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EXPLORING THE TIME-BASED BIOPRIMING EFFECTS OF *Trichoderma* ON GROWTH PARAMETERS OF VEGETABLE SEEDS

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ABSTRACT

This study investigated the effect of biopriming of cowpea and bottle gourd seeds with *Trichoderma yunnanense* at different time intervals on plant growth and development. Significant variations were observed among the treatments compared to the untreated control. The study was conducted to evaluate the influence of *Trichoderma* biopriming on seedling and growth promotion in cowpea and bottle gourd. The treatments, particularly T_4, markedly improved various growth parameters, including shoot length, root length, fresh weight, and dry weight of seedlings. The results indicate that seed biopriming with *Trichoderma yunnanense* effectively enhances seedling establishment and growth, thereby contributing to improved crop productivity. Overall, the findings demonstrate the potential of *Trichoderma* biopriming as a sustainable and eco-friendly approach for promoting plant growth and improving bottle gourd cultivation.

***Keywords* :** *Trichoderma yunnanense*, biopriming, spore suspension.

Introduction

Cowpea (*Vigna unguiculata* [L.] Walp.) is an annual legume cultivated globally, with its primary production concentrated in semiarid regions (Lonardi *et al*., 2019, Omomowo *et al*., 2021). This diploid species has a chromosome number of 2n = 2x = 22 and is a protein-rich legume (22–30%) vital for food security in rural and economically challenged communities. Cowpea is a rich source of essential nutrients, including vitamins, antioxidants, dietary fiber, trace minerals, and other beneficial compounds that support overall health and well-being (Abebe *et al*., 2022, Lazaridi and Bebeli, 2023). Cowpea plays a vital role in promoting environmental sustainability through its ability to biologically fix nitrogen and enhance soil health. By boosting microbial diversity, it enriches the soil ecosystem and significantly contributes to climate resilience both locally and globally (Mekonnen *et al*., 2022).

Bottle gourd (*Lagenaria siceraria* (Mol.) Standl.), a member of the Cucurbitaceae family, is widely recognized for the nutritional, medicinal, and economic value of its seeds and edible fruits (Ibrahim *et al*., 2024). The seeds are notable for their high levels of protein, healthy fats, and dietary fiber, while containing only a small amount of carbohydrates (Abdel *et al*., 2021). The fruit is abundant in vitamin B complex and choline, and also contains moderate levels of vitamin C and carotene. Its pulp serves both nutritional and medicinal purposes, offering a valuable source of bioactive compounds such as sterols, terpenoids, flavonoids, and saponins (Devi *et al*., 2023). Its juice and roots contain compounds such as A-glycosidase and cucurbitacins, adding medicinal value.

Despite its benefits, both crops face disease threats, cowpea suffers pathogens commonly affecting the foliar and stem tissues of bottle gourd include anthracnose, *Cercospora* leaf spot, powdery mildew, southern blight, stem rot, and rusts. In contrast, root systems and vascular tissues are predominantly compromised by charcoal rot, damping-off, and *Fusarium* wilt, bacterial blight (Mahesha *et al*., 2022); Chemical treatments have been employed as a means of disease management. Chemical disease control harms health, so eco-friendly methods like seed biopriming are preferred. This technique enhances germination and plant vigor by combining controlled hydration with beneficial microbes.

Seed biopriming involves several priming techniques, including incubation of seeds in a moistened, finely ground lignite or coal-based carrier material, commonly referred to as solid matrix priming (Harman and Taylor, 1988). Another approach involves incubating seeds with beneficial microorganisms under moist conditions in sealed plastic bags, which facilitates microbial colonization of the seed surface prior to sowing (Callan *et al*., 1991).

Several fungal species have demonstrated efficacy in the management of these diseases, with members of the genus *Trichoderma* being the most extensively employed. *Trichoderma* species are among the most abundant saprophytic fungi inhabiting the rhizosphere and constitute a significant proportion of the global biopesticide market (Woo *et al*., 2014). In addition to suppressing phytopathogenic fungi through various antagonistic mechanisms, *Trichoderma* spp. also enhances plant growth and development (Chen *et al*., 2015).

