Biological Forum – An International Journal 15(1): 728-731(2023)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Compatibility of *Trichoderma hamatum* with Chemical Fungicides and its effect on Yield of Green Gram

Adyasha Das[1*] and Shyama Sundar Mahapatra[2]
[1]Ph.D. Scholar, Department of Plant Pathology, College of Agriculture,
Odisha University of Agriculture and Technology, Bhubaneswar (Odisha), India.
[2]Professor, Department of Plant Pathology, College of Agriculture,
Odisha University of Agriculture and Technology, Bhubaneswar (Odisha), India.

(Corresponding author: Adyasha Das)*
(Received: 02 December 2022; Revised: 29 December 2022; Accepted: 07 January, 2023; Published: 11 January, 2023)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: An examination was embraced to assess the similarity of fungicides at suggested measurements with *Trichoderma hamatum* being utilized as a biocontrol specialist against soil borne sicknesses of green gram in field conditions. *Trichoderma hamatum* was viewed as profoundly viable with valid amycin both under *in-vivo* conditions. In field condition, the development boundaries of green gram were additionally seen to be most noteworthy giving better return (12 q/ha) as well as higher B:C proportion (5.21) in the mix of *Trichoderma hamatum* and validamycin. Viable mixes at their suggested measurements can be suggested for coordinated administration for soil borne microbes of the harvest.

Keywords: *Trichoderma hamatum*, fungicides, compatibility, B:C ratio, soil borne diseases.

INTRODUCTION

Natural control of soil borne plant microbes by Trichoderma is an essential area of plant neurotic examination all around the world in nowadays (Mukhopadhyay, 1987). The greater part of the dirt borne illnesses are not amiable for the board through synthetic compounds. Utilization of a few opposing types of *Trichoderma* sp against a scope of monetarily significant soil borne plant microorganisms have been irrefutable (Cook and Baker 1983). Lately, the pursuit of organic control specialists for the administration of feared soil borne sicknesses has been supported generally. Since the biocontrol specialists are applied either to seed or soil or both, there is each chance of collaboration and obstruction that would emerge with the usually utilized fungicides. The full articulation of potential biocontrol specialist is viewed as far as rhizosphere capability, concealment of microorganisms, resistance to pesticides, cutthroat saprophytic capacity, flexibility to climate and so on. Consolidated use of biocontrol specialists with ordinarily utilized fungicides might result either in synergism/hostility between these two. Different fungicides are suggested for the administration of significant soil borne microbes. Searching for the wide range execution of *Trichoderma hamatum* against the majority of the dirt borne organisms and foliar sicknesses, its similarity with the prescribed substance fungicides is viewed as fundamental so synergistic impact can be gotten for the administration of infections (Bagwan, 2010). However, couple of learns about the responsiveness of biocontrol specialists with specific fungicides are accessible, studies with exceptional reference to industrially accessible biocontrol specialists, types of Trichoderma are pitiful (Kumar *et al.*, 2019). Similarity of living creatures with current contributions to establish insurance like fungicides is pre-imperative for sickness the board. Consequently, there is need to test the similarity of fungicides with *Trichoderma hamatum* and their impact on rhizosphere mycoflora of different yields. Green gram is a significant heartbeat yield and utilization of biocontrol specialists as well as compound fungicides are fundamental for overseeing sicknesses of this harvests, particularly soil borne illnesses. Hence, it is a lot of vital for know the similarity between the different bio specialists and fungicides.

