Combating annual brome grass invasion in Mixedgrass Prairies

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Non-native annual brome grasses are well known across the western United States for their propensity to invade and dominate rangeland ecosystems, where they increase wildfire frequency and sharply reduce the provision of ecosystem services, including grazing opportunities, native biodiversity, and wildlife habitat quality. While rangelands of the Canadian Prairies have been mostly immune to annual brome invasion, this has changed in recent years, with the Mixedgrass Prairie of southern Alberta near the Montana border experiencing marked increases in brome abundance. High levels of seed production, together with an early growth pattern that usurps resources from native plants, has the possibility to reduce range health in several regions.

MSc student, Anabel Dombro (foreground), and others assess annual brome and native plant cover in the first year post-treatment (2020) when annual brome density was at its peak.

Annual brome biomass in 2020

In areas where annual brome invasion has occurred, various strategies are employed to attempt brome control and restore degraded rangeland. One promising new tool that has emerged is the use of indaziflam, a cellulose-biosynthesis inhibiting herbicide that is applied to the soil surface, and following entry into the topsoil, affects the development of establishing seedlings. As most native grassland species are perennials, their roots reside well below the treated surface layer, rendering them less impacted by indaziflam, while annual bromegrasses, which rely on annual seed production to maintain the

seedbank, are prone to decline as they germinate on or just below the soil surface. Indaziflam efficacy has been tested in the central plains of the United States, but not in northern temperate grasslands, where more fertile soils, cooler climates, and vegetation dominated by cool season species, may alter annual brome control with indaziflam.

Annual brome (*Bromus squarrosus*) surrounding a scarlet mallow (*Spharalcea coccinea*). Even small plants occurring at high density add large amounts of seed to the seedbank.

In 2019, the Rangeland Research Institute partnered with Bayer Crop Science (now Envu), and Alberta Environment and Parks, to evaluate indaziflam as a control strategy in affected native Mixedgrass Prairie grasslands. Anabel Dombro, a summer student initially hired to help sample the study sites, eventually became an MSc student in the project working with Dr. Edward Bork, and RRI Program Coordinator Lisa Raatz, and recently completed her summary of findings in January 2024. Anabel's work provided several interesting findings.

One of the earliest was that the most abundant annual brome species within the affected region was corn brome (*Bromus squarrosus*), a species that has been less reported, and not as intensively examined in other regions, much less for control. While an unfamiliar plant to most, it strongly resembles Japanese brome (*B. japonicus*) which is on the Noxious weeds list in Alberta.

In the second year after herbicides were applied (2021), there were reductions in brome biomass and density.

Following indaziflam application at different rates and seasons at two experimental field sites, Anabel examined the duration of annual brome control. Reductions in annual brome density and biomass peaked in the second growing season after application, but continued to be suppressed through four consecutive years, highlighting the long-term efficacy potential of indaziflam in northern temperate grasslands. Indaziflam requires some rainfall to wash into the soil and become active and annual brome also requires soil moisture to germinate. Brome control could be achieved using rates as low as 37.5 g ai ha^{-1} of indaziflam,

although higher rates (75 and 150 g ai ha^{-1}) generally led to the greatest control, findings further supported by studies of the surviving germinable seedbank from treated plots. In addition, reduced brome led to an increase in the biomass of native plant species in the field, highlighting the potential to restore livestock grazing opportunities.

Overall, few negative changes in native grassland composition were observed, although in the fourth year of the study indaziflam caused slight reductions in diversity and a shift in perennial grass composition with increases in Western Wheatgrass and reductions in Needle and Thread and Blue grama. However, one cautionary note was found, in that greenhouse trials conducted using young (establishing) native grass seedlings treated with indaziflam demonstrated negative root and shoot growth responses, thereby reinforcing the non-selective nature of indaziflam in affecting establishing plants. Thus, while indaziflam holds significant promise for helping to contain annual brome invasions into Alberta's native grasslands, some caution in warranted in its application, particularly if done frequently and at high rates, as this could alter the long-term recruitment and retention of important native plant species within these ecosystems. Additionally, indaziflam has a relatively long persistence in the soil which is how it depletes the annual weed seedbank in native grasslands, but also means that it is not a viable option within a seeded cropping system. Registration of indaziflam for use in Canadian rangelands in still pending, but is anticipated to be available within the next year or so.

Four years after herbicide treatments were applied (2023) and brome biomass and density in all treatments was very low.

Native grass cover and litter dominate instead of annual brome in 2023.