Exogenous Application Of Putrescine On Cotton Ovaries Under Two Temperature Regimes

Androniki C. Bibi, Derrick M. Oosterhuis, Evangelos D. Gonias and John D. Mattice

RESEARCH PROBLEM

Polyamines are organic polycations that have been associated with a large number of plant growth and developmental processes, such as pollination and fruit set. Most of the research has been done in horticultural plants, with only limited information existing for cotton. Numerous studies have correlated increased fruit set with increased polyamines concentration during flowering. Therefore in this study, it was hypothesized that exogenous putrescine application in cotton ovaries might have a positive effect on cotton seed set, particularly under high-temperature stress.

INTRODUCTION

Past experience and recent research has indicated that high temperature is the major factor adversely affecting cotton yields (Oosterhuis, 2002). The ideal temperature range in cotton has been reported to be 30/20°C (Reddy et al., 1991), although cotton physiological growth is not significantly affected up to 35°C (Bibi et al., 2004). The influence of temperature on the number of ovules per flower has not been determined directly, although there is an indication that extreme high temperatures can result in a lower number of ovules per locule (Hughes, 1966).

Plant growth substances play a controlling role in the process of reproduction. Polyamines (PAs) are substances that are naturally present in plants and act as promoters of growth. They play an important role at the time of flowering, pollination, and early fruit development (Costa et al., 1984). In addition, polyamines have been associated with plant response to abiotic stress (Kumar et al., 1997). To our knowledge no evidence exists on the effect of exogenous PAs on polyamines content of cotton ovaries. Also no information exists on how PAs affect seed set of cotton in high and normal temperatures. Therefore the objective of this study was to investigate the effect of exogenous putrescine application on seed set of cotton under two temperature regimes.

1 Graduate assistant, distinguished professor, graduate assistant, and research assistant professor, respectively, Crop, Soil, and Environmental Sciences Department, Fayetteville.
RESEARCH DESCRIPTION

A growth chamber study was conducted in the Altheimer Laboratory, Fayetteville, Ark., in December 2008. Cotton (Gossypium hirsutum L.) cultivar DP444BR was planted in 80 2-L pots filled with Sunshine growing media. Two growth chambers were used; one was used as a control with a day/night temperature regime of 30/20°C, while the second chamber was the high-temperature treatment with day/night temperatures of 38/20°C. The plants were maintained at the control temperatures until they reached the flowering stage (5 weeks after planting), after which 40 pots were placed in each growth chamber. The 40 pots in each chamber were split in two sets, half were used as control and half were used for the exogenous application of putrescine. Putrescine at 10 mM plus 0.5% Tween 20 was applied 2 days after the plants were in the temperature treatment. Putrescine was applied to 20 tagged “candles” of the same main stem node. In addition, 20 more candles were tagged from the control plants of each growth chamber. At anthesis (24 hours later), 4 “treated” white flowers and 4 “control” white flowers were collected for polyamine analysis. This procedure was repeated for 3 days. After 3 weeks, the remaining bolls were collected in order to determine the number of seeds per ovary. The treatment design was a split-plot with the main-factor temperature and the sub-factor Putrescine application. For the statistical analysis, JMP 6 software was used (SAS Institute Inc., Cary, N.C.).

RESULTS AND DISCUSSION

The statistical analysis of the data revealed that there was no significant temperature x exogenous putrescine application interaction. Because of the lack of interaction, we focused on the main effects of the exogenous putrescine application and the main effect of temperature. The results showed that the exogenous putrescine application significantly increased the putrescine content of cotton ovaries (Fig. 1). However spermidine and spermine concentrations in cotton ovaries were not significantly affected.

Subjecting the plants to temperatures above the 35-36°C physiological optimum (Bibi et.al., 2008) significantly decreased the spermidine concentration, but not the putrescine and spermine content (Fig. 2).

The results of seed set showed again that there was no significant temperature x exogenous putrescine application interaction. The main effects of seed set were significantly decreased by the high temperature compared to the control (Fig. 3).

In addition seed set was significantly increased by exogenous putrescine application (Fig. 4).

PRACTICAL APPLICATIONS

Polyamines play an important role in flowers and seed induction and have been shown to decrease under high-temperature stress. Exogenous application of putrescine increased the level of Put in flowers and this was associated with increased seed set. Therefore the possibility exists of ameliorating high-temperature stress in cotton flowers through exogenous application of Putrescine.
LITERATURE CITED


Fig. 1. Effect of exogenous Putrescine application on putrescine, spermidine, and spermine content of cotton ovaries. Pairs of columns with the same letter are not significantly different (P=0.05).
Fig. 2. Effect of high temperature on putrescine, spermidine, and spermine content of cotton ovaries. Pairs of columns with the same letter are not significantly different (P=0.05).

Fig. 3. Effect of temperature on seed set of cotton. Columns with the same letter are not significantly different (P=0.05).
Fig. 4. Effect of exogenous putrescine application on seed set of cotton. Columns with the same letter are not significantly different (P=0.05).