The Effect of Chemical Priming of Rubber Nursery Plants on Growth and Abiotic Stress Alleviation under Drought Conditions in the Intermediate Zone of Sri Lanka

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Introduction

In the wake of climate change, abiotic stress in plants has now been recognized as one of the biggest threats to agricultural productivity all over the world. Drought and heat stresses are are the two abiotic stresses undoubtedly having a huge impact on the growth and productivity of crops. These stresses in isolation and/or combination induce numerous adverse effects in plants impairing morphological and physiological changes of plants and eventually causing severe reductions in plant growth, development and overall productivity (Khan and Khan, 2013).

With the scope of further expansion of rubber to Non-traditional areas such as Moneragala, Padiyathalawa, Ampara, Vavuniya, Hambanthota, and Puttalam in the Intermediate and Dry Zones of the country, many research was carried out in alleviation abiotic stress such as drought and heat. Nevertheless, drought-tolerant rubber clones are yet to be identified in Sri Lanka, and therefore, it is essential to prime (preconditioning) the rubber nursery plants for enhanced tolerance to abiotic stresses such as drought and heat. Chemical priming is a promising area in plant stress physiology and crop stress management which involves exposure to a priming agent such as a natural or synthetic chemical compound. Sodium nitroprusside (SNP) and Salicylic acid (SA) are two widely used such chemical primers and plant growth regulators that have shown a significant effect on plant abiotic stress tolerance. Therefore, this is paper shares the results obtained by the concurrent research conducted for the exogenous application of Sodium nitroprusside (SNP) and Salicylic acid (SA) to rubber nursery plants in order to mitigate the drought stress when introducing them to Non-traditional areas in the Intermediate Zone of Sri Lanka where the prolonged dry periods are prevailing in every year.

Use of Sodium Nitroprusside (SNP) for enhancing root architecture and growth of plants

Nitric oxide (NO) donor SNP is an important endogenous signaling molecule involved in a variety of plant functions such as plant growth and development, and responses. Exogenous NO mitigated the decrease in plant growth caused by drought and heat through increasing antioxidant enzymes and thereby alleviating oxidative damage, accelerating proline accumulation, enhancing photosynthesis (Sanz *et al.,*2015). Therefore, the effect of Sodium nitroprusside (SNP) as a NO donor on the growth of rubber nursery plants was investigated through many nursery experiments conducted over several years. Nayanakantha *et al*. (2014 and 2016) reported that exogenous SNP could improve the root architecture and growth of rubber seedlings under the protected house and nursery conditions. Figure 1 shows the effect of different concentrations of NO donor SNP that increases the root architecture of rubber seedlings after 14 days of transplanting in a young budding polybag

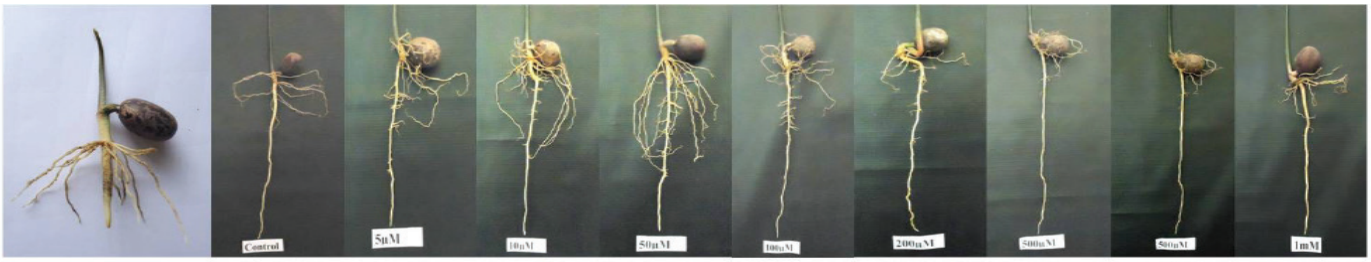

Figure 1*. Effect of NO on root architecture of rubber seedling treated with different concentrations of NO donor SNP and the observations were made 14 days after NO treatment. a:germinated rubber seedlings at the time of transplanting. b: control soil drench with water, c: 5µM SNP, d: 10µM SNP, e: 50µM SNP, f: 100µM SNP, g: 200µM SNP, h: 300µM SNP, i: 500µM SNP, j: 1000µM SNP*

nursery. Plant treatment with different concentrations of SNP in a range of 50 μM - 300 μM as soil drench was found to be the best range that significantly responded to the growth of rubber seedlings in a prolonged drought period (Nayanakantha *et al.*, 2014).

Use of Salicylic acid (SA) to alleviate drought stress in plants

Similarly, Salicylic acid (SA) is an important priming agent known to alleviate drought stress in rubber nursery plants. Several research studies were carried out during 2016-2017 to investigate the effect of the exogenous application of Salicylic acid on the growth performance of rubber nursery plants under drought stress conditions in the Intermediate Zone of Sri Lanka (Nakandala,2018). Pre-conditioning of rubber nursery plants by using an exogenous application of SA has been identified as a feasible solution for enhancing the growth of rubber nursery plants under drought-stress conditions. Nakandala (2018) reported in her postgraduate research study that the rubber seedlings treated with 100 ml of SA at a concentration in a range of 0.3 to 0.5 mM as a soil drench in monthly applications can significantly impact on stress tolerance of rubber nursery plants, thereby reducing the total irrigation requirement of the rubber nursery plants by 25 % when introducing them to drought-prone areas in the Intermediate zone of Sri Lanka. Based on the overall results obtained from the above research studies revealed that drought stress could be alleviated by applying Salicylic acid and Nitric oxide donor Sodium nitroprusside significantly and have identified to use of reducing the total irrigation requirement of rubber nursery management when introducing them to drought-prone areas in the Intermediate zone of Sri Lanka.

References

Khan M. I. R., Iqbal N., Masood A., Per T. S., Khan N. A. (2013). Salicylic acid alleviates the adverse effects of heat stress on photosynthesis through changes in proline production and ethylene formation. *Plant Signal. Behavior.* 8:e26374 10.4161/psb.26374.

Nakandala D S A, (2018). Techno-physiological package for young rubber nursery plants (Hevea brasiliensis Mull. Arg.) to withstand water stress conditions. Ph.D. Sri Lanka: University of Ruhuna.

Nayanakantha, N.M.C., N.N. Hettiarachchi, A.M.W.K. Senevirathna, and P. Seneviratne (2016). Exogenous nitric oxide donor sodium nitroprusside enhanced growth attributes of polybagged rubber (*Heveabrasiliensis*) seedlings. *Tropical Agricultural Research and Extension Journal.*18(3), pp.134–141.

Nayanakantha, N.M.C. P.D. Pathirana, A.M.W.K. Senevirathna and P. Seneviratne (2014). Exogenous nitric oxide-donor sodium nitroprusside ameliorates root architecture and growth of young budding polybagged plants of rubber (*Heveabrasiliensis*). *Journal of the Rubber Research Institute of Sri Lanka*. 94: 9-24.

Sanz, L., Albertos, P., Mateos, I., et al. (2015). Nitric oxide (NO) and phytohormones crosstalk during early plant development. *Journal of Experimental Botany*, 66: 2857–2868.