Analyzing the Effects of Chemical Pretreatments on the Germination of *Echinacea purpurea*

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Abstract

This study focused on the germination of *Echinacea purpurea* under different chemical pretreatments. Gibberellic acid (GA_3 and GA_{4+7}) as well as Thiourea were applied to the seed under three differing chemical concentrations (0.3, 0.5, & 1.0). Seeds were then observed daily for twenty- one days to determine the the effectiveness of these hormones. It was found that GA_{4+7} did increase the germination percentage for *Echinacea purpurea* in all concentrations.

Introduction:

Echinacea species have been recently increasing in popularity for its medicinal and ecological properties. For instance, it has been found to create specific antiviral hormones (Abbasi, Saxena, Murch , & Liu, 2007). The germination *Echinacea purpurea* seeds is naturally slow with a dormancy period of upwards of twenty-one days (Abbasi et al, 2007. Additionally, the percent germination is rather low compared to other species. Techniques for producing *Echinacea* plants such as tissue culture are very expensive to mass produce. This has led to the utilization of hormones to increase the efficiency of germination. The treatment of seeds with various hormones can shorten the lengthy germination period and increase the germination rate. Gibberellic acid (GA_3) is an artificial hormone that has been found to stimulate cell division, leaf production, and shoot growth (Bachelard, 1967). Gibberellic acid GA_{4+7} has been found to promote germination though the stimulation of enzymes that breakdown the endosperm of the seed (Watkins et al, 1985). This breakdown allows for the radical to pierce the seed coat several days prior to as compared to other formulations of gibberellic acid (GA_3)(Andreoli et al, 1999). The final hormone was Thiourea which was found to promote germination through the inhibition of the ABA signaling pathways (Srivastava, 2016).The purpose of this experiment was to determine the effect of these hormones on germination of *Echinacea* seeds. It was predicted that the seeds soaked in gibberellic acid (GA_{4+7}) would have the shortest dormancy period and would have the greatest percent germination overall.

References:

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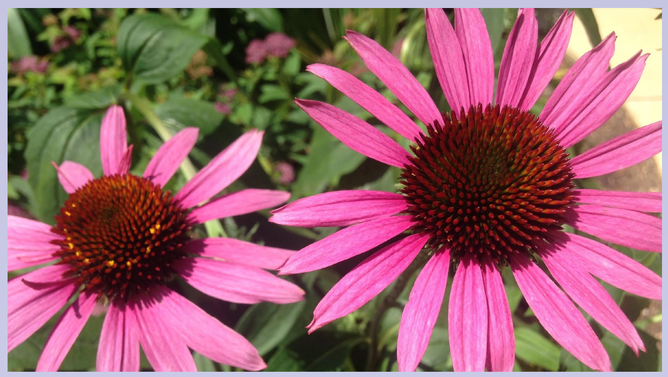
Methods:

To determine the effect of growth hormones on *Echinacea purpurea* (purple coneflower), seeds were soaked in three different growth hormone solutions at varying concentrations (0.1, 0.3, & 1.0). Solutions were prepared using one-liter beakers, distilled water was measured out using a graduated cylinder. GA_3, $GA_{4+7,}$ and Thiourea were measured out, using a scale, into 1.0-gram, 0.5-gram, and 0.3-gram increments, respectively. Those were then added to the beakers and placed on a hotplate with a stirring bar. The solutions were then heated to 100ºC and left to cool. Imbibition testing was then conducted on dry *Echinacea purpurea* seeds. A sample of 20-grams of seeds were soaked in water for fifteen minutes, dried, then reweighed. This process was repeated until the seeds stopped gaining weight. This occurred at one hour after initial placement. Making the imbibition/soaking time one hour for the experimentation. The three experimental groups of the three-concentrations contained two hundred seeds each that were soaked in each of the hormone concentration solution respectively for one hour. The seeds in the control group were soaked in water only for one hour. Daily observations made for twenty-one days. Notes were made as to the number of seeds that had germinated. The total seeds germinated in each group and the time each seed took to germinate.



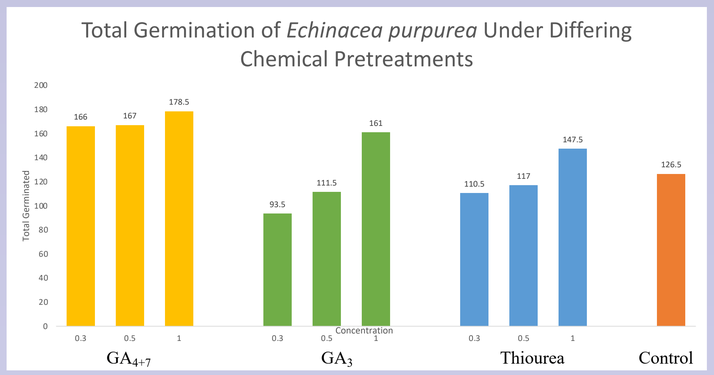


Figure 1: Shows the total germination of each trial group.

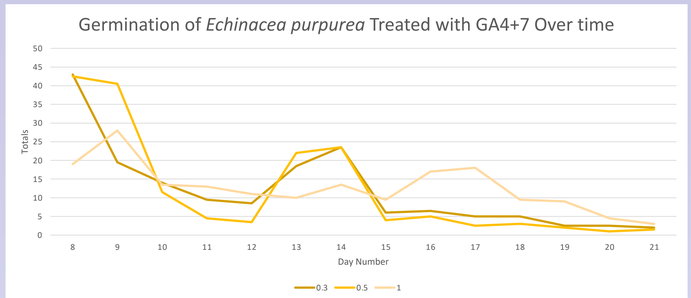


Figure 2: Shows the germination over time for the GA_{4+7} trial group.

