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In vitro Efficacy of Agrochemicals on Growth of *Ganoderma* sp. Causing Basal Stem Rot of Coconut and Bio control agent *Trichoderma viride*

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Abstract **- Nine agrochemicals were evaluated against *Ganoderma* sp., the causal agent of basal stem rot of coconut and bio control agent *Trichoderma viride* under laboratory conditions at 250 ppm, 500 ppm and 1000 ppm concentrations in the department of Plant Pathology, University of Agricultural Sciences, GKNK, Bengalore. Among chemical fertilizers tested against *Ganoderma* sp. urea recorded maximum (67.34 %) inhibition over control followed by single super phosphate which accounted 53.48 per cent inhibition over control at 1000 ppm. Among micro nutrients borax accounted 100 per cent inhibition over control at all concentrations tested and ZnSo4 accounted 100 per cent inhibition over control at 500 ppm and 1000 ppm concentration. However, on *T. viride* all chemical fertilizers tested are not found to inhibitory at lower concentration (250 ppm) whereas, at higher concentration (1000 ppm) urea, single super phosphate and muriate of potash are found to be inhibitory except DAP and it was found to be supportive for growth and sporulation of *T. viride.* Among micro nutrients borax exerted 100 per cent inhibition over control at 500 ppm and 1000 ppm. ZnSo4 and Gypssum recoded 52.53 and 7.42 per cent inhibition over control at 1000 ppm however, MgSo4 was found to be supportive for growth and sporulation of *T. viride.***

Keywords **– Coconut, *Ganoderma*, *Trichoderma,* Wilt, Agrochemicals, *In Vitro.***

I. INTRODUCTION

Coconut (*Cocos nucifera* L.) is an important oilseed as well as plantation crop in India with an area of 1.8 million hectares and an annual production of 54 billion nuts [1]. In India, basal stem rot disease (BSR), caused by *Ganoderma lucidum* (Leyss.) Karst., is a major limiting factor in coconut production. The disease referred as Thanjavur wilt, bole rot, *Ganoderma* disease and Anabe roga [2 & 3]. The disease is also reported from Tamil Nadu (Tanjavur wilt), Andhra Pradesh (basal stem rot), Kerala, Maharastra, Gujarath and Orisa [4 & 5]. *Ganoderma* sp. has a wide host range attacking variety of palms and several forest, avenue and fruit trees [6, 7 & 4]. The fungus usually attacks old or weak palms growing under unfavorable conditions. The pathogen is a soil dweller inhabiting dead as well as living plant material in the soil, enters through the wounds and disease spread mainly through soil. Basal stem rot disease incidence ranged from 6.06 to 36.15 per cent in Arsikere Taluk of Karnataka [8]. Its incidence observed was maximum (up to 62.50%) in coconut gardens raised in sandy and red soils in coastal district of Andhra Pradesh [9]. Though, several researchers [4 & 10] have reported different practices for the management of the disease. Integrated disease management practices are gaining more importance with the integration of chemicals, nutrients and bio control agents for effective management of the diseases and there is not much work was carried out on effect of chemical fertilizers on pathogen and bio control agents. Therefore, it is pertinent to generate information on the efficacy of chemical fertilizers on pathogen as well as bio control agent *T viride.* Hence, the present study was undertaken to evaluate effect of chemical fertilizers on basal stem rot pathogen of coconut and bio control agent under *in vitro* conditions, which intern it will be useful for further integration and investigation in the integrated disease management practices under field conditions.

II. MATERIAL AND METHODS

Infected root bits were collected during the survey and from various places in southern dry tracts of Karnataka. The collected specimens were surface sterilized in 1:1000 mercuric chloride solutions for 30 seconds and washed thoroughly thrice in sterile distilled water to remove the traces of mercuric chloride, if any and kept in sterilized bags along with wet cotton under room temperature (28 ± 2^0C) for about 8 to 10 days. After 8 to 10 days of incubation period, slight mycelial growth was observed and that was transferred into Potato Dextrose Agar (PDA) medium. Fungal bio control agent *T. viride* (GKVK Isolate) was used for study.

