Back to the Future: How Do We Get There From Here?

Making Restoration Work

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Abstract

Extreme temperatures and long periods of drought observed with increasing frequency in the southeastern United States (U.S.) have demonstrated the need to develop more robust forage systems. Native warm-season grasses (NWSGs) are well adapted to fill this role, but their expanded use comes with several challenges, most notably, reliable establishment. The high cost of site preparation, high cost of seed, and slow initial growth of NWSG seedlings must be addressed to achieve increased adoption of NWSG in the eastern U.S. If these challenges are overcome, incorporating NWSG into grazing systems would benefit producers by filling the summer forage gap, mitigating drought risk, and extending the grazing season, while also enhancing native biodiversity.

Introduction

Native warm-season grasses are productive forages that produce high rates of gain in cattle. (Burns and Fisher 2012; Keyser et al. 2016; Monroe et al. 2017). In addition, using NWSGs as part of a forage plan can reduce the need to feed hay during summer, reduce exposure to endophyte-infected tall fescue (TF) (*Schedonorus arundinaceus*), and allow cool-season paddocks to rest during the heat of summer (Anderson 2000, Hoveland 1992, Kallenbach 2015). While forage programs containing NWSGs have several benefits, the biggest challenge to incorporating them is seen during establishment (Barnes 2004 et al., Dewald 1996 et al., Muir 2016 et al.) because they are slow growing as seedlings and compete poorly with other non-native grasses and annual weeds (Barnes 2004 et al., Keyser et al. 2015, Lawrence et al. 1995).

Because of their slow initial growth and allocation of energy to root development, it can take NWSGs a full season or more to fully establish (Miller 1998, Torok et al. 2012). Furthermore, to limit impact on their first-year root production, grazing in the first season is discouraged (Doll 2011 et al., Lawrence et al. 1995, Miller 1998, Torok et al. 2012, Washburn and Barnes 2000). This foregone forage production is a concern for many producers. Therefore, finding approaches that can successfully propagate NWSGs while also off-setting lost forage production could help overcome a major barrier to the adoption of NWSGs.

Best practice

Recommendations for establishing NWSG pastures typically include elimination of competition before planting and continued aggressive management of such competition through the NWSG's early development **(**Barnes et al. 2000, Doll et al., 2011**)**. Competition control commonly comes via application of broad-spectrum herbicides but can also be accomplished via tillage and fire (Doll et al. 2011**,** Washburn and Barnes 1999, 2000). When these methods are utilized correctly, usually in combination, NWSGs tend to develop into productive stands with very few weeds (Doll et al. 2011**,** Hall et al. 2012, Washburn and Barnes 2000).

Studies involving the establishment of NWSGs have historically focused on sowing methods, chemical weed control, and achieving adequate stocking to ensure weed suppression and long-term productivity (Barnes et al. 2004, Dewald et al. 1996, Hall et al. 2012, Washburn and Barnes 2000). These best practices rely on improved herbicide options such as imazapic (5-methyl-2-[4-methyl-5-oxo-4-(propan-2-yl)-4,5-dihydro-1H-imidazol-2-yl]pyridine-3-carboxylic acid), modifications to seed drills, high quality seed, and greater experience. Regardless, a one- to three-year period is still required before these grasses are ready for forage production (Meyer and Gaynor 2002, Torok et al. 2012). As such, development of methods that can establish NWSGs while remaining economically viable in the first season should be explored (Keyser et al. 2019a).

Closing the gap

In the last several decades however, there has been an increased push towards more sustainable agriculture and the adoption of NWSGs in forage programs has garnered more attention.

Companion Crops

One line of research directed at finding a profitable first-season approach is the use of companion crops, either cover crops or nurse crops. Cover crops can provide a measure of weed control (directly through competition or, potentially, through allelopathy), be used as forage prior to planting season, incorporated as green manure, and improve soil characteristics (Haramoto and Gallandt. 2004, Richwine et al. 2021, Sadeghpour et al. 2014a, Singh et al. 2003). Any combination of these traits can ease the loss in productivity normally associated with NWSG establishment (Hedtke et al. 2014, Keyser et al. 2016, Sadeghpour et al. 2014a, Singh et al. 2003).

