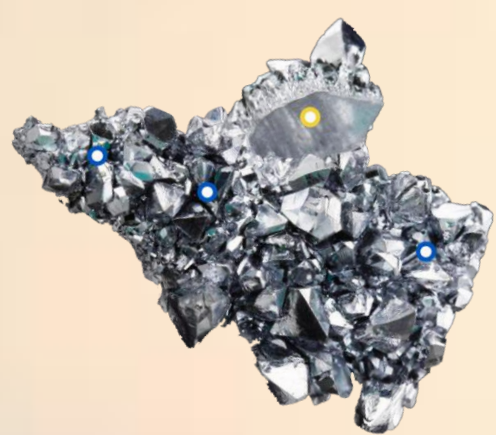




Ameriolation Of Chromium Induced Oxidative Stress In Soybean Through Application Of Chromium (Vi) Reducing Bacterium

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Introduction

The leather processing industry in Dhaka's Hazaribagh area has long contributed to Bangladesh's economy but caused severe chromium (Cr) pollution from untreated tannery effluents. Hexavalent chromium [Cr(VI)] is highly toxic, mobile, and carcinogenic, severely affecting soil, water, and plant health. In soybean (*Glycine max* L.), Cr toxicity disrupts photosynthesis, nutrient uptake, and metabolism, leading to oxidative stress and reduced growth. Certain Cr(VI)-reducing bacteria, such as *Bacillus* and *Pseudomonas*, can convert toxic Cr(VI) to the less harmful Cr(III) while promoting plant growth through phytohormone production and antioxidant activation. This study investigates a Cr(VI)-reducing bacterium isolated from tannery wastewater for its potential to alleviate Cr-induced oxidative stress, improve growth, and enhance antioxidant defense in soybean grown in contaminated soil. Objectives:

1. Evaluate Cr (VI)-reducing capacity of isolated bacteria.
2. Assess Cr impact on soybean growth and yield in contaminated soils.
3. Determine the bacterium's potential to alleviate Cr-induced oxidative stress in soybean.

Working Procedure



Results

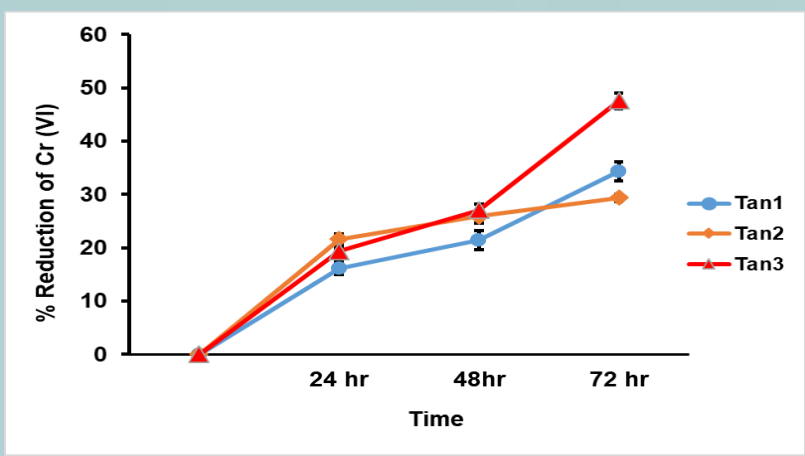


Figure 1: Percentage reduction of hexavalent chromium Cr (VI) by bacterial isolates Tan1, Tan2, and Tan3 at 24, 48, and 72 hours of incubation.

