Impact of Fertilizer Type, Seeding Coating, and Duration of Exposure on the Germination of Red Clover Seed

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Abstract. Legumes are important components in grassland ecosystems. Red clover is one the most used legumes in the transition zones states like Kentucky. To maintain legumes in grass pastures, improved red clover varieties are often overseeded in the late-winter or early-spring. In many cases seed is mixed with fertilizer and top-dressed onto pastures. Little data are available on the impact of fertilizer type or duration of exposure on the germination of raw and coated red clover seed. The objective of this study was to evaluate the impact of two fertilizer types, muriate of potash and a blended fertilizer (urea, diammonium phosphate, and muriate of potash), and the duration of exposure (1 to 28 days) on the germination of an improved red clover variety that was raw or coated. Mixing seed with the blended fertilizer resulted in a linear decrease in germination rate for the raw seed and quadratic decrease for the coated seed. After 20 days of exposure to the blended fertilizer, the germination rate of the coated and raw seed was 0 and 60%, respectively. Combining seed with muriate of potash resulted in a linear decline in germination rate with the decline being greater for the coated seed. Overall, the rate of decrease was considerably less than that of the blended fertilizer. Results of this study indicate that seed coating enhanced the detrimental effects of fertilizer on seed germination.

Introduction

Legumes are important parts of sustainable grassland ecosystems. They improve both pasture yield and forage quality and decrease the negative effects of the toxic endophyte found in tall fescue (*Schedonorus arundinaceus* (Schreb.) Dumort., nom. cons.) (Roberts and Andrae, 2004). Red and white clover (*Trifolium pratense* L. and *Trifolium repens* L.) in combination with *Rhizobium* bacteria are capable of fixing 84 to 168 kg N ha^{-1} yr^{-1} (Ball et al., 2015). To maintain legumes in grass stands, improved clover varieties are commonly overseeded in late winter or early spring (Lacefield and Smith, 2009). In many cases, clover seed is mixed with fertilizer and top-dressed onto pastures. It is recommended that these mixtures be spread immediately. However mechanical issues and inclement weather can delay spreading. There is little information on the impact of prolonged exposure to fertilizer on the germination of clover seed. The objective of this study was to evaluate the impact of two fertilizer types, muriate of potash and a blended fertilizer (urea, diammonium phosphate, and muriate of potash), and the duration of exposure (0 to 28 days) on the germination of an improved red clover variety that was raw or coated.

Methods and Study Site

A study with a randomized complete block design with factorial treatment arrangement and four replications was conducted at the University of Kentucky Research and Education Center located in Princeton, KY. The entire experiment was repeated. The trials began on 15-Jun-20 and 22-June-20 and ended on 12-Jul-20 and 20-Jul-20, for trials 1 and 2, respectively. Treatments were fertilizer types, seed coating, and duration of exposure to fertilizer. The fertilizer types were muriate of potash (0-0-60), a blended fertilizer (19-19-19) comprised of urea, diammonium phosphate, and muriate of potash, and a no fertilizer control. Red clover seed (same variety and seed lot) was either raw (no coating) or coated with a propriety lime-based seed coating (Summit Seed Coating, Caldwell, ID). Seed, 5 g, was mixed with fertilizer, 100 g, and placed in a 120 ml cup on a table under a pop-up canopy in a tobacco barn. This allowed the seed-fertilizer mixture to be exposed to ambient temperature and humidity but protected it from rainfall. Germination was evaluated after 1, 3, 5, 7, 10, 14, 21, and 28 days of fertilizer exposure. Seed-fertilizer mixes were taken to the lab where 50 random seeds were gently extracted using tweezers.

Seeds were then placed in a 10-cm petri dish that was lined with Whatman Grade 4 filter paper that had been saturated with 10 ml of distilled water. Tops were secured on the petri dishes using parafilm. Germination counts were made at 3 and 7 days. At each count, germinated seeds were removed from the petri dish. Data were entered into a spreadsheet and final germination was calculated. Data were analyzed across trials using the General Linear Model Procedure (SAS, Cary, NC). SigmaPlot 15.0 (SYSTAT Software, San Jose, CA) was used for regression analysis.