MATERIAL AND METHOD

Efficacy of different fungicides at recommended concentrations and biocontrol agent *Trichoderma hamatum* was tested in the field experiments carried out during rabi 2021 and rabi 2022 in the Agronomy Research Field, College of Agriculture, OUAT, Bhubaneswar which goes under East and South Eastern Seaside Plain Zone of Odisha. The environment is hot and damp sort. Mean yearly Precipitation is 1577mm. The field tests were spread out in lateritic soils having great waste office. Suggested portion of nitrogen, phosphorus and potassium (20-20-40 kg/ha) were applied as urea, single super phosphate and muriate of potash. The green gram assortment Virata was chosen for the review, which is of 60-65 days span. All bundles of practices suggested for green gram were followed. Field explore was spread out in a randomized block plan with 8 medicines repeated threefold with a plot size of 2.5 × 2 m^2. The spacing adopted was 30 × 10 cm. Care was taken to maintain optimum plant population. The trial was raised during rabi, 2021 and rabi, 2022. The experimental plot was cultivated once with tractor and hand hoeing was done twice at 20 and

35 days after planting. In addition, weeds were removed as and when necessary. The experiment was conducted with different treatments and their combinations in the field. The total area of the experimental site is 200 m^2 with 36 sub plots of size 2.5 × 2 m^2.

The treatments were as follows

T1: Seed treatment (ST) with Thiram (75%WP) @ 3g/kg seed

T2: ST with Validamycin 3%L @ 2ml / l

T3: ST with Copper oxychloride 50%WG @ 3 g/kg seed

T4: ST with Metalaxyl 8%+ Mancozeb 64% WP @ 2g/kg seed

T5: ST with Carboxin 37.5% + Thiram 37.5% DS @ 2.5 g / kg seed

T6: ST with Thiram (75%WP) @ 3g/kg seed + *Trichoderma hamatum* @ 5g / kg seed

T7: ST with Validamycin 3% L @ 2ml/l + *Trichoderma hamatum* @ 5g / kg seed

T8: ST with Copper oxychloride 50%WG @ 3 g/ kg seed + *Trichoderma hamatum* @ 5g/kg seed

T9: ST with Metalaxyl 8%+ Mancozeb 64% WP @ 2g / kg seed + *Trichoderma hamatum* @ 5g/kg seed

T10: ST with Carboxin 37.5% + Thiram37.5% DS @ 2.5 g / kg seed + *Trichoderma hamatum* @ 5g / kg seed

T11: ST with *Trichoderma hamatum* @ 5g / kg seed

T12: Control

Cost of cultivation, gross return, net return and benefit cost ratio were worked out to evaluate the economics of each treatment, based on the existing market prices of inputs and output. The cost of cultivation for each treatment was worked out separately, taking into consideration all the cultural practices followed and costs of inputs used in the cultivation. The gross return from each treatment was calculated as Gross return (ha^{-1}) = Income from grain (ha^{-1}) + income from stover (ha^{-1}). The net profit from each treatment was calculated separately, by using the following formula

Net return(ha^{-1}) = Gross return (ha^{-1}) – Cost of cultivation (ha^{-1})

The benefit cost ratio was calculated using the Ratio between Gross return per ha and total cost of cultivation per ha.

RESULT AND DISCUSSION

Observations were recorded on the incidence of diseases along with the yield attributing characters and yield in both the years and subjected to pooled analysis (2021 & 2022) which is mentioned below (Table 1).

A. Effect on growth parameters

No. of pods per plant. There was a maximum increase in no. of pods per plant (21.60 no./plant) by the seed treatment with *Trichoderma hamatum* enriched vermicompost and Validamycin 3% L followed by the treatment *Trichoderma hamatum* enriched vermicompost and Metalaxyl 8% + Mancozeb 64% WG (20.8 no./plant).

No. of grains per pod. The maximum increase in no. of grains per pod (11.10 grains /pod) was observed in case of the seed treatment with *Trichoderma hamatum* enriched vermicompost and Validamycin 3% L followed by the treatment with *Trichoderma hamatum* enriched vermicompost and Metalaxyl 8% + Mancozeb 64% WG (10.6 grains/pod).

Thousand (1000) grain weight. There was maximum increase in 1000 grain weight (55.70 g) in the seed treatment with *Trichoderma hamatum* enriched vermicompost and Validamycin 3% L followed by the treatment with *Trichoderma hamatum* enriched vermicompost and Metalaxyl8%+Mancozeb64%WG (55.0g).

