ABSTRACT

In the Northern Great Plains, spring seeding is the most commonly-selected season for perennial forage establishment. With historically plentiful spring moisture, most producers find it the best time to guarantee adequate stand establishment. However, in recent years, with increases in the number of irrigated acres, altering timing of establishment may be a more feasible option. This study evaluated the impact of a later seeding date on forage establishment and yield. Research was conducted at the USDA-NRCS Bridger Plant Materials Center in Bridger, MT. Two establishment dates were evaluated: early June, 2015 (spring planting), and late July, 2015 (summer planting). Research was conducted using a replicated completely randomized block design testing eight different cool-season, perennial forage cultivars. Each treatment was replicated four times within each block. There was a significant impact of seeding date on plant count, with summer plantings having higher plant density compared to spring plantings ($P = 0.039$). There was a trend ($P = 0.052$) for an effect of variety on weed count, with summer plantings having higher weed density compared to spring planting. There was no significant impact ($P = 0.522$) of seeding date on plant yields the year after establishment, but there was an impact of harvest and variety on plant yields ($P < 0.001$). When water availability is not limiting, summer planting may be a feasible option for perennial forage establishment. However, care must be taken to allow for adequate plant growth prior to first frost.

INTRODUCTION

In the Northern Great Plains, spring seeding is the most commonly-selected season for perennial forage establishment. With historically plentiful spring moisture, most producers find it the best time to guarantee adequate stand establishment. However, in recent years, with increases in the number of irrigated acres (USDA, 2016), altering timing of establishment may be a more feasible option.

Planting later in the season offers several advantages: it spreads out the workload, as many producers are very busy in the spring; it often has decreased weed pressure, with summer annual weeds being more prominent compared to cool season annual and perennial weeds; it allows for potential double cropping after an annual crop has been harvested; and it provides for an extra herbicide application prior to planting. There are also some disadvantages to summer seeding,
including moisture shortage, which can lead to decreased germination and growth, as well as frost damage that may occur if stands are planted too late (Collins et al., 2017).

Previous studies performed many years ago evaluated the impact of seeding date on stand performance. Blaser et al. (1956) measured the seedling growth rate and stand density of several species of grasses and legumes planted in March or August in Virginia. They found that species had significant effects on plant growth, as well as sowing date, but that summer-seeded species such as alfalfa (*Medicago sativa* L.) produced adequate stands when compared to their spring-seeded counterparts. Legumes most commonly had higher rates of growth when seeded later in the year compared to cool season grass species, likely due to higher optimum temperature requirements associated with legume growth. Buxton and Wedin (1970) evaluated yields of forages using five establishment methods in Iowa. They found that seeding alfalfa, smooth bromegrass (*Bromus biebersteinii* Roem. & Schult. [excluded], reed canarygrass (*Phalaris arundinacea* L.) and orchardgrass (*Dactylis glomerata* L.) in August resulted in greater second-year yields compared to when these species were seeded in April.

Although some studies indicate similar or better performance for summer compared to spring seeding of perennial forages, Buxton and Wedin (1970) found that for all species evaluated, summer seeding of perennial forages often resulted in increased presence of weeds. It should be noted that in this study, the spring plots were hand-weeded during the growing season of the seeding year, likely resulting in lower weed counts the following year. In contrast, Hall et al. (1995) evaluated weed control practices for spring and summer alfalfa establishment and found that on average, first harvest of summer-seeded plots only consisted of 653 lbs/ac weed content, compared to 828 lbs/ac in the spring-seeded plots.

While there have been several studies conducted in the past evaluating seeding date and impact on stand performance, many of them are several decades old, utilize older cultivars, and have not been conducted under Montana conditions. Therefore, the objectives of this experiment were to evaluate the impacts of seeding date on eight different cultivars planted in flood irrigated fields in southeastern MT, a semi-arid environment. We hypothesized that a later seeding date, coupled with adequate water availability, would not negatively impact stand establishment and production in years after establishment.

**MATERIALS AND METHODS**

**Site Description and Experimental Design**

The experiment site was located at the USDA-NRCS Bridger Plant Materials Center in Bridger, MT (45°17’12.7”, 108°, 53’9.7”). The soils of the site were Heldt silty clay loam. The mean average precipitation was 11.5 inches (WRC, 2000). Soil samples were taken from the research site in spring 2015 and fertilizer was applied according to soil analysis recommendations.

