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Proceeding Paper

The Response of Drought-Stressed Green Pea (*Pisum sativum* L.) to Boron Nanoparticle Application †

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1. Introduction

Maintaining pea-growing areas is becoming increasingly difficult because they are highly sensitive to environmental stresses, especially drought. Green peas *(Pisum sativum* L.) are a very important source of amino acids in the diet of humans, poultry, and livestock nutrition, as well as in crop rotation. To reduce the potential adverse effects of drought on peas, this study aimed to investigate the effects of different concentrations of boron nanoparticles (B NPs) on plants via different routes of exposure: through leaves spraying and root watering.

2. Methods

Plants and growth conditions: The research was carried out in a greenhouse; 10 green pea seeds ('Respect') were sown in 10 L vegetative pots and were thinned up to 7 plants per pot after germination. When the peas reached the 39 BBCH growth stage (had 9 or more visibly extended internodes) they were foliar sprayed to full wetness (ca. 14 ± 0.5 mL plant^{-1}) or watered (100 ± 1 mL per pot) with suspensions containing different concentrations of B NPs: 0 (watered or sprayed with distilled water), 0.0125, 0.025, and 0.05 mg mL^{-1} During the 10-day drought period, low substrate moisture (30%) was maintained for peas exposed to B NPs, other plants (controls) were grown under normal substrate moisture (80%). At the end of the experiment, peas were harvested to assess the interactive effects of B NPs and drought on plants growth and enzymatic (SOD, GR, APX) and non-enzymatic (TPC, FRAP) antioxidants activity.

Boron (B) NPs preparation: B NPs (particle size: 100 nm; purity: 99.9%) were used for this experiment (US Research Nanomaterials, Inc., Houston, TX, USA). The NPs with concentrations of 12.5 ppm, 25 ppm, and 50 ppm were suspended in deionized water and ultrasonically dispersed for 60 min. The NPs size and suspension stability were measured using Delsa™ Nano Submicron Particle Size (Beckman Coulter Instruments. Corporation, Fullerton, CA, USA) and Zeta Potential device (Dispersion Technology Inc., Bedford Hills, NY, USA).

3. Results

The results showed that foliar spraying or watering at a concentration of 0.05 mg L^{-1} B NPs had a strong positive effect on pea leaf area, shoot height, fresh biomass, root length, and the number of nodules when plants grown in drought conditions. Positive effects on the activity of enzymatic (SOD, GR, APX) and non-enzymatic (TPC, FRAP) antioxidants in the pea plant were found. In general B NPs protected green peas from the

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adverse effects of drought stress if the appropriate concentration and application to the plant were selected.

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