Pod length. Maximum increase in pod length (9.8 cm) was recorded in the seed treatment with *Trichoderma* enriched vermicompost and Validamycin 3% L followed by the treatment with *Trichoderma* enriched vermicompost and Metalaxyl 8% + Mancozeb 64% WG (9.5cm).

No. of branches per plant. The highest no. of branches (7.50) could be observed in the seed treatment with *Trichoderma* enriched vermicompost and Validamycin 3% L followed by the treatment with *Trichoderma* enriched vermicompost and Metalaxyl8% + Mancozeb 64% WG (6.3).

Plant height. The highest plant height (63.6 cm) could be achieved by the seed treatment with *Trichoderma* enriched vermicompost and Validamycin 3% L (T7) followed by the treatment with *Trichoderma* enriched vermicompost and Metalaxyl 8% +Mancozeb 64% WG (62.4cm).

Plant dry weight. Maximum plant dry weight (16.3 g) was obtained from the seed treatment with *Trichoderma* enriched vermicompost and Validamycin 3% L followed by the treatment with *Trichoderma* enriched vermicompost and Metalaxyl 8% + Mancozeb 64% WG (15.8g).

Seed yield. Highest seed yield (12 q/ha) was recorded in the seed treatment with *Trichoderma* enriched vermicompost and Validamycin 3% L followed by the treatment with *Trichoderma* enriched vermicompost and Metalaxyl 8% + Mancozeb 64% WG (11.8 q / ha).

Percent disease incidence. The lowest percent disease incidence (6.0%) was observed in the seed treatment with *Trichoderma* enriched vermicompost and Validamycin 3% L followed by the treatment with *Trichoderma* enriched vermicompost and Metalaxyl 8% + Mancozeb 64% WG (8.4%).

B. Economics & B:C Ratio

The B:C ratio of treatment with *Trichoderma* enriched vermicompost and Validamycin 3% L was highest (5.21) due to higher productivity followed by the treatment with *Trichoderma* enriched vermicompost @ 5 g / kg of seed (4.86). Hence, benefit: cost ratio being an important parameter for recommendation of any treatment for successful control of plant disease, this treatment can be recommended for use by the farmers.

These findings are similar with findings of the biocontrol activities of *Trichoderma* sp as reported to promote plant growth by Inbar *et al.* (1994). Possible explanation of this phenomenon includes control of minor pathogens leading to stronger growth and nutrient uptake. Harman *et al.* (2004) reported that many *Trichoderma sp* maintain a relationship with the plants as a virulent symbiont with benefits that included better root development, increases in crop and defence stimulation. That active uptake mechanism, increase in root development, efficiency of nitrogen use, solubilization of nutrients in the soil, possible deactivation of toxic compounds as *Trichoderma* species released certain molecular elicitors of plant growth promotion. Similar reports are available from Rini and Sulochana (2006) where in the combination of *T. harzianum* and *P. fluorescens* enhanced plant growth and crop yields in chilli.

Kulkarni and Raja (2019) also reported that benefit: cost ratio was an important parameter for recommendation of any treatment for successful control of plant disease. The results obtained in the present investigation are in agreement with earlier reports showing that the integrated treatments with *Trichoderma* increased growth of green gram.

Shashikumar *et al*. (2019) evaluated the compatibility of commonly used fungicides at recommended dosages with *T. viride* and *T. harzianum* being used as a biocontrol agent against soil borne diseases of tomato and cabbage under *in vitro* and *in vivo* conditions and their results indicated that Azoxystrobin was found highly compatible with *T. viride* and *T. harzianum* at all the three tested concentrations (0.05, 0.10 and 0.15 %) followed by Metalaxyl. With respect to non-systemic fungicides, Mancozeb recorded least inhibitory effect on *Trichoderma* sp. Ramarethinam *et al*. (2001) had also reported that fungicides like Carbendazim (50%WP), Hexaconazole (5%EC) completely inhibited the growth of *Trichoderma*. Desai *et al. (*2002) also reported that mancozeb at 500ppm recorded a lower inhibition of hyphae (5.70%) & sporulation (11.02%) of *Trichoderma harzianum*. The present results are also in agreement with the works of Mukhopadhyay *et al*. (1986); Sharma & Mishra (1995); Agarwal and Tripathi (1999), who also found good growth of *Trichoderma* isolates at low & medium concentration of various fungicides.