Five chemical fertilizers and four micro nutrients (Table I) were tested at 250, 500 and 1000 ppm concentration by poison food technique. The pathogen *Ganoderma* isolate (G_{14} CN) and bio control agent *T viride* was grown on PDA medium in Petriplates for seven days prior to setting the experiment. Chemical fertilizers and micro nutrients suspension was prepared in PDA by adding required quantity of fertilizers to obtain the desired concentration on the basis of active ingredient and whole product present in the chemical. Twenty ml of poisoned medium was poured in each of the sterilized Petriplates and allowed to solidify. Mycelial disc of 0.6 cm was taken from the periphery of seven day old culture and placed in the centre and incubated at room temperature (28 ± 2^0C) till growth of the fungus touched the periphery in control plate. Suitable checks were also maintained without addition of any fertilizers, three replications were maintained for each treatment.

The diameter of the colony was measured in three directions and average was worked out. The per cent inhibition of growth was worked out. The per cent inhibition of growth was calculated by using the formula given by Vincent [11].

I = 100 (C-T) / C

Where,

I = Per cent inhibition of mycelium.

C = Growth of mycelium in control.

T = Growth of mycelium in treatment.

III. Results and Discussion

Among chemical fertilizers tested on the growth and development of *Ganoderma* sp. at 250 ppm, 500 ppm and 1000 ppm, urea recorded 67.34 per cent inhibition over control followed by SSP and MOP which accounted 53.48 and 49.37 per cent inhibition over control. Minimum (17.93 %) inhibition over control was recorded by DAP. At lower concentration (250 ppm) all the chemical fertilizers tested are not found to be inhibitory on basal stem rot disease causing pathogen (*Ganoderma* sp). Among the micronutrients, borax recorded 100 per cent inhibition over control at all concentrations tested whereas ZnSo4 recorded 100 per cent inhibition over control at 500 and 1000 ppm (Table 2 and plate1)

When the efficacy of agrochemicals on growth and development *T. viride* is considered, all chemical fertilizers tested are not found to inhibitory at lower concentration (250 ppm), whereas, at higher concentration (1000 ppm) urea, single super phosphate and muriate of potash were shown slightly inhibitory effect on bio control agent. However, DAP supported growth of bio control agent at all concentrations tested. Among micro nutrients tested, borax recorded 100 per cent inhibition over control at 250, 500 and 1000 ppm. ZnSo4 and Gypssum recoded 52.53 and 7.42 per cent inhibition over control respectively at 1000 ppm and MgSo4 was found to be supportive for growth and sporulation of *T. viride* (Table 3 and Plate 2)

These findings are in agreement with those of Danielson and Davey [12] who found that ammonical form appeared to be the most readily utilized source of N by *Trichoderma* Spp. in buffered media and other sources of N such as amino acids, urea, nitrate and even nitrite supported abundant vegetative growth of antagonist. Palanna *et al*., [13] reported that ammonical form of nitrogenous sources and NPK complex fertilizers as well as phosphorous and potash fertilizers were found to be better for enhanced growth of *T. viride* than the nitrate form of nitrogen. Watanabe *et al.,* [14] reported that, the mycelial weight of eight out of nine isolates of *Trichoderma* sp. and *Glicladium virens* increased in media supplemented with 2g/l N supplied as NH4 Cl, NaNo3 and a commercial 20: 20: 20 fertilizer. Neelamegan [15] observed better growth of *T. viride* when ammonical form of N was incorporated in the medium. The addition of ammonium sulphate was supportive and stimulatory to the growth of *T. harzianum* [16]. ZnSo4.7H_2O (1%) was found to inhibitory to *Ganoderma* sp. but not to *T. viride, T. harzianum* and *T. hamatum* [17].

Jaganthan and Ramasami [18] stated that ZnSo4 found to inhibit the *G. lucidum* and *G. applanatum* completely and significantly hampered the growth of *T.* sp. The manganese sulphate when applied @ 227g/palm/year reduced the intensity of BSR disease in coconut. Palanna *et al*., [19] reported that manganese sulphate, magnesium sulphate, ammonim molybdate, calcium sulphate and ferrous sulphate are found to be supportive for the growth of *T. viride* under *in vitro* conditions, whereas copper sulphate and sodium borate exerted 100 per cent inhibitory effect. Sulkla and Mishra [20] reported that growth of *T. viride* was significantly increased by Na, K and Mg salts compared to medium without salts. Srinivasalu *et al.,* [9] reported that Bordeaux mixture (1%), Copper oxy chloride (0.3%) Bitertanol (0.1%), Tridomorph (0.1%), Hexaconazoal (0.1%) and Traidemifon (0.1%) were found to completely inhibit the growth of both *G. lucidum, G. applanatum* and three species of *Trichoderma*.