Trichoderma spp. have garnered significant attention in scientific research as promising biocontrol agents (Rodrigues *et al*., 2023). *Trichoderma*, a fungal biocontrol agent, improves seedling health by defending against pathogens like *Fusarium* and *Rhizoctonia*. It induces antioxidant defenses and phytohormones (auxins, gibberellins), boosting stress resistance and crop yield. The aim behind the present investigation was to explore the potential of seed biopriming with *Trichoderma yunnanense* at various time intervals for defense activation in cowpea and bottle gourd.

Material and Methods

The experiments were carried out during 2023 & 2024 at Department of Mycology and Plant Pathology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh.

Preparation of spore suspension

Spore suspension was prepared by scraping mature microbial cultures in Petri plates with 10 mL sterile distilled water to create a slurry. Serial dilutions were done to achieve a 10^5 dilution. For seed biopriming, healthy cowpea and bottle gourd seeds were selected, surface-sterilized with 1% sodium hypochlorite for 1 minute, rinsed thrice with sterile water, and air-dried under Laminar Air Flow to prevent contamination and promote optimal germination (Verma *et al*., 2007; Jain *et al*., 2012; Singh and Nautiyal, 2012; Singh *et al*., 2016).

Table 1 : Biopriming time intervals used for in vitro evaluation of *T. yunnanense*

Treatment	Time Interval
T1	Control
T2	0 h
T3	6 h
T4	12 h
T5	18 h
T6	24 h
T7	30 h

Seed bio priming

Cowpea and bottle gourd seeds were treated with *Trichoderma yunnanense* (10^5 concentration) at intervals ranging from 30 hours before sowing to the time of sowing. Treated seeds were kept in a moisture chamber, then planted (3 seeds per pot) with three replications per treatment and covered with soil to support germination (Alizadeh *et al*., 2022). After one month of seed sowing the observations were recorded.

Growth Parameter

The observations, including root length, shoot length, fresh weight, and dry weight, were recorded. Shoot length was measured in centimeters from the collar region to the apical bud, while root length was determined from the collar region to the tip of the longest fibrous root. Fresh weights of roots and shoots were obtained using a top-loading electronic balance and expressed in grams. For dry weight determination, root and shoot samples were oven-dried at 60 °C until a constant weight was achieved, after which the measurements were recorded in grams.

Statistical Analysis

Statistical analysis was performed using one-way ANOVA to evaluate treatment effects, followed by Duncan's multiple range test for mean separation. SPSS version 20 was used for all analyses. Tukey's HSD test identified significant differences between treatments ($p \leq 0.05$).

