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MANAGEMENT OF PHYTOPHTHORA ROOT ROT IN NAGPUR MANDARIN BY USING INTEGRATED APPROACH

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ABSTRACT

Studies were undertaken to compare different combinations of bioagents, chemicals and organic amendments to manage root rot in Nagpur mandarin. The experiment was conducted by selecting root rot infected Nagpur mandarin garden during the year 2013-14. Combination of Neem cake with fungicides, bioagents and FYM showed significant results in reducing the intensity of the disease. Among these soil amendments with Neem seed cake 2 kg/Tree followed by drenching of Metalaxyl + Mancozeb 72 WP @ 20 g/lit of water and biological control agent *T. harzianum* 50 g+ 50 kg FYM gave relatively significant reduction in root rot (55.42%), followed by Neem seed cake 2 kg/ Tree and drenching of metalaxyl + Mancozeb 72 WP @ 20g/ 10 liter of water + *P. fluorescens* 50 g/ 50 kg of FYM. There was tremendous increase in shoot length in all treatments. However, soil amendment with Neem cake 2 kg/tree followed by drenching of Metalaxyl + Mancozeb 72 WP @ 20 g/ 10 lit of water and biological control agent *T. harzianum* 50 g/ 50 kg of FYM gave significant increase in shoot length (23.55 cm) as compared to other treatments. Similar treatment gave significant improvement in canopy volume of the tree (10.89%).

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INTRODUCTION

Phytophthora root rot is most important soil borne disease of Nagpur mandarin causing mortality, slow decline and yield loss of mature trees (Graham and Trimmer, 2003). *Citrus* spp. are prone to attack by more than 150 pathogens and disorders caused by fungal, viral and few bacterial pathogens right from nursery level to bearing stage resulting in severe losses. All citrus orchards in central India and other citrus cultivation belts of India are infected by *Phytophthora* diseases. Every year 5-10% plants die due to severe root rot in bearing orchards (Naqvi, 2000). It requires due attention for their effective management that includes use of tolerant rootstocks and fungicides. Use of fungicides can mitigate the problem up to some level but cannot eradicate it. It is clear that single component alone is not effective to manage the disease in orchards and further emphasized the needs for integration of effective components of management practices to protect the orchards. In order to develop ecofriendly management of *Phytophthora* diseases, it is necessary to integrate biological and chemical management practices along with soil amendments and nutrition. Thus, present investigation was carried out to find out best suitable combinations of organic soil amendment, bioagents and chemicals for integrated management of root rot in Nagpur mandarin.

MATERIALS AND METHODS

Field experiment

The field experiment was carried out in Nagpur mandarin orchard by using factorial randomized block design (FCRD). It includes fungicides, soil amendments and bioagent combinations. Treatments contain two main factors as M_1 - Neem seed cake 2 kg/tree and M_2 - Groundnut cake 2 kg/tree and five sub factors *viz.*, S_1 - Drenching of Metalaxyl + Mancozeb 72 WP @ 20 g/ 10 lit of water + *Trichoderma harzianum* 50 g /50 kg FYM, S_2 - Drenching of Fosetyl-AL @ 20 g/ 10 lit of water + *Trichoderma harzianum* 50 g /50 kg FYM, S_3 - Drenching of Metalaxyl + Mancozeb 72 WP @ 20 g/10 lit of water + *Pseudomonas fluorescens* 50 g /50 kg FYM, S_4 - Drenching of Fosetyl-AL 80 WP @ 20 g/ 10 lit of water + *Pseudomonas fluorescens* 50 g /50 kg FYM and S_5 - Control. In each treatment one tree was selected showing mild to moderate decline. The treatments were started from November-January and observations taken after 30 days subsequently.

Root Rot

Soil samples from rhizosphere of the root zone were collected from the trees showing yellowing in the midrib and lateral veins of leaves and browning of root cortex. The association of pathogen was confirmed by using bait method (Grimm and Alexander, 1973). The disease incidence was recorded by using 0-4 scale and disease Intensity was calculated. The scale was 0 = No yellowing, 1 = yellowing of leaves and leaf fall (0-10%), 2 = yellowing of leaves and leaf fall (10-25%), 3 = yellowing of leaves and leaf fall (25-50%) 4 = above 50% yellowing of leaves and leaf fall (Gade *et al.*, 2006).