Mycoparasitism of *T. harzianum* and *Fusarium oxysporum* f sp. *jiagariae* was enhanced by maltose and Co $(NO_3)2$ as the carbon and nitrogen sources respectively and KH_2PO_4 was also an effective element. Mycoparasitism was enhanced by high carbon and low nitrogen medium. [21]. Lee *et al*., [22] reported that microbial population in rhizosphere positively correlated with Ca and the ratio of Ca and Mg, K and P. Jackson *et al*. [21] stated that minerals like Mg, P and K were essential for more enhanced growth of *Trichoderma* Spp.

IV. Conclusion

The present investigation revealed that while recommending the bio control agents *ie T. viride* along with chemical fertilizers or micronutrients in integrated disease management approaches for control basal stem rot (*Ganoderma* wilt) of coconut care must be taken not to combine *Trichoderma* sp with urea, zinc sulphate and ferrous sulphate which are reported to inhibitory effect on *Trichoderma* sp. Further, inhibitory effect chemical fertilizers and micronutrients on bio control agents can be tested under field conditions.

References

[1] Rethinam P., "Coconut - Making industry competitive. In: The Hindu Survey of Indian Agriculture", pp.70-72, 2004.

[2] Nambiar KKN., and Rethinam P., "Thanjavur wilt/Ganoderma disease of coconut", Pamphlet No. 30. Central Plantation Crops Res Instit, Kasaragod., 1986.

[3] Bhaskaran R., Suriachandraselvan M., and Ramachandran TK., "*Ganoderma* wilt disease of coconut-a threat to coconut cultivation in India", Planter., vol.66, pp 467-471., 1990.

[4] Bhaskaran R., Rethinam P., and Nambiar K KN., "*Ganoderma* wilt disease of coconut. In: *Advances in Horticulture"*. Vol-10-Plantation and Spice Crops. Part-2. pp. 898- 920. 1994.

[5] Wilson K.I., Rajan K.M., Nair M.C. and Bhaskaran S.. *Ganoderma* disease of coconut in Kerala. *International Symposium on Ganoderma Wilt Disease on Palms and Other Perennial Crops*, TNAU, Coimbatore (Abstract) pp. 4-5. 1987.

[6] Naidu GVB., Kumar SNS and Sannamarappa M., "Anabe roga,

Ganoderma lucidum (Leys.) Karst. On arecanut palm: a review and further observations", Journal of Mysore Horticulture Society, vol. 1, no.3, pp. 14-20, 1966.

[7] Govindu HC., Rao, ANS., and Kesavamurthy KV., "Biology of *Ganoderma lucidum* (Leys.) Karst. And control of Anabe Roga of coconut", In Coconut Research and Development (N.M. Nayar, Ed.). Wiley Eastern Ltd., pp. 325-32, 1983.

[8] Naik RG., Palanimuthu V., Hanumanthappa M., and Indiresh KM., "Prevalence and intensity of basal stem rot disease of coconut in Arsikere taluk of Karnataka", Indian Coconut J., vol.31, no.1, pp. 8-10, 2000.

[9] Srinivasalu B., Aruna K., Rao DVR. and Hameed Khan H., "Epidemioligy of Basal Stem Rot (*Ganoderma wilt*) disease of coconut in Andra Pradesh", Indian J. Plant Protection, vol. 31, no.1, pp. 48-50, 2003.

[10] Srinivasalu B., Aruna K., Sabitha Doraiswamy., and Rao, DVR., "Occurrence and Bio control of *Ganoderma* wilt disease of coconut in Coastal Agro-Ecosystem of Andra Pradesh", J. Indian Sco. Coastal Agric. Res., vol.19, no.1 & 2, pp. 191-195, 2001.

[11] Vincent JM., "Distribution of fungal hyphae in the presence of certain inhibitors". *Nature,* 159, pp.850, 1947

[12] Danielson RM., and Davey CB., "Effect of nutrients and acidity on phialospore germination of Trichoderma in vitro", Soil Biol Biocheme, vol. 5, pp. 517-524, 1973.

[13] Palanna KB., Chidanandaswamy and Muthamilan, M., "Effect of chemical fertilizers on growth sporulation and antifungal activity of *Trichoderma viride in vitro",* Mysore J. Agric. Sci., vol. 39, no. 4, pp. 570-573, 200 5b.

