POLYAMINES DURING COTTON REPRODUCTIVE DEVELOPMENT AS AFFECTED BY NODAL POSITION AND A PLANT GROWTH REGULATOR

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Abstract

Polyamines have been associated with a large number of plant growth and developmental processes. In particular, they have been associated with floral initiation due to increased polyamines concentration occurring during flowering in horticulture plants. However, there is limited information about how polyamines are distributed in cotton (*Gossypium hirsutum* L.) and how they can be affected by plant growth regulators. Goemar BM86 is a plant growth regulator formulated to stimulate polyamines synthesis and seed production is. A growth chamber study was conducted to investigate the nodal distribution of polyamines in cotton and to evaluate the effect of BM86 on polyamine content and seed set efficiency of cotton. There was a clear pattern of polyamines concentration decreasing up the main stem of cotton. Putrescine decreased above the 7th node, while Spermidine and Spermine decreased significantly above and below the 9th node. In addition BM86 application caused a significant increase in putrescine and spermidine of cotton ovaries one week after the first application, while increase in putrescine of cotton ovaries was also observed two weeks after 1st application. One week after the send BM86 application the effect was not significant possible due to the small quantities detected.

Introduction

Polyamines are substances which are naturally present in plants and act as promoters of growth. They are involved in cellular multiplication and also in cellular differentiation at the time of flowering, pollination and early fruit development (Costa et al., 1984). Generally, it appears that polyamines are growth regulators indispensable to plants at the time of flowering, as well as at the first stage of fruit development (Kloareg et al., 1986). To the knowledge of the authors there are no reports on polyamine content in cotton ovaries. Therefore the first objective of this study was to investigate how the polyamines are distributed in the cotton plant.

Plant growth substances play a controlling role in the process of reproduction. The diamine putrescine and the polyamines spermidine, and spermine are substances that appear in young tissues where they are involved in cellular multiplication, in cellular differentiation during organogenesis, flowering, pollination and early fruit development (Costa et al., 1984). A plant growth regulator BM86 was formulated to stimulate polyamines synthesis and seed production by the Goëmar Laboratories in France. BM86 contains oligosaccharides that are reported to regulate the synthesis of endogenic polyamines which regulate plant differentiation and growth. Tests with horticulture plants have shown that BM 86 act as stimulator of plants development. However there is no evidence of the effect of BM86 in cotton during the reproductive stage. Therefore the second objective of this study was to determine the effect of the plant growth regulator BM86 on polyamines and seed set efficiency of cotton.

Material and Methods

A field study was conducted in 2006 at the Cotton Branch Station in Marianna, eastern Arkansas. The cultivars used were DP444BR, ST5599BR, and FM960BR. The soil was a Captina silt loam. A randomized complete block design with five replications and a split-block arrangement of treatments was used. The main factor was cultivars, and sub-factor BM86 application. The plot size was 4 rows by 15 m. The study was irrigated based on an irrigation scheduler program. The fertilization program was determined by preseason soil tests and recommended values for cotton. Weed and insect control were conducted according to Arkansas recommendations.

At first flower on July 8, 2006 the BM86 (Goëmar Laboratories, Saint Malo, France) was applied to the right 2 rows of each plot at 2 pt/acre with a backpack CO_2 sprayer calibrated to deliver 10 gal/acre (94 L/ha). The left two rows of each plot were used as the control. The day before the application, the flowering node was determined and 10 first-position white flowers were collected from each plot. Sampling was performed weekly using first-position

flowers two nodes higher than the previous position, for a total of three weeks. The PGR BM86 was reapplied two weeks after the first application. At harvest five bolls were sampled from each plot from the same node from which flowers had been previously collected, for both control and BM86 treated plants. Half of the flowers were used to determine the number of ovules per ovary. The procedure involved separating the ovary from the petals and sepals, dissecting the ovaries to determine the number of locules and the number of ovules. The remaining flowers were stored at -80 ^{o}C for subsequent polyamines determination. Polyamines were measured with HPLC and included Putrescine (Put), Spermine (Sp), and Spermidine (Sd) (Smith and Davies, 1985). The number of final number of seed was determined from the hand-picked bolls, and seed set efficiency was calculated using the equation: [seed set efficiency = (# of seeds/ # of ovules) x 100].

