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Drought Influences Control of Parasitic Flies of Cattle on Pastures Managed with Patch-Burn Grazing☆

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A B S T R A C T

We compared the influence of patch-burn grazing to traditional range management practices on abundance of the most economically injurious fly parasites of cattle. Horn flies (*Haematobia irritans*), face flies (*Musca autumnalis*), stable flies (*Stomoxys calcitrans*), and horse flies (*Tabanus* spp.) were assessed at study locations in Oklahoma and Iowa, USA, in 2012 and 2013. Experiments at both locations were spatially replicated three times on rangeland grazed by mature Angus cows. Grazing was year-long in Oklahoma and seasonal in Iowa from May to September. One-third of patch-burn pastures were burned annually, and traditionally managed pastures were burned completely in 2012 but not at all in 2013. Because of significant location effects, we analyzed locations separately with a mixed effects model. Horn flies and face flies were below economic thresholds with patch-burn grazing but at or above economic thresholds in unburned pastures in Iowa. Pastures in Iowa that were burned in their entirety had fewer horn flies but did not have fewer face flies when compared with no burning. There was no difference among treatments in horn fly or face fly abundance in Oklahoma pastures. Stable flies on both treatments at both locations never exceeded the economic threshold regardless of treatment. Minimizing hay feeding coupled with regular fire could maintain low stable fly infestations. Horse flies at both locations and face flies in Oklahoma were in such low abundance that treatment differences were difficult to detect or explain. The lack of a treatment effect in Oklahoma and variable year effects are the result of a drought year followed by a wet year, reducing the strength of feedbacks driving grazing behavior on pastures burned with patchy fires. Patch-burning or periodically burning entire pastures in mesic grasslands is a viable cultural method for managing some parasitic flies when drought is not a constraint.

Introduction

External parasites of beef cattle cause substantial financial losses, exceeding $2 billion annually in the United States (Byford et al., 1992). Parasitic flies of the order Diptera are some of the most damaging arthropods affecting grazing livestock (Huddleston et al., 1974). Production losses associated with fly parasites are directly attributed to blood loss, annoyance, disease exposure, reduced foraging time, and reduced gains (Harvey and Launchbaugh, 1982; Buxton et al., 1985; Boland et al., 2008). Considering that approximately 50% of the US beef cattle herd relies on the forage base of central North American grasslands, the ecology and management of these grasslands may have meaningful implications for fly parasite mitigation and profitability of beef enterprises (USDA-NASS, 2012).

Before European settlement, central North American grasslands burned regularly due to natural and anthropogenic ignitions followed by ungulate focal grazing on recently burned areas (Anderson, 2006). Over the past 2 centuries, settlement patterns and domestic livestock grazing have largely resulted in the removal of these fire and grazing disturbances in favor of a more utilitarian approach to rangeland management (Pyne, 1997). These changes have included removal of bison and replacement with domestic livestock, fire suppression, and moderate forage utilization across the landscape. Rangeland ecologists have recently suggested a different management paradigm is needed for conservation of patterns and processes essential to conserving biodiversity in these fire-dependent grasslands (Fuhlendorf et al., 2012). Rather than fire suppression and moderate utilization of forage across the landscape associated with traditional rangeland management, it is argued that fire

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and grazing should be allowed to interact through space and time across the landscape (Fuhlendorf and Engle, 2001). The primary management tool to restore the fire-grazing interaction has been called *patch-burn grazing*. Functionally, it is applied by burning spatially discrete patches of a pasture and allowing cattle to select where they want to graze. Patch-burn grazing results in a mosaic of patches with variable probabilities of igniting or being grazed that shifts through space and time (Fuhlendorf and Engle, 2004).

The interaction of fire and grazing creates structural heterogeneity of the vegetation benefitting many trophic levels of wildlife (Fuhlendorf and Engle, 2004; Leis et al., 2013). Consequently, this regular application of fire also mitigates invasive plant encroachment and maintains native herbaceous plant dominance in grasslands (Cummings et al., 2007). Although the benefits to biodiversity are well documented, researchers have only recently reported benefits to livestock production. Patch-burn grazing can sustain cow-calf and stocker cattle production compared with traditional management and can stabilize losses associated with climate variability (Limb et al., 2011; Allred et al., 2014).

Patch-burn grazing also can reduce external parasites on cattle. Horn flies (*Haematobia irritans*) on cows during peak periods of activity were reduced on patch-burned pastures compared with pastures not burned at all (Scasta et al., 2012). Season-long tick burdens on cows and calves were also reduced with patch-burn grazing compared with not burning or burning the entire pasture (Polito et al., 2013). These results are encouraging because no other cultural livestock parasite management practice has been developed that can be logistically applied across large landscapes. Furthermore, using insecticides to control livestock parasite results in adverse effects including development of insecticide resistance by the parasite and off-target effects. These concerns drive the need to develop cultural methods that could minimize applications of insecticides (Spratt, 1997; Oyarzún et al., 2008).

