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Integrated bioagent-organic formulations for enhancing seed quality and suppressing soil-borne pathogens in legumes under biotic stress

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Abstract

Sustainable management of soil-borne pathogens remains a critical challenge in legume production systems, necessitating eco-compatible alternatives to chemical fungicides. The present investigation synthesizes three field experiments evaluating bioagents (*Trichoderma asperellum*, *Pseudomonas fluorescens*) and organic formulations (Beejamrit, Jeevamrit and Herbal Kunapjal) against *Macrophomina phaseolina* in soybean and *Fusarium oxysporum* and *Rhizoctonia bataticola* in chickpea. A total of 12 treatments comprising seed treatment (ST) alone and in combination with soil drenching at 15, 30 and 45 DAS were assessed. Across all pathosystems, integrated application (ST + soil drenching) significantly outperformed individual seed treatments.

Field emergence increased substantially under all treatments. In soybean, emergence improved from 65 % in control to 85 % under *T. asperellum* ST + drenching and 93 % in chemical check. Similarly, chickpea recorded enhancement from 47–57 % (control) to 84–89 % under integrated bioagent treatments and 91–92 % under chemical control.

Disease incidence at 60 DAS was markedly reduced across treatments. In soybean (*M. phaseolina*), it declined from 58.10 % (control) to 17.85 % with *T. asperellum* ST + drenching (69.28 % reduction) and 12.95 % under chemical treatment. In chickpea, *F. oxysporum* and *R. bataticola* incidences were reduced to 17.55 % (71.25 %) and 15.95 % (73.96 %), respectively. Growth parameters improved substantially, with soybean recording increases from 13.8 to 28.1 cm (shoot length) and 2.3 to 3.95 g (biomass), while chickpea attained 24.85–26.25 cm shoot length and 3.45–3.95 g biomass.

Among organic formulations, Beejamrit and Herbal Kunapjal (ST + drenching) also demonstrated substantial efficacy, reducing disease by 65–71 % and improving biomass over control. However, treatments involving only seed application consistently showed lower performance, highlighting the necessity of integrated application strategies.

In conclusion, *T. asperellum* applied as seed treatment combined with periodic soil drenching emerged as the most effective non-chemical approach, delivering disease suppression comparable to chemical fungicides while significantly enhancing plant vigour. The study strongly advocates the integration of bioagents and organic inputs as a viable, sustainable alternative for managing soil-borne diseases in legume-based cropping systems.

Keywords: Beejamrit, chickpea, dry root rot, Herbal Kunapjal, soybean, trichoderma asperellum