Improving Germination of Red Elm (*Ulmus rubra*) Seeds With Gibberellic Acid©[2]

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Red elm (*Ulmus rubra*) is considered an important tree for many Native American tribes in the United States. Native Americans use red elm, a native tree species, for firewood in cultural ceremonies, to treat skin and respiratory conditions, and as an eyewash. Since red elm is susceptible to Dutch elm disease it is not grown commercially. Tribal leaders would like to plant more of this species on tribal land, but it is difficult to germinate due to multiple dormancy mechanisms. This has led to declining natural tree populations and difficulties in commercial propagation. The objective of this study was to evaluate techniques to promote germination of red elm. Studies were conducted with stratified and nonstratified red elm seeds treated with 0, 250, 500, or 1,000 ppm of gibberellic acid (GA_3). Highest seed germination occurred at 500 and 1,000 ppm GA_3 with nonstratified seed. While seed stratified for 90 days had higher germination than nonstratified seed, germination of stratified seed was lower when treated with GA_3.

INTRODUCTION

Red elm, also called slippery elm, is a native American tree that is valued by many American Indian tribes as fuel for ceremonial fires at pow wows, funerals, or sweat lodges. Other past uses of red elm included the inner bark for cordage, fiber bags, and storage baskets. The mucilaginous inner bark has several medicinal uses, including as a treatment for swollen glands, as an eyewash, for sore throats, and women drink a tea of the bark to make childbirth easier (USDA, 2010). Current tribal use centers on using red elm for firewood in traditional ceremonies. Unfortunately, red elm is also susceptible to Dutch elm disease (caused by the fungus *Ophiostoma ulmi*) which is transmitted by bark beetles and root grafts. Due to this susceptibility, red elm has not undergone extensive research.

Gibberellic acid (GA_3) is a naturally occurring plant hormone that can release seeds from dormancy. The positive effect of GA_3 promotes uniform seedling germination and higher percent germination (Adams et al., 2010). Gibberellic acid removes physiological dormancy mechanisms that often require lengthy stratification or light to maximize germination (Norden et al., 2007). However the seeds of red elm exhibit several kinds of dormancies which is the subject of this investigation.

MATERIALS AND METHODS

Seeds of red elm were collected from two locations, near the town of Leon, in south-central Kansas (37° 41' 25" N / 96° 46' 56" W), and at Lawrence in northeastern Kansas (38° 58' 18" N / 95° 14' 6" W), in late April 2010. Seeds were air dried for 3 days and stored in a sealed container. On 11 May 2010 half of the seeds (240 seeds) received cool moist stratification at 5 °C (41 °F) for 90 days. Stratifica-

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tion was achieved by placing seed (60 per bag) in a polyethylene bag containing 1 lb (450 g) of moist peat moss. Remaining seeds (240 seeds) were immediately treated with GA_3 (Research Organics, Cleveland, Ohio) at 0, 250, 500, or 1,000 ppm dissolved in distilled water. Sixty seeds were placed in beakers containing 120 ml of GA_3 solution and placed on a shaker at 175 RPM for 24 h. Seeds were then placed on filter paper in 47-mm-diameter petri dishes (Fisher Scientific). The filter paper was moistened with 2 ml of distilled water to maintain humidity. Petri dishes were arranged on a lab bench at room temperature 18 °C (65 °F). Stratified seed were handled identically upon removal from the peat moss after 90 days.

Germination was monitored every 3 days starting on 13 May 2010. Seed germination was recorded when a radicle of 3 mm long had emerged. Data were taken over a period of 2 weeks, when seeds in all treatments either germinated or died. The experimental design was completely randomized with a 2 × 4 arrangement of factorial treatments. There were two stratification treatments and four GA_3 treatments. The experiment was replicated six times with two petri dishes per replication per treatment with 5 seeds per dish. Data were subjected to ANOVA (Statistical Analysis System, SAS Institute Inc., Cary, North Carolina) and the means separated by LSD test ($p<0.05$).

RESULTS

Both seedlots exhibited similar trends in germination across the various treatments (Tables 1 and 2). For the Lawrence seedlot, the best treatment for the nonstratified seeds was 1000 ppm GA_3, with a 78.3% germination rate (Table 1). Germination steadily increased from the control (0 ppm), 250, and 500 ppm GA_3, respectively with 13.3%, 28.3%, and 45% germination. For the stratified Lawrence seed, the best germinating treatment was the control (0 ppm of GA_3) with 30.8% germination. With increasing GA_3 concentrations of 250, 500, and 1,000 ppm, respectively, the germination of stratified seed was 22.3%, 14.1%, and 5.6 % germination, although treatments of 250 and 500 ppm GA_3 were statistically similar. Germination of stratified seed from the Lawrence seedlot exposed to 1,000 ppm GA_3 was significantly lower than all other treatments (Table 1).

For the Leon seedlot, the highest germination rate for nonstratified seeds was also 1,000 ppm GA_3 with 86.6% germination; however, seeds treated with 500 ppm GA_3 had statistically similar germination (73.3%) (Table 2). Nonstratified seeds treated with 0 and 250 ppm GA_3 had 30% and 50% germination, respectively. The reverse situation was true for the stratified seed, with the best treatment being the

Table 1. Percent germination of red elm seedlot from Lawrence, Kansas.

	Treatments	
GA_3 concentration (ppm)	Non-stratified	Stratified
0	13.3 cd B	30.8 bc A
250	28.3 bcd A	22.3 bcd A
500	45.0 b A	14.1 cb B
1000	78.3 a A	5.6 d B

Means within a column (lower case) or row (uppercase) followed by the same letter were not significantly different with LSD ($p<0.05$); n = 6.

Table 2. Percent germination of red elm seedlot from Leon, Kansas.

	Treatments	
GA_3 concentration (ppm)	Non-stratified	Stratified
0	30.0 cd B	47.3 bc A
250	50.0 b A	30.5 cd B
500	73.3 a A	19.5 de B
1000	86.6 a A	2.8 e B

Means within a column (lower case) or row (uppercase) followed by the same letter were not significantly different with LSD ($p<0.05$); n = 6.

control (0 ppm GA_3) with an average of 47.3% germination. Germination of stratified seed declined with increasing GA_3 concentrations, with 47.3%, 30.5%, 19.5%, and 2.8% germination, respectively, for 0, 250, 500, and 1,000 ppm GA_3 (Table 2).

DISCUSSION

Seed germination of nonstratified seeds was highest at 1,000 ppm GA_3, with 86% and 78.3% germination, respectively, for the Leon and Lawrence seed lots. Previous work (Dirr and Heuser, 2006) has indicated that stratification will increase red elm germination. While this was true for the control treatment not exposed to GA_3, treatments with GA_3 resulted in significantly less germination of 90-day stratified seed from both locations.

Gibberellic acid treatment had a negative effect on germination of stratified seeds that was consistent with both seedlots. There was also a strong interaction between the stratification and GA_3 treatments. This suggests that there may be a supraoptimal response of stratification to red elm seeds treated with GA_3. Nonstratified seeds benefited from exposure to exogenous GA_3, while stratified seeds (which naturally produce endogenous gibberellins) experienced an inhibitory response when exposed to additional GA_3. This relationship will be an important one to investigate in the future.

Based on this study, we recommend red elm seed be soaked in 1,000 ppm GA_3 for 24 h before sowing. Seeds typically took 10–15 days to germinate. Future studies should evaluate higher levels of GA_3 and shorter stratification periods to determine optimum rates for maximum germination.

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