Control of Pecan Seedling Growth with a Heat Treatment to the Seeds

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Abstract

In previous experiments we were able to control the growth of pecan seedlings using synthetic growth retardants and naturally occurring phenolic compounds, but in this work we wanted to investigate if their growth could also be controlled by giving a heat treatment to the seeds. We subjected pecan seeds *cv.* Western to water soaking for 2 days, followed by a treatment at 2° and 30°C for 10 days in a humid substrate, using a refrigerator and a seed germination chamber, respectively. The control received only the water soaking. After this 10-day period, we found that the seeds receiving the 30°C treatment had sprouted, producing a root about 5 cm long, while the 2°C seeds showed no sign of germination. After this treatment, the seeds were planted in a bed under greenhouse conditions to record their emergence and shoot length. We found that the 30°C seeds emerged first, followed by the 2°C seeds and then the control. This response continued for some time until we had 95% emergence in the two treatments, including the control. Because of the initial differences in seedling emergence, the length of shoots was greater in the 30°C seeds, followed by the 2°C and then the control; however, after some time, we found that the shoot growth of the 30°C seeds slowed and then stopped while the shoots of both the 2°C seeds and the control continued their normal growth, so that after a while the final shoot length of these seeds was higher than that of 30°C seeds. We present some speculations which possibly indicate that ABA and Jasmonic acid may be involved in the growth inhibition induced by the heat treatment given to the seeds

INTRODUCTION

The control of pecan tree growth in orchards is desirable to facilitate tree management and to reduce the problems of shading and overcrowding that can affect nut yields. The use of different growth retardants is one possible method that can be used to control tree growth, but the cost and effectiveness of this strategy is still under investigation. We have evaluated previously (Marquez and Bustamante, 1988) the use of two synthetic growth retardants, (paclobutrazol and dikegulac), and two naturally occurring growth inhibitors, (cinnamic acid and p-coumaric acid), to control the growth of pecan seedlings with good results, but in this research we wanted to investigate if the growth of seedlings could be controlled by giving a heat treatment to the seeds.

MATERIALS AND METHODS

In this experiment we subjected pecan seeds cv. Western to water soaking (running water) for two days followed by a treatment at 2°C or 30°C for ten days in a humid substrate (sawdust), using a refrigerator or a seed germination chamber respectively; the control received only the water soaking. We used 300 seeds in each treatment. After this 10 – day period, the seeds were planted (February 15th) in a bed containing a substrate made of 50% soil, 25% perlite and 25% peat moss under greenhouse conditions to record their emergence and shoot length every 15 days.

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RESULTS

Seed Germination

We found that after 10 days in the humid substrate, the seeds receiving the 30°C treatment had sprouted, producing a root about 5 cm long while the 2°C seeds showed no signs of germination (Fig. 1).

Seedling Emergence and Shoot Length

We found that 15 days after sowing the seeds treated at 30°C showed 80% seedling emergence and the shoots were 6 cm long.

30 days after sowing we observed that seedling emergence was 10, 75 and 95% in the control, 2°C and 30°C seeds, respectively; with mean shoot lengths of 4, 7 and 12 cm, respectively (Fig. 2).

45 days after sowing, seedling emergence was 85, 90 and 95% in the control, 2°C and 30°C seeds, respectively; with seedlings producing shoot lengths of 8, 13 and 15 cm, respectively (Fig. 3).

75 days after sowing we found a similar 95% seedling emergence in both treatments and the control, but by this time the control and the 2°C seedlings had superior shoot lengths (20 and 23 cm, respectively), compared to the 30°C seedlings that were 15 cm long.

105 days after sowing, the same 95% seedling emergence was evident in all cases, with the shoots of both the control and the 2°C seedlings continuing growth; they were 27 and 30°C long respectively, while the shoots of the 30°C seedlings remained the same length (15 cm) as recorded 60 days before.

135 days after sowing (Figs. 4 and 5) we recorded a final shoot length of 40, 45 and 15 cm in the control, 2°C and 30°C seedlings, respectively.

DISCUSSION

It is useful to speculate why the 30°C seeds germinated and emerged first but then their shoots stopped growing. It is well known (Come, 1980; Lewake, 1985) that certain seeds require a moist-chilling treatment or stratification in order to germinate, and that unchilled seeds may produce abnormal seedlings or physiological dwarfs (Croker 1948; Flemion and Waterbury, 1945). An imbibed seed can develop secondary dormancy when other environmental conditions (such as high temperature) are not favorable (Bewley and Black, 1985; Karssen, 1980). Many studies have shown that ABA levels are high in dormant seeds, but the levels drop sharply during stratification (Lin and Boe, 1972; Lipe and Crane, 1966).

Some seeds have independent after – ripening requirements in order for the radicle, hypocotyl and epicotyl to grow (Baskin and Baskin, 1985). In general, the seeds need a warm period to produce root and hypocotyl growth, but then require a chilling period to enable the epicotyl to grow. In peach seeds, the concentration of gibberellin – like compounds increases during stratification (Gianfanga and Rachmiel, 1986), and introduction of an inhibitor of gibberellin synthesis (paclobutrazol) strongly inhibits epicotyl and seedling elongation, but only slightly decreases the germination percentage, indicating a separation between the radicle and epicotyl response during chilling. We speculate, therefore, that the heat treatment given to the pecan seed stimulated radicle emergence and induced high ABA levels in the embryo, which later had its inhibitory effect on seedling growth. On the other hand, the seeds receiving the cold treatment demonstrated earlier seedling emergence compared to the control because they had a longer time for imbibition, and both subsequently showed normal seedling growth possibly because their embryo ABA levels were lower compared to the seeds receiving the heat treatment.