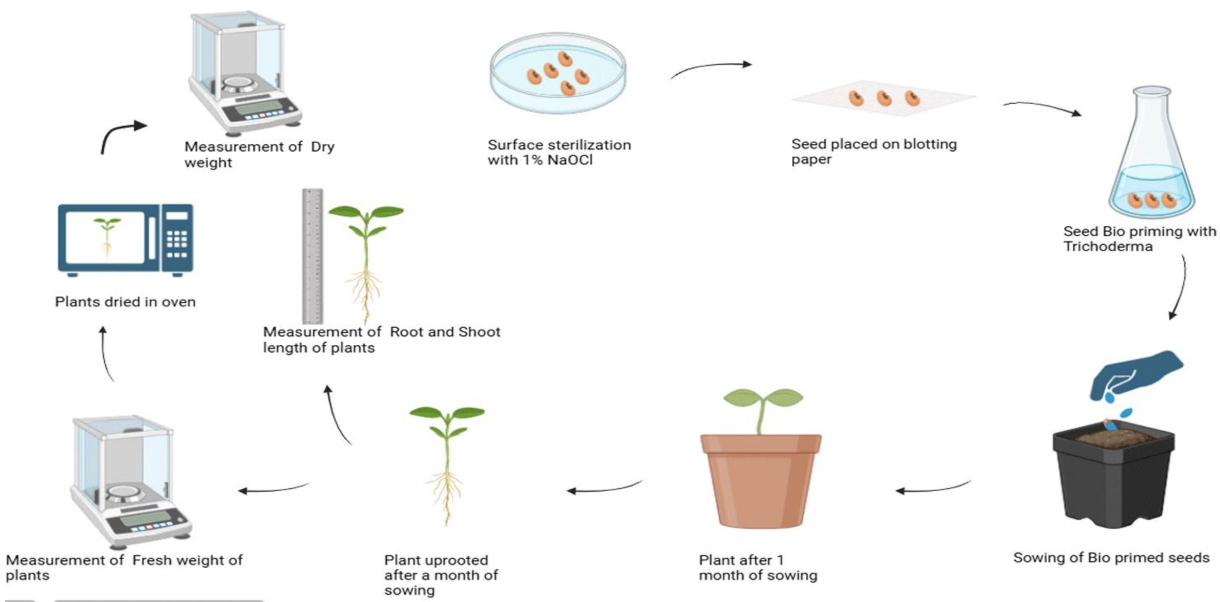

Fig. 1 : Schematic representation of seed biopriming, sowing, and analysis of different growth parameters

Results

Cowpea plants treated with *T. yunnanense* for 6 hours showed the greatest shoot length at 16.33±0.47 cm, similar to the 16.33±1.25 cm length seen with 18-hour treated seeds. The shortest shoot length in cowpea, 11.00±0.82 cm, was for non-bioprimed seeds. For bottle gourd, 6-hour *T. yunnanense*-treated seeds had the greatest shoot length at 18.67±0.47 cm, comparable to 17.66±0.47 cm for 18-hour treated seeds. The shortest shoot length in bottle gourd, 9.00±2.16 cm, was also for non-bioprimed seeds.

In cowpea, the 12-hour pre-sowing treatment (T_4) resulted in the longest root measurement at 15.33±0.47 cm, followed by the 30-hour treatment (T_7). The shortest root length was in the control group at 9.33±0.47 cm. For bottle gourd, the 30-hour treatment (T_7) had the longest root measurement at 16.67±0.47 cm, with treatments T_4, T_3 and T_5 following. The control group also had the shortest root length at 9.33±0.47 cm.

In cowpea, biopriming with *T. yunnanense* for 6 hours (T_3) resulted in the highest shoot fresh weight of 5.19±1.13 grams, followed by T_4 at 4.74±0.86 grams. The lowest fresh weight was observed in the control group at 3.21±0.62 grams. For bottle gourd, 6-hour biopriming with *Trichoderma* (T_3) yielded the highest shoot fresh weight of 22.22±1.95 grams, followed by T_5 at 22.09±1.45 grams. The lowest fresh weight was seen in the control group at 11.51±4.78 grams.

In cowpea, the highest fresh weight of roots was in seeds treated 12 hours before sowing (T_4) at 0.54±0.013 grams, followed closely by T_3 at 0.50±0.18 grams. The lowest was in the untreated control group at 0.20±0.03 grams. In bottle gourd, the highest fresh weight was with 18-hour pre-sowing treatment at 1.33±0.78 grams, followed by T_3 (6 hours) at 1.21±0.04 grams and T_4 (12 hours) at 1.15±0.03 grams. The lowest was in the control group at 0.38±0.04 grams.

Biopriming with *Trichoderma* 6 hours before sowing resulted in the highest shoot dry weight for cowpea at 1.03±0.054 grams, followed by T_5 at 0.93±0.058 grams. The control group had the lowest at 0.56±0.005 grams. Similarly, in bottle gourd, the highest shoot dry weight was 1.17±0.069 grams after 6-hour biopriming, closely followed by T_5 at 1.14±0.025 grams, with the control group showing the lowest at 0.32±0.05 grams.

The highest dry weight of roots in cowpea was recorded for T_4 at 0.077±0.005 grams, closely followed by T_3 (0.076±0.003 grams) and T_5 (0.072±0.002 grams). The control treatment had the lowest at 0.037±0.001 grams. For bottle gourd, the highest root dry weight was for T_5 at 0.116±0.002 grams, followed by T_3 at 0.107±0.004 grams. The control treatment recorded the lowest at 0.063±0.0012 grams.