A recent study reported parasitic fly response to fire and grazing (Scasta et al., 2012), but the study reported only a single fly species, assessed only peak periods of activity, and compared only patch-burn grazing with no burning. Therefore, our objective was to expand on that previous work to better understand how fire and grazing interactively affect season-long numbers of the most injurious parasitic flies of beef cattle on central North American grasslands: (horn flies, face flies *[Musca autumnalis]*, stable flies *[Stomoxys calcitrans]*, and horse flies [*Tabanus* spp.]). Of these four species, horn flies are vectors of mastitis (McDougall et al., 2009), face flies are vectors of pinkeye and nematode eyeworms (Hall, 1984; O'Hara and Kennedy, 1991), stable flies transmit anthrax (Turell and Knudson, 1987), and horse flies are vectors of at least 30 viral, bacterial, protozoal, and helminth disorders including anaplasmosis (Krinsky, 1976; Hawkins et al., 1982). All species, except face flies, are vectors of bovine leukosis (Buxton et al., 1985). We hypothesized that 1) fire would result in lower numbers of parasitic flies compared with not burning, 2) patchy fires would result in a lower number of parasitic flies than burning an entire pasture, and 3) the effect of patch-burn grazing on parasitic flies would be similar across locations.

Materials and Methods

In 2012 and 2013, we examined patch-burn grazing experiments in Oklahoma and Iowa, United States, that were established in 1999 and 2006, respectively. Parasitism of cattle by four species of parasitic flies was assessed on pastures managed with patch-burn grazing (PBG) and compared with more traditional management. The traditional management approach was considered the control treatment in which a pasture was burned in its entirety followed by no burning the following 2 years, henceforth referred to as the grazing and burning (GAB) treatment. Experiments at both locations were spatially replicated three times with three patch-burn grazed pastures and three control pastures. All cattle were mature beef cows *(Bos taurus)* of the Angus breed (Franks et al., 1964). Mean pasture area was 55 ha in Oklahoma and 27 ha in Iowa. The Oklahoma experiment used year-long grazing with stocking rate of 2.6 ± 0.1 AUM · ha^{-1} in 2012 reduced to 1.8 ± 0.1 AUM · ha^{-1} in 2013 due to drought in 2011 and 2012. The Iowa experiment used seasonal grazed from May to September with stocking rate of 2.6 ± 0.3 AUM · ha^{-1} in 2012 and 2.4 ± 0.4 AUM · ha^{-1} in 2013.

At both locations, we used a 3-year fire-return interval. In PBG pastures, a different third of the pasture was burned each year. In Oklahoma, one-sixth of each PBG pasture was burned each spring (March or early April) and one-sixth burned each growing season (July through October depending on burn bans and fire weather). In Iowa, one-third of each PBG pasture was burned in the spring (March or early April). Cattle in the Oklahoma study were never removed from the study pastures, and they remained in the study pastures when pastures were burned. GAB pastures at both locations were burned in spring 2009 and again in spring of 2012. GAB pastures were not burned in 2010, 2011, or 2013. Pastures and patches were burned by lighting back-fires and flank-fires to build sufficient fire breaks before igniting headfires in a ring fire technique (Weir, 2009). In Iowa, cattle were put on pastures between April 20 and May 2, with an average of April 23 $\pm$ 2 days, regardless of treatment or when fires were conducted. In 2012, when all treatments were burned, mean time to stocking after fire was 42 ± 10 days and 47 ± 7 days, GAB and PBG respectively. Mean time to stocking after fire was 21 ± 6 days after fire in 2013 for PBG, but burning was more than 2 weeks later than 2012 due to weather constraints.

Vegetation at the Oklahoma study location is dominated by perennial C4-tallgrass prairie grasses including big bluestem (*Andropogon gerardii* Vitman), little bluestem (*Schizachyrium scoparium* [Michx.] Nash), and indiangrass (*Sorgastrum nutans* [L.] Nash). Vegetation at the Iowa study location is codominated by the aforementioned species, earlier successional grasses and forbs, and the exotic C3-grass tall fescue (*Schedonorus arundinaceus* [Schreb.] Dumort., nom. cons.).

We assessed the same four species of parasitic flies at both locations: horn flies, face flies, stable flies, and horse flies. Sixty-four tabanid species have been identified in Oklahoma (Wright et al., 1986), but for this study, we identified tabanids only to genus. The most common tabanid species was *Tabanus abactor*, but several other species including *T. sulcifrons* were observed in our samples. Flies were assessed weekly from May to October in Oklahoma and May to August in Iowa. We collected digital photographs of one side of each of four randomly selected cows in each pasture at each sampling date taken between 0700 am and 1100 am (Thomas et al., 1989; Lima et al., 2002; Boland et al., 2008) from a distance of < 30 m and included the single side of each cow (Pruett et al., 2003; Castro et al., 2005). This procedure of randomly selecting new animals that are a subset of the total herd (or replicate group) for monitoring flies has been used in previous livestock entomology studies (Harvey and Brethour, 1979; Haufe, 1982; Kinzer et al., 1984; Kunz et al., 1984; DeRouen et al., 2009, 2010; Li et al., 2011). To assess face flies, we limited images to those in which cows were standing broadside to the camera with the head turned facing the camera so that eyes and nostrils were visible. Images were then systematically evaluated in the laboratory by the same trained technician for the duration of the project. The technician overlaid a digital grid on each image and used digital zoom to count the number of each fly species per cow. None of the herds received insecticides for fly parasites during the study.

Because cattle are free ranging, it is nearly impossible to position yourself the same distance for all photos. However, we used the optical zoom feature of the lens to account for this in the field and