Does Timing of Defoliation Affect Spotted Knapweed Seed Production and Viability?

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Project Location

INTRODUCTION

Spotted knapweed (*Centaurea biebersteinii*) infestations increase surface water runoff, soil erosion, and sediment yield in streams and decrease biodiversity and available livestock and wildlife forage. Spotted knapweed can produce 25-35 flowers per plant and 5,000-40,000 seeds per meter^2 each year, and seeds can remain viable for at least 8 years. Buds form on spotted knapweed plants in June and flowering generally occurs from July through September, with mature seeds being formed by mid-August. Most seeds are shed upon maturity, contributing a substantial number of seeds into the seedbank annually. Prescribed sheep grazing can be used to suppress spotted knapweed and avoid the high cost and environmental concerns that are associated with herbicides. However, the optimal timing of defoliation to reduce the production of viable seeds must be identified to improve the efficacy of prescribed livestock grazing for controlling spotted knapweed.

PURPOSE

To determine the appropriate timing(s) or combination(s) of timings of defoliation on spotted knapweed to maximally reduce viable seed production.

METHODS

Study Area

- Foothill rangeland in western Montana (Figure 1).
- Rough fescue (*Festuca campestris*)/bluebunch wheatgrass (*Pseudoroegneria spicata*) habitat type.
- 286-m^2 exclosure.

Study Design

- 80 spotted knapweed plants: 8 treatments with 10 plants in each treatment.
  - Trt 1: Clip plants to 9-cm stubble height (45% utilization) during bolting stage (mid-June)
  - Trt 2: Remove 100% of buds/flowers + 3 cm of foliage beneath buds during late-bud/early-flower stage (mid-July)
  - Trt 3: Remove 100% of flowers + 3 cm of foliage beneath buds during full flower stage (mid-August)
  - Trt 4: Treatment 1 + Treatment 2 (June + July)
  - Trt 5: Treatment 1 + Treatment 3 (June + August)
  - Trt 6: Treatment 2 + Treatment 3 (July + August)
  - Trt 7: Treatment 1 + Treatment 2 + Treatment 3 (June + July + August)
  - Trt 8: Unclipped Control
- Buds/flowers from an entire treatment were collected when the flowers of at least 50% of the plants in the treatment (n=10) were in the well-developed, post-flowering stage, but when bracts were still tightly closed. Collections were made from mid-August to late September.
- Responses measured: number of doughy, intermediate, and mature seeds per plant (Table 1); percent viability of doughy, intermediate, and mature seeds (Table 2); number of viable doughy, intermediate, and mature seeds (Table 3); number of buds/flowers per plant (Figure 3); total seeds per plant (Figure 4); and total viable seeds per plant (Figure 5).

Data Analysis

- Analysis of covariance was used to compare response variables among treatments.
- Percent canopy cover of spotted knapweed, lupine (*Lupinus* spp.), and perennial graminoids (Figure 2) and percent of buds/flowers with evidence of seedhead gall fly (*Urophora quadrifasciata*) damage were used as covariables in the analyses.
- Differences were considered significant at $P \leq 0.05$.

Figure 2. Estimating canopy cover in a 50-cm radius around treatment plants.

Figure 1. Foothill rangeland study site in western Montana.

RESULTS

Table 1. Number (SE) of doughy, intermediate, and mature spotted knapweed seeds produced per plant after defoliation on foothill rangeland in western Montana.

	Timing of Clipping							
Seed Maturity	Unclipped Control	June	July	August	June + July	June + August	July + August	June + July + August
Doughy	144.9(30.4)a	61.1(17.0)b	13.5(8.0)c	0c	16.0(13.8)c	0c	0.3(0.3)c	0c
Intermediate	20.4(3.5)a	6.9(2.5)b	3.3(2.4)bc	0c	1.3(1.3)c	0c	0c	0c
Mature	196.9(35.1)a	22.6(7.1)b	0.5(0.5)b	0b	0.1(0.1)b	0b	0b	0b

[a]Means within rows followed by the same letter are not different ($P > 0.05$).

- **Clipping in June reduced the number of *doughy seeds* by 58% and clipping at all other times or combinations of timings reduced the number of doughy seeds by 97% compared with no clipping.**
- **Clipping in June or July reduced the number of *intermediate seeds* by 75% and clipping in July, August, June+July, June+August, July+August, or June+July+August reduced the number of intermediate seeds by 96% compared with no clipping.**
- **Clipping at any time or combinations of timings reduced the number of *mature seeds* by 98% compared with no clipping.**

Table 2. Percent viability (SE) of doughy, intermediate, and mature spotted knapweed seeds after defoliation on foothill rangeland in western Montana.

