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Interseeding berseem clover in winter wheat

Randy L. Anderson*

USDA-ARS, Brookings South Dakota, SD 57006, USA.
*Corresponding author: randy.anderson@ars.usda.gov

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Abstract

Interseeding annual clovers in cereal grains may help organic producers reduce use of tillage following cereal harvest. Using clovers that winterkill would minimize need for tillage in the spring also. The objective of this study was to evaluate seedling emergence and survival of berseem clover (*Trifolium alexandrinum* L.) in winter wheat (*Triticum aestivum* L.). Berseem clover (hereafter, referred to as berseem) was planted 0, 2 and 4 weeks after initiation of winter wheat growth in the spring. Berseem density was highest when planted on April 12, 2 weeks after winter wheat broke dormancy. Establishment density was 40–80% less with the other planting dates. A dry interval during the 5 weeks preceding winter wheat harvest reduced seedling survival of berseem, killing more than 80% of seedlings. Winter wheat yield was reduced at the last planting date of berseem, which was attributed to mechanical injury to winter wheat by the drill when planting berseem. Berseem may not be viable for interseeding at this location or in drier regions. Clover species that are more drought tolerant will be needed.

Key Words: drought, mechanical injury, no-till, planting date, seedling survival

Introduction

Interseeding can be used to establish legumes in cereal grains. For example, alfalfa (*Medicago sativa* L.) is commonly interseeded with oat as a companion crop during establishment. Also, clovers can be interseeded in cereal grains (Blaser et al., 2011; Amosse et al., 2013.) to increase nitrogen levels in soil (Clark, 2012), yield of subsequent crops (Ghaffarzadeh, 1997) and soil protection (Hartwig and Ammon, 2002). Because of their slow growth, clovers rarely affect grain yield of the cereals (Picard et al., 2010; Amosse et al., 2013).

An additional benefit of interseeded clovers in cereal grains is suppressing weed growth following cereal harvest (den Hollander et al., 2007; Kruidhoff et al., 2008). For example, red clover (mammoth type) interseeded in early April when winter wheat was tillering reduced biomass of after-harvest weeds, such as volunteer grains, more than 98% compared with a no-till control (Anderson, 2016). Weed seed production was almost eliminated.

Organic producers would like to reduce the amount of tillage in their farming systems (Carr et al., 2012; Armengot, et al., 2015). Weed suppression by interseeding can eliminate tillage during the interval following cereal grain harvest (Anderson, 2015). Furthermore, tillage may not be needed the following year, if the interseeded clover winterkills. A limitation with interseeded red clover, however, is that it does not winterkill in eastern South Dakota (Anderson, 2015), so tillage is required the following year before planting the next crop. Annual clovers, such as berseem, are more susceptible to winterkill (Ghaffarzadeh, 1997; Clark, 2012) and may be more suitable for interseeding with no-till systems.

In our initial research with berseem, density of berseem planted on April 1 was lower than expected at cereal harvest (Anderson, 2017a). We speculated that frost in the spring may have killed berseem seedlings, as clovers can be injured by cold temperatures (Meyer and Badaruddin, 2001). To minimize cold temperature impact on seedling survival, berseem could be planted later in the spring (Badaruddin and Meyer, 2001), but competition from the cereal canopy may reduce seedling survival (Blaser et al., 2011). Therefore, our objective with this study was to evaluate establishment and survival of berseem interseeded into winter wheat, as affected by planting date of berseem.

Materials and Methods

The study was conducted on a Barnes-Buse loam soil in 2016 near Brookings, SD, where yearly precipitation is 580 mm. Three planting dates were evaluated for establishing berseem in winter wheat, 0, 2 and 4 weeks after winter wheat started spring growth. Winter wheat was

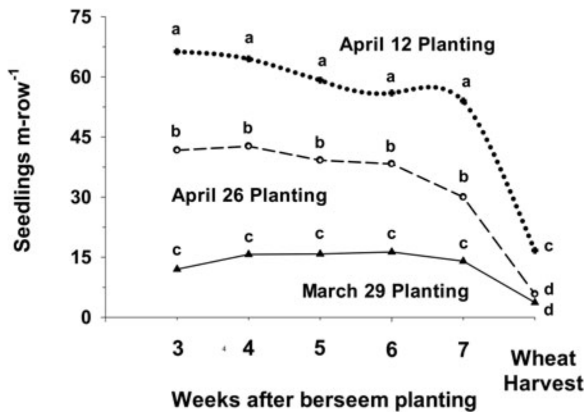

Figure 1. Density of berseem in weeks 3–7 and at winter wheat harvest, as affected by berseem being planted on March 29, April 12 or April 26. Means with the same letter are not significantly different based on the Fisher LSD (0.05).