[14] Watanabe N., Lewis JA., and Papavizas GS., Influence of nitrogen fertilizers on growth, spore production and germination and bio control potential of *Trichoderma* and *Gliocladium*. J. Phytopathol., vol. 120. pp. 337-346, 1987.

[15] Neelamegam R., "Integrated control of damping off of tomato. Ph.D Thesis", Annamalai Univ., Annamalainagar, India. 184 p. 1992.

[16] Sharma S.D. and Mishra A. "Tolerance of *Trichoderam horzianum* to agrochemicals. In: Abs Global conf. on Advances in Research on Plant Disease and their management", Feb. 12-17, 1995. Rajasthan College of Agric., Udaipur, India. 1995.

[17] Srinivasalu B., Aruna K., Lakshmi BKM., Sabitha Doraiswamy., Rao DVR. and Hameed Khan, H., "*Trichoderma hamatum* - a potential bio control agent for basal stem rot (Ganoderma wilt) disease of coconut", Proceedings of Placrosym (XV), vol.5, pp.41-544, 2002.

[18] Jagannath T., and Ramaswamy R., "Annual report 1974-75", Tamil Nadu Agric. Univ., Ciombatore, pp.173. 1975

[19] Palanna KB., Muthamilan M, Harish. S., and Chidanandaswa--my, "Effect of secondey and micronutrients (0.25 & 0.5 % w/v) on growth sporulation and antifungal activity of *Trichoderma viride in vitro"*. Mysore J. Agric. Sci., vol. 39, no.4, 498-502, 2005a

[20] Shukla DD., and Mishra, A., "Effect of salt on growth of *T. viride"*. *Fricsia*, vol. vol. 9, pp. 299-301, 1970

[21] Moon BJ., Chung, HS., and Chu, C., Studies on antagonism of Trichoderma spp. to Fusarium oxysporum f. sp. fragariae. II. Effect of nutrient and environment on antagonistic activity. J.Pl. Pathology, vol.4, pp.124-135, 1988

[22] Lee S.K., Ko JY., Yoon S.Y., Kim S.H., and Suh J.S., "Enumeration and identification of soil microorganisms in rhizosphere of upland crops under different agricultural climatic zones" Research Reports of the Rural Development Administration, Soil and Fertilizer, Agricultural Science Institute, RDA Suwon, Korea, vol.32, pp. 62-70., 1990.

[23] Jackson KM, Whipps JM., and Lynch JM., "Effect of temperature, pH and water potentail on growth of four fungi with disease control potential", World J microbial Technology, vol.7, pp. 494-501, 1991.

Table I. Chemical formula and composition of agrochemicals tested against *Ganoderma* isolate of coconut and bio control agent *Trichoderma viride*

Sl. No.	Name of the Agrochemicals	Chemical formula	Major Nutrient Content (%)			
			N	P	K	Others
1	Urea	$CO(NH_2)_2$	46.00	-	-	-
2	Diammonium phosphate	$(NH_4)_2HPO_4$	18.00	46.00	-	-
3	SSP	$Ca H_2 (PO_4)3$	-	16	-	19.5(Ca) & 12.5 (S)
4	Muriate of potash	Kcl	-	--	60.00	48.00 (Cl)
5	MAP	$NH_4 H_2 PO_4$	12	61	-	-
6	Zinc sulphate	$Zn SO_4.7H_2O$	-	-	-	22- 35 (Zn) 17.80 (S)
7	Magnesium sulphate	$Mg SO_4.7H_2O$	-	-	-	16.00 (MgO) & 13.00 (S)
8	Gypsum	$Ca SO_4.2H_2O$	-	-	-	29.20 (Ca) 23.50 (S)
9	Borax	$Na2 B_4 O_7 10H_2O$	-	-	-	11 (B)

Table II. *In vitro* efficacy commonly used agrochemicals in coconut system on *Ganoderma* isolates of coconut (G_{14})

Sl. No	Chemical name	*Ganoderma* isolate (G_{14} - CN)		
		Percent inhibition over control*		
		250ppm	500ppm	1000ppm
1	UREA	0.00 (0.55)	38.26 (38.18)	67.34 (55.15)
2	DAP	0.00 (0.55)	0.00 (0.55)	17.93 (24.83)
3	SSP	0.00 (0.55)	27.37 (31.37)	53.48 (47.00)
4	MOP	0.00 (0.55)	1.23 (4.04)	49.37 (44.65)
5	MAP	0.00 (0.55)	0.00 (0.55)	25.07 (30.03)
6	MgSo4	0.00 (0.55)	8.64 (16.67)	23.04 (28.69)
7	ZnSo4	60.48 (51.09)	100.00 (89.45)	100.00 (89.45)

