			
Very cold	0	0	0
Cold	50	40	12
Cold fluctuating	24	26	18
Fluctuating	31	13	41
Warmer	9	10	11
Moderate	80	54	45

CONCLUSION

THE AMOUNT OF VARIABILITY OBSERVED AMONG PROFILES FROM DIFFERENT ACCESSIONS OF BULL THISTLE SEEDS AND UNUSUAL DISTRIBUTION GERMINATION IN RELATION TO SEEDBED TEMPERATURES SUGGESTS THE SEEDBED ECOLOGY OF THIS SPECIES IS QUITE COMPLEX.

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