Elk (Cervus elaphus) grazing reduces volunteer soybean density

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SHORT COMMUNICATION

Elk (*Cervus elaphus*) grazing reduces volunteer soybean density

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Abstract: Management of glyphosate resistant volunteer soybean can be challenging and costly in other glyphosate resistant crops. This study examined the effect of elk (*Cervus elaphus*) grazing on volunteer soybean (*Glycine max*) management. Volunteer soybean density was assessed in four fields grazed by elk and three without elk in western Manitoba, Canada. This study determined that elk grazing of soybean stubble significantly reduced soybean volunteer density in the following crop. These results demonstrate that winter elk grazing can be an effective management technique for volunteer soybeans.

Key words: elk, grazing, volunteer, soybean, seed consumption.

Résumé : Lutter contre les repousses spontanées du soja (*Glycine max*) résistant au glyphosate dans les cultures d'autres plantes résistantes à cet herbicide peut s'avérer aussi difficile qu'onéreux. Les auteurs ont tenté de voir si la paissance du cerf rouge (*Cervus elaphus*) pourrait servir comme moyen de lutte contre les repousses spontanées du soja. À cette fin, ils ont évalué la densité des repousses spontanées dans quatre champs où paissaient des cerfs et trois, où les cerfs étaient absents, dans l'ouest du Manitoba, au Canada. Les résultats montrent que les cervidés broutant le chaume de soja réduisent significativement la densité des repousses dans la culture subséquente. La paissance de cerfs en hiver peut donc s'avérer une technique efficace dans la lutte contre les repousses spontanées de soja. [Traduit par la Rédaction]

Mots-clés : cerf rouge, paissance, repousse spontanée, soja, consommation de graines.

Introduction

Glyphosate resistant soybean [*Glycine max* (L.) Merr.] volunteers can be challenging to control in subsequent year's crops (Jhala et al. 2021). During the harvest of soybeans in the fall, low-hanging pods on the plant are commonly missed by the harvester. These pods are the source of the seeds that can lead to glyphosate resistant soybean volunteers in the subsequent crop year. While volunteer soybean is not a major weed as it is a poor competitor with crops such as canola (Gregoire et al. 2021; Van Acker et al. 1993), it can be a problem in sunflower causing yield losses if not controlled effectively and efficiently (Alms et al. 2016; Jhala et al. 2021). Further, while diseases and pests such as soybean rust and aphids are currently not a major concern in Manitoba, it remains good practice to control volunteer soybeans to reduce the number of host plants available (Cooper et al. 2015; Sikora et al. 2014). With cultivation of soybean, primarily glyphosate [N-(phosphonomethyl) glycine] resistant varieties, increasing in the prairies (Statistics Canada 2021), measures can be required to control volunteer soybeans in other glyphosate tolerant crops. Commonly, volunteer control requires an expensive line up of alternative herbicides to get complete control of the soybeans (Jhala et al. 2021). Here, we explore the potential for seed consumption as an alternative management approach.

Seed consumption, including consumption by small mammals and birds, is commonly suggested as a component in integrated pest management (IPM) programs (Holmes and Froud-Williams 2005; Sarabi 2019). Seed consumption by large mammals is typically not discussed in IPM (Sarabi 2019). Anecdotal observations by producers of feral elk (*Cervus elaphus canadensis* Erxleben) preferentially winter grazing in soybean stubble in western Manitoba however suggest that elk consumption of these pods missed at harvest may reduce the soybean seed density. In the winter, elk leave tree cover to forage in the surrounding agricultural lands, frequently selecting fields cropped to soybean the

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previous year. The objective of this study was to quantify whether this winter foraging by feral elk had an impact on the rate of soybean volunteerism in the subsequent crop.

Methods and Materials

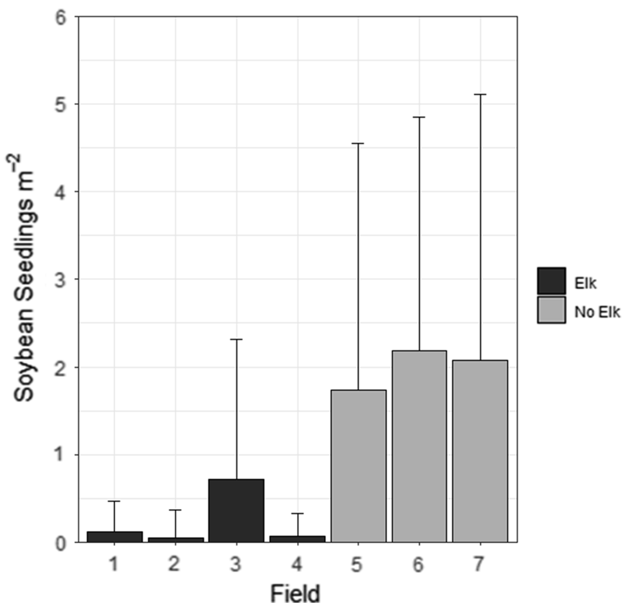
This study was conducted in 2019 and 2020 in the rural municipality of Prairie View west of Birtle, Manitoba (50.44° N 101.13° W). The study area supports a feral elk herd of approximately fifty-two animals that had previously been observed foraging in soybean stubble. The study area is dominated by Chernozem soils on rolling terrain underlain by glacial till and includes stream valleys that provide shelter and cover for the elk herd. A total of seven fields were surveyed (Supplementary Table 1[1]); fields had been cropped to soybeans from the Syngenta lineup in the year prior to survey (Syngenta 2019). In 2019, two elk grazed and two ungrazed fields were surveyed. Similarly, in 2020 two elk grazed and one ungrazed field were surveyed. Elk-grazed fields had clear signs of grazing in late November and early December including wide areas that had been trampled by the herd, as well as patches of ground that had been cleared by the elk. Control fields were on similar soils and topography to the grazed fields and had a clear absence of signs of elk presence.