Sl. No	Chemical name	*Ganoderma* isolate (G_{14} - CN)		
		Percent inhibition over control*		
		250ppm	500ppm	1000ppm
8	Gypssum	0.00 (0.55)	3.67 (9.10)	23.45 (28.94)
9	Borax	100.00 (89.45)	100.00 (89.45)	100.00 (89.45)
SEm ±		1.237	18.955	5.302
CD (p=0.01)		2.654	10.380	5.498
CV (%)		6.932	14.028	4.733

Note: DAP; Di ammonium phosphate, SSP; Single Super Phosphate, MOP; Murite of potash, MAP; Mano ammonium phosphate, MgSo4; Magnesium Sulphate, ZnSo4; Zinc sulphate
* Fig. in parenthesis are arc sign transformed values

Table III. Efficacy of commonly used agrochemicals in coconut and arecanut system on *Trichoderma viride in vitro*

Sl. No.	Agrochemicals	Percent inhibition over control			Sporulation		
		250ppm	500ppm	1000ppm	250ppm	500ppm	1000ppm
1	UREA	0.00 (0.55)	0.00 (0.55)	11.12 (19.47)	++++	+++	+
2	DAP	0.00 (0.55)	0.00 (0.55)	0.00 (0.55)	++++	++++	++++
3	SSP	0.00 (0.55)	8.56 (16.99)	18.53 (25.24)	++	+	+
4	MOP	0.00 (0.55)	0.00 (0.55)	14.19 (21.92)	+++	+++	+
5	MAP	0.00 (0.55)	0.00 (0.55)	13.00 (21.02)	++++	+++	-
6	MgSo4	0.00 (0.55)	0.00 (0.55)	0.00 (0.55)	++++	+++	+++
7	ZnSo4	22.23 (28.14)	31.63 (34.22)	52.53 (46.44)	++	+	-
8	Gypssum	0.00 (0.55)	0.00 (0.55)	7.42 (13.17)	+++	+	+
9	Borax	29.04 (32.47)	100.00 (89.45)	100.00 (89.45)	++	-	-
SEm ±		**2.60**	**0.30**	**20.30**			
CD (p=0.01)		**3.84**	**1.32**	**10.75**			
CV (%)		**22.52**	**3.46**	**17.05**			

Note: DAP; Di ammonium phosphate, SSP; Single Super Phosphate, MOP; Murite of potash, MAP; Mano ammonium phosphate, MgSo4; Magnesium Sulphate, ZnSo4; Zinc sulphate
* Fig. in parenthesis are arc sign transformed values

PLATE I.