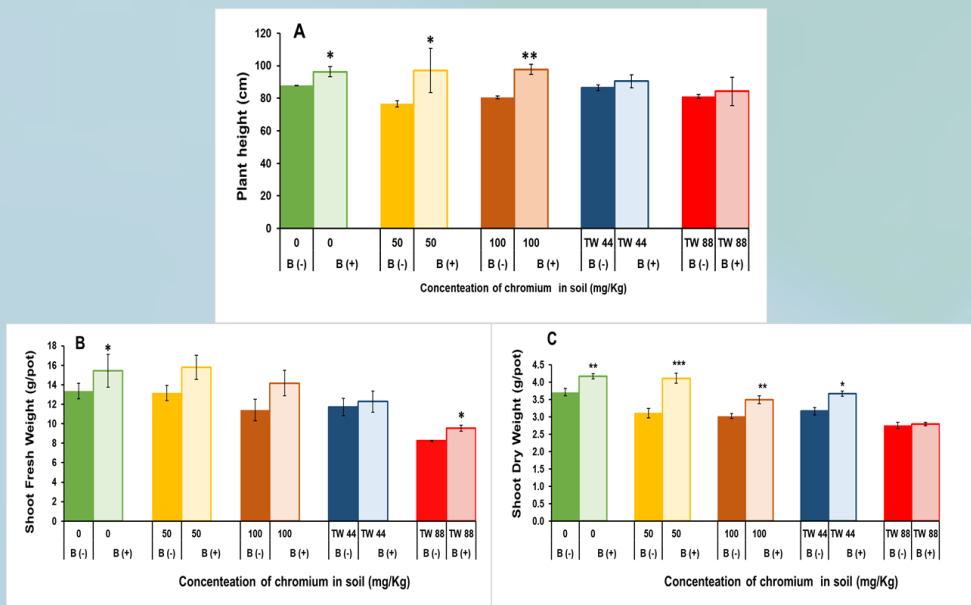


Figure 2: Effect of Tan3 on soybean growth in Cr-contaminated soil

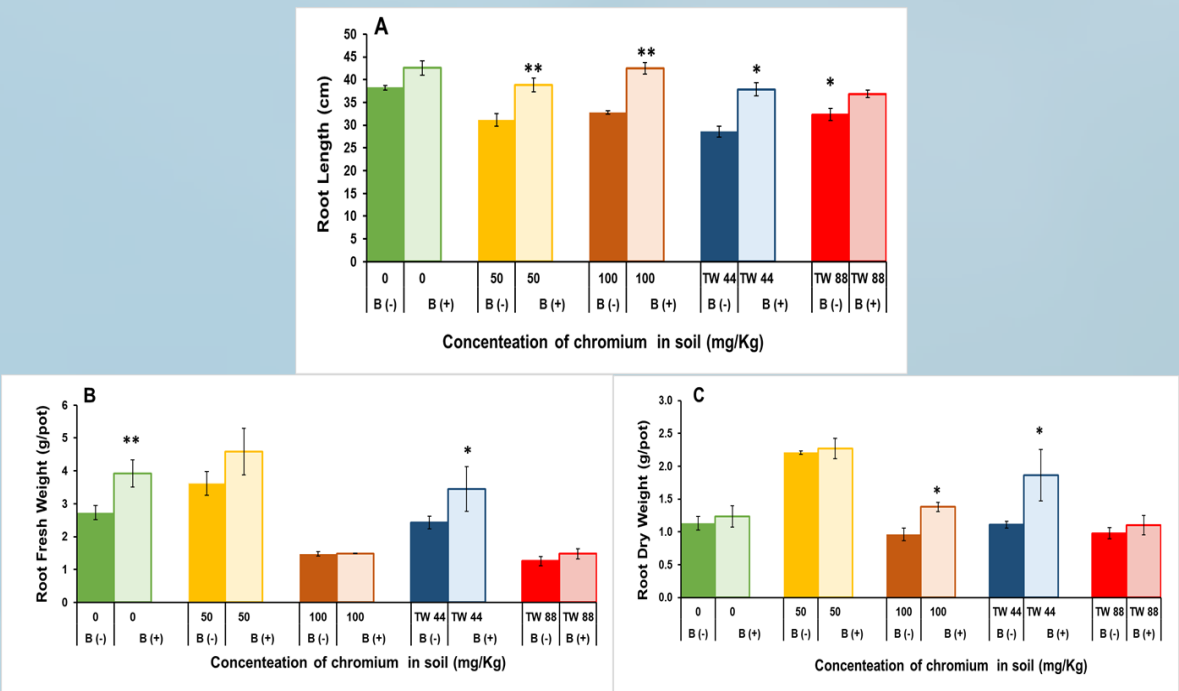


Figure 3: Effect of Tan3 on root growth of soybean in Cr-contaminated soil

Treatments	Chl a	Chl b	Total Chlorophyll	Carotenoid
B(-) 0 mg/kg	43.437 ± 3.16 ^a	56.910 ± 1.26 ^{ab}	100.346 ± 3.92 ^{ab}	8.416 ± 0.62 ^{ab}
B(-) 50 mg/kg	45.344 ± 2.59 ^a	49.952 ± 2.46 ^{a-d}	95.297 ± 4.69 ^{abc}	6.745 ± 2.56 ^{abc}
B(-) 100 mg/kg	48.777 ± 0.34 ^a	43.101 ± 3.08 ^{b-b}	91.878 ± 5.76 ^{abc}	2.850 ± 0.64 ^{cd}
B(-) TW 44 mg/kg	48.338 ± 0.53 ^a	44.546 ± 3.30 ^{b-b}	91.551 ± 3.39 ^{abc}	3.835 ± 0.79 ^{bcd}