The selected grazed and ungrazed fields were planted to canola (*Brassica napus* L.) between 15 May and 7 June of the survey year. Pre-emergence glyphosate and light tillage were used to manage early emerging weeds. Soil temperatures at seeding were between 6.8 °C and 7.2 °C, and spring rainfall was between 12.7 and 16.2 mm. Volunteer soybeans began to emerge within two weeks following canola seeding.

Volunteer soybean surveys were conducted between 21 June and 15 July. Surveys began once seedlings had reached the first unifoliate true leaf stage. Counts of volunteer soybean plants were made in 1 m × 1 m plots which were arrayed in a grid pattern on each of the fields with approximately 30 m between plots. Each field was therefore systematically surveyed at a density of approximately 12 plots per hectare for a total of 3897 plots. In each plot the number of volunteer soybean plants were counted.

The effect of the elk presence on soybean numbers per plot was tested with a generalized linear mixed model using the glmer function in the R lme4 package (Bates et al. 2015; R Development Core Team 2018). The mean number of seedlings per quadrat was the response variable with a binary (elk presence or absence) fixed explanatory variable. Field was included as a random factor to account for nesting of plots within fields. The model was fitted with a Poisson distribution and a log link function.

Fig. 1. Volunteer soybean density in seven fields with and without elk grazing. Error bars are one standard deviation. Fields 1, 2, 5, and 6 were surveyed in 2018, and the remainder in 2019.



Results and Discussion

Elk grazing significantly reduced the number of volunteer soybeans ($\beta = -2.713 \pm 0.599$ (SE); $\chi^2 = 9.628$; $p = 0.002$, $n = 3897$; Fig. 1). Seed consumption is a component of many integrated pest management (IPM) programs (Sarabi 2019); this is the first report suggesting the potential for elk seed consumption in an IPM. Elk foraging works in this system because the short stature of soybeans leaves many pods on standing stubble post-harvest (Philbrook and Oplinger 1989). Some of these pods drop seeds to the soil surface in the winter or spring, which allows them to germinate and become a weed in the following crop. Here we show that elk grazing greatly reduced the number of volunteer soybeans in comparison to fields that did not receive any elk grazing. Management of soybeans by elk grazing may have influenced the yield of the canola crop as the producers harvesting the study fields reported canola yields of 3800–4200 kg·ha^{-1} from the elk-grazed fields and 3300–3700 kg·ha^{-1} from non-grazed fields. However the relative contribution to yields due to reduced competition from soybean volunteers relative to factors such nutrient redistribution via feces and urine is not clear.

Periodic observations of the elk herd during the winters by the lead author were made; anecdotally, these observations suggest that the elk were seeking out soybean stubble fields. For example, a 65 hectare field of soybean stubble attracted the elk herd regularly for

[1]Supplementary data are available with the article at https://doi.org/10.1139/cjps-2021-0135.

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4–6 wk; once the field was exhausted the elk searched for another field. Travel distances to fields of up to 3.2 km from their bedding area in the valley were observed. Soybean stubble was apparently preferred over alfalfa and bale yards as the elk avoided these food sources while soybean fields remained available. The soybean field feeding thus likely had the added benefit of reducing elk damage by drawing the elk away from valuable materials (Brook 2009). Elk move and forage in response to the quality of available forages, and soybean seeds provide a high nitrogen food source at a time of year when most other available foods are very low in nitrogen (Barker et al. 2019; Mould and Robbins 1981). Utilizing grazing as a management tool for volunteer soybeans has the potential to reduce producer costs by avoiding herbicide use, and suggests the potential for winter feeding program partnerships between soybean producers and elk producers. Whether the additional costs (i.e., fencing and transport) would offset the benefits requires further study. Cattle grazing of soybean stubble may be an alternative approach, as cattle will also consume residual soybeans (Jordon et al. 1997). Utilizing feral elk is logistically much less challenging, but does require methods to draw elk to the desired fields. We observed that it was difficult to predict which fields the elk would choose to graze during the winter months. Attractants such as a small amount of grain and or a salt block may be effective, as would deterrents such as fencing to prevent the elk from accessing alternative food sources such as bale yards.

Competing Interests

The authors declare no competing interests.

Contributor's Statement

Conceptualization: ENB; methodology: ENB, EGL; investigation: ENB; formal analysis: EGL; writing – original draft: ENB; writing – review and editing: ENB, EGL; supervision: EGL.

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