Nanopriming: An Effective Technique to Improve Seed Germination, Growth and Quality in Onion (*Allium cepa* L.)

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Abstract

Nano-priming is an innovative technique for improving seed germination and initial growth. Silver nanoparticles (AgNPs), gold nanoparticles (AuNPs) and nanoemulsions prepared using turmeric and citrus oil were formulated and used for priming onion seeds for 12 hrs. Dry and hydroprimed seeds were used as controls. Seeds were planted in the greenhouse and germination percentage (GP) was recorded at 6 and 21 days after sowing (DAS). GP was found to be 47% and 19% higher in AuNPs treatment at 6 and 21 DAS respectively, as compared to controls. Different growth and yield parameters were assessed in the field after transplanting. Results demonstrated that nanopriming had significant effects on root length, shoot length, leaf length, number of leaves per plant, and neck diameter. Quality parameters were evaluated after harvesting of onions. Pyruvate levels were found to be lower and total phenolics in bulbs were higher in nano treated plants as compared to controls. Results indicate that nanopriming has a significant impact in seed germination, growth, quality and yield of onion.

Introduction

Onion (*Allium cepa* L.) is a monocotyledonous, cool season vegetable crop with selectively permeable seed coat. High quality seed is the critical aspect in onion on which all other inputs depend for their potential yield. To enhance the quality of onion seed, nanopriming can be one of the suitable methods. Conventionally, inorganic reducing agents are used to synthesize nanoparticles which pose risks for environmental and human health hazards. In this study, phytochemicals extracted from agro-industrial byproducts were used to synthesize nanoparticles instead of highly toxic inorganic reducing agents. Green nanoparticles were prepared by a dropwise reduction method and characterized using ultraviolet-visible (UV-Vis) spectroscopy and dynamic light scattering (DLS) techniques. Previous studies have revealed that onion seed priming with metallic nanoparticles can enhance seed germination, root and shoot length, early flowering and increased enzyme activity [1,2] and foliar spray enhances growth in different crops [3].

Fig 1: Onion seeds priming from left to right (T2-T6) arranged sequentially in each picture. T2: Hydro priming, T3 : Citrus oil nanoemulsion, T4: Turmeric oil nanoemulsion, T5: Silver nanoparticles ,T6: Gold nanoparticles

Objectives

- To synthesize green nanoparticles using plant extracts.
- To assess nanopriming effects in the seed germination, growth and yield of onion.
- We hypothesized that nanoparticles prepared from agro industrial byproducts will show unique physical and chemical properties.

Methodology

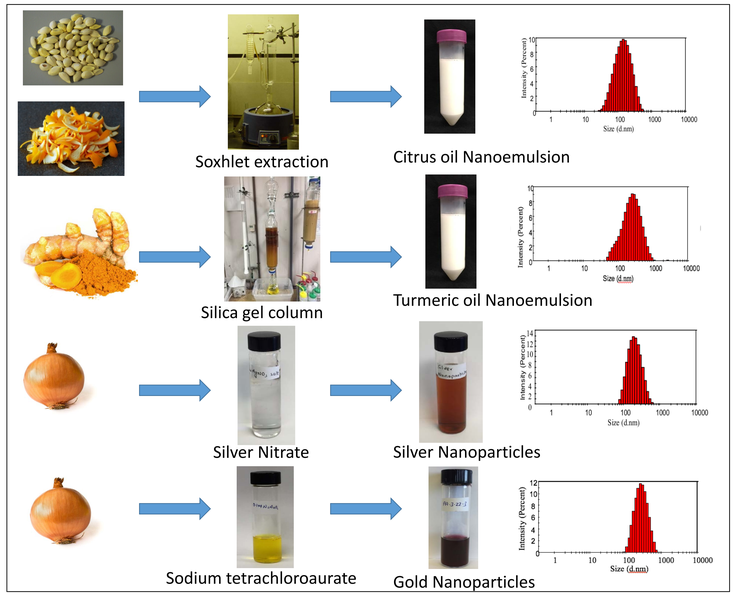

Fig 2. Green nanoparticle synthesis and characterization

Results

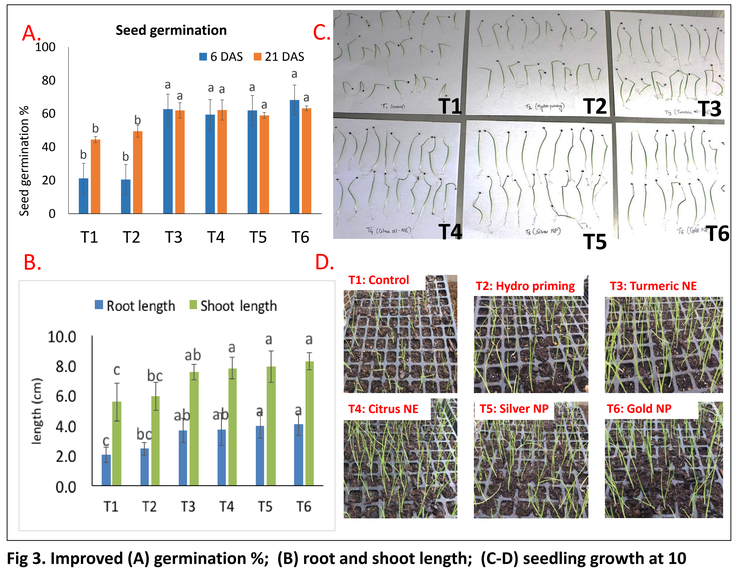

Fig 3. Improved (A) germination %; (B) root and shoot length; (C-D) seedling growth at 10 days after sowing the primed onion seeds using green nanoparticles