	Timing of Clipping							
Seed Maturity	Unclipped Control	June	July	August	June + July	June + August	July + August	June + July + August
Doughy	0a	0a	0a	0a	0a	0a	0a	0a
Intermediate	25.0(7.4)a	13.5(6.7)b	0c	0c	0c	0c	0c	0c
Mature	89.0(2.0)a	68.2(12.0)b	2.0(2.0)c	0c	0c	0c	0c	0c

[a]Means within rows followed by the same letter are not different ($P > 0.05$).

- **No seeds in the *doughy stage* were viable, regardless of treatment.**
- **Clipping in June reduced the viability of *intermediate seeds* by 46% and clipping at all other times or combinations of timings reduced the viability of *intermediate seeds* by 100% compared with no clipping.**
- **Clipping in June reduced the viability of *mature seeds* by 23% and clipping at all other times or combinations of timings reduced the viability of *mature seeds* by almost 100% (99.7%) compared with unclipped plants.**

Table 3. Number (SE) of viable doughy, intermediate, and mature spotted knapweed seeds produced per plant after defoliation on foothill rangeland in western Montana.

	Timing of Clipping							
Seed Maturity	Unclipped Control	June	July	August	June + July	June + August	July + August	June + July + August
Doughy	0a	0a	0a	0a	0a	0a	0a	0a
Intermediate	6.1(2.0)a	1.4(0.6)b	0b	0b	0b	0b	0b	0b
Mature	173.0(30.3)a	20.1(6.7)b	0.1(0.1)b	0b	0b	0b	0b	0b

[a]Means within rows followed by the same letter are not different ($P > 0.05$).

- **There were no viable *doughy seeds*, regardless of treatment.**
- **Clipping at any time or combinations of timings reduced the number of viable *intermediate seeds* by 97% compared with no clipping.**
- **Clipping at any time or combinations of timings reduced the number of viable *mature seeds* by 98% compared with no clipping.**

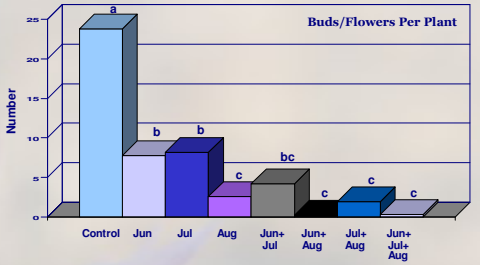

Figure 3. Clipping in June, July, or June+July reduced the number of buds by 72% and clipping in August, June+July, June+August, July+August, or June+July+August reduced the number of buds by 92% compared with no clipping.

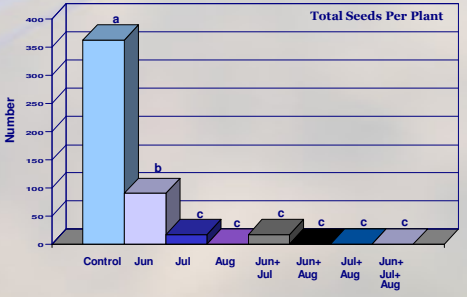

Figure 4. Clipping in June reduced the total number of seeds by 75% and clipping at all other times or combinations of timings reduced the total number of seeds by 98% compared with no clipping.

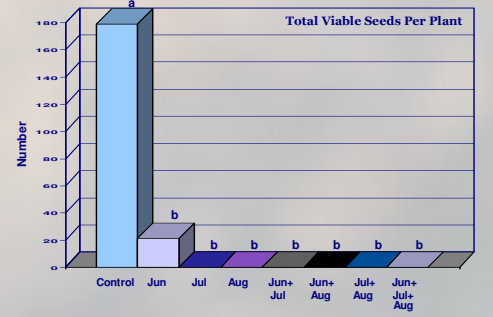

Figure 5. Clipping at any time or combination of timings reduced the total number of viable seeds by 98% compared with no clipping.

CONCLUSIONS

Clipping in mid-June, mid-July, mid-August, or any combination of these timings reduced viable seed production by 98% compared with no clipping. Because spotted knapweed is a short-lived perennial that reproduces solely by seed, results indicate that prescribed livestock grazing in summer should effectively suppress this weed, especially when seedheads are removed by grazing in July or August.

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Background Photo Courtesy of Stacee Henderson