The experiment was arranged as a replicated randomized complete block design, consisting of six cultivars (two from each species), each replicated four times. The first block, consisting of four replicates, was established on June 12, 2015 and was designated as the “spring” planting, while the second block, also consisting of four replicates, was established on July 27, 2015, and was designated as the “summer” planting. The spring planting occurred slightly later than normal due to delays in procuring seeding equipment and plot preparation. The plot area was irrigated using flood irrigation. Each plot measured 5.9 ft x 19.7 ft.
The cultivars selected for this study are some of the most common introduced cool season perennial grass cultivars planted in Montana and included two cultivars of alfalfa, ‘Shaw’ and ‘Cooper’, two cultivars of meadow bromegrass, ‘Cache’ and ‘Macbeth’, and two cultivars of pubescent wheatgrass \(\text{Thinopyrum intermedium}\) \([\text{Host} \text{ Barkworth & D.R. Dewey}\), ‘Manska’ and ‘Oahe’. Two cultivars of sainfoin \((\text{Onobrychis viciifolia}\) Scop.), ‘Shoshone’ and ‘Delaney’ were also planted, but yield data is not included due to heavy wildlife predation concentrated in these plots only. Figure 1 depicts the effects of wildlife pressure on sainfoin establishment.

Plots were established using a Hege (Colwich, KS) single-cone plot drill with 10.2 inch row spacing. Plots were seeded at a rate of approximately 9.8 lbs pure live seed (PLS) per acre for ‘Manska’, ‘Oahe’, ‘Macbeth’, and ‘Cache’, 7.9 lbs PLS per acre for ‘Shaw’ and ‘Cooper’, and 29 lbs PLS per acre for ‘Delaney’ and ‘Shoshone’.

Prior to establishment in the spring plots, the area was sprayed with glyphosate at a rate of 20 oz. per acre. Plots were hand-weeded on July 8, 2015 in the spring seeded plots, as there were minimal amounts of weed invasion. An additional application of glyphosate was applied to the summer plots immediately prior to planting. Plots were not harvested during the 2015 growing season due to insufficient resources, and were only evaluated the following year in 2016.

**Field Sampling**

Plant counts were taken the year after establishment on April 26, 2016 and June 9, 2016. Two, 1 ft x 1 ft quadrats were randomly thrown into each plot. Plants within each quadrat were counted individually and used to represent plant count. Herbage mass production was determined using a single 3 ft x 20 ft strip taken from the middle of each plot at each harvest using a Carter plot harvester \((\text{Carter Manufacturing Co., Brookston, IN})\). All plots were harvested twice in 2016: first harvest was taken on June 20, 2016, and the second on August 15, 2016. Samples were collected and fresh weights were taken immediately in the field. Samples were then taken to Montana State University \((\text{Bozeman, MT})\) where they were placed in a forced-air oven at 60 degrees Celsius to dry for 72 hours, or until two consecutive dry weights were recorded. This
method was used to obtain the dry matter production in order to evaluate yield differences across cultivars. Dry matter (DM) was calculated as: DM = (wet weight - dry weight)/ dry weight.

**Statistical Analysis**

Effect of harvest, variety, and planting date on yield, plant count, and percent weed were measured using the GLM procedure in SAS (version 9.4; SAS Inst. Inc., Cary, NC). Significance was determined at $P \leq 0.05$ for all analyses in this study, with a trend considered at $P \leq 0.10$.

**RESULTS AND DISCUSSION**

There was an impact of planting date on plant densities ($P= 0.04$). The summer established treatments had a higher plant count compared to spring established treatments during evaluations in both April and June of 2016 (Table 1). When evaluated in June, summer established plots had significantly higher counts, with 2.6 plants/ft$^2$, compared to 2.1 plants/ft$^2$ in the spring established plots. There was no effect of variety on plant count ($P > 0.05$), with all varieties having statistically similar plant densities. Additionally, there was no effect of planting date on weed count ($P = 0.30$), with summer established plots having similar weed counts as their spring established counterparts.

**Table 1.** Impact of planting date on plant counts of evaluated entries taken twice following the year of establishment. This table presents the average of all cultivars within the trial. USDA-NRCS, Bridger, MT.