Canopy volume

Canopy volume was recorded before and after application of treatments as per the formula.

Canopy volume = $\sqrt{4\ (3\pi a^2 b)}$

Where,

a = NS + EW/4;

NS = Length of canopy at north south direction;

EW = Length of canopy at east west direction;

b = h/2, h = height of tree (Gade *et al.,* 2006).

RESULTS AND DISCUSSION

Soil amendment with Neem seed cake (M_1) and groundnut cake (M_2) were compared to see the reduction in intensity of root rot in Nagpur mandarin. It was observed that organic amendment, Neem seed cake 2 kg/Tree (35.60%) was significantly superior to groundnut cake (Table 1). Mirza *et al.,* (2000) reported that as Neem seed cake is also a seed based product so azadirachtin could also be responsible for antifungal activity against *Phytophthora*. Drenching of Metalaxyl + Mancozeb @ 0.2 % along with *Trichoderma harzianum* 50 g with 50 kg FYM (S_1) significantly reduced root rot upto 41.86 %. This treatment was found statistically at par with the drenching of Metalaxyl + Mancozeb @ 0.2 % along with *Pseudomonas fluorescens*50 g / 50 kg FYM (Table 1). *Phytopthora* as a cellulolytic fungi, Metalaxyl is an excellent fungicide to manage this pathogen (Naqvi, 1993; Farih *et al*., 1981). The reduction of root rot by *Trichoderma* spp. may be due to high antagonistic potential that includes antibiosis, parasitism and production of lytic enzymes (Singh *et al*., 2004). The antagonism of *Trichoderma* spp. against many fungi is mainly due to production of acetaldehyde may be the reason for antagonistic effect of *Trichoderma* against *Phytophthora* spp. (Dennis and Webster, 1971). Inhibition of *Phytophthora parasitica* through *P. fluorescens* takes place *in vitro* due to the production of pyoverdine and hyphal colonization and suggesting that these bacteria may be useful in control of citrus root rot (Yang *et al*., 1994). Combination of organic amendment with fungicides, bioagents and FYM gave significant result to reduce root rot in Nagpur mandarin. There was significant reduction in intensity of root rot in M_1S_1(55.42 %). The intensity of root rot decreased from 73.10 to 32.59 % at the end of the experiment. Gade and Koche (2012) recorded considerable reduction in population density and intensity of rootrot and gummosis in Nagpur mandarin due to combination of Metalayl, Neem cake, Fosetyl Al, *Trichoderma* sp. and *P. fluorescens*.Davis (1982) observed that soil drenching of Metalaxyl and foliar spray of Fosetylaluminium reduced root rot of potted sour orange seedlings inoculated with *Phytophthora parasitica*. Lokesh *et al.,*(2008) showed that the disease *Phytophthora* foot rot (*Phytophthora capsici*) could be managed by application of metalaxyl gold (100 ppm) in combination with *T. harzianum* (@ 50 g / vine) with one kg of neem cake to the root zone for effective management of the disease. Bairwa *et al*., (2015) also showed the efficiency of bioagent, fungicides and FYM for management of root rot and gummosis in Kinnow mandarin.

The present study revealed that drenching of Metalaxyl + Mancozeb @ 0.2 % along with *Trichoderma harzianum* with FYM (S_1) consistently increased number of shoots upto 8.56, 14.89, 19.56 in the month of December, January and February, respectively. Drenching of Metalaxyl + Mancozeb @ 0.2 % along with *Pseudomonas fluorescens* with FYM (S_3) was at par with this treatment with increase in no. of shoots were 8.11, 14.11, 18.78 in the month December, January, February, respectively (Table 2). The results achieved in the present study corroborates with the findings of Sandler *et al.,*(1988) who have obtained effective control of citrus foot rot with Ridomil

Table 1: Effect of different treatments on disease intensity of root rot in Nagpur mandarin