Population of *Trichoderma* sp *in* compatibility with chemical fungicides in soil at different day interval (colony forming units per gram of soil). The average total no. of cfu/g of soil increased from a day before sowing of green gram to 15 DAS and Pooled analysis of two-year data (2021 & 2022) revealed that highest *Trichoderma* sp population (cfu count) was obtained in treatment with *Trichoderma hamatum* + Validamycin 3%L i.e., 4.43×10^4 cfu/g of soil followed by *Trichoderma hamatum* @5g/kg of seed (4.30×10^4cfu/g of soil).

Pooled analysis of two-year data (2021 & 2022) revealed that the highest mean cfu/g of soil of *Trichoderma* sp population in 30 DAS was obtained in the treatment with *Trichoderma hamatum* + Validamycin 3% L i.e., 4.80×10^4 cfu/g of soil followed by *Trichoderma hamatum* @ 5 g/kg of seed (4.58×10^4 cfu /g of soil).

Pooled analysis of two-year data (2021 & 2022) showed that the highest mean cfu/g of soil of *Trichoderma* sp population (5.08×10^4 cfu/g of soil) in 60 DAS was obtained in the treatment with *Trichoderma hamatum* + Validamycin3% L followed by *Trichoderma hamatum* @ 5g/kg of seed (4.97×10^4 cfu/g of soil).

Similar reports are available from Kumar and Singh (2017) who observed *in vitro* toxicity and compatibility of commonly used fungicides like Hexaconazole, Propiconazole, Crossman and Carbendazim which were not compatible with the *T. viride* at recommended dose or even at lower dosages whereas, Mancozeb was found moderately compatible with *T. viride* at recommended dose (2000 ppm). Maximum population (5.33 cfu g^{-1} soil) of *T. viride* was recorded in untreated control followed by Mancozeb (5.0 cfu g^{-1} soil), Crossman (4.66 cfu g^{-1} soil), Hexaconazole (4.33 cfu g^{-1} soil) and Carbendazim (3.33 cfu g^{-1} soil) in fungicides treated pots at recommended doses after 30 days of inoculation. All these fungicides were found highly compatible with *T. viride* whereas, Carbendazim was moderately compatible with *T. viride* at 30 and 60 days after inoculation. The study was carried out to determine *in vitro* and *in vivo* sensitivity of *T. viride* to chemical fungicides which are usually applied in cultivation of crops to reduce the severity of a number of plant pathogens. Hence the present findings are in agreement with these earlier findings.

Table 1: Compatibility of *Trichoderma hamatum* with chemical fungicides *in-vivo* (2021 & 2022 pooled).

