The Viability of Cut-Leaved Teasel (*Dipsacus laciniatus* L.) Seed Harvested From Flowering Stems: Management Implications

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ABSTRACT: Cut-leaved teasel (*Dipsacus laciniatus* L.) is an invasive nonnative species in some midwestern prairies; its control has been attempted by cutting stems prior to complete flowering to halt seed set and dispersal. In this study, stems of cut-leaved teasel were harvested prior to complete flowering to determine if viable seed was produced in these heads. Seeds removed from laboratory-stored heads at one month and seven months after harvest were tested for viability. The germination rate was 41 percent for one-month-old seed and increased to an average rate of 97 percent for seven-month-old seed. This study indicates that cut stems must be removed from the site to prevent the dispersal of viable seed. Several other nonnative ruderal species are capable of producing viable seed from flowering stems cut before seed has fully matured. Natural area managers should take this capability into account when implementing control measures.

INTRODUCTION AND PROBLEM

The practice of cutting flowering stems of exotic plant species to prevent seed production has been used to eradicate exotic or undesirable species from agricultural land and native plant communities (Gill 1938, Schwarzmeier 1984, Kline 1986a, 1986b). This practice is an effective control for certain species if conducted at the proper growth stage and if seed production is prevented or if seeds produced are removed from the site (Gill 1938, Schwarzmeier 1984). Stem cutting is a useful alternative for controlling exotic species in natural areas where mechanical or biological control measures are preferable to chemical control. Species that resprout after cutting, such as cut-leaved teasel, may require repeated stem cutting before flowering to inhibit seed production completely (Werner 1979).

Some plant species cut or harvested at immature stages of seed development are capable of producing viable seed (McAlister 1943, McLemore 1959, Lawrence 1960, 1967). The viability of seed harvested at various stages of maturity has been studied to determine harvest times for seed production of certain cultivated species and to control the spread of agricultural weeds (Gill 1938, Hermann and Hermann 1939, Harrington 1959, Hawthorn et al. 1962). Studies of postharvest seed set in exotic species that invade natural areas are needed to establish cutting times for most effective control and to determine whether cut stems should be removed from the site.

Removing cut stems from a natural area is costly and time-consuming when the site is remote and a nearby disposal site is unavailable. In many instances (e.g., large infestations of exotics) allowing cut stems of the target species to remain on the site is logistically easier than gathering cut flowers or seed heads and hauling them to a suitable disposal site. Allowing cut stems to remain on the site can be counter-productive, however, if the stems contain, or eventually produce, viable seed.

Dipsacus laciniatus L., cut-leaved teasel, is prevalent at Loda Cemetery Prairie, an Illinois nature preserve. For the past seven years efforts to control cut-leaved teasel at this prairie consisted of annually cutting teasel stems at the base after flower buds developed (prior to peak flowering) and leaving the cut stems lying on the site. Typically, cut-leaved teasel flowers within the heads were either in bud or at early stages of growth. Stems that resprouted were cut again the same year. *Dipsacus laciniatus* is a biennial or short-lived perennial that occurs as a basal rosette for one to several years, subsequently flowers, and then dies after flowering (Ferguson 1965). Repeated cutting has been effective in controlling the closely related teasel, *Dipsacus sylvestris* Huds. (Werner 1979). Likewise, it was thought that repeated cutting of cut-leaved teasel would prevent on-site seed set and eventually decrease the population size and seed bank. Despite this control effort, the cut-leaved teasel population at Loda Cemetery Prairie has not been noticeably reduced in size (F.

Harty pers. comm., J. White pers. comm.). I investigated the possibility that cut-leaved teasel seeds are capable of germinating when harvested before they reach full maturity.

STUDY AREA

Loda (Pine Ridge) Cemetery Prairie is a high quality 1.42-ha remnant of mesic tallgrass prairie that lies on the northwest edge of the town of Loda in Iroquois County, Illinois. The prairie was regularly mowed prior to its acquisition by The Nature Conservancy in 1983. Mowing and related disturbances apparently fostered the initial invasion of cut-leaved teasel. This exotic, however, has continued to spread despite the cessation of mowing.

METHODS

Dipsacus laciniatus L. flowering heads were obtained from stems that had been cut at Loda Cemetery Prairie on August 8, 1987. At the time of harvest the central half of the head was flowering, but flower buds in the upper and lower one-fourth of the heads had not opened. In *D. laciniatus*, as in other members of the genus, flowering begins in a ring at the center of the head and progresses both upward and downward (Ferguson 1965). Heads were green, ovaries were enclosed by the calyxlike involucel, and no mature seeds were evident. Cut heads were removed from the prairie and kept indoors at room temperature (18.3 to 21.1° C) until used in germination experiments.