B(-) TW 88 mg/kg	47.129 ± 0.75 ^a	37.275 ± 3.17 ^{def}	83.566 ± 4.70 ^{bc}	3.023 ± 0.28 ^{cd}
B(+) 0 mg/kg	47.542 ± 2.78 ^a	61.097 ± 1.84 ^a	107.639 ± 2.88 ^a	11.801 ± 1.14 ^a
B(+) 50 mg/kg	49.302 ± 1.10 ^a	54.194 ± 2.18 ^{abc}	103.496 ± 1.31 ^{ab}	7.117 ± 1.03 ^{abc}
B(+) 100 mg/kg	52.910 ± 4.83 ^a	41.058 ± 3.92 ^{cde}	93.635 ± 6.74 ^{abc}	1.541 ± 0.43 ^d
B(+) TW 44 mg/kg	49.511 ± 1.50 ^a	34.134 ± 2.12 ^{ef}	83.645 ± 2.92 ^{bc}	3.956 ± 0.28 ^{bcd}
B(+) TW 88 mg/kg	48.552 ± 1.85 ^a	24.901 ± 3.39 ^f	73.454 ± 5.24 ^c	4.914 ± 0.28 ^{bcd}

Table 1: Effect of Tan3 on chlorophyll (Ch) concentration of soybean in Cr-contaminated soil

