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Eastern gamagrass \{\textit{Tripsicum dactyloides}\} seed dormancy

Abstract: Eastern gamagrass has considerable value as a forage source and conservation aid, but can be very difficult to establish because its seed does not germinate easily, even with all the necessary environmental factors present. Understanding seed dormancy in eastern gamagrass is the major objective of this work.

Background

Eastern gamagrass is a highly productive and palatable native, warm-season, perennial grass. Indigenous to the eastern, central, and southern United States, it probably represents a climax species in tall-grass prairies. Interest in gamagrass has increased recently because of its potential value for

- Forage use,
- Possible silage replacement for corn on marginal and sloping land,
- Wildlife habitat,
- Biomass production, and
- Reclamation of certain lowland areas and disturbed sites.

However, eastern gamagrass seed is largely dormant, which makes stand establishment difficult. (Dormant seed is viable seed that will not germinate even though it receives all the environmental triggers necessary for germination.) Fall and spring planting of hydrated, prechilled seed are used to aid establishment, but the success rate with these procedures varies.

Understanding the seed dormancy mechanisms in eastern gamagrass could lead to the evolution of better dormancy-breaking procedures, improved seed management practices, greater ease of establishment, and more widespread use of this potentially valuable species.

Approach and methods

The first step in the project was to better understand the role of encompassing structures on the germination of dormant seed, so the influence of the cupule was tested. (The cupule is a cup-shaped outer layer that partially encloses the seed.)

The second set of experiments was designed to evaluate the role of the pericarp on germination of decupulated caryopses (seeds). (The pericarp is the outer layer of the ovary wall around the seed.) Various methods of scarification were used to penetrate the pericarp. (Scarification involves the abrasion or chemical treatment of seeds to increase water absorption, thereby improving germination chances.) Mechanical or chemical scarification of any seed must be done carefully to avoid damaging the seed while hastening germination.

The third round of experiments was designed to evaluate the effect of gibberellic acid on germination of dormant gamagrass caryopses (cupule removed). Gibberellic acid (GA), a promoter of germination, was applied to eastern gamagrass caryopses either in water or in a buffer solution. The buffer solution was maintained at a low pH level in order to evaluate the value of acidifying the germination environment (briefly) and the potential benefits of the penetration of GA into the caryopses.
The fourth set of studies looked at the value of aqueous and buffer solutions of GA on the germination of dormant cupules.

The final group of laboratory tests centered on the development of a solid matrix priming protocol, potentially incorporating GA to break the dormancy of eastern gamagrass cupules, but also allowing for the seed to be dried and stored for a reasonable period before use. Work on these experiments continues.

The field program included three replicated plots in Ames and one in Calumet. The replicated and space-planted nursery in Ames was killed by a late frost. The plantings at McNay Research Farm were made with prechilled seed, but emergence was poor and weed pressure was high. Herbicide failed to control the weeds, but the stand was too poor to save.

Results and discussion

First phase: Cupule removal approximately doubled the germination of the eastern gamagrass seed lots, but did not result in germination of all the viable seed in the seed lots. In some seed lots, over half of the viable caryopses did not germinate after cupule removal.

Second phase: Cupule removal, combined with scarification of the pericarp over the embryo, resulted in nearly complete germination of viable seed at an alternating temperature of 20 to 30 degrees C in light. The rapid and nearly complete germination of scarified eastern gamagrass seed led to consideration of various mechanical and chemical means of seed scarification.

Figure 6. The germination (percent of viable seed) of Pete (lot PS) eastern gamagrass seed, as affected by treatment. The treatments consisted of intact cupules (C), cupules removed (R), and cupules removed and the pericarp scarified (RS). Error bars reflect the standard error of the respective means.
The investigators believed that mechanical and chemical scarification of eastern gamagrass would not produce satisfactory results for these reasons:

- The cupule surrounding the caryopsis is large and irregular in size and shape, making it difficult to remove without substantial mechanical stress.
- The embryo of the caryopsis often rises above the surface plane of the caryopsis and extends the length of the caryopsis. These embryo characteristics usually enhance the probability that mechanical handling will reduce germination.
- Chemical scarification would be difficult to accomplish because of the potential of the cupule to act as a reservoir for the acids or organic solvents usually used in the process. These substances could lead to seed damage.

*Third round:* Exposure to the buffer solution for 24 hours slightly improved germination, though the effect was significant for only one seed lot. Adding GA to the buffer solution improved germination to within an average of 10 percent of the viability of the seed lots.

*Fourth round:* When applied to cupules, the buffer was detrimental to germination and GA was only marginally beneficial. It is likely that some of the buffer remained in the cupule and progressed beyond a neutral or beneficial "acid effect" to a situation where metabolism was restricted by prolonged exposure to low pH.

**Conclusions**

The cupule contributes to some extent to the reduced germination of eastern gamagrass. The pericarp and/or testa (seed coat) are the main factors in restricting germination of this species.

Caryopsis scarification increased the germination rates. Depending on the seed lot, the germination test could be shortened to 21 or even 14 days. Fungicide application inhibited
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Germination. This could be due to alterations in water uptake and/or gas exchange.

A previous study showed that structures surrounding the embryo restricted germination of eastern gamagrass. Seeds germinated when these structure were removed. Application of GA$_3$ improved germination of caryopses of different commercial seed lots of eastern gamagrass. The stimulatory effect of GA$_3$ on seed germination in gamagrass could involve weakening those structures through enzymatic degradation.

It should be noted that gibberellic acid did not end the dormancy—an average of 10 percent dormant seed remained. The failure of a small proportion of seeds to respond to GA$_3$ could be due to insensitivity or the presence of other factors limiting the processes leading to germination.

Gibberellic acid application, under buffered conditions, at three different concentrations, improved seed germination of eastern gamagrass. The positive effect was consistent across varied commercial seed lots produced in different years.

In contrast to the marked positive effect of the application of exogenous GA to caryopses, application of GA to cupules offered only slight stimulation to germination. This could be attributed to a lack of penetration of GA through the cupule. Results here suggest that use of acid buffers to improve penetration is not useful. However, the application of GA as an amendment to a solid matrix priming procedure could be beneficial.

Impact of results

Optimizing the concentration of gibberellic acid applied to the cupule and applying this phytohormone as an amendment to solid matrix priming should result in a uniform improvement of seed germination in eastern gamagrass. If solid matrix priming protocols could be developed to break dormancy yet allow for the seed to be dried and stored for a period, substantially more eastern gamagrass could be used for crops, forages, erosion control, wildlife habitat, and landscape reclamation. Potentially, these protocols could be handled by seed companies that could then dry and store the seed, thus allowing for better seed management and fewer concerns on the part of the growers.

The investigators have received inquiries from Oklahoma and Texas indicating that improved establishment rates would spur more use of gamagrass in these states. They recognize that the ability of eastern gamagrass to withstand flooding, act as a barrier to erosion, and offer high forage quality make it a valuable species.

Education and outreach

Research papers on this project have appeared in *Crop Science*, publications of the American Forage and Grassland Council, and *Iowa Seed Science*. The investigators presented results of this project at the 1999 American Society of Agronomy annual meeting, the Native Warm Season Grass Conference and Expo, and the Society of Range Management meeting.