Cut-leaved teasel seeds, technically achenes, were tested by two age groups: seed developed one month after harvest and seven months after harvest. The first group consisted of 100 teasel seeds removed by hand from the lower half of a head thirty-two days (one month) after harvest and placed on moist paper towels in a plastic tray covered with a clear lid. Seven months (212 days) after harvest, 300 teasel seeds were removed by hand from the lower half of a head; an additional 300 seeds were obtained by shaking seeds loose from seven heads. These two subgroups comprised the second group of seeds (Table 1). Each subgroup of 300 seeds was placed on moistened Whatman #3 filter paper in covered petri dishes. All seeds in both groups were kept moist with tap water and maintained at room temperature (19.9 to 21.1° C) with ambient indoor light levels. Stratification and other germination treatments were not used on either age group since Werner (1975a, 1975b) showed that seed from a related teasel, *Dipsacus sylvestris*, did not require cold treatment, scarification, or a specific period of light and dark to germinate. Germination of the one- and seven-month-old seed was measured by radicle emergence. The number of seeds germinated in each group and subgroup was recorded daily. Cotyledons subsequently developed on all germinated seeds in the one- and seven-month-old groups.

RESULTS AND DISCUSSION

Teasel seeds taken from inflorescences that were green and only partially flowering at the time of harvest were subsequently viable, and germination success increased with seed age (Table 1, Figure 1). Germination rates were moderate for one-month-old seed (41 percent) and considerably less than the average germination rate for the two subgroups of seven-month-old seed (97 percent). At seven months after harvest, seed removed from the lower half of a head had slightly higher germination (99 percent) than that

TABLE 1. Germination rates of *Dipsacus laciniatus* seed harvested from flowering stems.

Group	Postharvest Age (Months)	No. of Seeds	No. of Heads Used Per Group	Germination Rate (%)
1	1	100	1	41
2A	7	300	1	99
2B	7	300	7	95

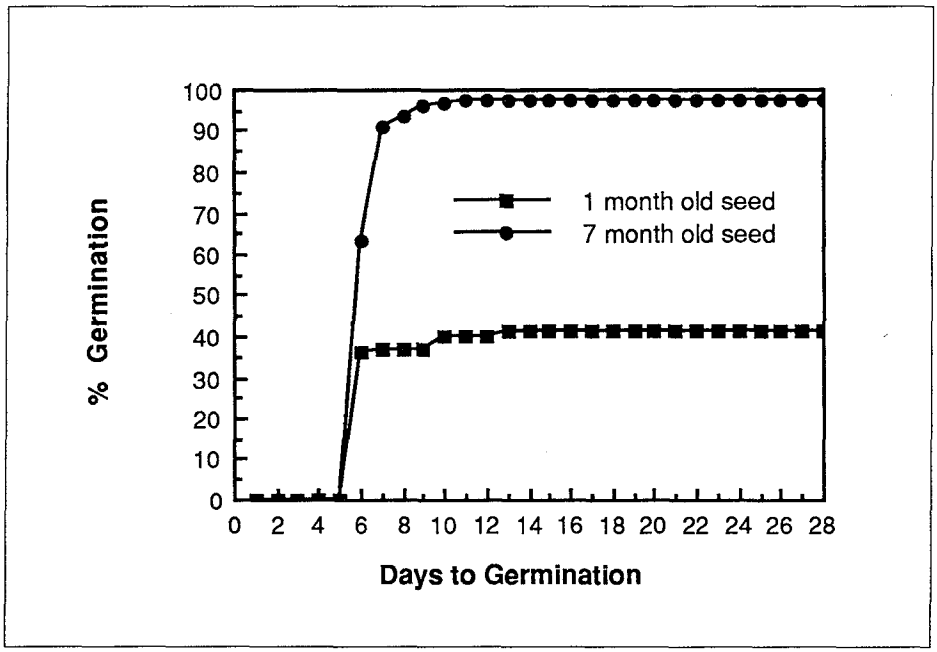

FIGURE 1. Percent germination of *Dipsacus laciniatus* L. seed harvested from stems cut prior to full flowering. Seed ages are months after harvest.

freely shaken from the head (95 percent). These germination rates are for laboratory-stored seed and may differ from germination rates of seed maintained under field conditions. However, germination rates of seven-month-old seed are comparable to rates reported for mature *Dipsacus sylvestris* seed (99.6 percent seedling emergence) taken from plants in a Michigan old field (Werner 1975a, 1975b).

The ability of immature seeds to germinate has been documented in several other invasive, disturbance-adapted species. Gill (1938) studied germination rates of various weed seeds obtained from plants cut during or just after flowering but before seed had ripened. Species that produced viable seed from stems cut before seed had fully matured included *Senecio jacobaea* L. (ragwort)—80 percent germination; *Senecio vulgaris* L. (groundsel)—35 percent germination; *Sonchus oleraceus* L. (sow thistle)—100 percent germination; *Hordeum nodosum* L. (meadow barley grass)—90 percent germination; and *Bromus mollis* L. (soft brome grass)—81 percent germination. In contrast, Gill found that certain members of the Asteraceae family did not produce viable seeds from stems cut during flowering. These include *Taraxacum officinale* L. (common dandelion), *Cirsium arvense* (L.) Scop.(Canada thistle), *Hypochaeris radicata* L. (cat's ear), and *Cirsium vulgare* (Savi) Tenore (bull thistle). McAlister (1943) harvested immature seed of two Eurasian grasses—*Agropyron cristatum* (L.) Gaertn. (crested wheatgrass) and *Bromus inermis* Leyss.(smooth brome)—and found that germination ranged from 73 to 95 percent and 71 to 95 percent, respectively, for three stages of immature seed planted four months after harvest. Finally, immature *Daucus carota* L. (carrot) seed harvested twenty-five to thirty-five days after flowering began yielded approximately 15 to 38 percent germination (Hawthorn et al. 1962). Thus, the ability of immature seeds to germinate occurs in a variety of plants including members of at least three families (Asteraceae, Poaceae, and Apiaceae) with annual, monocarpic perennial, or perennial habits.