Treatments	Intensity of root rot(%) Initial	90 DAT	Percent Decrease in disease
Main Factor (Organic amendments)			
M_1	71.58	46.10	35.60
M_2	72.20	56.55	21.68
CD P =0.05		3.38	
Sub Factor (Chemicals + bioagent +FYM)			
S_1	73.10	42.50	41.86
S_2	72.75	52.41	27.96
S_3	76.20	46.29	39.25
S_4	66.20	53.62	19.00
S_5	71.20	61.80	13.20
CD P =0.05		5.35	
Interaction M x S			
M_1S_1	87.50(73.10)	29.17(32.59)	55.42
M_1S_2	87.50(69.30)	54.17(47.41)	31.59
M_1S_3	91.67(76.20)	41.67(40.17)	47.28
M_1S_4	83.33(66.20)	58.33(49.83)	24.73
M_1S_5	87.50(73.10)	75.00(60.51)	17.22
M_2S_1	87.50(73.10)	62.50(52.41)	28.30
M_2S_2	91.67(76.20)	70.83(57.41)	24.66
M_2S_3	91.67(76.20)	62.50(52.41)	31.22
M_2S_4	83.33(66.20)	70.83(57.41)	13.28
M_2S_5	87.50(69.30)	79.17(63.10)	8.95
CD P =0.05		7.56	

Table 2: Effect of different treatments on increase in number of shoots per branch upto 30 cm length in Nagpur mandarin

Treatments	No. of shoot per branch up to 30 cm length		
	Dec	Jan	Feb
Main Factor (Organic amendment)			
M_1	8.33	14.42	18.98
M_2	5.20	8.78	11.73
CD p =0.05	0.70	1.08	1.33
Sub Factor (Chemicals + bioagent +FYM)			
S_1	8.56	14.89	19.56
S_2	7.17	12.11	15.78
S_3	8.11	14.11	18.78
S_4	6.39	11.17	15.67
S_5	3.61	5.72	7.00
CD p =0.05	1.10	1.72	2.10
Interaction M x S			
M_1S_1	10.66	18.22	23.55
M_1S_2	9.11	15.66	20.33
M_1S_3	10.11	17.66	23.11
M_1S_4	8.00	14.33	20.11
M_1S_5	3.77	6.22	7.77
M_2S_1	6.44	11.55	15.55
M_2S_2	5.22	8.55	11.22
M_2S_3	6.11	10.55	14.44
M_2S_4	4.78	8.00	11.22
M_2S_5	3.44	5.22	6.22
CD p = 0.05	1.56	2.43	2.98

Table 3: Effect of different treatments on increase in canopy volume of Nagpur mandarin

Treatments	Before treatment		After treatment		Increase in canopy volume over prunning (%)	
	Initial	After pruning	Jan	Feb	Jan	Feb
Main Factor (Organic amendment)						
M_1	18.90	15.05	2.28	3.19	5.19	10.17
M_2	18.27	15.70	1.79	2.53	3.20	6.40
CD p =0.05			0.15	0.18		
Sub Factor (Chemicals + bioagent +FYM)						
S_1	18.66	14.67	2.37	3.30	5.62	10.89
S_2	18.24	14.86	2.14	3.04	4.58	9.25
S_3	18.84	14.51	2.30	3.19	5.29	10.18
S_4	19.08	15.72	2.07	3.00	4.29	9.00
S_5	18.11	17.13	1.28	1.79	1.64	3.21
CD p =0.05			0.24	0.28		
Interaction (M x S)						
M_1S_1	18.54	13.83	2.74	3.76	7.52	14.19
M_1S_2	19.50	15.40	2.44	3.46	6.02	12.14
M_1S_3	19.01	14.55	2.59	3.53	6.75	12.56
M_1S_4	18.98	14.99	2.31	3.41	5.35	11.63
M_1S_5	18.46	16.50	1.32	1.82	1.73	3.32
M_2S_1	18.78	15.51	2.00	2.84	4.02	8.08
M_2S_2	16.99	14.32	1.84	2.61	3.41	6.85
M_2S_3	18.66	14.47	2.01	2.85	4.05	8.15
M_2S_4	19.19	16.45	1.83	2.60	3.36	6.75
M_2S_5	17.75	17.75	1.25	1.76	1.68	3.13
CD p = 0.05				0.40		

MZ. Gade and Giri (2005) tried various fungicides against *Phytophthora* spp. in citrus and found that metalaxyl was the best for the reduction in propagules (cfu / g) in soil. The increase in number of new shoots and leaf colour in the trees treated with Ridomil MZ and Aliette confirmed the effective control of root rot and also their findings.

