Integrating Grazing with 2,4-D and Florpyrauxifen to Control Broadleaf Weeds and Maintain Red Clover Productivity in Grass-Legume Pastures

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Key words: red clover; 2,4-D; florpyrauxifen; weed; grass-legume pastures

Abstract

In grass-legume pastures, 2,4-D-amine + florpyrauxifen-benzyl controls broadleaf weeds but red clover (*Trifolium pratense* L.) is eliminated. Grazing within a week prior to herbicide application is likely to reduce leaf surface area and may reduce red clover injury and maintain productivity. Experiments were conducted in 2020 and in 2021 to determine if red clover could be productive when 560 g ae ha-1 2,4-D-amine + 6.3 g ae ha^{-1} of florpyrauxifen-benzyl with 1% v/v methylated seed oil applied in the spring was grazed before or after herbicide application. Grazing timings occurred 6, 4, or 2 days prior to herbicide application, the day of application, or 6 days after application. Grazing timing did not affect productivity or cover of red clover, white clover, forage grasses, broadleaf weeds, or annual grasses. In contrast, aboveground biomass of broadleaf weeds, red clover, and white clover was >55, 56, and 44% less, respectively, in 2,4-D-amine + florpyrauxifen-benzyl treated pasture than nontreated pasture. Less clover and broadleaf weed biomass in herbicide treated pasture was associated with 16% more perennial grass biomass and no changes in total forage productivity. Results suggest that all grazing timings applied with 2,4-D-amine + florpyrauxifen-benzyl provided effective weed control that persisted more than 1 year with only partial injury to red clover populations. Grazing in concert with herbicide applications improves herbicide selectivity of preferentially grazed species, while improved from conventional standards practicality to producers is still unknown.

Introduction

Interest in improving pasture productivity and livestock performance exists among producers (Yucel & Taskin, 2018). The addition of legumes is one way to increase productivity and livestock performance (Beuselinck et al., 1994; Zegler et al. 2017). Red clover (*Trifolium pratense* L.) and white clover (*Trifolium repens* L.) are the most prevalent legumes utilized in grass-legume mixed pastures where they can contribute > 40% of the total forage production over the season (Zegler et al., 2018). Red and white clover populations need to be managed optimally in order to maximize benefits. Herbicides, a common weed management practice, eliminate red and white clover from pastures (Enloe et al. 2014). A recent commercial premix of 2,4-D-amine and florpyrauxifen-benzyl (2,4-D + florpyrauxifen) has shown promise in providing effective broadleaf weed control with minimal injury to white clover, however, red clover was eliminated the year of treatment and populations remained suppressed the year after application (Greene 2021). Given the importance of red clover to pasture production, interest in mitigating impacts to clover productivity with this premix of 2,4-D + florpyrauxifen exists among producers.

One potential way to reduce injury is to graze just prior to or after an application of 2,4-D + florpyrauxifen. The commercial premix of 2,4-D + florpyrauxifen has no grazing restrictions in the United States therefore could be applied during this timeframe (Goodis 2019). Grazing animals preferentially select red clover over weeds (Forwood et al., 1989); therefore, rotational grazing before an application could reduce clover biomass and leaf area with minimal effect on weeds. The objective of this research was to determine if altering the timing of grazing relative to 2,4-D + florpyrauxifen application reduces injury and allows for productive red clover populations while still providing acceptable weed control.