Studies of *Dipsacus sylvestris* indicate that germination rates and establishment in old fields can be high, and parallels to the establishment of *D. laciniatus* in prairies can be drawn. *Dipsacus sylvestris* can produce an average of 2666 viable seeds per plant under field conditions (Werner 1975b). Teasel seed introduced in fallow fields four to five years old had 28 to 86 percent germination within two years after introduction (Werner 1975b). Assuming that *D. laciniatus* yields similar amounts of viable seed (the number and size of inflorescences are similar in the two species) and that germination rates vary between 28 and 86 percent, a single plant can produce approximately 746 to 2292 new plants. These figures suggest a high potential for teasel to multiply in prairies. Between 0 and 1926 cut-leaved teasel seedlings occurred in each of seven 3 m^2 plots at Loda Cemetery Prairie (pers. observ.). The seed bank may also contribute to the persistence of this species at Loda. Teasel germination may be hindered by heavy litter cover such as that found in prairies that have not been recently burned or mowed. Werner (1975a) reports a negative correlation between teasel seed germination and the percent cover of leaf and stem litter.

The present study indicates that *Dipsacus laciniatus* can produce high percentages of viable seed from heads cut before flowering was completed. Therefore, cutting stems of this species prior to full flowering is not sufficient to halt seed set. To control the spread of this species in natural areas, heads must be cut before seed readily falls out and removed from the site to prevent dispersal of viable seed. When implementing control measures, natural area managers should bear in mind the potential capability of cut stems of this and other species to produce viable seed.

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LITERATURE CITED

Ferguson, I. K. 1965. The genera of Valerianaceae and Dipsacaceae in the southeastern United States. Journal of the Arnold Arboretum 46: 218-231.

Gill, N. T. 1938. The viability of weed seeds at various stages of maturity. Annals of Applied Biology 25: 447-456.

Harrington, J. F. 1959. Effect of fruit maturity and harvesting methods on germination of muskmelon seed. Proceedings of the American Society for Horticultural Science 73: 422-430.

Hawthorn, L. R., E. H. Toole, and V. K. Toole. 1962. Yield and viability of carrot seeds as affected by position of umbel and time of harvest. Proceedings of the American Society for Horticultural Science 80: 401-407.

Hermann, E. M. and W. Hermann. 1939. The effect of maturity at time of harvest on certain responses of seed of crested wheatgrass, *Agropyron cristatum* (L.) Gaertn. Journal of the American Society of Agronomy 31: 876-885.

Kline, V. 1986a. Effects of mowing on wild parsnip: six year study (Wisconsin). Restoration & Management Notes 4: 82-83.

Kline, V. 1986b. Response of sweet clover (*Melilotus alba* Desr.) and associated prairie vegetation to seven experimental burning and mowing treatments. Pp. 149-152 *in* G. K. Clambey and R. H. Pemble, eds., The prairie—past, present, and future: proceedings of the ninth North American Prairie Conference. Tri-College University, Fargo, N.D.

Lawrence, T. 1960. Quality of Russian wild ryegrass seed as influenced by time and method of harvesting. Canadian Journal of Plant Science 40: 474-481.

Lawrence, T. 1967. Effect of age on the germination and emergence of Russian wild ryegrass seed harvested by two methods at progressive stages of maturity. Canadian Journal of Plant Science 47: 181-185.

McAlister, D. F. 1943. The effect of maturity on the viability and longevity of the seeds of western range and pasture grasses. Journal of the American Society of Agronomy 35: 442-453.

McLemore, B. F. 1959. Cone maturity affects germination of longleaf pine seed. Journal of Forestry 57: 648-650.

Schwarzmeier, J. A. 1984. Sweet clover control in planted prairies: refined mow/burn prescription tested (Wisconsin). Restoration & Management Notes 2: 35-36.

Werner, P. A. 1975a. The effects of plant litter on germination in teasel, *Dipsacus sylvestris* Huds. American Midland Naturalist 94: 470-476.

Werner, P. A. 1975b. Prediction of fate from rosette size in teasel (*Dipsacus fullonum* L.). Oecologia 20: 197-201.

Werner, P. A. 1979. The biology of Canadian weeds: 12—*Dipsacus sylvestris* Huds. Pp. 134-145 *in* G. Mulligan, ed., The biology of Canadian weeds, contributions 1-32. Information Services, Agriculture Canada, Ottawa, Ontario.