Results and Discussion

The results from the statistical analysis showed that there was no significant interaction between nodal position and cultivars. The main effect "cultivar" had no significant effect on any of the polyamines measured. However, this was not the case for the "nodal position" effect. Putrescine content in the cotton plant decreased significantly up the main stem (Fig.1A).

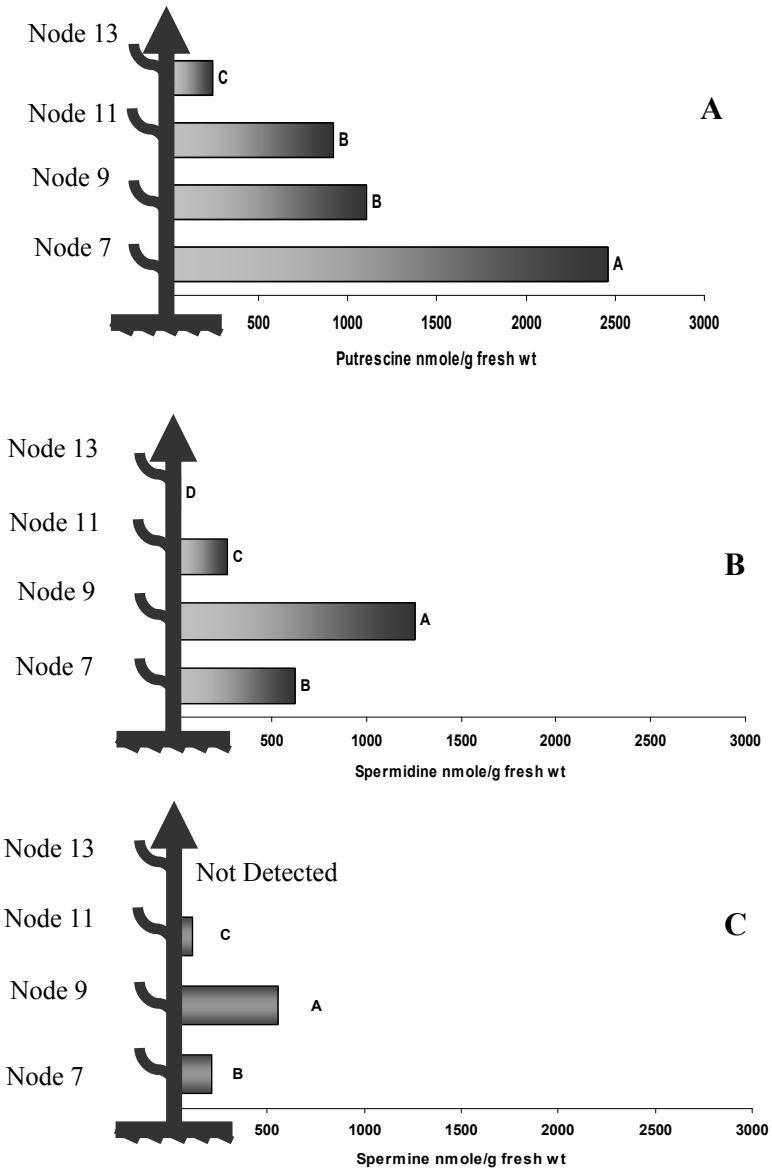

Fig.1. Effect of main-stem nodal position on Putrescine (A), Spermidine (B), and Spermine (C) content in cotton ovaries. Columns with the same letter are not significantly different (P≤0.05).