Discussion

Previous studies have demonstrated direct impact of *Trichoderma* based biopesticides or *Trichoderma* spore suspension on plant growth promotion. The present study focuses on the pivotal role of *Trichoderma yunnanense* (10^5 concentration) at intervals ranging from 30 hours before sowing to the time of sowing on two vegetable crops i.e. cowpea and bottle gourd. The study clearly reveals that different spore dose act variably on each crop. There was enhancement in root and shoot length of each vegetable crops depending upon time of biopriming prior to sowing. The requirement of time at a specific spore concentration for different vegetable crops varies from each other. The optimum spore dose identified for each vegetable crop not only improves seed biopriming efficiency but also effectively promotes plant growth under greenhouse conditions. The enhanced growth performance may be attributed to the ability of *T. yunnanense* to stimulate root development, improve nutrient uptake and promote overall plant health. In conclusion, our findings provide insights into the precise duration required for seed biopriming prior to sowing in different vegetable crops. This will provide a method for biopriming a larger quantity of seeds with a specific concentration of spores from a *Trichoderma*-based product or spore suspension.

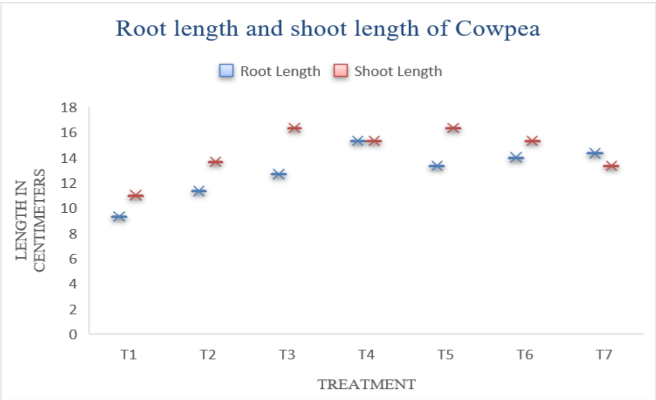

Fig. 2 : Root length and shoot length of Cowpea

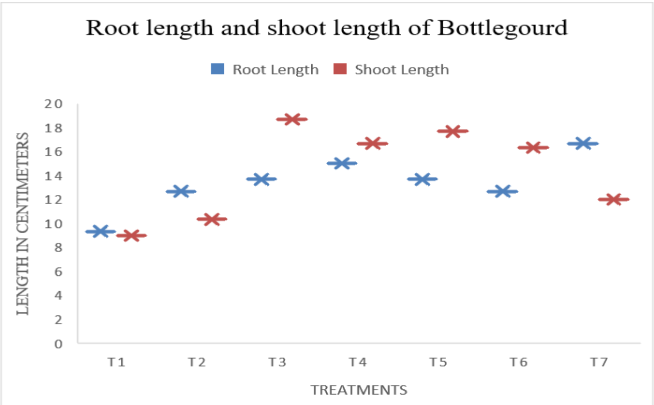

Fig. 3 : Root length and shoot length of Bottlegourd

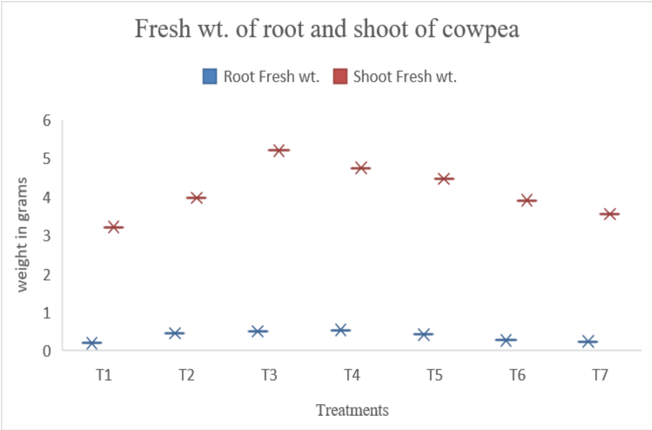

Fig. 4 : Fresh wt. of root and shoot of cowpea

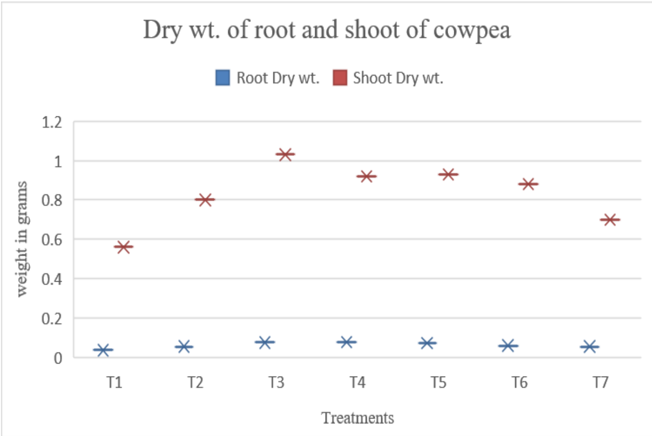

Fig. 5 : Dry wt. of root and shoot of cowpea

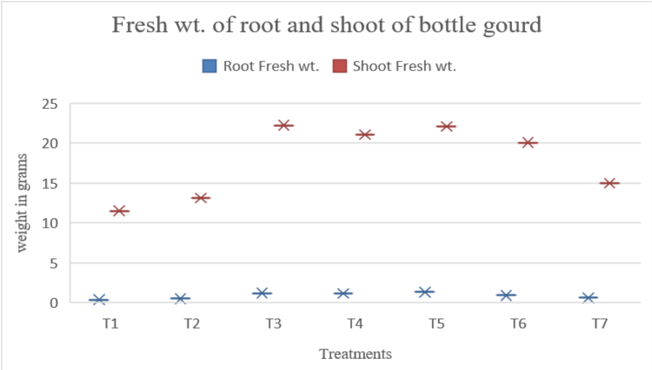

Fig. 6 : Fresh wt. of root and shoot of bottle gourd

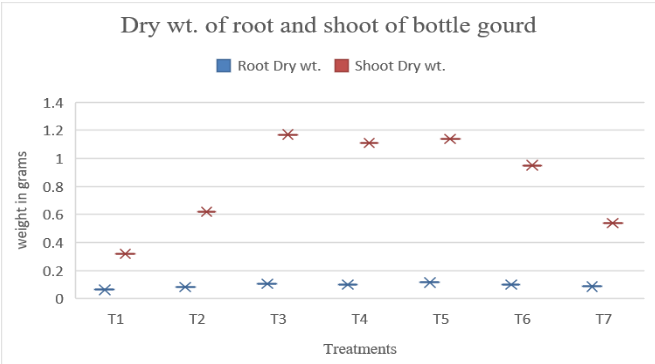

Fig. 7 : Dry wt. of root and shoot of bottle gourd

References

Abdel-Razek, A. G., Badr, A. N., Alharthi, S. S. and Selim, K. A. (2021). Efficacy of bottle gourd seeds' extracts in chemical hazard reduction secreted as toxigenic fungi metabolites. *Toxins*, **13**(11), 789.

Abebe, B. K. and Alemayehu, M. T. (2022). A review of the nutritional use of cowpea (*Vigna unguiculata* L. Walp) for human and animal diets. *Journal of Agriculture and Food Research* , **10**, 100383.

Alizadeh, M., Vasebi, Y., Chauhan, M. and Rani, A. (2021). Biopriming: a prospective techniques for crop improvement. *Innovations*, **66**, 1035-1058.

Callan, N. W., Mathre, D. E. and Miller, J. B., (1991). Field performance of sweet corn seed bio-primed and coated with *Pseudomonas fluorescens* AB254. *Hortic. Sci.* **26**, 1163–1165.