***In vitro* efficacy of agrochemicals on *Ganoderma* sp of coconut**

i) Macro nutrients

ii) Micro nutrients

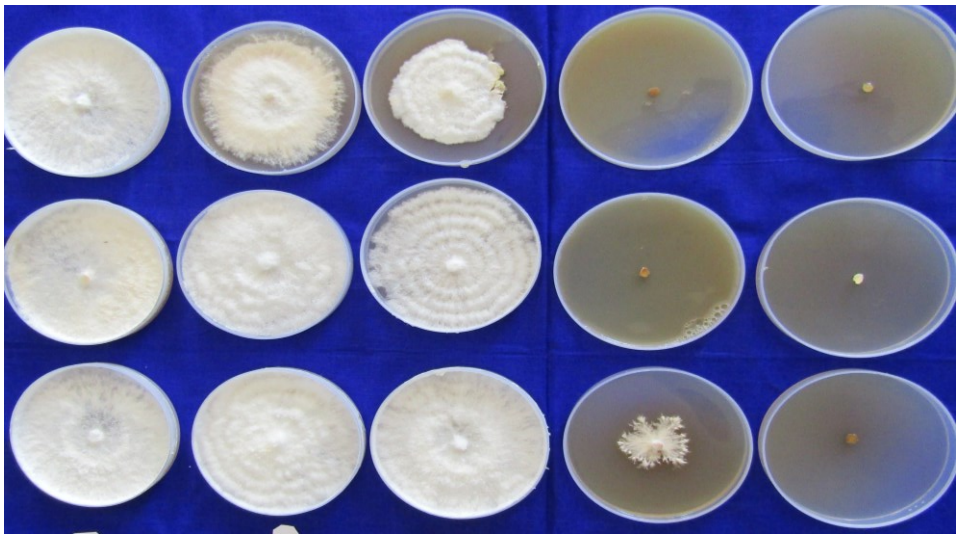
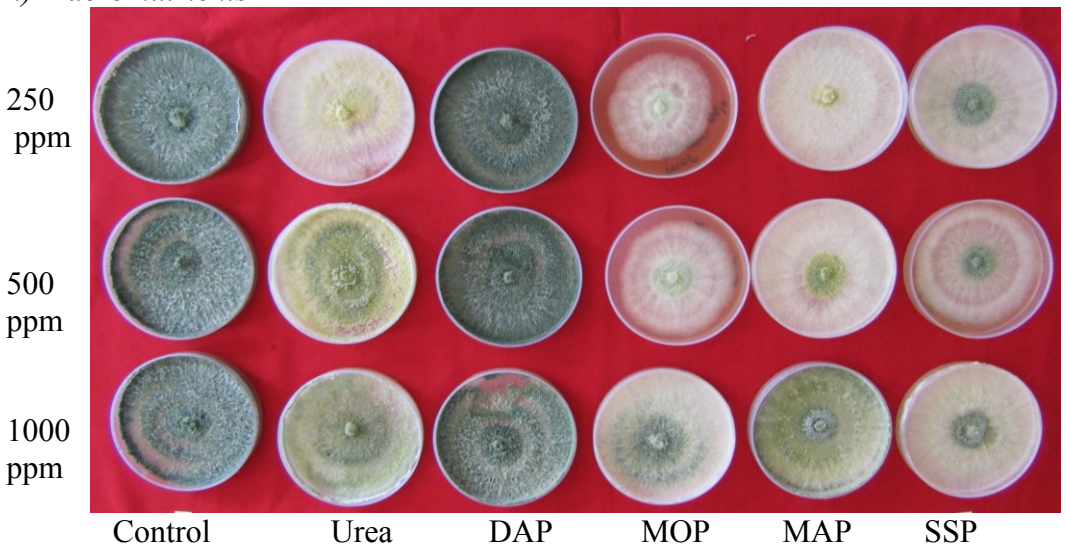


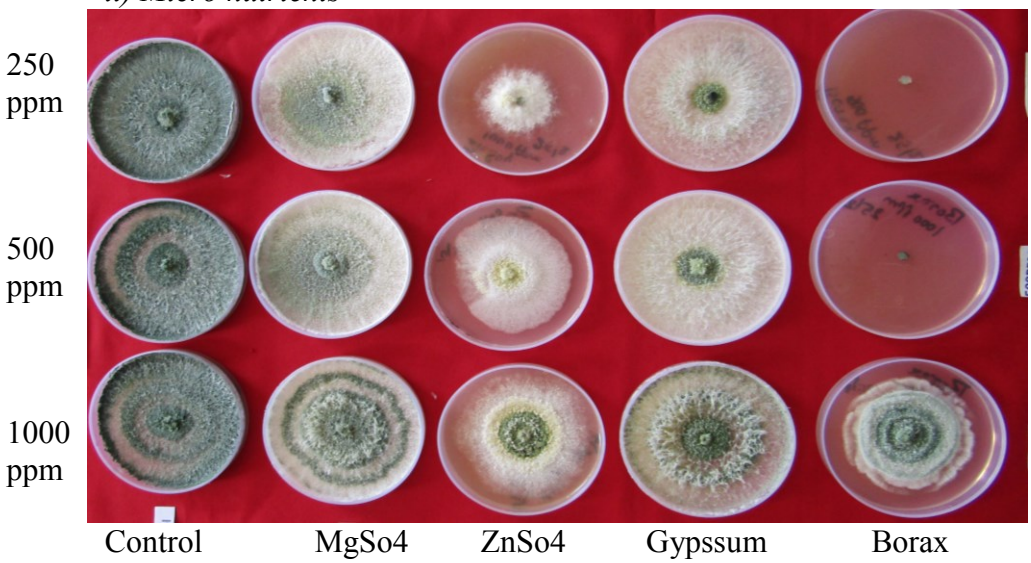
PLATE II.

In vitro* efficacy of agrochemicals growth of bio control agent *T. viride

i) Macro nutrients



ii) Micro nutrients



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