Figure 1. Seed and fertilizer were weighed out and placed into 120 ml cups (top right) and uncapped cups were placed under a canopy in a tobacco barn (top left) for 1 to 28 days. Cups were transported back to the lab at specified exposure intervals and 50 random seeds were extracted (bottom left) and placed into a petri dish for germination (bottom right).

Results and Discussion

No trial x treatment interactions occurred ($P < 0.05$) so data are being presented averaged over trials. Within trials, fertilizer x treatment interactions occurred ($P < 0.05$) so data are being presented by fertilizer type. Muriate of potash resulted in a linear decrease in germination and this decrease was greater for the red clover seed that was coated (Figure 2). The control treatments did not decrease in germination (Figure 2 and 3). The blended fertilizer resulted in a linear and quadratic decrease in seed germination with the coated seed declining at a greater rate (Figure 3). In general, the decreases in germination observed in the blended fertilizer were greater (Figure 3). This was likely due to the hygroscopic nature of the blended fertilizer (Adams and Merz, 1929). At the end of 28-day period, the seed-blended fertilizer mixture had absorbed enough moisture to become a slurry at ambient temperature and humidity. Seed coating also caused a greater decline in seed germination for both the potash and blended fertilizer, although the rate of decline was greatest for the blended fertilizer. Seed coating may have enhanced imbibition leading to higher levels of salt injury. At 21 days of exposure to the blended fertilizer, the germination of the coated seed was near 0 compared to the raw seed which was near 55%.

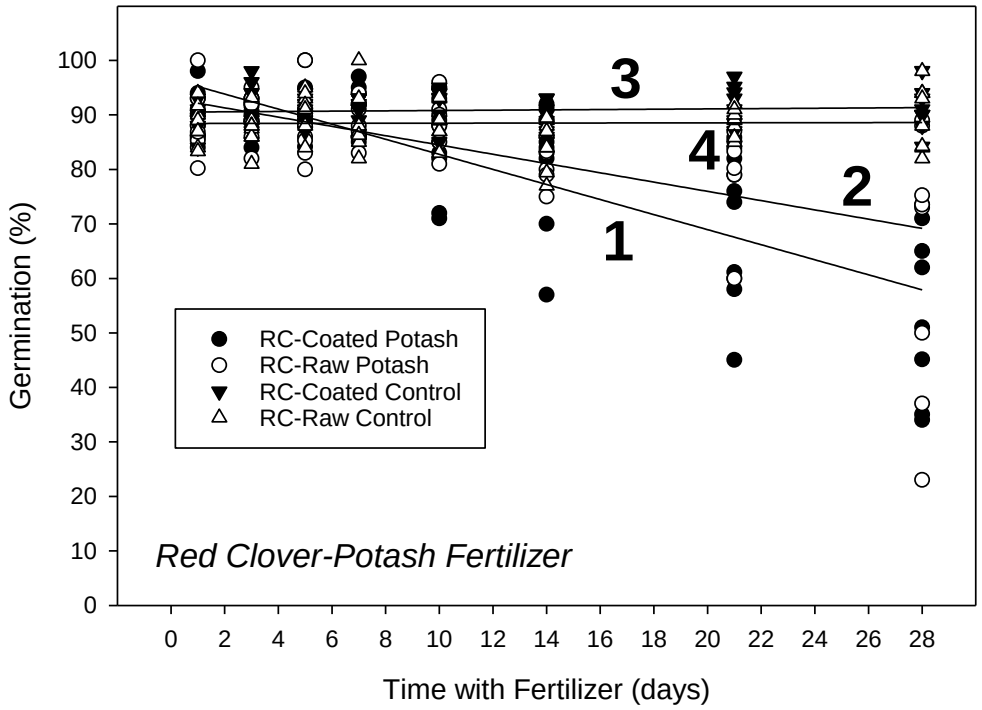

Figure 2. Impact of exposure time to muriate of potash (0-0-60) on the germination of raw and coated red clover seed averaged across Trials 1 and 2. The regression equation for the lines corresponding to the adjacent number can be found in Table 1.