Consequences

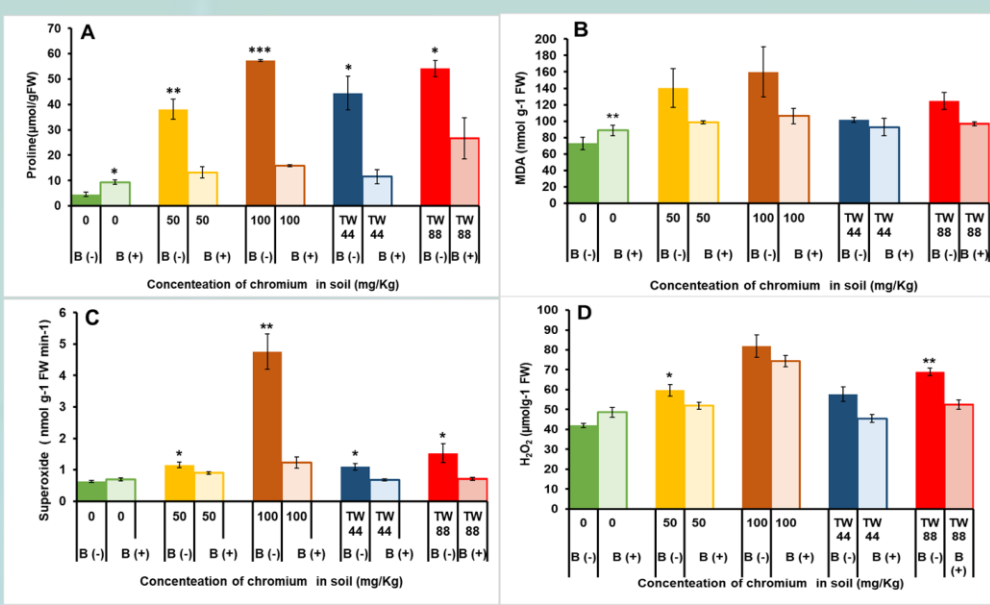


Figure 4: Effect of Tan3 on expression of oxidative stress markers and reactive oxygen species (ROS) in soybean under chromium stress

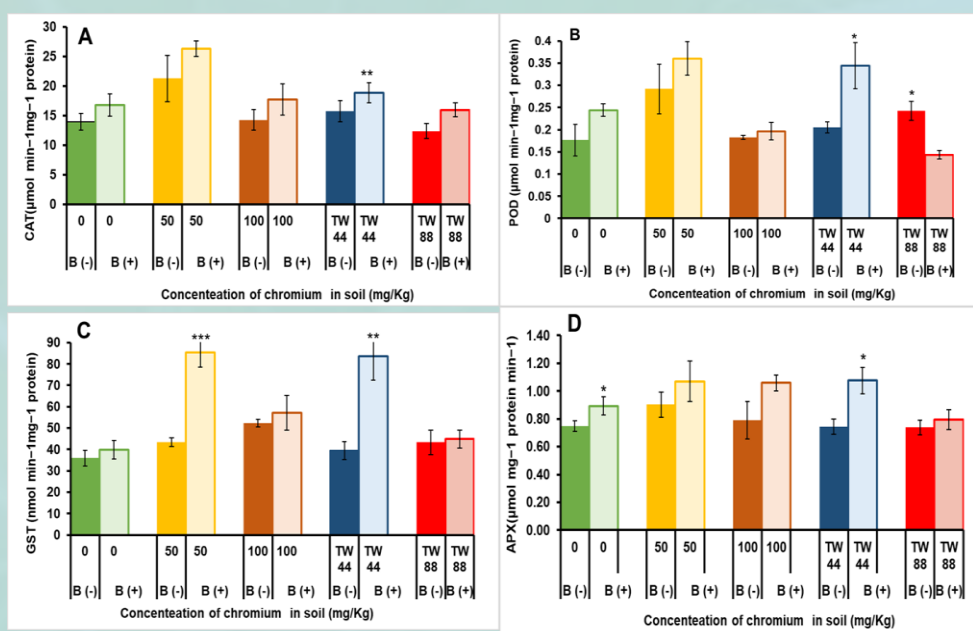


Figure 5: Effect of Tan3 on expression of antioxidant enzymes of soybean under chromium stress

