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

Tracy K. Mosley*[1], Katie R. Benzel[2], and Jeffrey C. Mosley[3]

[1]Agriculture Extension Agent, Montana State University Extension, Park County, Livingston, Montana 59047
[2]Wildlife Biologist, Bureau of Land Management, Dillon Field Office, Dillon, Montana 59725
[3]Extension Range Specialist, Montana State University Extension, Dept. of Animal and Range Sciences, Bozeman, MT 59717

ABSTRACT

Spotted knapweed (*Centaurea stoebe* L.) is an economically and environmentally destructive invasive forb that reproduces largely by seed. It is capable of producing 25-35 flowers/head, 60 heads/plant, and 5,000-40,000 seeds/meter^2/year. Prescribed livestock grazing is an effective control method for spotted knapweed, however, it is unknown if new flowers that are produced following spring/summer defoliation produce viable seed by the end of the growing season. The purpose of this research was to determine the appropriate timing(s) of spotted knapweed defoliation to reduce viable seed production. Ten spotted knapweed plants located on infested rangeland in west-central Montana were hand-clipped for each of the following treatments: 1) 45% relative utilization of above-ground biomass at bolting stage, 2) 100% of buds removed at late-bud/early-flowering stage, 3) 100% of flowers removed at full-flowering stage, 4) Treatment 1+Treatment 2, 5) Treatment 1+Treatment 3, 6) Treatment 2+Treatment 3, 7) Treatment 1+Treatment 2+Treatment 3, 8) unclipped control. Clipping at any timing or combination of timings reduced the number of buds/flowerheads/plant ($P < 0.01$), number of seeds/plant ($P < 0.01$), percent viability of seeds ($P < 0.01$), and number of viable seeds/plant ($P < 0.01$) compared with no clipping. Clipping during the bolting stage reduced the number of viable seeds by nearly 90% compared with no clipping. Clipping during the late-bud/early-flower or full-flower stage reduced the number of viable seeds by nearly 100% compared with no clipping. Prescribed sheep grazing of spotted knapweed in summer should effectively suppress viable seed production of spotted knapweed.

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, research has yet to determine if new flowers produced following spring/summer bud removal produce viable seed by the end of the growing season that may be contributed to the seed bank.

PURPOSE OF STUDY

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

Figure 1. Foothill rangeland study site in western Montana.

PROJECT METHODS

Study Area

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

Study Design

- 80 spotted knapweed plants excluded from grazing were treated each year (2006, 2007)
- 8 treatments with 10 plants in each treatment, each year.
- 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: percent viability of doughy, intermediate, and mature seeds; number of buds/flowers per plant; total seeds per plant; and total viable seeds per plant.

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 (above). Estimating canopy cover in a 50-cm radius around treatment plants.

Figure 3 (below). Close-up of a **spotted knapweed flower.**

RESULTS , CONCLUSIONS, AND MANAGEMENT IMPLICATIONS

Figure 4. Number of buds/flowerheads per plant.

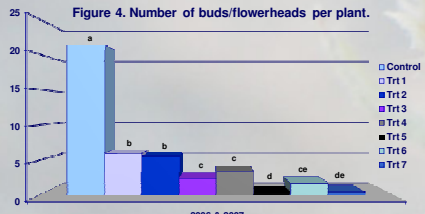


Figure 5. Number of seeds per plant.

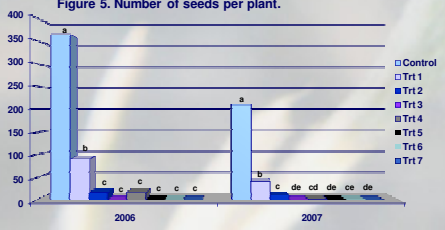


Figure 6. Percent viability of seeds.

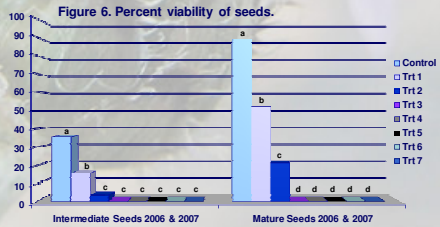
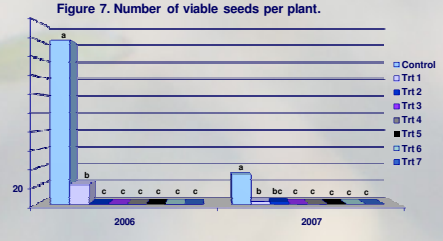


Figure 7. Number of viable seeds per plant.



CONCLUSIONS

- Bud/flowerhead production was reduced 72-98% by clipping at all timings (**Figure 4**).
- Total seed production was reduced 75-81% by clipping during the bolting stage (Trt 1) and 98-100% by clipping at all other timings (Trt 2-Trt 8) (**Figure 5**).
- No doughy seeds were viable.
- Percent viability of intermediate seeds was reduced 57% by clipping during the bolting stage (Trt 1) and 99% by clipping during all other timings (Trt 1-Trt 8) (**Figure 6**).
- Percent viability of mature seeds was reduced 23-58% by clipping during the bolting stage (Trt 1) and 59-99.6% by clipping during all other timings (Trt 2-Trt 8) (**Figure 6**).
- Total viable seed production was reduced by nearly 90% by clipping during the bolting stage (Trt 1) and 100% by clipping in the late-bud/early-flower stage (Trt 2), during the full-flower stage (Trt 3), or at any combination of timings (Trt 4-8) (**Figure 7**).

MANAGEMENT IMPLICATIONS

Spotted knapweed reproduces largely by seed, therefore, prescribed sheep grazing should effectively suppress its reproduction when defoliation occurs during the bolting, late-bud/early flower, or full flower stages. Viable seed production can be maximally reduced when grazing occurs in the late-bud/early flower or full flower stages.