Treatment details	No. of pods/plant	No. of grains per pod	1000 grain weight (g)	Pod length (cm)	No. of branches	Plant dry weight (g)	Mean plant height (cm)	Seed yield (q/ha)	Disease incidence (%)	B:C Ratio
T1-Thiram 75% WP@3g/kg of seed	15.3	4.8	37.9	6.1	3.8	10.2	45.9	5.6	26.9	2:61
T2-Validamycin 3% L @ 2ml/l	18.5	8.8	45.5	7.0	5.1	12.0	48.3	7.0	22.0	3:16
T3-Copper Oxychloride 50% WG@3g/kg of seed	17.6	7.8	44.4	6.4	4.0	11.2	47.6	6.5	23.0	2:98
T4-Metalaxyl 8% + Mancozeb 64% WP@2g/kg of seed	16.3	6.6	43.2	6.2	4.0	10.8	47.1	6.2	22.5	2:65
T5-Carboxin 37.5%+ Thiram 37.5% DS@2.5g/kg of seed	14.8	4.5	40.2	5.7	3.1	9.5	44.9	5.4	30.0	2:54
T6- *Trichoderma hamatum*@5g/kg of seed + Thiram 75% WP@3g/kg of seed	19.0	9.5	42.7	7.3	4.6	13.9	60.5	8.0	31.9	3:54
T7-*Trichoderma hamatum* @5g/kg of seed + Validamycin 3% L@2ml/l	21.6	11.1	55.7	9.8	7.5	16.3	63.6	12.0	6.0	5:21
T8-*Trichoderma hamatum* @5g/kg of seed + Copper Oxychloride 50% WG @3g/kg of seed	19.8	10.0	49.6	8.8	6.1	15.2	61.6	11.1	10.8	4:78
T9-*Trichoderma* isolate-5@5g/kg of seed + Metalaxyl 8% + Mancozeb 64% WP@2g/kg of seed	20.8	10.6	55.0	9.5	6.3	15.8	62.4	11.8	8.4	4:86
T10-*Trichoderma* isolate-5@5g/kg of seed+ Carboxin 37.5% + Thiram 37.5%@2.5g/kg of seed	17.5	9.0	41.2	7.1	3.8	13.6	58.9	7.6	12.6	3:35
T11- *Trichoderma* isolate -5@5g/kg of seed	19.5	9.3	45.7	7.8	5.5	15.2	59.7	11.0	10.9	4:73
T12-Control	11.6	3.6	33.4	3.5	3.0	9.8	40.4	4.3	56.3	2:06
SE (m)±	0.34	0.20	0.39	0.17	0.27	0.17	0.13	0.2	0.4	-
CD (0.05)	0.72	0.60	1.16	0.31	0.82	0.52	0.39	0.7	1.4	-

Table 2: Population of *Trichoderma* sp in compatibility with chemical fungicides (2021 & 2022 pooled).

Treatment details	Cfu counts of *Trichoderma* sp in compatibility *in vivo* ($x10^{-4}$)		
	15 DAS	30 DAS	60DAS
T1-Thiram 75%WP@3g/kg of seed	2.05	2.17	2.66
T2-Validamycin 3% L@2ml/l	1.65	3.43	3.18
T3-Copper Oxychloride 50% WG@3g/kg of seed	1.58	2.18	2.67
T4-Metalaxyl 8% + Mancozeb 64%WP@2g/kg of seed	2.02	2.22	2.55
T5-Carboxin 37.5% + Thiram 37.5% DS @ 2.5g/kg of seed	1.63	1.85	2.59
T6- *Trichoderma hamatum*@5g/kg of seed + Thiram 75% WP@3g/kg of seed	3.22	3.36	3.66
T7-*Trichoderma hamatum* @5g/kg of seed + Validamycin 3%L@2ml/l	4.43	4.80	5.08
T8-*Trichoderma hamatum* @5g/kg of seed + Copper Oxychloride 50% WG@3g/kg of seed	3.18	3.26	3.68
T9-*Trichoderma hamatum* @5g/kg of seed + Metalaxyl 8%+Mancozeb 64%WP@2g/kg of seed	3.62	3.77	4.15
T10-*Trichoderma hamatum* @5g/kg of seed + Carboxin37.5% + Thiram37.5% @ 2.5g/kg of seed	2.59	3.13	3.48
T11- *Trichoderema hamatum* @5g/kg of seed	4.30	4.58	4.97
T12-Control	2.41	3.7	3.55
SE(m)±	0.11	0.14	0.13
CD (0.05)	0.32	0.41	0.39

CONCLUSIONS

The present study indicates that application of *Trichoderma* would be compatible with fungicides (*viz*., Validamycin 3% L, Metalaxyl 8% +Mancozeb 64% WP, Copper oxychloride 50%WG) at recommended dosage and can be recommended for integrated management of soil borne pathogens of these crops.

FUTURE SCOPE

Consequently, more detailed studies are still needed among the various isolates of Trichoderma species in order to provide a better understanding of the threshold limit of different chemicals compatible with Trichoderma to utilize them in integrated disease management. Further compatibility tests should be done with other fungicides. Botanicals and other bioagents should be integrated in with Trichoderma for compatible study.

