Relationship between pericycle cell length and lateral root spacing in maize root

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ABSTRACT

Exogenous auxin inhibits seminal root elongation and promotes the formation of lateral roots (LR). Searching for one possible relationship between the inhibition of elongation and the spacing of LR, we have simultaneously determined pericycle, cortex and epidermis cell lengths and LR density in NAA-treated maize roots. The inhibition of root elongation is proportional to NAA concentration and correlates with a decrease in cell length. NAA treatments reduced pericycle cell length in a range from 30 to 50%. The first step in the LR formation is a division of the founder cells that, in maize, are some pericycle cells located opposite to phloem poles. Treatment with 0.01 μM NAA results in increased number of LRs and reduced pericycle cell length. Nevertheless, 0.05 μM NAA, which strongly reduced pericycle cell length, did not stimulated LR formation. This result suggests that auxin stimulation on LR formation is modulated by pericycle cell length.
KEYWORD: auxin, lateral root, pericycle.

INTRODUCTION

Lateral roots originate from mature zones of a seminal root from a very few parent cells, called founder cells. In maize, LR founder cells are recruited from the pericycle cells opposites to phloem poles (Lloret and Casero, 2002). Auxin appears to play a critical role in LR initiation and a local accumulation of auxin in root pericycle cells is the necessary and sufficient signal to respecify these cells into lateral root founder cells (Dubrovsky, 2008). NAA application promotes LR formation (Lloret and Casero, 2002) and inhibits seminal root elongation in maize (Alarcón et al., 2009). Recently, LR spacing has been analysed in the model species *Arabidopsis thaliana* (Dubrovsky et al., 2009). In this paper we search for a relationship between the reduction of cell length of pericycle cells and the increase of LR formation promoted by exogenous auxin.

METHODS

Maize roots were grown in well-aerated solution at 30ºC in darkness. NAA applied to roots of 60-80 mm in length generates two segments, named A and B, formed just before and after NAA treatment, respectively. In the segment A, the elongation occurred without NAA, but LR formation is developed in presence of NAA because LR formation takes a time. Nevertheless, in the segment B both processes are influenced by NAA. Root length was measured with a ruler. LR density was calculated recounting the number of LRs per cm of main root. Cell length was measured using longitudinal sections of paraffin-embeded root segments.

RESULTS AND DICUSSION

Exogenous auxin treatments inhibited seminal root elongation rate and resulted in shorter root cells in the region with affected elongation (segment B). Control untreated, 0.01, and 0.05 μM NAA-treated roots elongated at a rate of 2.7, 1.7 and 0.8 mm/h respectively. In the same experimental groups, epidermal cell length was reduced from 141 μm (control) to 102 and 70 μm

(0.01 and 0.05 μM NAA treatments). Cortical cell also decreased cell length from 176 μm to 139 and 76 μm under the effect of the same NAA treatments.

Auxin treatment increased LR density independently of pericycle cell length in A segments (Fig. 1). On the contrary, LR formation is apparently dependent of cell length in B segments. In this region after a treatment with 0.01 μM NAA, LR density increased as pericycle cell length decreased. However, application of 0.05 μM NAA resulted in even a shorter pericycle cell length but with a lower LR density than in 0.01 μM NAA-treated roots (Fig. 1).

In order to quantify the influence of variations in cell length on LR density we have supposed an ideal root formed by a single column of opposite phloem pericycle cells. Hence, we have estimated the mean distance between two consecutives LRs in terms of the number of intervening pericycle cells (NIPC) between them. This index is similar to the LR initiation index recently proposed by Dubrovsky et al. (2009) as a method to normalize root growth for variations in cell length. In the segment A, between two RL were 26-39 intervening pericycle cells, without significant differences between treatments. In B segment the NIPC was 34-36 in control and 0.01 NAA-treated roots. The NIPC increased significantly to 72 cells in the segment B of 0.05 NAA-treated roots. This result means that under these conditions some founder cells have been inhibited for LR formation, probably because they are too much short to initiate LR primordia. Consequently we propose that auxin stimulation on LR formation is modulated by pericycle cell length.

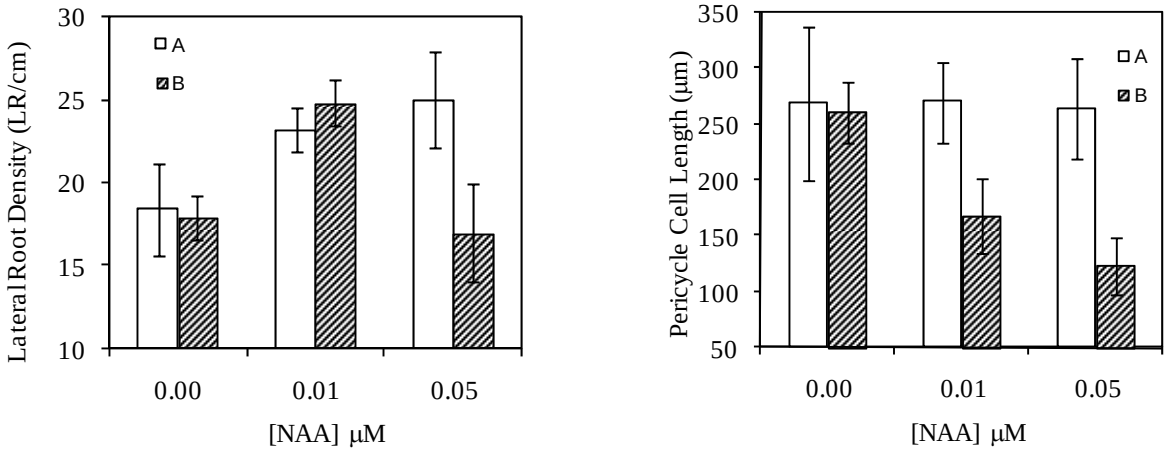

Fig. 1.- Effects of NAA on LR density and the pericycle cell lengths in A and B segments.

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