We do not know if this dwarfing effect was maintained in the pecan seedling after the conclusion of the experiment, since we ceased taking records and could not, therefore, follow their further development.

We think that jasmonic acid (JA) may also be involved in the response, given its effect on growth inhibition (Yamane et al., 1980) and its accumulation in response to different external stresses including salt, wounding, pathogens, and elevated temperature or heat-shock (Neumann et al., 1989; Parthier, 1990). The question is: Is ABA or JA or both involved in this response, given the similarity of effects (Sembdner et al., 1989) induced by the two compounds? ABA is known as a stress-related, probably stress-mediating phytohormone (Skriver and Mundy, 1990). JA has a similar role in stress responses, and so it may act either complementing ABA or in addition to ABA. In order to answer this question it will be necessary to repeat this experiment, either with pecan seeds or another type of seeds, and quantify ABA and JA levels during seed germination and seedling growth.

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Figures

Fig. 1. Appearance of pecan seeds after 10 days in a humid substrate at 2°C and 30°C, compared to the control.

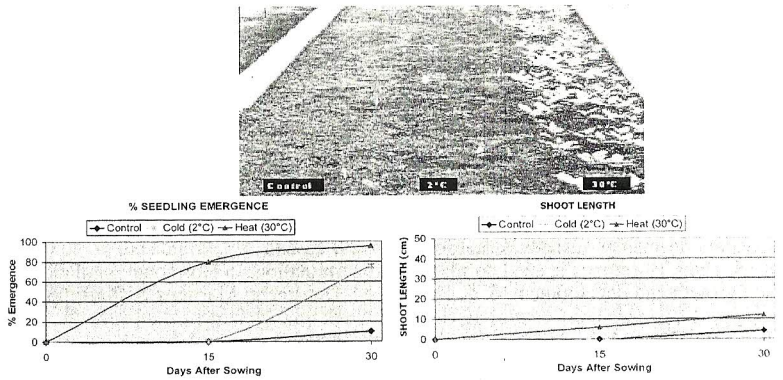


Fig. 2. Pecan seedling emergence and shoot length 30 days after sowing.

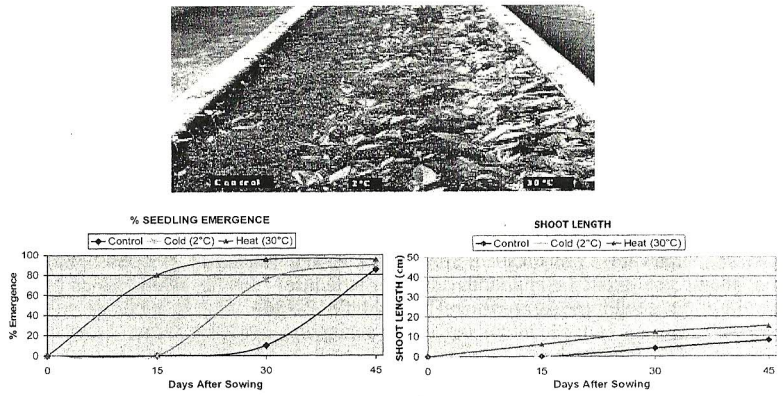
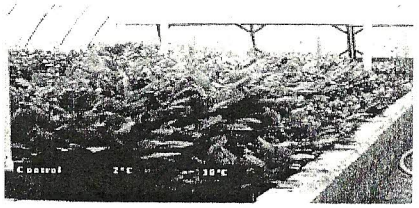


Fig. 3. Pecan seedling emergence and shoot length 45 days after sowing.



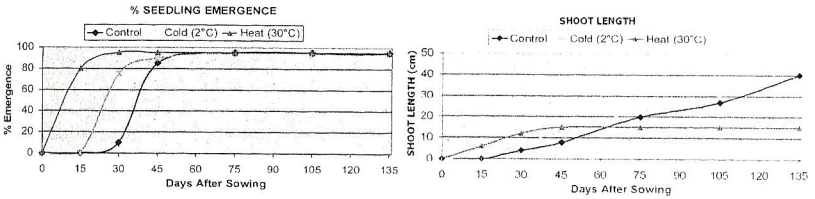


Fig. 4. Pecan seedling emergence and shoot length 135 days after sowing.

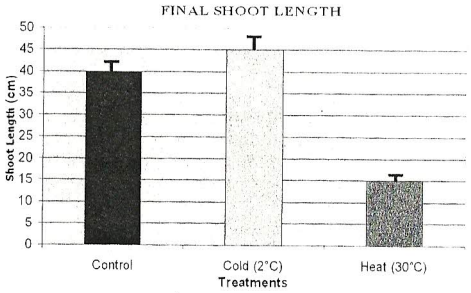


Fig. 5. Final shoot length of pecan seedlings 135 days after sowing seeds which received a cold (2°C) or heat (30°C) treatment for 10 days, compared to the control.