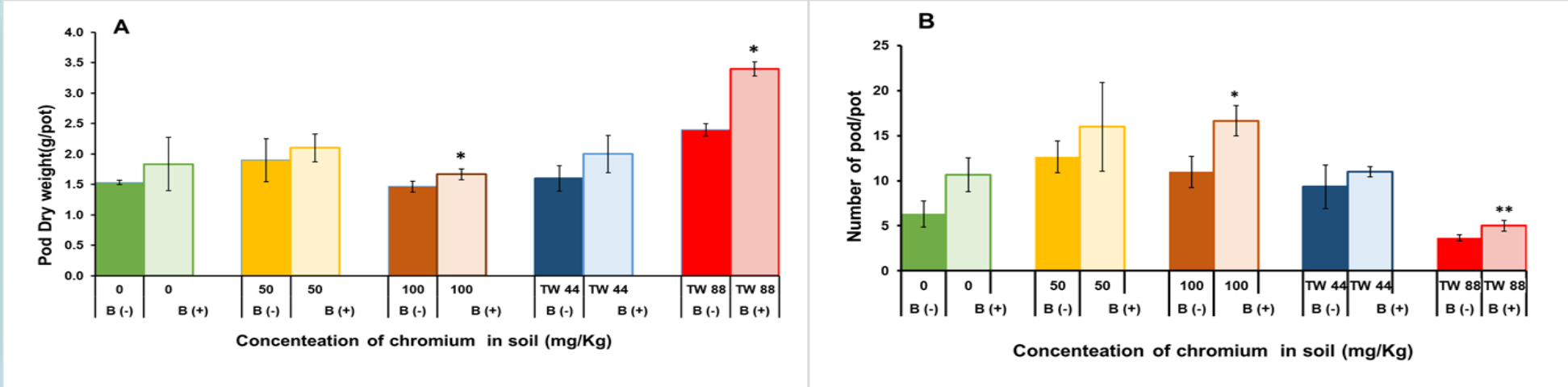


Figure 6: Effect of Tan3 on yield attributes of soybean in Cr-contaminated soil

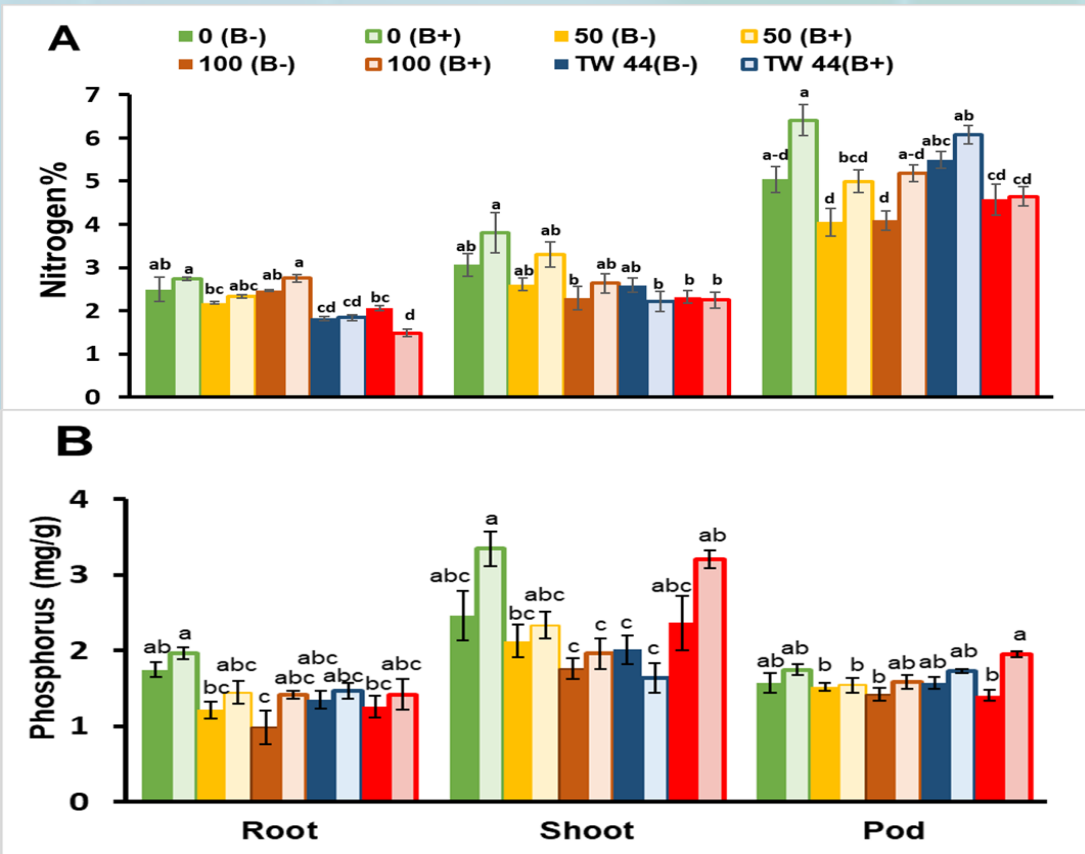


Figure 7: Effect of Tan3 on nutrient contents of soybean in Cr-contaminated soil (N & P)