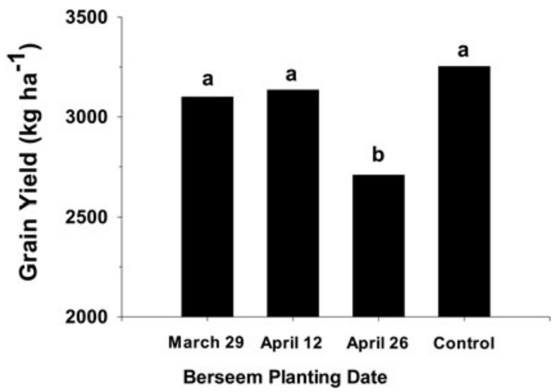

Figure 2. Grain yield of winter wheat when berseem was interseeded at three dates. Bars with the same letter are not significantly different based on the Fisher LSD (0.05).

planted September 12, 2015, whereas berseem was planted March 29, April 10 and April 24, 2016. Winter wheat had initiated spring growth by late March, and was tillering at the first two planting dates of berseem and at stem elongation for the last planting. A winter wheat treatment with no cover crops was included as a control.

Winter wheat was planted at 3 million seeds ha^{-1} and berseem at 14 kg ha^{-1}. Varieties were 'Expedition' winter wheat and 'Balady' berseem. Winter wheat was planted at 5 cm depth and berseem at 1 cm depth with a no-till drill equipped with single disc openers. No fertilizers were used in the study. Treatments were arranged in a randomized complete block design with four replications; plot size was 7 m × 20 m.

Seedling establishment and density of berseem were recorded in 1-m row sites, starting 2 weeks after planting and continuing for 6 weeks. A final density was recorded at winter wheat harvest. Five sites were established in each plot and permanently marked for repeat measurements.

Grain yield of winter wheat was determined by harvesting an area, 2 m × 20 m, in each plot with a plot combine on July 20, 2016. Yield data are expressed at 13.5% moisture. Weather data were recorded at an automated station within 0.5 km of the study (climate.sdstate.edu/awdn/archive/Brookings).

After data analysis (Statistix 9, Analytical Software, Tallahassee, FL), treatments means were compared with Fisher's LSD (0.05). Assessment of berseem seedling density across time was analyzed with the repeated measures procedure.

Results and Discussion

The highest density of berseem, 68 plants m-row^{-1}, occurred when planted on April 12, 2 weeks after winter wheat started spring growth (Fig. 1). In contrast, only 15 plants m-row^{-1} established when berseem was planted March 29. Berseem density at the April 26 planting was almost 40% less than when berseem was planted April 12. Competition by winter wheat may have suppressed seedling germination and emergence with the last planting date.

We recorded berseem seedling survival across time to understand factors affecting seedling establishment and survival. Based on our initial study with berseem (Anderson, 2017a), we speculated that berseem seedlings may have been killed by spring frosts. Clover seedlings are sensitive to cold temperatures, but this sensitivity varies with growth stage and duration of freezing temperatures (Badaruddin and Meyer, 2001; Meyer and Badaruddin, 2001). In our study, maximum density of berseem seedlings usually was observed 3 weeks after planting (Fig. 1). Number of seedlings did not vary in the first 7 weeks after planting within any planting date. Thus, cold temperatures likely did not kill berseem seedlings. Temperatures as low as −8°C occurred after berseem seedlings had emerged, but seedling death was not observed in weekly counts. Rather, we suggest that cold soil temperatures inhibited seed germination and seedling emergence with the first planting date of berseem.

However, more than 80% of berseem seedlings died in the 5-week interval before winter wheat harvest, averaged across all planting dates (Fig. 1). The treatment with the highest density, berseem planted on April 12, had only 15 seedlings alive at winter wheat harvest, compared with a maximum of 68 seedlings. We attribute seedling death to drought and winter wheat competition. Rainfall during the latter part of the growing season was 23% below normal in 2016.

Interference from berseem did not affect yield of winter wheat at the first two planting dates (Fig. 2). Yield was less at the April 26 planting date, which we attribute to possible crop injury by the drill. Winter wheat was in the stem elongation stage of development during planting, and stems may have been mechanically injured; visible injury was noticeable for weeks after the planting operation.

Our study demonstrated that planting berseem in mid-April, 2 weeks after winter wheat begins spring growth, was most effective for establishment. However, berseem was not tolerant of dry conditions before winter wheat harvest. We observed a similar trend with berseem survival in oat (*Avena sativa* L.) at this location (Anderson, 2017b). In two growing seasons, we were able to establish berseem, but dry conditions preceding oat harvest killed seedlings in this study also. Based on results from this study, our initial study (Anderson, 2017a), and the oat study (Anderson, 2017b), we believe that berseem may not be a viable choice for this location, as it is not unusual to have dry intervals during the growing season here. Other regions where berseem has been successfully interseeded in cereals have higher rainfall (Ghaffarzadeh, 1997; Ross et al., 2005; den Hollander et al., 2007). Our future research will test subterranean clover (*Trifolium subterraneum* L.), an annual clover that is more drought-tolerant than berseem (Clark, 2012).

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