Putrescine in node 7 was significantly higher compared to nodes 9 and 11, and even higher compared to node 13. Spermidine and spermine showed similar trends (Fig.1B and Fig.1C). The node effect was significant and the content of both spermidine and spermine decreased up the main stem. However node 9 had statistically the highest concentration of spermidine and spermine compared to the other nodes.

The statistical analysis showed that there was no significant cultivar x BM86 interaction. One week after the first BM86 application a significant increase in Put and Spd levels was observed (Fig.2A). In addition Put was significantly increased in the BM86 treated plants two weeks after the BM86 application (Fig. 2B). The polyamine data one week after the second BM86 application appeared to be non significant (data not shown) possible to the minute quantities detected in the 13th nodal position.

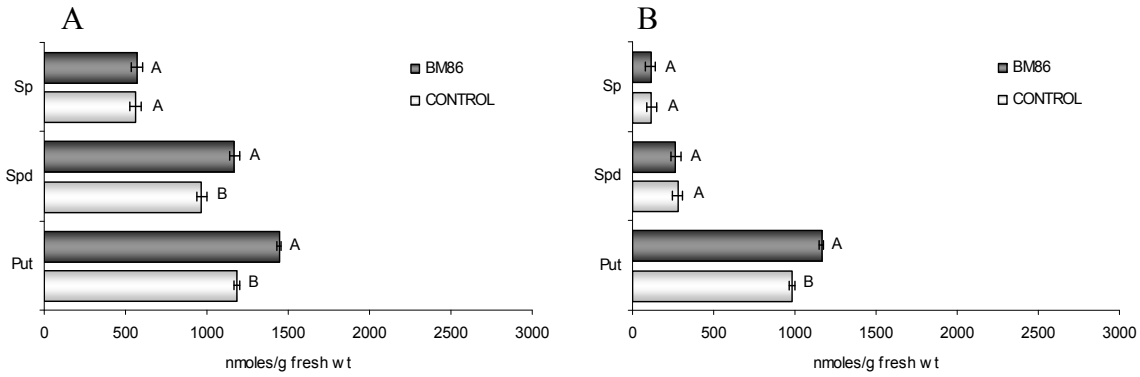

Fig.2. The effect of the plant growth regulator BM86 on the polyamine content of cotton ovaries one week after the first BM86 application (A), and two weeks after the first BM86 application (B). Pair of columns with the same letter are not significantly different (P≤0.05).

The effect of cultivars was significant on the polyamine content of cotton ovaries (P=0.05). One week after the BM86 application FM960BR showed significantly higher Spd content compared to the other two genotypes (Fig.3A). Two weeks after the BM86 application FM960BR showed significantly higher Put content compared to the other two genotypes (Fig.4A).