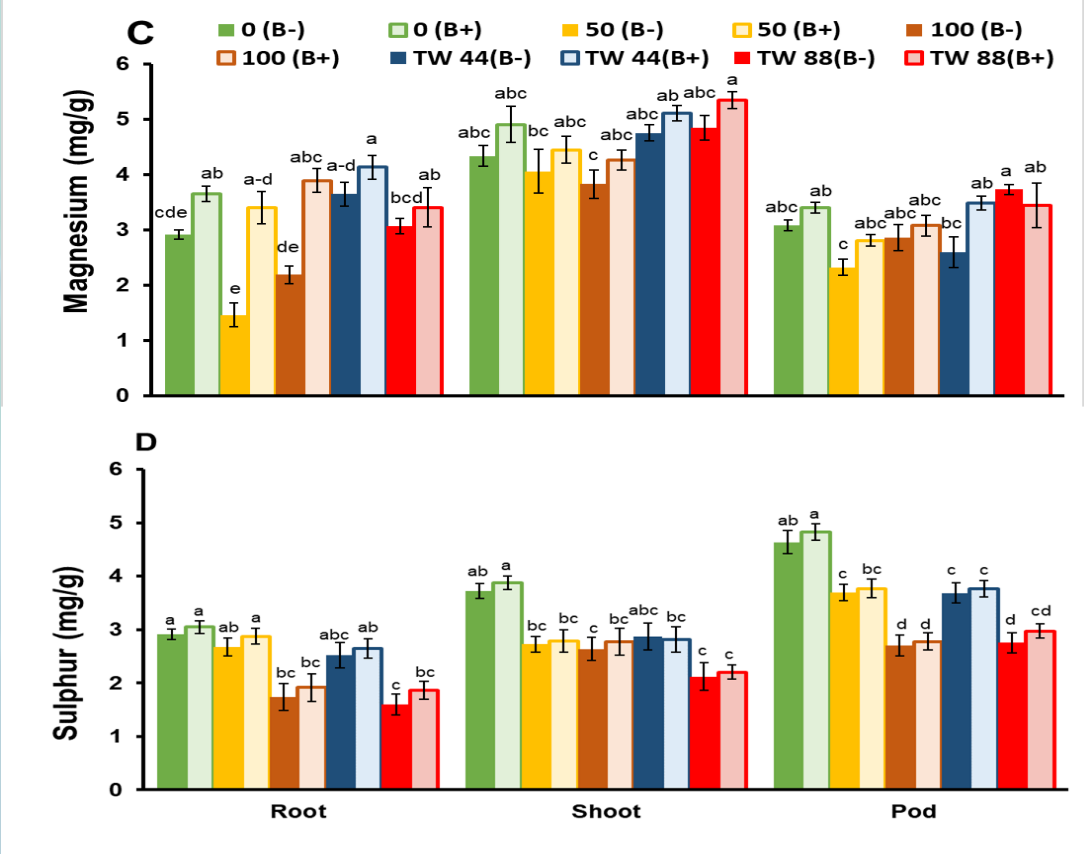


Figure 8: Effect of Tan3 on nutrient contents of soybean in Cr-contaminated soil (Mg & S)