<table>
<thead>
<tr>
<th>Date Evaluated</th>
<th>Spring Planted (June 2015)</th>
<th>Summer Planted (July 2015)</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>April (2016)</td>
<td>4.3*</td>
<td>5.1†</td>
<td>± 0.3</td>
</tr>
<tr>
<td>June (2016)</td>
<td>2.1a</td>
<td>2.6b</td>
<td>± 0.1</td>
</tr>
</tbody>
</table>

*a,b Denotes significant effect of planting date on plant count

*+,† Denotes a trend towards an effect of planting date on plant count

Although differences in plant count for spring compared to summer seeding dates were not significantly different amongst the cultivars ($P > 0.05$), numerical differences for plant count were observed in the ‘Manska’ bromegrass cultivar (Table 2). Plant count for ‘Manska’ was 3.1 and 4.9 plants/ft$^2$ for spring and summer seeded plots, respectively, and had the lowest density of all entries. This is most likely the cause for the trending effect of planting date on plant density mentioned above. These results correspond with the results of Blaser et al. (1956) and Buxton and Wedin (1970) who found that in some summer seeded perennial forages, performance can be similar, or even higher when seeded in the summer, rather than in the spring.
There was a trend for an effect of variety on weed count ($P = 0.06$), with alfalfa having lower weed densities compared to grass plots (Table 3). Average values for weed percent were 16.3% in the alfalfa varieties, and 27.4% for the meadow bromegrass and wheatgrass varieties. These results suggest that wheatgrass and meadow bromegrass cultivars were less competitive against weeds than alfalfa cultivars at this site. Weed count in wheatgrass plots might be explained by the effect seeding rate has on wheatgrass growth and its ability to compete with weeds, as described by Sheley et al. (1999). Hybner and Jacobs (2012) justified this phenomenon by comparing various wheatgrass cultivars. The results of Hybner and Jacob’s study concluded that the ‘Oahe’ cultivar was the slowest to grow in the spring, with only 16% of total growth observed by mid-May and 30% of total growth observed by mid-June. Peak wheatgrass production in Hybner and Jacob’s study occurred by late July to mid-August.

Individual cultivars did have a significant impact on yield ($P < 0.001$), with 2016 total production for the two bromegrass cultivars being significantly lower than the other cultivars (Figure 2). Additionally, harvest 1 had significantly higher yields ($P < 0.001$) for all varieties compared to harvest 2 yields, which was expected, particularly for the grasses, as cool-season grasses generally exhibit lower production during summer months. It is common for first harvest yields to exceed second harvest yields in Montana for cool-season perennials because maximum rates of photosynthesis for cool-season grasses are in the spring, when temperatures are between 64 and 75 degrees Fahrenheit, and spring moisture is plentiful (Volesky et al., 2010).
Interestingly, there was not a significant impact ($P = 0.62$) of planting date on forage yield the year after establishment, with summer established plots having similar production to spring established plots. One would assume that an effect of planting date on plant density would lead to a corresponding effect of planting date on forage yield. However, in this study, higher plant density associated with summer seeded cultivars was not associated with higher yields. This finding indicates that from a yield standpoint, summer seeding can be comparable to spring seeding in Montana. However, from an economic standpoint, it should be noted that in Montana, producers who seed forages in the summer will most likely not be able to harvest summer seeded forages during the seeding year due to temperature and timing of first frost. Producers who seed forages in the spring are more likely to get at least one harvest during the seeding year, which might be more economical in some situations, and was a limitation in the current study.

**CONCLUSION**

Choosing to delay planting is a management decision that is situation dependent and limited by resource availability and production goals. Under irrigation, or when water is not a limitation, a delayed planting may be a successful option for establishing perennial forages without negatively impacting forage production. Care must be taken so enough time is provided between planting and the first killing frost to allow for adequate growth. While this study did not include an economic evaluation of planting dates, later planting may be a viable option in instances where producers are pressed for time during the spring, as long as water is plentiful. Further research is warranted to determine the economics associated with seeding date of perennial forages.
LITERATURE CITED


WRC. 2000. Western Regional Climate Center. Tuweep, Arizona Station Report, Reno, Nevada, USA.

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