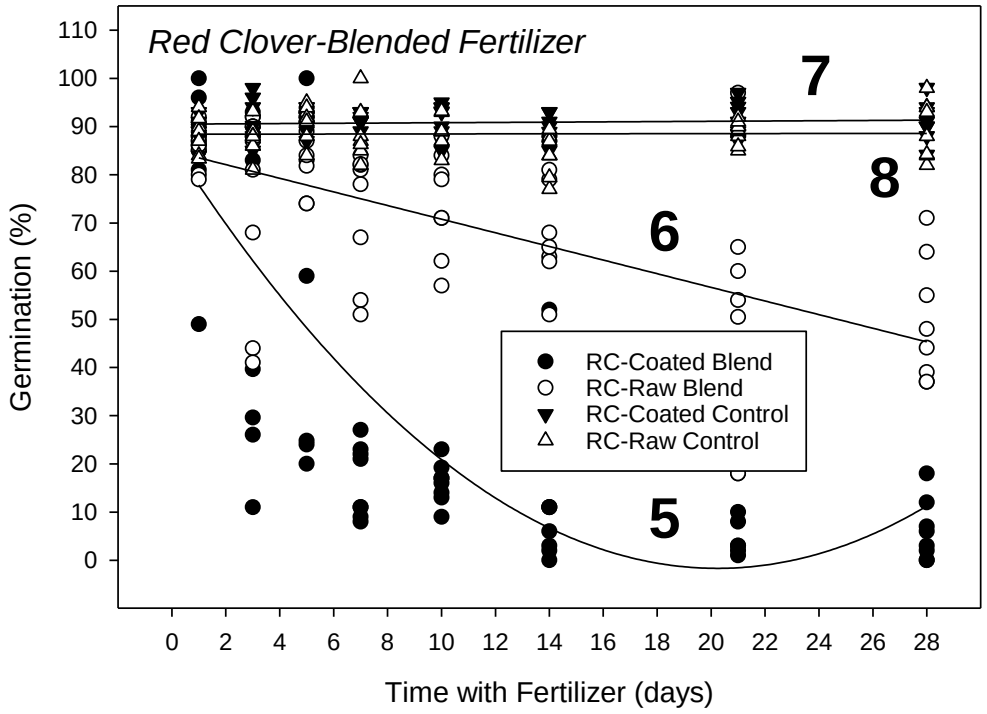

Figure 3. Impact of exposure time to blended fertilizer (19-19-19) on the germination of raw and coated red clover seed averaged across Trials 1 and 2. The regression equation for the lines corresponding to the adjacent number can be found in Table 1.

Table 1. Equations for regression lines found in Figures 2 and 3.

Line Number	Species	Coating	Fertilizer	Equation	R^2	P-value
1	Red Clover	Coated	Potash	y = 96.6 – 1.38x	0.62	< 0.001
2	Red Clover	Raw	Potash	y = 93.0 + 0.851x	0.41	< 0.001
3	Red Clover	Coated	Potash	y = 90.5 + 0.0294x	0.01	< 0.001
4	Red Clover	Raw	Potash	y = 88.4 + 0.0064x	< 0.01	< 0.001
5	Red Clover	Coated	Blended	y = 86.4 – 8.70x + 0.215x	0.62	< 0.001
6	Red Clover	Raw	Blended	y = 84.9 – 1.41x + 0.215x	0.36	< 0.001
7	Red Clover	Coated	Blended	y = 90.5 + 0.0294x	0.01	< 0.001
8	Red Clover	Raw	Blended	y = 88.4 + 0.0064x	< 0.01	< 0.001

Conclusions

The results of this study indicate that prolonged exposure to fertilizer has a detrimental impact on the germination of red clover seed. This impact is greater for fertilizer materials that are more hygroscopic. In addition, seed coatings that increase seed imbibition also tend to increase salting injury and decrease germination. One limitation of this study is the size of the experimental unit. The small size of the experimental units, 120 ml cups, likely increased the rate of decline in germination observed compared to what might be found in larger piles or loads in spreader trucks. In the case of larger quantities of seed-fertilizer mixtures a crust would likely form that may slow the rate of germination decline in the interior of the pile. More work is needed to test this hypothesis.

References

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