The integration of chemicals, bioagents and organic amendments M_1S_1 significantly increase number of new shoots (23.55 cm), followed by M_1S_3 (23.11 cm) (Table 2). This findings correlates with Raina (2012) who reported that the maximum new shoots have been recorded in Aliette and Ridomil MZ i.e. 32.8 and 32.0 per cent , respectively along with dark green colour. Gade (2012) also showed improvement in shoot weight due to application of *Trichoderma* and *Pseudomonas fluoresens* and metalaxyl.

All treatments of organic amendment significantly increase

canopy volume of trees (Table 3). However application of neem seed cake (M1) was found significantly superior over groundnut cake (M2). In this treatment canopy volume increases 5.19% in January and 10.17% in February over pruning**.** Gade and Koche (2012) recorded improvement in plant health due to management of root rot and gummosis in Nagpur mandarin. These was significant improvement in root and shoot fresh weight due to application of *Trichoderma, P. fluorescens* and metalaxyl. Singh (1983) found that organic matter influences physical characters of soil such as pore size, aeration, water retention capacity etc. which helps in better solubilization and release of minerals by decomposable organic matter resulting in rapid extension of the root system, better uptake of nutrients and finally the plant vigour. Drenching of Metalaxyl + Mancozeb @ 0.2% + *Trichoderma harzianum* 50 g with 50 kg FYM/tree gave statistically significant differences due to different chemical treatment in increase in canopy volume (10.89 %). These findings are in accordance with the findings of Gade *et al.,* (2006) who reported that Ridomil MZ 72 stem pasting increases canopy 9.15 % over control (6.42%).

Various combinations of treatments showed a positive influence on significant increase in canopy volume on treated plants. In M_1S_1 initial canopy volume of plant was 18.54 m^3 which decrease after pruning to 13.83 m^3, while after treatment in January, there was increase in canopy volume to 7.52% and in February it increased up to 14.19 % (Table 3). This treatment was found superior over all other treatments including control. These findings are in agreements with Sharma*et al.,* (2014) who reported that effective management of collar rot (*Phytophthora cactorum*) in apple by a combined application of *Trichoderma harzianum, Enterobacter aerogenes* and metalaxyl MZ (0.25%) provided complete control under nursery conditions, whereas under orchard conditions it increased the shoot length up to 32.2 cm as compared 6.1 cm in untreated plants.Thus it can be concluded that integration of organic amendments, chemicals and bioagents under field conditions play an important role in successful management of root rot and gummosis in Nagpur mandarin and also reduce sole use fungicides to manage the disease, which will help in restricting the pathogen to develop resistance against fungicides.

REFERENCES

Bairwa, S. R., Srivastava, A. K., Kumar, P., Meena, R. S. and Koli, C. R. 2015. Developing strategies for integrated management of *Phytophthora* root rot and gummosis in kinnow mandarin (*Citrus reticulata*). *Indian Phytopath.* **68(1):** 101-105.

Davis, R. M. 1982. Control of *Phytophthora* root rot and fruit rot of citrus with systemic fungicides Metalaxyl and phosethyl aluminium. *Plant Disease.* **66:** 218-220.

Dennis, C. and Webster, J. 1971. Antagonistic properties of species groups of *Trichoderma* II. Production of volatile antibiotics.*Trans. Br. Mycol. Soc.* **57:** 41-48.

Farih, A. J., Menge, A., Tsao, P. H. and Ohr, H. D. 1981. Metalaxyl and Efosite aluminium for control of *Phytophthora* gummosis and root rot of citrus. *Plant Disease*. **65:** 654-657.

Feichtenberger, E. and Aubert, B. 1999. Effect of systemic fungicide applications on growth response and fruit yields of sweet orange trees in *Phytophthora* infested soil. Proceeding 5th World Congress of the International Society of Citrus, Nurserymen, Montpellier France. pp. 267-279.

Gade, R. M. and Giri, G. K. 2005. Integration of soil solarization and fungicides for management of *Phytophthora* sp. in citrus nursery. *Indian Phytopathology*. **58(1):** 114-116.