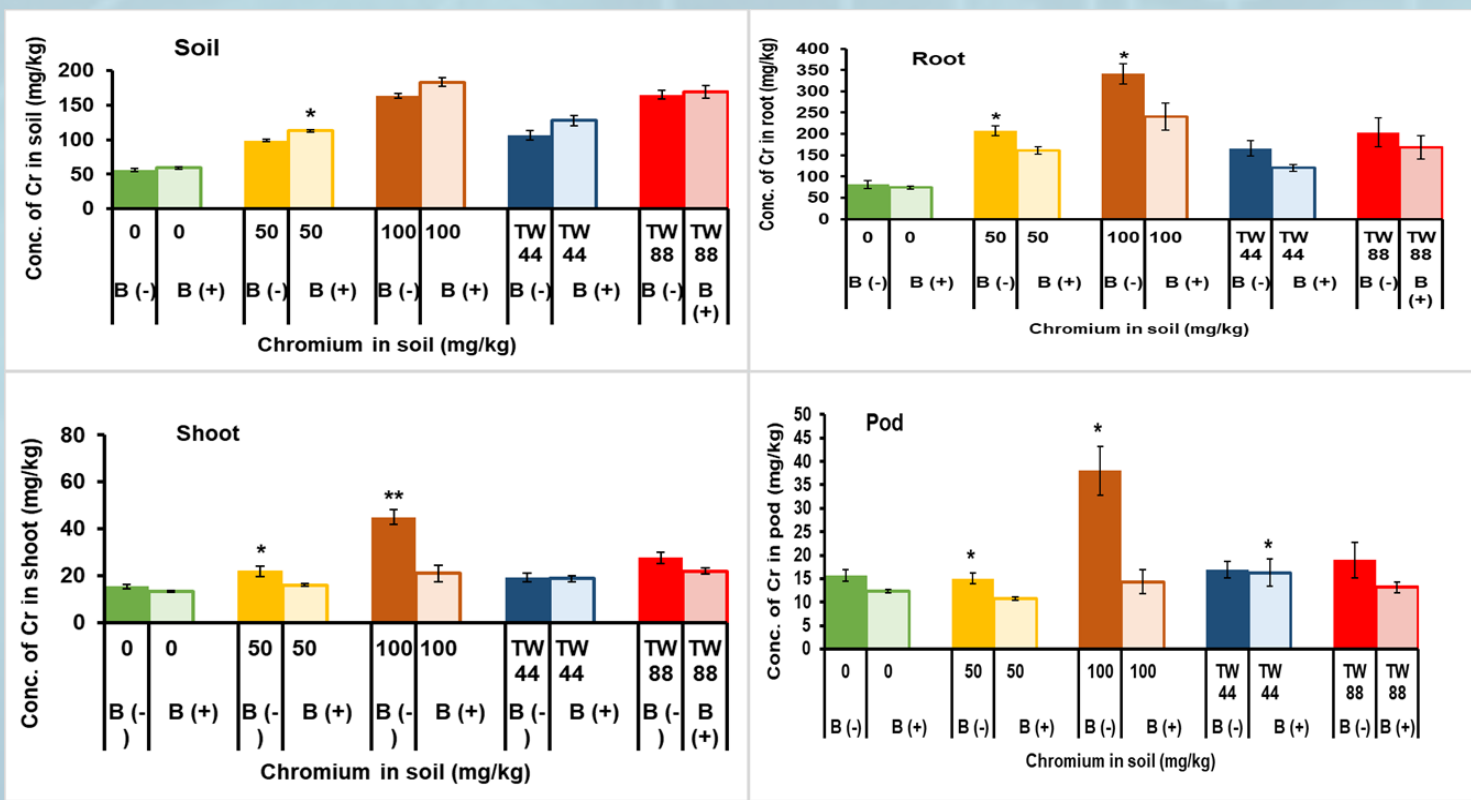


Figure 9: Effect of Tan3 on Cr uptake in soybean Cr-contaminated soil

Conclusion

The study concludes that *Bacillus thuringiensis* Tan3 effectively mitigates chromium-induced oxidative stress in soybean by reducing Cr(VI) to the less toxic Cr(III), enhancing antioxidant activity, and improving plant growth, photosynthetic pigments, and nutrient content. This bacterium shows strong potential for sustainable cultivation of chromium-sensitive crops in contaminated soils and tannery wastewater-affected areas.

References

1. Aebi, H. (1984). *Catalase in vitro*. In L. Packer (Ed.), *Methods in Enzymology* (Vol. 105, pp. 121–126).
2. Chen, J., & Tian, Y. (2021). Hexavalent chromium reducing bacteria: Mechanism of reduction and characteristics. *Environmental Science and Pollution Research*, 28(17), 20981–20997.