Chen, J. L., Sun, S. Z., Miao, C. P., Wu, K., Chen, Y. W., Xu, L .H., Guan, H. L. and Zhao, L. X. (2015). Endophytic *Trichoderma gamsii* YIM PH30019: a promising biocontrol agent with hyperosmolar, mycoparasitism, and antagonistic activities of induced volatile organic compounds on root-rot pathogenic fungi of *Panax notoginseng*. *Journal of Ginseng Research*, http://dx.doi. org/10.1016/j.jgr.2015.09.006.

Devi, S. R., Kumari, T. and Deka, S. C. (2023). Extraction of dietary fiber and phytochemicals from bottle gourd seeds (*Lagenaria siceraria*), its physicochemical properties and application in food model. *Food Chemistry Advances*, **2**, 100252.

Harman, G. E. and Taylor, A. G., (1988). Improved seedling performance by integration of biological control agents at favorable pH levels with solid matrix priming. *Phytopathology* **78**, 520–525.

Ibrahim, E. A., Alhaithloul, H. A., Shamseldin, S. A., Awaly, S. B., El-Latif Hesham, A., Abdelkader, M. F. and Abdein, M. A. (2024). Morphological, biochemical, and molecular diversity assessment of egyptian bottle gourd cultivars. *Genetics Research*, *2024*(1), 4182158.

Jain, A., Singh, S., Sarma, B. K. and Singh, H. B. (2012). Microbial consortium-mediated reprogramming of defence network in pea to enhance tolerance against *Sclerotinia sclerotiorum*. *Journal of Applied Microbiology*. **112**, 537–550.

Lazaridi, E., and Bebeli, P. J. (2023). Cowpea constraints and breeding in Europe. *Plants*, **12**(6), 1339.

Lonardi, S., Munoz-Amatriaín, M., Liang, Q., Shu, S., Wanamaker, S. I. and Lo, S. (2019). The genome of cowpea (*Vigna unguiculata* [L.] Walp.). *Plant Journal*, **98**, 767–782. doi: 10.1111/tpj.14349.

Mahesha, H. S., Keerthi, M. C., Shivakumar, K. V., Bhargavi, H. A., Saini, R. P., Manjunatha, L., and Blair, M. W. (2022). Development of biotic stress resistant cowpea. *Genomic Designing for Biotic Stress Resistant Pulse Crops*, 213-251.

Mekonnen, T. W., Gerrano, A. S., Mbuma, N. W., and Labuschagne, M. T. (2022). Breeding of vegetable cowpea for nutrition and climate resilience in Sub-Saharan Africa: progress, opportunities, and challenges. *Plants*, **11**(12), 1583.

Omomowo, O. I. and Babalola, O. O. (2021). Constraints and prospects of improving cowpea productivity to ensure food, nutritional security and environmental sustainability. *Frontiers in Plant Science*, **12**, 751731.

Rodrigues, A. O., May, De Mio, L. L. and Soccol, C. R. (2023). *Trichoderma* as a powerful fungal disease control agent for a more sustainable and healthy agriculture: Recent studies and molecular insights. Planta. *Springer International Journal of Plant Biology*, **257**(2):31.

Singh, P. C. and Nautiyal, C. S., (2012). A novel method to prepare concentrated conidial biomass formulation of *Trichoderma harzianum* for seed application. *Journal of Applied Microbiology*. **113**, 1442–1450.

Singh, V., Upadhyay, R. S., Sarma, B. K. and Singh, H. B. (2016). *Trichoderma asperellum* spore dose depended modulation of plant growth in vegetable crops. *Microbiological research*, **193**, 74-86.

Verma, M., Brar, S. K., Tyagi, R. D., Surampalli, R. Y. and Valero, J. R., (2007). Antagonistic fungi, *Trichoderma* spp.: panoply of biological control. *Biochemical Engineering Journal*. **37**, 1–20.

Woo, S. L., Ruocco, M., Vinale, F., Nigro, M., Marra, R., Lombardi, N., Pascale, A., Lanzuise, S., Manganiello, G. and Lorito, M., (2014). *Trichoderma*-based products and their widespread use in agriculture. *Open Mycology Journal*. 8.