Methods

Experiments were conducted near Lancaster, WI (LARS) from May 2020 to May 2021 and repeated from May 2021 to May 2022. Pastures consisted of common perennial forage grasses including orchardgrass (Dactylis glomerate L.), smooth brome (*Bromus inermis* Leyss.), reed canary grass (*Phalaris arundinacea* L.) and tall fescue (*Festuca arundinaceae* Schreb.). Red and white clover were abundandant with cover of each >20% throughout both experiments. Broadleaf weed consisted of dandelion (*Taraxacum officinale* L.), buckhorn plantain (*Plantago lanceolata* L.), and broadleaf plantain (*Plantago major* L.). Yellow foxtail (*Setaria pumila*) was common (>10% cover) in September. The experimental design was a randomized split plot with three replications. The whole plot factor (0.4 ha) was time of grazing, and the subplot was herbicide application. Whole plots were grazed 6, 4, or 2 days before, the day of, or 6 days after herbicide application. The whole plot was randomly split into two subplots (0.2 ha) where one subplot was treated with 2,4-D + florpyrauxifen and the other subplot was the nontreated control. Herbicide was applied with a tractor-mounted sprayer equipped with flat-fan Teejet-XR11002 nozzles calibrated to deliver 140 L ha^{-1} of solution at a rate that consisted of a commercial premix of 560 g ae ha^{-1} 2,4-D and 9 g ae ha^{-1} florpyrauxifen and 1% v/v methylated seed oil. Herbicide was applied on May 27 in the first experiment (2020) and the second experiment (2021). Whole plots were rotationally grazed by 9-11 beef heifers and cows at a stocking density of between 10,000 and 11,000 kg ha^{-1} where animals grazed for 2 days until residual grass height was 10 to 15 cm. Animals were removed just prior to herbicide application on the day of grazing treatment. After grazing, plots were allowed to regrow for approximately 30 days resulting in three additional grazing events.

Plant cover and aboveground biomass were measured 1-2 days prior to grazing events. Percent cover of red clover, white clover, forage grasses, broadleaf weeds, and annual grasses were visually estimated. Aboveground biomass was estimated from four-eight 0.25-m^2 quadrats, sorted into plant categories described above, dried to constant mass and weighed. Biomass data were summed across the season for each class and among classes for analysis.

Statistical analyses were performed using the open-source statistical software R 4.0.4 (R Core Team 2014). Biomass, change in cover, and cover were analyzed by fitting mixed-effects models using the “lme4” package that included herbicide treatment, grazing timing, year, and their interactions as fixed effects, whereas block was a random effect. Significant interactions among experimental years were observed therefore variables were analyzed separately for each experiment. Comparisons of means were conducted using Tukey's HSD using the “emmeans” package and were considered significant when $P \leq 0.05$.

Results and Discussion

Weed Control

Rotational grazing at a moderate stocking density within 6 days before or after 2,4-D + florpyrauxifen application reduced broadleaf weeds as compared to pastures not treated with herbicide. Weed cover was <5% of total cover throughout the season and weed biomass was < 1% of total pasture biomass (Figure 1). While differential responses in weed biomass reductions were observed from herbicide treatment in the 2020 experiment (93%) vs the 2021 experiment (56%) broadleaf weed biomass was <50 kg DM ha^{-1} across both years (Figure 1). This result was consistent with previous research results (unpublished, Greene, 2021). Given that other studies were not grazed or mowed for 30 days after herbicide treatment this suggests that equivalent control can be achieved with 2,4-D + florpyrauxifen even if grazing occurs within 6 days of application.

Red and white clover response

Biomass of red and white clover was approximately 50% less when grazed 6 days before or after herbicide application as compared to nontreated pasture (Figure 1). While no other studies have evaluated the response of individual clover species, previous research observed a 70% (Greene 2021) decrease of combined legume biomass from 2,4-D + florpyrauxifen treatment. In this study, total white and red clover biomass in treated pasture was 790 kg DM ha^{-1}, equivalent to 58% less than nontreated pasture. This is a marked improvement over other active ingredients used in pasture weed management for which clover biomass was 85% less compared to nontreated pasture (Laird et al., 2016). Averaged over grazing treatments and experiments, red clover biomass was 50% less in treated compared to nontreated pasture. As red clover was still substantial contributing (12% cover and 7% of total biomass), this supports the hypothesis that grazing within 6 days of herbicide application improves red clover productivity when 2,4-D + florpyrauxifen is applied compared to previous research where no grazing or mowing occurred for 30 DAA (Greene, 2021). Surprisingly white clover productivity was 50% less in 2,4-D + florpyrauxifen treated pasture compared to nontreated pasture. Previous research suggested that white clover productivity was not impacted from spring applications (Greene 2021). The cause for the reduction in biomass from treatments grazed after application is not known and warrants additional research to identify potential reasons.

