Original Research Article

Integrated Management of Root Rot Disease Complex of Tomato (*Solanum lycopersicum* L.) Incited by Concomitant Occurrence of *Rhizoctonia solani* and *Meloidogyne javanica*

ABSTRACT

Tomato (*S. lycopersicum* L.) is an important vegetable crop not only for its economic importance but also because of its nutritional value. The root rot disease complex of tomato is considered as a common problem in tomato fields of Haryana due to concomitant occurrence of *R. solani* and *M. javanica.* It is very difficult to manage the disease complex through fungicides and nematicides alone which despite of being costly are not eco-friendly as well. Therefore, in this study, an attempt was made to explore and exploit other methods of root rot disease complex management in an integrated manner. The different treatments like organic amendment (mustard cake), fungicide (Carbendazim 50 % WP), mycorrhizal fungi (*Glomus mosseae*) and biocontrol agent (*Trichoderma harzianum*) were evaluated in different combinations for the integrated management of root rot disease complex in tomato cv. Hisar Arun (Selection 7). The evaluation of different treatments and their combinations under *in vivo* condition revealed that a significantly low disease incidence (10.5 per cent) and a maximum disease control of 83.4 per cent was observed when seeds were dressed with Carbendazim 50 % WP @ 2g/kg seed and sown in soils incorporated with *T. harzianum* (10g/kg soil), *G. mosseae* (200 sporocarps/kg soil) and mustard cake (2g/kg soil). It was followed by disease incidence of 13.7 per cent when Carbendazim dressed seeds (2g/kg seed) were sown in soil incorporated with *T. harzianum* (10g/kg soil) and mustard cake (2g/kg soil). It is possible to manage the disease complex only by the use of integration of different treatments including seed dressing with carbendazim, soil incorporation of *T. harzianum, G. mosseae* and soil amendments with mustard cake which acted in a synergistic way.

Keywords: Management; mortality; pre-emergence; post-emergence; root rot; tomato.

1. INTRODUCTION

Tomato (*S. lycopersicum* L.) is one of the major vegetable crops grown widely in almost every country in the world. It belongs to family *Solanaceae* and is universally considered as a protective food because of its high nutritive value and availability round the year. India ranks second after China in area as well as in production of tomato. It is a rich source of minerals, vitamins and organic acids and has a high degree of lycopene and ascorbic acid content [1]. Its fruits are used in making many value added products like soup, pickle, ketchup etc. Its juice and pulp is easily digestible and promote digestive secretion as well as help in blood purification. The products are now being used in preventive strategies against some diseases [2].

The tomato productivity is comparatively low in India than many other countries, presumably due to some major diseases, improper and inadequate supply of nutrients and lack of adoption of new improved production technologies in crop. It is prone to attack by several disease causing agents like fungal, bacterial, nematode, viral diseases etc. The root rot disease complex caused by *R. solani* and *M. javanica* is collectively an important disease complex particularly in Haryana. This crop is prone to attack from early sowing to maturity, meaning thereby that the disease can appear at any stage of plant growth from nursery beds to fields after the transplanting of seedlings. However, an early stage of crop growth is highly susceptible to disease complex. It has been reported to cause a loss up to 69.25 per cent in tomato crop [3].

The root rot disease complex caused by *R. solani* in combination with *Meloidogyne* spp. leads to more severe damage to the plants rather than their individual effect. Their association takes a heavy toll and is responsible for poor stand of the crop. The *R. solani* and *M.*

javanica interaction has a significant effect on root rot disease complex incidence in tomato [4]. It is very difficult to manage the *R. solani* alone by virtue of its presence in soil or plant debris, polyphagous nature and vast distribution. Moreover, the association of *Meloidogyne* sp. makes the situation more complex for successful and economical control of this disease complex. It is not possible to manage this disease complex only through fungicide or nematicide. The chemicals despite of being costly have an undesirable effect on the environment when applied regularly and their continuous use may also encourage the development of resistance in pathogen toward chemicals. In addition to the target pests, they are harmful to the beneficial microorganisms in the soil, contaminate soil, water and accumulate in plant parts also. So, it was felt to explore other methods of root rot disease complex management in an integrated manner.

