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Efficacy of Integrated Seed Treatment for Enhancing Growth, Yield and Sustainability in Mungbean [*Vigna radiata* (L.) Wilczek]

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ABSTRACT

Cultivating mungbean [*Vigna radiata* (L.) Wilczek] holds a great potential to meet the food security needs with sustainability. However, cultivation challenges, like low seed quality and vulnerability to pests and diseases should be addressed to maximise the yield and quality of mungbean. In order to explore integrated seed treatment as a solution to these challenges eight seed treatment combinations, including chemicals (Bavistin + Cypermethrin), bioagents (Rhizobium + Trichoderma), botanicals (Neem oil) and domestic substances (Camphor) were evaluated for seed quality under field condition to evaluate crop growth and yield potential. Results indicated that seeds treated with combination of Bavistin (3 g/kg) + Cypermethrin (3 g/kg) + Rhizobium (25 g/kg) + Trichoderma (10 g/kg) + Neem oil (5 ml/kg) + Camphor (4 g/kg) led to better growth, yield and seed quality.

Key words: Integrated, Mungbean, Seed treatment, Sustainability.

Mungbean [*Vigna radiata* (L.) Wilczek] is one of the most important pulse crop grown in India. However, the crop's yield potential is limited due to poor seed management procedures and no agricultural procedure can develop a crop beyond the restrictions established by the seeds (Pavithra *et al.,* 2025). Adopting effective seed management procedures like pre sowing seed treatment is among the enhanced seed production procedures that can increase production and yield (Yadav *et al.,* 2014). The conventional chemical seed treatments, though highly effective in providing rapid protection, can have long-term detrimental effects on both soil health and the environment. On the other hand, while organic treatments such as neem oil, Trichoderma and Rhizobium are environmentally sustainable and beneficial for soil health (Raj and Raj, 2021; Yadav *et al.,* 2021), their slower action and limited immediate effectiveness posses challenges. This paper aims to focus on identifying an integrated approach that combines the advantages of both chemical and organic treatments. By doing so, it is possible to improve crop yield and support the long-term sustainability of mungbean production.

The field experiment was conducted on mungbean var. Sweta during *Kharif* 2021 and *Kharif* 2022 at Student Instruction Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur U.P. Initially, the seeds were treated with eight treatment combinations namely, T_1: Bavistin+Cypermethrin+Rhizobium+ Trichoderma. T_2: Bavistin+Cypermethrin+Rhizobium+ Trichoderma +Neem oil. T_3: Bavistin+Cypermethrin+Rhizobium+Trichoderma+ Neem oil + Camphor. T_4: Rhizobium+Trichoderma+Neem oil+Camphor. T_5: Bavistin+Cypermethrin+ Rhizobium+ Camphor. T_6: Cypermethrin+Rhizobium+Trichoderma+ Camphor. T_7: Bavistin+Rhizobium+Neem oil+Camphor, T_8: Bavistin+Cypermethrin+ Trichoderma+Neem oil. All the compounds were applied at their recommended doses: Bavistin at 3 g/kg, Cypermethrin at 3 g/kg, Rhizobium at 25 g/kg, Trichoderma at 10 g/kg, Neem oil at 5 ml/kg and Camphor at 4 g/kg. The treated seeds were dried under shade for an hour and thereafter used for sowing. The field trial was conducted with the above treated seed along with control by adopting a randomized block design replicated thrice to evaluate the efficacy of pre-sowing seed treatment on crop growth and yield parameters. The field data recorded for agronomic traits were statistically analyzed as per Panse and Sukhatme (1985).

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Table 1: Yield and yield attributing parameters for mungbean crop in relation to application of different treatments combinations.

Treatment	Plant height (cm)			No. of root nodules per plant			No. of pods per plant			No. of seeds per plant			Test weight (g)			Seed yield (q/ha)		
	Zaid 2021	Zaid 2022	Pooled	Zaid 2021	Zaid 2022	Pooled	Zaid 2021	Zaid 2022	Pooled	Zaid 2021	Zaid 2022	Pooled	Zaid 2021	Zaid 2022	Pooled	Zaid 2021	Zaid 2022	Pooled
T_0	30.02	32.05	31.03	26.95	26.04	26.50	22.95	23.28	23.11	11.01	9.06	10.03	34.46	34.34	34.40	8.98	8.85	8.92
T_1	35.05	35.78	35.42	34.67	34.01	34.34	26.00	25.67	25.84	12.33	11.00	11.67	37.20	37.07	37.13	9.31	9.18	9.25
T_2	38.31	37.53	37.92	36.33	36.01	36.17	26.33	25.33	25.83	12.67	11.34	12.01	37.17	37.87	37.52	9.87	9.74	9.80
T_3	41.11	42.93	42.02	36.67	36.68	36.68	27.67	28.00	27.84	14.00	12.67	13.34	39.93	40.33	40.13	11.63	11.50	11.56
T_4	40.23	40.02	40.12	38.98	39.45	39.22	27.00	26.67	26.84	13.66	12.33	13.00	38.60	38.50	38.55	10.98	10.85	10.91
T_5	37.32	36.29	36.81	35.67	35.73	35.70	26.00	25.33	25.67	12.33	11.00	11.67	36.80	36.80	36.80	9.95	9.82	9.88
T_6	37.64	36.51	37.07	32.00	31.23	31.62	26.00	25.67	25.84	13.67	12.34	13.01	37.10	37.30	37.20	9.74	9.61	9.67
T_7	38.12	37.89	38.01	35.33	35.08	35.21	26.33	26.00	26.17	13.33	12.00	12.67	37.77	37.75	37.76	10.04	9.91	9.98
T_8	39.23	39.04	39.14	35.67	35.36	35.51	27.00	26.33	26.67	12.67	11.34	12.01	39.00	39.00	39.00	10.70	10.57	10.64
SEm(±)	1.253	1.430	0.951	1.190	1.299	0.881	0.720	0.741	0.516	0.464	0.475	0.332	0.822	0.63	0.52	0.338	0.333	0.237
CD (p=0.05)	3.61	4.12	2.69	3.43	3.74	2.49	2.07	2.13	1.46	1.34	1.37	0.94	2.36	1.81	1.46	0.97	0.96	0.67