Forage and annual grasses

Perennial grass biomass was greater in treated areas (550 kg ha^{-1} increase, 16 %) than nontreated areas, and compensated for the loss in clover and weed biomass (Figure 1). This response is common when broadleaf weeds (Enloe et al. 2014; Renz 2010; Greene 2021) or legumes (Payne et al. 2010) are removed, although this doesn’t always occur (Payne et al., 2010; Strevey & Mangold, 2015). Similar to perennial grasses, annual grass biomass was greater in treated than nontreated areas (Figure 5 and 6). While annual grasses productivity was relatively low (<183 kg DM ha^{-1}) in treated pasture, the presence of foxtail seed heads are of concern as they have the potential to cause physical injury to livestock (Angelos, 2010).

Conclusions and/or Implications

The commercial herbicide premix 2,4-D + florpyrauxifen effectively controlled broadleaf weeds while reducing, but not eliminating white and red clover if grazed within 6 days (+/-) of application. Impacts to red and white clover were modest, but reductions in productivity were significant (50% less) for each species. While this approach shows promise with increased biomass of legumes after a broadcast application, additional research is needed to determine what scenarios would result in improved animal performance/profit from this premix.

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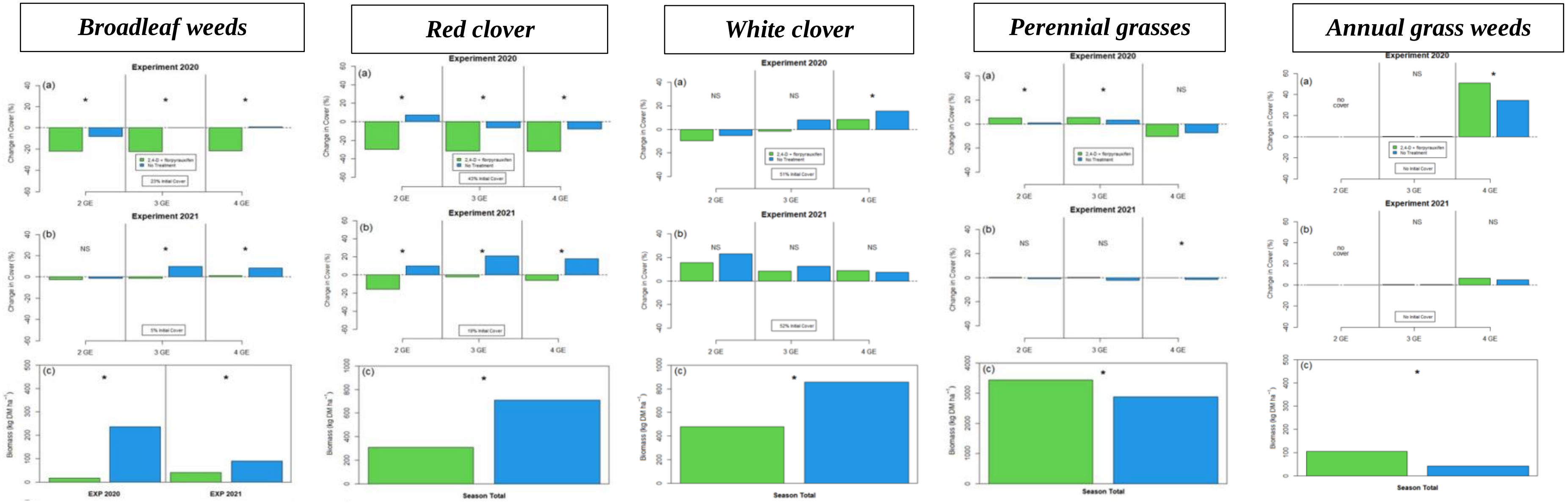

Figure 1. Broadleaf weeds, red clover, white clover, perennial grasses, and annual grass change in cover and seasonal biomass as affected by 2,4-D-amine + florpyrauxifen-benzyl (2,4-D + florpyrauxifen) or no treatment. Values represent means pooled across experiments conducted in 2020 and 2021 except for change in cover for which data were analyzed separately for each year due to significant interactions between experimental year and herbicide treatment.