Field pennycress (Thlaspi arvense L.) is a new crop being investigated for its potential as a possible off season source for biodiesel. Related to the Brassicaceae species of mustard and canola, winter annual field pennycress is also susceptible to heat stress during the reproductive stage of development. The objective of this study was to determine at what temperature seed development was inhibited in pennycress. The hypothesis of our experiment is that pollen viability becomes diminished as temperatures rise above 30°C as seen in the 2012 growing season. A growth chamber experiment was conducted on spring pennycress ‘Spring 32’ over an 8 week period. Thirty plants in individual pots were grown to anthesis at 24°C day /18°C night. Five plants were transferred to 30, 32, 33, 34, and 35°C for 7 days and returned to normal conditions (24°C). Plant height, pod number, seed number, seed mass, dry biomass, seeds per pod, and harvest index were calculated for each plant. Pollen was collected from each plant after treatment, fixed in Canovy’s fixative, and examined for viability under a dissecting microscope. Pollen was also placed on growing media to evaluate percentage of pollen germination. Plant height was not significantly impacted by increased temperatures when compared to plants which remained under 24°C conditions. However, temperatures above 30°C had a significant impact on pod and seed numbers. Pollen viability decreased by 84% at 30°C and 100% at 32°C. Pollen germination could not be determined due to the small size and poor viability. Pennycress’s ability to handle heat stress will greatly impact which regions of the country are best suited for commercialization and aid breeders in evaluating lines for improved heat tolerance.

INTRODUCTION

Development of diverse and renewable feed stocks for the production of fuels has become a priority for the U.S. However, displacement of crops that produce the world’s food from tillable land is a concern. One approach to simultaneously solve needs for food and fuel is to rotate both types of crops through the same land in one extended growing season. In recent years, it has been discovered that field pennycress (Thlaspi arvense L.) can be used as a domestic source of biodiesel fuel (Moser et al. 2009). Pennycress belongs to the Brassicaceae family and grows as a common weed throughout the temperate climate in North America. Pennycress is especially beneficial because it is a winter annual, grown in the off-season, and does not take land away from producing crops such as corn and soybean. Pennycress can be worked into a corn-soybean rotation, and it can also act as a cover crop. Unfortunately, with many winter annual crops, pennycress can be susceptible to heat stress in early spring. In studies done with Brassica species, it was found that at temperatures above 35/15°C day/night temperatures for 7 days during flowering caused yield reduction (Singh et al. 2008). Singh also reported that yield reduction is caused by pollen infertility which causes flower abortion. Heat stress during early flowering has a greater impact on yield than heat stress during pod development. To improve the growth of pennycress as an agronomic crop, it is necessary to understand the response of pennycress to higher temperatures. In 2012, it was noticed that pennycress had decreased pod and seed set during the reproductive stage when temperatures rose in March and early April. The main objective of this study was to determine at what temperature pennycress plants display heat stress symptoms and what impact this would have on pollen viability.

RESULTS

Overall, temperatures above 32°C had a significant negative impact on pennycress growth and development resulting in seed production. Plants exposed to 30°C continued to grow but seed pods had an average of only 1 seed per pod (Figure 3). At 24°C, plants had an average of 68 pods and 610 seeds per plant (Table 1). Although total oil decreased slightly, change in total oil and oil constituents was not significant at temperatures of 24°C and 30°C (Figure 4). Unfortunately, pollen tube development was too small and too difficult to visualize pollen tube growth (Figure 5). Utilizing the pollen stain method, pollen count and viability at 30°C were not significantly different from the control (Figure 6).

CONCLUSIONS

Understanding heat stress symptoms that occur in pennycress (Thlaspi arvense L.) at temperatures above 30°C will enable producers to identify cooler regions for production and to modify their production practices to avoid high temperatures. In addition, plant breeders can use the above methodologies to screen the available collection of pennycress populations to identify potential new breeding lines for increasing heat tolerance or develop early flowering to avoid high temperatures. Improving heat tolerance in pennycress will greatly improve production of pennycress in variable environments and expand the current production areas.

LITERATURE CITED


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ABSTRACT

Field pennycress (Thlaspi arvense L.) is a new crop being investigated for its potential as a possible off season source for biodiesel. Related to the Brassicaceae species of mustard and canola, winter annual field pennycress is also susceptible to heat stress during the reproductive stage of development. The objective of this study was to determine at what temperature seed development was inhibited in pennycress. The hypothesis of our experiment is that pollen viability becomes diminished as temperatures rise above 30°C as seen in the 2012 growing season. A growth chamber experiment was conducted on spring pennycress ‘Spring 32’ over an 8 week period. Thirty plants in individual pots were grown to anthesis at 24°C day /18°C night. Five plants were transferred to 30, 32, 33, 34, and 35°C for 7 days and returned to normal conditions (24°C). Plant height, pod number, seed number, seed mass, dry biomass, seeds per pod, and harvest index were calculated for each plant. Pollen was collected from each plant after treatment, fixed in Canovy’s fixative, and examined for viability under a dissecting microscope. Pollen was also placed on growing media to evaluate percentage of pollen germination. Plant height was not significantly impacted by increased temperatures when compared to plants which remained under 24°C conditions. However, temperatures above 30°C had a significant impact on pod and seed numbers. Pollen viability decreased by 84% at 30°C and 100% at 32°C. Pollen germination could not be determined due to the small size and poor viability. Pennycress’s ability to handle heat stress will greatly impact which regions of the country are best suited for commercialization and aid breeders in evaluating lines for improved heat tolerance.