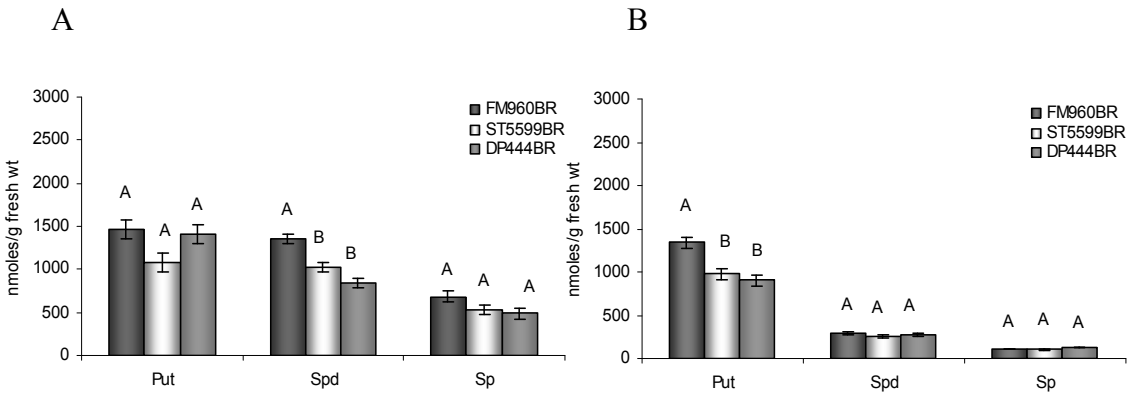

Fig.3. The cultivar effect on the polyamine content of cotton ovaries one week after the first BM86 application (A), and two weeks after the first BM86 application (B). Pairs of columns with the same letter are not significantly different (P≤0.05).

There was not significant cultivar x BM86 interraction on seed set efficiency, therefore the mani effects were tested separately. The cultivar effect on seed set efficiency was not significant (data not shown), however BM86 significantly altered seed set efficiency of cotton (Fig.4). A significant increase on seed set efficiency was observed in the BM86-treated plants when the total number of seeds (mature and undeveloped) was determined at harvest in 2006 (Fig.5A). However, this result was not observed when only mature harvestable seeds were counted and seed set efficiency recalculated. Exactly the same pattern was observed in 2007, with a significant increase in seed set efficiency in the BM86- treated plants when the total number of seeds (mature and undeveloped) was determined, but not when mature harvestable seeds were counted (Fig.5B).

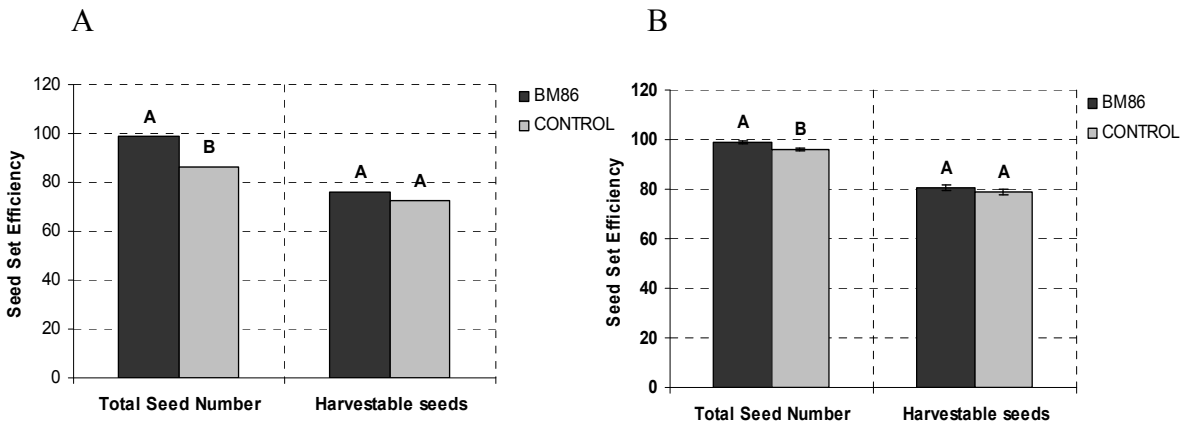

Fig.4. The effect of Goemar BM86 on seed set efficiency of cotton in 2006 (A) and in 2007 (B). Pairs of columns with the same letter are not significantly different (P≤0.05).

Conclusions

Polyamines play a critical role in reproductive development. Therefore knowledge of their distribution in the cotton plant and how they are affected by exogenous plant growth regulaters will allow the formulation of strategies for yield improvement and stabilization. It was obvious that the application of BM86 had a significant positive effect on cotton ovary polyamine content, specifically on putrescine and spermidine. In addition the number of total seeds (mature and undeveloped) was significantly increased in the treated plants, but the number of harvestable seeds was not affected. Therefore, we can say that application of BM86 can increase significantly the seed number by increasing the polyamine content, but we need investigate how to capitalize on the increase potential seed number for improved yield and economic return.

References

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