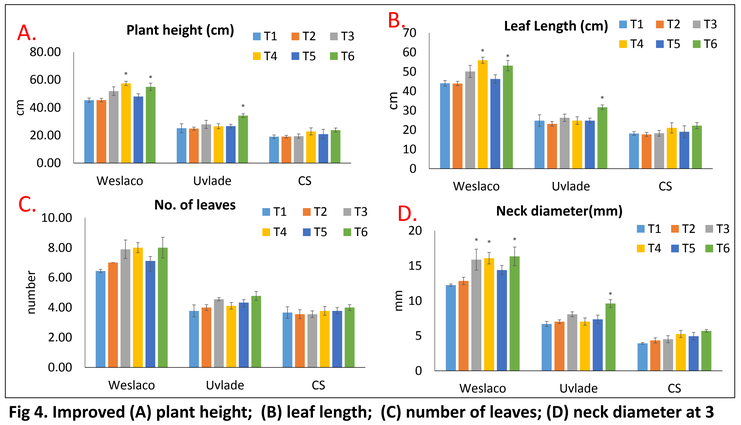

Fig 4. Improved (A) plant height; (B) leaf length; (C) number of leaves; (D) neck diameter at 3 months after transplanting the primed onion seeds using green nanoparticles

Results

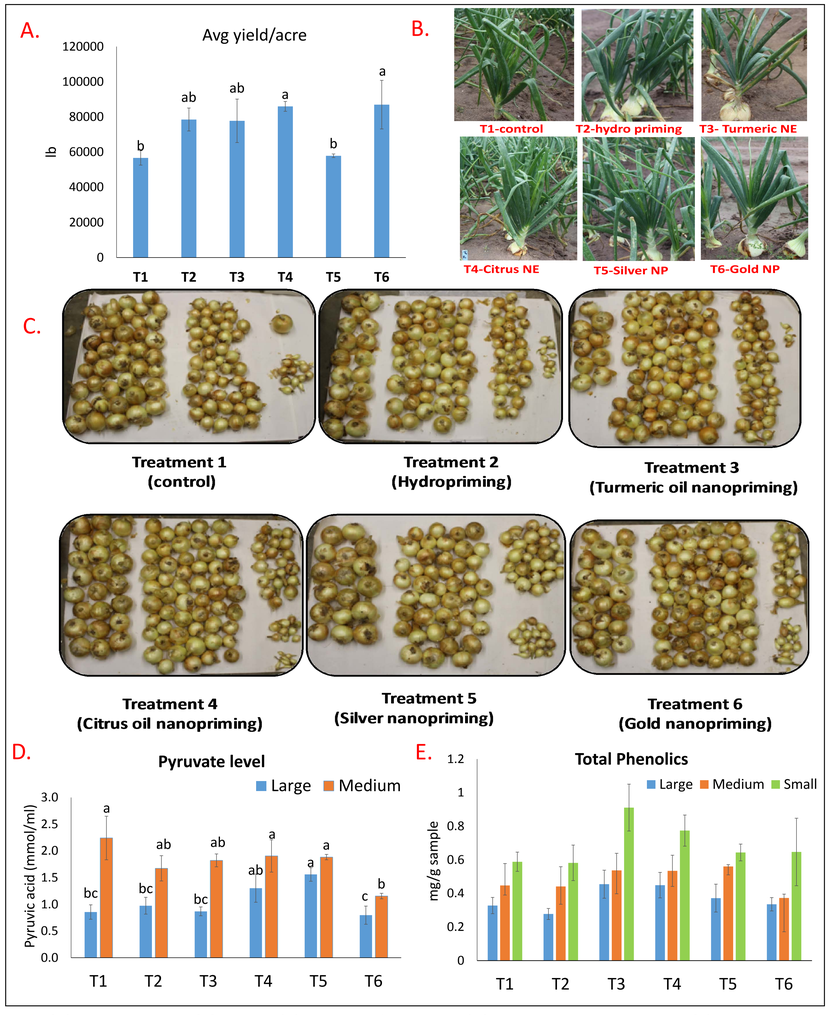

Fig 5. (A) Enhanced yield (B) growth (C) number of bulbs and (D) decreased pungency level (E) enhanced total phenolics in nano-primed onions as compared to control

Conclusions

- Agro food industrial byproducts can be utilized for the green synthesis of nanoparticles.
- Nanopriming minimized the time between sowing and seedling emergence, improved the germination rate, uniformity of germination and total germination percentage.
- Nanopriming influenced the pyruvate and total phenolic composition.
- Number of bulbs, leaf length, number of leaves, plant height, neck diameter and the total yield were increased by nanopriming.

References

1. Pagano, Luca, et al. "Molecular response of crop plants to engineered nanomaterials." *Environmental science & technology* 50.13 (2016): 7198-7207.
2. Farooq, M., A. Wahid, and Kadambot HM Siddique. "Micronutrient application through seed treatments: a review." *Journal of soil science and plant nutrition*12.1 (2012): 125-142.
3. Elmer, Wade H., and Jason C. White. "The use of metallic oxide nanoparticles to enhance growth of tomatoes and eggplants in disease infested soil or soilless medium." *Environmental Science: Nano* 3.5 (2016): 1072-1079.

Acknowledgements

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