Temperature effects on radish root development essay sample

Several studies have been conducted to establish how temperature, seed germination, and root growth are related. Because temperature plays a main role in many growth processes, we decided to focus on how it affected root growth. Radish (Raphanus sativus) seeds were chosen due to their ability to produce a distinct bulbous tuber, and their relatively short growing time. Three test groups were placed under different temperature conditions. There was one “ control” group, one “ hot” group, and one “ cold” group. All test groups were placed in metal trays and set on a cycle of 12 hours of light exposure and12 hours of dark exposure. Each group was monitored and given the appropriate amount of water to maintain moist soil. The radishes were removed from their soil and root lengths were measured. We then ran a two-tailed t-test to determine if there was a significant difference between groups. We found that there was no difference between hot and control groups, but that a significant difference did exist between the cold and hot/control groups. This is most likely because the radishes used are grown in the summer and are not accustomed to the colder temperatures.

Introduction

The relationship between temperature, seed germination, and root growth has been established through studies dating back to the 1800’s. Almost all studies have been conducted with a constant temperature for 24 hours a day (Reddick 1917). A 12 hour cycle was chosen to reinforce the strong diurnal rhythms that are shown in most dicots (Yazdanbakhsh and Fisahn 2011). The majority of plant root growth occurs during dark periods and exposure to different temperatures during this period has been shown to produce the greatest response (Yazdanbakhsh and Fisahn 2011). Percentage of water

within a seed greatly affects seed germination (Waggoner 1971). As percentage of water increases seed germination time also increases. While radish seeds with a water content of four percent germinate within two days, a seed that contained eighteen percent water will not germinate after seven days (Waggoner 1971). Waggoner (1971) also proved that seeds are heat resistant if internal water content is approximately one percent.

Water content of soil also influences seed germination. Seeds exposed to high temperatures had greater survival when kept in moist soil (Elegy 1990). Most plants have an optimum temperature that will elicit the fastest germination time. For citrus seeds, this optimum germination temperature existed between 31-35°C (Camps et al 1932). Temperatures outside this optimum may retard seed germination. Seedling germination from natural weed species was reduced by 90 percent when the maximum soil temperature reached 61°C (Melander 2005). In another study it was determined that seed germination did not occur below 20°C or above 40°C (Egley 1990). The relationship between extreme temperatures and seed germination was also confirmed in an experiment on cabbage plants (Fusarium conglutinans) by Reddick (1917). Seeds that were kept at extreme temperatures did not germinate. Extreme temperatures have been shown to have a greater effect on initiating germination compared to later developmental processes (Dell'Aquila 2005).

Methods

Our experiment was conducted at Tennessee Technological University Cookeville in a biology lab room. The room was kept at a constant

temperature of 21°C. Study organisms were radish (Raphanus sativus) seeds. Seeds were grown indoors near a west facing window in plastic starter pots. Pots were placed into metal trays for the duration of the study. Growth time for the radish seeds was five weeks. A fluorescent light provided artificial sunlight for this study. To ensure seed germination, extreme temperatures were avoided and seeds were moistened with 20 ml of lukewarm water every night before temperature treatment. We used seeds with equal water contents and were kept on a diurnal cycle. Radishes used were “ pink beauties”. Test groups were placed under three different soil temperature conditions labeled “ cold”, “ control”, and “ hot”. Soil temperatures were 4°C, 21°C, and 30°C respectively. Average soil temperature was measured with a thermometer inserted 2. 54 cm into the soil of each pot. A total of 15 plastic starter pots were used with 5 pots per group. Miracle Grow Seed Starter soil was mixed in a bucket with 1200 ml lukewarm water until evenly moistened. 300 ml of moistened soil was placed into each starter pot.

Once soil was distributed, one radish seed was positioned approximately 1. 27 cm deep into every pot. An additional 40 ml of water was added to each pot to ensure soil was thoroughly moistened. All test groups were placed in metal trays and set on a 12 hour light and 12 hour dark cycle. During 12 hours of light, the test groups did not receive any treatment. During the 12 hour dark period, the “ cold” group was kept in a refrigerator set at constant 4°C and the “ hot” group was placed on a heating pad set at a constant temperature of 30°C. The control group remained at room temperature (21°C). After the 12 hour dark period, all groups were returned to normal

room conditions. After 5 weeks, we removed the plants from their pots. We measured root length using a 10 centimeter ruler. We determined root growth by measuring where leaves emerged from the main shoot to where pink coloration of the radishes ended. While this does not include the entirety of root length it does give us a good indication of overall radish development. This method was used because radishes did not develop as quickly as anticipated and taproots were to flimsy and broken to be properly measured.

Results

We used a two-tailed t-test with α = 0. 05 to analyze our data. The t-test was run using Microsoft Excel. Statistical differences were determined by comparing our calculated p values with our initial value of . 05. If our calculated values were less than . 05 then there was a statistical difference. A statistical difference was found between control and cold groups (p = 0. 009), and a statistical difference was also found between hot and cold groups (p= 0. 044). No statistical difference was found between the hot group and control group. Average root lengths (Figure 1.), and raw root length data for each pot (Table 1.) can be seen below.

Table 1.-Root Length of (Raphanus sativus) (cm)

ControlHotCold

14. 54. 52. 7

24. 53. 42. 2

33. 44. 91. 8

46. 533. 5

55. 33. 12. 8

Figure 1.- Average root lengths of all three groups in centimeters

Discussion

Overall, development retardation was most likely due to poor light conditions. Pink Beauty Radishes are cultivated in summer months when days are longer. The window that the radishes were sitting next to only provided direct sunlight for approximately three hours daily. Radishes were in lower light conditions than is usually required for proper cultivation and the fluorescent bulb was not a sufficient supplement for natural light. Cold radishes most likely experienced slow growth due to their inability to cope with the colder temperature. As Pink Beauty Radishes are meant to be cultivated in summer months they are ill-equipped for colder temperatures. The stunted development in the cold group can also be attributed to the fact that refrigeration provided a more extreme change in temperature than the heating pad. The temperature was lowered 17 degrees while in the hot group temperature was raised by only 9 degrees. Development retardation may have also occurred due to the overall atmospheric change that occurs within the refrigerator.

Radishes in the refrigerator had cold air constantly flowing over the pots. Hot radishes had a heating pad placed underneath their metal tray, and air flowing over pots was not affected by the heating pad; leaving the air at room temperature (21°C). From root length measurements, we found that radish seeds do have an optimum temperature for root development. Radish

root development will not be retarded in temperatures from at least 21-30°C. The cold temperatures had a greater adverse effect on the radish roots than the hot temperatures. Radishes may be able to handle extreme temperatures that reach well over 30°C; however, the optimal temperature range most likely does not reach much farther below our control temperature of 21°C. Hot radishes did not have a significant difference in root length from the control specimens. However, hot radish roots were less developed than the control and tubers did not exhibit any pink color. In future studies, different heating methods should be used to ensure even heating for all of radishes. Researchers may also want to allot longer growth periods for radish seeds to fully develop.

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