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Spotted Knapweed (*Centaurea maculosa* Lamarck) Seed and *Urophora* spp. Gall Destruction by *Larinus minutus* Gyllenhal (Coleoptera: Curculionidae) Combined with *Urophora affinis* Frauenfeld (Diptera: Tephritidae) and *Urophora quadrifasciata* (Meigen) (Diptera: Tephritidae)

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Abstract

Four-hundred mature unopened individual spotted knapweed seedheads were bagged in the late summer in the years 1997 and 1998. The seedheads were collected and dissected in the late fall. Seed reduction was increased by 26.5 percent with the addition of *Larinus minutus* Gyllenhal to the already existing *Urophora affinis* Frauenfeld and *Urophora quadrifasciata* (Meigen) populations. The numbers of seeds destroyed in individual seedheads increased as the number of *L. minutus* adults in the seedhead increased. Up to three adult *L. minutus* were found in individual seedheads. *L. minutus* and the two *Urophora* spp. were found to successfully cohabit the spotted knapweed seedheads.

Keywords: *Larinus*, seed, spotted knapweed, *Urophora*

Larinus minutus Gyllenhal, a seedhead weevil, was first introduced into the United States in 1991 at East Helena, Montana (Lang, Story, and Piper 1996). *L. minutus* was tested for host specificity and cleared for release in the United States in June 1991. The female *L. minutus* feeds on the florets of spotted knapweed open flower heads and as a result prepares an oviposition site in the flower head. The first instar larva feed inside a floret and then the later instars feed on the developing seeds and mature spotted or diffuse knapweed (*Centaurea maculosa* Larmarck and *Centaurea diffusa* Lamarck) seed. The larvae pupate in late August in a pupal chamber consisting of damaged knapweed seed, frass, and parts of the seedhead (Groppe 1990, Jordan 1995). In Montana the adult *L. minutus* emerge in late September to early October leaving an exit hole in the middle of the open seedhead. The newly emerged adults feed on the knapweed plants and then diapause in the litter and soil for the Winter. When the soil warms up in May the adults begin to emerge and begin feeding on the knapweed rosettes (Groppe 1990, Jordan 1995). Adult *L. minutus* can be readily seen and collected from bolting knapweed plants in the Spring. When the adult *L minutus* populations reach high densities the knapweed plants are sometimes destroyed.

Urophora affinis Fraunfeld and *Urophora quadrifasciata* (Meigen) over winter as larvae in the spotted or diffuse knapweed seedheads. The adults oviposit on newly forming flower buds in the Spring and the larvae burrow into the seedhead causing the knapweed plant to grow a gall around the larvae. The galls become a nutrient sink, stressing the plant, and therefore reducing seed production (Harris 1980). *U. affinis* were tested for host

specificity and cleared for release in September 1971 and *Urophora quadrifasciata* was cleared in August 1988. *Urophora quadrifasciata* larvae develop in the ovary causing the plant to produce a gall instead of a seed and also act as a nutrient sink and reduce the plants seed production (Harris 1980).

Spotted knapweed is a major weed pest of range land and causes annual losses of 4.5 million dollars worth of forage in Montana (French and Lacey 1983). Attempted control of spotted knapweed is being done with herbicides, cultural practices, and biological control. This study was conducted to assess the effect of *L. minutus* in addition to *U. affinis* and *U. quadrifasciata* in the reduction of spotted knapweed seed. The clearance report for introduction of *L. minutus* suggests that *L. minutus* would destroy twenty-five to one-hundred percent of the seed in a spotted or diffuse knapweed seedhead (Groppe 1990, Kashefi and Sobhian 1998).

Materials and Methods

An infestation of spotted knapweed infested with *U. affinis*, *U. quadrifasciata,* and *L. minutus* was selected for the seed destruction evaluation. The site is semi riparian with cottonwood tree spp. open spaces, and sandy soil. *Larinus minutus* were released in 1991 and 1992. The *Urophora* spp. were present from earlier Montana releases. Seed loss was prevented in four-hundred seedheads by securing fine mesh bags over the individual seedheads. Seedheads were chosen that were turning brown and not yet opened and bagged on Aug. 20 - 29, 1997 and Aug. 4 1998. The bags were left on the seedheads until October 3, 1997 and September 24, 1998. The individual seedheads were dissected and the number of *U. affinis*, *U. quadrifasciata,* and *L. minutus* present in the seedheads were recorded. Mature and immature seed were collected and the number of seed present was recorded. The damaged seed were counted and classed as immature and mature viable. Seeds were considered viable if they were black or at least had visible stripes on the seed coat. Seed were considered damaged if there was any sign of feeding on the seed. The seed were divided according to agent combinations such as one *U. affinis* gall and one *L. minutus* adult. The final seed destruction figures were figured on those seedheads that had *L. minutus* adult or pupa present in the seedhead. *L. minutus* were considered absent if those seedheads had no sign of being attacked by a *L. minutus* larvae or adult. The seedheads with no *Urophora* spp. or *L. minutus* present were used as controls recognizing that *Urophora* spp. galls are a nutrient sink and because of this nutrient sink effect seed production of the total plant has been effected.

Fifty viable seed, from all *L. minutus, U. affinis*, and *U. quadrifasciata* combinations, were randomly selected using Synder and Cochren random number table for germination evaluation of inhibition effects from the presence of *U. affinis, U. quadrifasciata,* and *L. minutus*. Seeds from seedheads with no agents present were used as the control. The seeds were placed in a "Revco" growth chamber at 20 C with 16 hours daylight and 8 hours of darkness. The seeds were placed on germination paper in 11 cm x 11 cm clear plastic boxes. The germination paper was moistened with tap water.

The number of galls destroyed or damaged by *L. minutus* feeding was recorded to evaluate the competition between the two species. It could not be determined if the *U. quadrifasciata* galls were damaged by *L. minutus* or damaged by dissecting the seedheads.

Results and Discussion

The results of the experiment indicated that the greater the number of *L. minutus* pres-

ent in the spotted knapweed seedhead the greater the destruction of the seed. Mature achenes were destroyed as well as the young immature achenes by the *L. minutus.* The added presence of *L.* minutus increased seed destruction by 26%. Increasing the number of *U. affinis* galls did not significantly increase seed destruction in individual seedheads. It was found that the three species *U. affinis, U. quadrifasciata*, and *L. minutus* successfully coexist in spotted knapweed seedheads. Spotted knapweed seed germination was not effected by the presence or absence of *Urophora* galls or *L. minutus* weevils.

Conclusion

L. minutus increases spotted knapweed seed destruction in combination with *U. affinis* and *U. quadrifasciata.* The tests show that *L. minutus* increased seed destruction by 26% in combination with *U. affinis* and *U. quadrifasciata. Urophora* spp. and *L. minutus* can coexist in the same spotted knapweed seedhead.

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