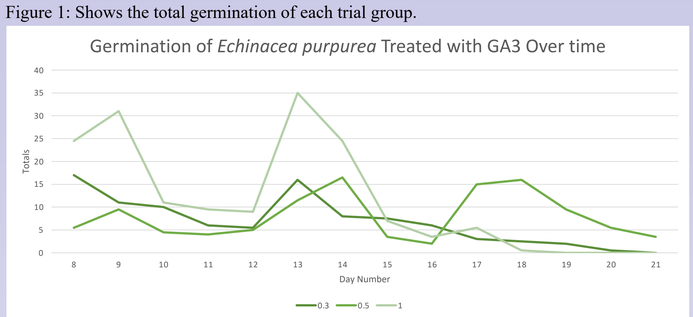


Figure 3: Shows the germination over time for the GA_3 trial group.

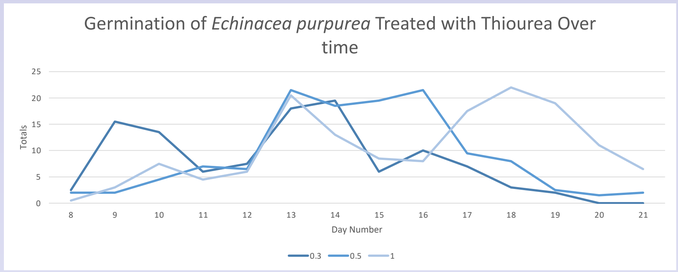


Figure 3: Shows the germination over time for the Thiourea trial group.

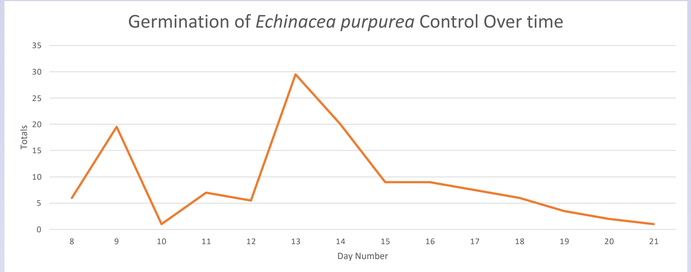


Figure 3: Shows the germination over time for the control group.

Results:

The data shows that GA_{4+7} at all concentrations (0.3, 0.5, and 1.0) had an increased effect on the germination of *Echinacea purpurea.* There was an overall high of 89.25% germination for the trial group which has the 1.0 concentration (Figure 1). This can be compared directly to the germination of the GA_3 trial group. Which, had a germination percentage of of 80.5% at the 1.0 concentration (Figure 1). At the other concentration levels, there was germination inhibition as compared to the control group. The Thiourea had some overall effect of the total germination at the 1.0 concentration. With a germination percentage of 73.75% (Figure 1). However, at lower concentration levels of both GA_3 and Thiourea there was significant inhibition to germination. Even lower than the control group with a germination percentage of 63.25%. Figure 2 shows the spike in germination of the seeds for GA_{4+7} with the bulk occurring within the first 8-10 days after planting. This can be compared to GA_3 where the bulk of seeds germinated on days 12-15 (Figure 3). The Thiourea spiked in germination on days 13-19, much later than other groups and the control (figure 3). The control's germination spike on days 13-15 and was otherwise fairly constant (Figure 3).

Conclusions:

The germination of *Echinacea purpurea* seeds is naturally slow with a dormancy period of upwards of twenty-one days (Abbasi, Saxena, Murch , & Liu, 2007). This fact makes *Echinacea purpurea* difficult for nurseries in mass production. Techniques have been developed to increase the survival rates, such as tissue culture but this proves costly for the grower. Other hormones in this experimentation did not produce results that would indicate large scale benefits and therefore would not be viable options for treating this species. The species *Echinacea purpurea* is a highly important native species in many local ecosystems, that fact making it a popular species for many commercial growers in the industry.

Discussion & Application :

The results supported the hypothesis that *Echinacea purpurea* seeds soaked in GA_{4+7} would have the shortest dormancy period and would have the greatest overall germination. The seeds treated in GA_{4+7} had the lowest dormancy period on average with the bulk germinating after the first eight days (figure 2). Gibberellic acid functions to promote germination by the destruction of proteins within the nucleus that inhibit the germination response (Piskurewicz, et al., 2018). The GA_{4+7} Treated seeds had the greatest percent germination with 89% of the seeds germinating. The highly concentrated solution of GA_{4+7} caused a shorter germination period. When the gibberellic acid is used in highly concentrated solutions it reduces the cell division in the developing leaves and uses the added energy to help elongate the stem through the seed coat, creating the germination response (Bachelard, 1967).This is the same with the GA_3. Which too had a better germination response when used at high concentrations compared to the control. However, at low concentrations the chemical inhibited growth as compared to the control. Gibberellic acid (GA_3 or GA_{4+7}) could be used in nursery operations to increase production rates however this may deem costly for little results. The Thiourea had little to no effect on the germination of the *Echinacea purpurea* when compared to the control the is levels of the chemicals concentration that prevented germination (Figure 1). There were possible sources of error in this experimentation, including variations in the planting depth of the seeds. Additionally due to the large-scale nature of these plantings some seeds were later to be planted than others, as all seeds were soaked at the same time. These techniques while beneficial in theory would prove too costly for the little benefits that they give. The installation of these practices are costly and labor intensive for not enough of a germination benefits to go along with them. It is for this reason that these results are not viable for replication in large scale operations.

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