While there have been studies using nurse crops during NWSG establishment (Richwine et al. 2021), the majority of them focused only on establishing switchgrass (SG) or were conducted in the northern U.S. (Hedtke et al. 2014, Sadeghpour et al. 2014b). Nurse crops have also been successfully used alongside NWSG in mine reclamation and roadside restoration (Brown et al. 2010, Miller 1998). However, use of nurse crops during the seedling year has not been studied extensively in NWSG grazing systems and may have the potential to mitigate lost forage production. Further studies are needed to examine the benefits of these practices on the other agriculturally relevant NWSGs such as big bluestem (*Andropogon gerardii*) (BB), little bluestem (*Schizachyrium scoparium*) (LB), and indiangrass (*Sorghastrum nutans*) (IG) in the eastern U.S.

Site preparation

Native warm-season grasses require a high-quality seedbed for successful establishment (Dewald et al. 1996, Keyser et al. 2019b). Thus, in addition to weed control, producers must also ensure that heavy thatch is removed before planting. Thresholds for the amount of thatch that can be left on the seedbed without interfering with successful establishment have not been established. Lastly, additional data are needed regarding lower thresholds for P and pH, and their interactions, for successful NSWG establishment.

Current research

During the last decade, research on NWSG establishment in the eastern U.S. have included dormant-season planting, planting behind winter annuals (WA), managing warm-season annual nurse crops (WSA) through grazing, and various seedbed manipulations. Dormant-season planting successfully established SG with a March planting indicating the potential for a broader planting window than traditionally thought practical (Keyser et al. 2015). A 2008-10 study observed that there was no penalty to NWSG seedling stand density or second-year yield when preceded by a small grain cover crop (Keyser et al. 2016b). Similarly, a wheat cover crop with combinations of N fertilizer and an insecticide-fungicide seed treatment also found dormant-season planting to be successful suggesting a small grain cover crop could help offset lost forage production (Keyser and Ashworth 2022).

A 2016-17 study investigated browntop millet (BTM) as a nurse crop during BB and SG establishment. Using BTM reduced NWSG seedling density, however, in all cases, the resulting stands were still within the acceptable density range (Richwine et al. 2021). In 2019, an extension publication was cooperatively developed and published by TN, Auburn, and GA Extension highlighting current best practices for NWSG establishment in the eastern U.S. (Keyser et al. 2019b).

Several ongoing studies are examining nurse crops as well as site preparation techniques. These include a trial using WSAs during the establishment period and grazing those WSAs to manage competition with developing NWSG seedlings (K. Swilling, University of Tennessee, unpublished data). In another trial, thatch cover depth of 1 cm reduced NWSG seedling recruitment by 50% (K. Swilling, University of Tennessee, unpublished data). In an effort to better understand the role of soil phosphorus (P), pH, and their interactions on germination and seedling development of NWSGs observed that soil P and pH levels above medium soil test recommendations did not increase plant height and that taproot length increased at the low P and pH level. Indicating no benefit to raising P and pH above medium but that at lower pH's, plants may invest more energy into root length development at the expense of aboveground plant height. The same trend was observed in total plant biomass, wherein the lowest soil P level produced the least biomass, but the highest level did not increase total plant biomass over that of the medium level (K. Swilling, University of Tennessee, unpublished data).

Conclusion

This and similar research continues to elucidate the intricacies of NWSG establishment with the intent of reducing the first-year forage loss during NWSG establishment. Improved establishment success will increase adoption of NWSGs as a viable forage tool. Extreme temperatures and drought are not exclusive to the southeastern U.S. however, so the principles and experience gained from these and similar trials may further benefit grassland restoration efforts around the globe.

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