Acknowledgement. The authors are thankful to Odisha University of Agriculture and Technology, Bhubaneswar for funding the project.
Conflict of Interests. None.

REFERENCES

Agarwal, A., & Tripathi, H. S. (1999). Biological and chemical control of botrytis gray mould of chickpea. *Journal of Mycology and Plant Pathology* (India).

Bagwan, N. B. (2010). Evaluation of Trichoderma compatibility with fungicides, pesticides, organic cakes and botanicals for integrated management of soil borne diseases of soybean [*Glycine max* (L.) Merril]. *International Journal of plant protection, 3*(2), 206-209.

Cook, R. I. and Baker, K. F. (1983). APS Books, St. Paul., MN, U.S.A: 539.

Desai, S. A., Thammaiah M. and Suresh K. (2002). Fungicidal tolerance by *Trichoderma harzianum Rifai* – A biocontrol agent. *Karnataka Journal of Agricultural Sciences, 15* (2), 397-398.

Harman, G. E., Howell, C. R., Viterbo, A., Chet, I., & Lorito, M. (2004). *Trichoderma* species—opportunistic, avirulent plant symbionts. *Nature reviews microbiology*, *2*(1), 43-56.

Inbar, J., Abramsky, M., Cohen, D. and Chet, I. (1994). Plant growth enhancement and disease control by *Trichoderma harzianum* in vegetable seedlings grown under commercial conditions. *European journal of plant pathology, 100*, 337–346.

Kulkarni, S. and Raja (2019). Integrated disease management of anthracnose of greengram. *Journal of Pharmacognosy and Phytochemistry*, *8*(3), 200-203.

Kumar, N. and Singh, S. K. (2017). Screening of tolerance and compatibility of *Trichoderma viride* against common fertilizers and fungicides. *International Journal of Chemical Studies*, *5*(4), 1871-1874.

Kumar, A., Bansal, R. D. and Chelak, Y. K. (2019) Compatibility of *Trichoderma viride* with Fungicides for Plant Disease Management. *International Journal of Pure Applied Bioscience*, *7*(3), 44-51.

Mukhopadhyay, A. N., Birambhatt, A. and Patel, G. J. (1986). *Trichoderma harzianum* – a potential bio-control agent for tobacco damping-off. *Tobacco Research*, *12*(1), 26-35.

Mukhopadyay, A. N. (1987). Biological control of soil borne plant pathogens by *Trichoderma* spp. Presidential address delivered at the 9th Annual meeting of the Society of Mycology and Plant Pathology. *Indian J. Mycol. Plant Pathology*, *17*, 1-10.

Ramarethinam, S., Murugesan, N. V. and Marimuthu S. (2001). Compatibility studies of fungicides with *Trichoderma viride* used in commercial formulation. *Bio-Cure F. Pestology*, *25*(5), 2-6.

Rini, C. R. and Sulochana, K. K. (2006). Management of Seedling rot of Chilli (*Capsicum annuum* L.) using Trichoderma sp. and flourecent Pseudomonas. *J. Tropical Agriculture, 44*(1-2), 79-82.

Sharma, S. D. and Mishra, A. (1995). Tolerance of *Trichoderma harzianum* to agrochemicals. In: Abst. Global conference on Advances in Research on Plant Diseases and Their Management. Rajasthan College of Agriculture, India, 162.

Shashikumar, H. M., Koulagi S. A. and Navyashree, S. (2019). Compatibility of *Trichoderma viride* and *Trichoderma harzianum* with Fungicides against Soil Borne Diseases of Tomato and Cabbage. *International Journal Current Microbiology Applied Science*, *8*(4), 1920-1928.

How to cite this article: Adyasha Das and Shyama Sundar Mahapatra (2023). Compatibility of *Trichoderma hamatum* with Chemical fungicides and its effect on Yield of Green Gram. *Biological Forum – An International Journal, 15*(1): 728-731.