Gade, R. M. 2012. Biological and chemical management of *Phytophthora* root rot /collar rot in citrus nursery. *The Bioscan*. **7(4):** 631-635.

Gade, R. M., Bambawale, O. M., Sangle, U. R. and Shinde, V. B. 2006. Chemical management of gummosis in Nagpur mandarin (*Citrus reticulate* Blanco). *Pesticides Res. J.* **18(2):** 169-172.

Gade, R. M. and Koche, M. D. 2012. Integrated disease management for root rot and gummosis in Nagpur mandarin. *Indian Phytopath*. **65 (3):** 272-275.

Graham, J. H. and Timmer, A. Z. 2003. *Phytophthora* disease of citrus. Plant disease of international importance. *EdisIfas of Education.* **5:** 13-14.

Grimm, G. R. and Alexander 1973. Citrus leaf pieces as traps for *Phytophthora parasitica* from soil slurries. *Phytopathol.* **63:** 540-541.

kumar, S. Maurya, Anjali kumari, J. Choudhary, B. Das, Naik, S. K. and Kumar, S. 2012. Biocontrol potentials of *Trichoderma harzianum* against sclerotial Fungi. *The Bioscan*. **7(3):** 521-525.

Lokesh, M. S., Hegde, H. G. and Naik, N. 2008. Efficacy of systemic fungicides and antagonistic organism for the management of *Phytophthora* foot rot of black pepper in arecanut cropping system. *J. Spices and Aromatic Crops*. **17(2):** 114-121.

Mirza, J. I., Hameed, S., Ahmad, I., Ayub, N. and Strang, R. H. C. 2000. *In vitro* antifungal activity of neem products against *Phytophthora infestans. Pakistan J. Biological Science*. **3(5):** 824-828.

Naqvi, S. A. M. H. 2000. Managing *Phytophthora* diseases of Citrus. *Indian Horticulture*. **44:** 5-9.

Naqvi, S. A. M. H. 1993. Efficacy of some fungicides in control of *Phytophthora* diseases of Nagpur mandarin in central India. *Indian Phytopath*. **47(4):** 430-434.

Raina Rajeev 2012. Management *Phytophthora* induced foot rot and gummosis of Kinnow mandarin in low hills of Himachal Pradesh. *J. of Pl. Dis. Sci*. **7(1):** 9-12.

Rini, C. R. and Sulochana, K. K. 2007. Substrate evaluation for multiplication of *Trichoderma* spp. *J.Tropical Agriculture*. **45(1-2):** 58-60.

Sandler, H. A., Timmer, L. W. and Graham, J. H. 1988. Effect fosetyl -Al and matalaxyl applications on foot rot incidence and growth of young citrus trees under field conditions. *Proc. Fla. State Hort. Soc.* **101:** 10-12.

Sharma, I. M., Negi, H. S. and Shweta Sharma. 2014. Integrated management of collar rot in apple caused by *Phytophthora cactorum*. *Indian Phytopathology*. **7(2):** 45-47.

Singh, R. S. 1983. Organic amendments for root rot disease control through management of soil microbiota and the host. *Indian J. Mycol. and Pl. Pathol.* **13:** 1-16.

Singh, U. S., Zaidi, N. W., Joshi, D., Khan, T., John, D. and Bajpai, A. 2004. Volatile and non volatile antibiotics produced by *T. harzianum. Annual Reviews Plant Pathology.* **3:** 33-75.

Sunaina Bisht, P. Kumar, Srinivasan raghavan, A. and Jyotika, P. 2013. In Vitro Management of Curvularia Leaf Spot Of Maize Using Botanicals, Essential Oils And Bio-Control Agents. *The Bioscan.* **8(3):** 731-733.

Sunita Mahapatra and Srikanta Das 2013. Bioefficacy of botanicals against Alternaria leaf blight of mustard under field condition. *The*

Bioscan. **8(2):** 675-679.

Verma, V. S. 1999. Studies on non-chemical management of mango wilt in nurseries. Ph.D. thesis, (Unpub.) Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan, p.119.

Yang, C., Menge, J. A. and Cooksey, D. A. 1994. Mutations affecting hyphal colonization and Pyoverdine production in *Pseudomonas* antagonistic toward *Phytophthora parasitica*. *Appl. Enviorn. Microbiol.* **60(2):** 473-481.