T_0: Control; T_1: Bavistin + Cypermethrin + Rhizobium + Trichoderma; T_2: Bavistin + Cypermethrin + Rhizobium + Trichoderma + Neem oil; T_3: Bavistin + Cypermethrin + Rhizobium + Trichoderma + Neem oil + Camphor; T_4: Rhizobium + Trichoderma + Neem oil + Camphor; T_5: Bavistin + Cypermethrin + Rhizobium + Camphor; T_6: Cypermethrin + Rhizobium + Trichoderma + Camphor; T_7: Bavistin + Rhizobium + Neem oil + Camphor; T_8: Bavistin + Cypermethrin + Trichoderma + Neem oil

In the present study, seeds subjected to various pre-sowing seed treatments are tested for their effects on crop growth and yield of mungbean under field conditions. The results have proven that pre sowing seed treatments have highly significant ($p<0.05$) differences on plant growth and germination.

Among the treatments, T_3: Bavistin + Cypermethrin + Rhizobium + Trichoderma + Neem oil + Camphor higher values for growth parameters *viz.* plant height (42.02 cm) and and yield attributing traits *viz.* number of pods per plant (27.84), number of seeds per pod (13.34), seed yield (11.56 q/ha) and test weight (40.13 g) whereas lower values for above traits were registered in T_0: Control (Table 1). Enhanced plant growth can be attributed to synergistic effects of combining chemical and organic seed treatments which improved nutrients availability and uptake which is essential for chlorophyll production, greater cell division and elongation enhancing overall plant growth. Additionally, increment in plant height might be due to rapid rate of emergence because of which the seedlings reached autotrophic stage well in advance than untreated seeds leading to the production of longer seedlings (Bahadur and Tiwari, 2014 and Hussain *et al.,* 2014). Greater plant height and branching facilitated more efficient capture and use of photosynthetic energy which was redirected toward the development of reproductive structures, ultimately increasing the number of pods and seeds per plant (Kanti *et al.,* 2013, Ovalesha *et al.,* 2017). Furthermore, the combined use of chemical (Bavistin and Cypermethrin) and botanical (Neem oil and Camphor) pesticides provided effective protection against pests and pathogens. Additionally, biofertilizers like Rhizobium and Trichoderma, ensured better nutrient assimilation making more photosynthates available for seed filling. As a result, there was a noticeable increase in seed weight (Bony *et al.,* 2017). The integrated application of these chemical and organic components not only improved plant health but also enhanced nitrogen translocation to the above-ground parts. This contributed to better root development, effective pod formation and ultimately, a higher yield (Dubey and Singh, 2013; Vinodkumar *et al.,* 2013; Kumar *et al.,* 2015).

Additionally, the highest number of root nodules was recorded in T_4: Rhizobium + Trichoderma + Neem oil + Camphor, with an average of 39.22 nodules per plant. In comparison, the control exhibited 32% fewer nodules. This enhancement can be attributed to the beneficial symbiotic relationship between Rhizobium and the host plant, which not only fixes atmospheric nitrogen but also produces amino acids and plant growth regulators like auxins, cytokinins and gibberellins (Nadeem *et al.,* 2017). Meanwhile, Trichoderma improves the rhizosphere environment, promoting root growth, while Neem oil and Camphor contribute their pesticidal properties to protect the roots from soil-borne pathogens (Bjelica, 2016).

In the present study, seeds treated with T_3: Bavistin + Cypermethrin + Rhizobium + Trichoderma + Neem oil + Camphor recorded increased plant height, number of pods

per plant, number of seeds per pod, seed yield and test weight which were 26.19%, 16.98%, 18.8%, 22.8% and 14.27% higher than control.

CONCLUSION

This study proposes a pragmatic approach that combines organic and chemical seed treatments as a transitional strategy, balancing immediate benefits with the long-term goal of sustainable organic farming. This hybrid method offers a feasible path toward environmentally responsible agricultural practices while addressing the challenges of land degradation and gradual transition.

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Disclaimers

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Conflict of interest

The authors confirm that they have no conflicts of interest to disclose.

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