

Salicylic acid treatment changes plant root system patterning

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Motivation and Aim: Plant hormone salicylic acid (SA) mediates responses to pathogen and pest attacks and abiotic stresses, including drought, salinity, chilling, heavy metals and others [1]. Besides, to date, numerous data have been accumulated that favor a versatile role of SA in plant development. The SA content, the ratio of free and conjugated forms and their dynamics differ in shoots and roots, and thus can potentially cause differences in SA functions there. However, unlike in shoots, morphogenetic role of SA in roots has been poorly generalized so far [2]. Here we infer the patterns of root system response to SA across different species.

Methods and Algorithms: We performed a systematic analysis of more than 100 papers on SA treatments in about 40 plant species, with SA concentration ranging from 10 fM to 10 mM to summarize data on root system response to this hormone. A simple root structure facilitates description of treatment effects.

Results: SA regulates root morphology from radicle emergence during seed germination to middle cortex formation in aged plants. SA influences most of these processes in a concentration-dependent manner with opposite effects manifested at different concentrations [3]. Wherein, concentration ranges, which cause a certain effect, are genotype-specific. SA concentration dependence was found for following processes: radicle emergence (in cucumber, wheat, maize, carrot, and Arabidopsis); root elongation (in cucumber, wheat, beans, lens, *Trigonella foenum-graceum* L., and *Pennisetum glaucum* L.) and adventitious rooting (in mungbean, rhododendron, and Arabidopsis). For many species, SA concentrations that only activate or only inhibit the aforementioned processes have been found yet. The same unidirectional patterns are observed for SA impact on lateral root development in Arabidopsis and *Catharanthus roseus* hairy root tissue culture obtained from *Agrobacterium rhizogenes* infected leaves [4-6]. In Arabidopsis, SA (3-250 μ M) inhibits lateral rooting whereas in *Catharanthus roseus* hairy root tissue culture very low SA concentrations (10 fM) stimulate this process, pointing out that any case of the unidirectional SA inhibition of root growth needs to be tested with nano and femto mole SA concentrations. In its turn, unidirectional SA stimulation of root growth requires verification with higher SA concentrations.

Conclusion: At least in some species, it was demonstrated that SA is a hormetic regulator, having a biphasic dose response, where low and high concentrations promote and inhibit growth respectively. This allows SA to control the growth-stress response balance in root system development.

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References

1. Zhang Y. et al. Salicylic acid: Biosynthesis, perception, and contributions to plant immunity. *Curr Opin Plant Biol.* 2019;50:29-36.

2. Rivas-San Vicente M. et al. Salicylic acid beyond defence: Its role in plant growth and development. *J Exp Bot.* 2011;62:3321-3338.
3. Bagautdinova Z. et al. Salicylic Acid in Root Growth and Development. *Int J Mol Sci.* 2022;23(4):2228.
4. Pasternak T. et al. Salicylic acid affects root meristem patterning via auxin distribution in a concentration-dependent manner. *Plant Physiol.* 2019;180(3):1725.
5. Armengot L. et al. Functional interplay between protein kinase CK 2 and salicylic acid sustains PIN transcriptional expression and root development. *Plant J.* 2014;78(3):411.
6. Echevarría-Machado I. et al. Responses of transformed *Catharanthus roseus* roots to femtomolar concentrations of salicylic acid. *Plant Physiol Biochem.* 2007;45(6-7):501.