2. MATERIALS AND METHODS

The present study was carried out in the Department of Plant Pathology, Chaudhary Charan Singh Haryana Agricultural University, Hisar during 2018-19 under screen house conditions on tomato cv. Hisar Arun (Selection 7).

The application of Carbendazim 50WP as a seed dressing fungicide (2g/kg seed), mustard cake as a soil organic amendment (2g/kg soil), *T. harzianum* (10g/kg soil) and *G. mosseae* (200 sporocarps/kg soil) as bio control agents were selected to conduct the experiment and used in different combinations as per detail of treatments given below. The organic amendments and bio control agents were added in the soil one week before sowing and both pathogens were inoculated in sterilized soil two days before sowing at the rate of 1000 mg/kg soil (*R. solani*) and 1000 J_2/kg soil (*M. javanica*). The check 1 (with both pathogens in soil) and check 2 (without pathogens in soil) were also maintained in this experiment. Ten seeds of tomato were sown in each earthen pot having sandy loam soil. The experiment was laid out in Completely

Randomized Design (CRD), each treatment was replicated thrice and the crop was irrigated at regular intervals to maintain proper moisture level. The pre emergence (PEM) and post emergence mortality (POEM) was recorded up to 30 days after sowing. The statistical analysis was done using opstat [5].

The treatments detail:

T_1 = Mustard cake (MC) alone- (Soil application)

T_2 = Carbendazim 50WP alone (Seed treatment)

T_3 = *T. harzianum* (TH) alone –(Soil application)

T_4 = *G. mossease* (GM) alone – (Soil application)

T_5 = Carbendazim 50WP (Seed treatment) + MC (Soil application)

T_6 = Carbendazim 50WP (Seed treatment) + TH (Soil application)

T_7 = Carbendazim 50WP (Seed treatment) + GM (Soil application)

T_8 = MC (Soil application) + TH (Soil application)

T_9 = MC (Soil application) + GM (Soil application)

T_{10}= TH (Soil application) + GM (Soil application)

T_{11}= Carbendazim 50 WP (Seed treatment) + MC (Soil application) + GM (Soil application)

T_{12}= Carbendazim 50 WP (Seed treatment) + MC (Soil application) + TH (Soil application)

T_{13}= Carbendazim 50 WP (Seed treatment) + MC (Soil application) + TH (Soil application) + GM (Soil application)

T_{14} = Check 1 (With pathogens)

T_{15} = Check 2 (Without pathogens)

$$\text{Per cent plant mortality} = \frac{\text{Plants stand in inoculated treatment}}{\text{Plants stand in uninoculated check}} \times 100$$

3. RESULTS AND DISCUSSION

The data presented in Table 1 revealed that a significantly minimum disease incidence of 10.5 per cent was found when seeds were dressed with Carbendazim 50WP at 2g/kg seed and sown in soil incorporated with *T. harzianum* at 10g/kg soil, *G. mosseae* at 200 sporocarps/kg soil and mustard cake at 2g/kg soil as compared to disease incidence of 63.3% in check 1. In other words, it revealed that integration of treatments resulted in 83.4 per cent root rot disease complex management. It was followed by a disease incidence of 13.7 per cent when three best treatments *i.e.* Carbendazim dressed seeds at 2g/kg seed were sown in soil incorporated with *T. harzianum* at 10g/kg soil and mustard cake at 2g/kg soil were integrated and it gave 78.4 per cent disease control. The disease incidence of 16.8 per cent was noticed when the other three treatments *i.e.* Carbendazim 50WP dressed seeds at 2g/kg seed were sown in soils incorporated with *G. mosseae* at 200 sporocarps/kg soil and mustard cake at 2g/kg soil were combined together and the disease control was recorded at 73.5 per cent (Table 1, Fig. 1).

Table1. Effect of different treatments and their combinations on root rot disease complex of tomato cv. Hisar Arun (Selection 7) under screen house conditions

Treatments	*** Disease Incidence (%)**		**Total mortality (%)**	**Disease control (%)**
	[1]PEM (%)	**[2]POEM (%)**		
Mustard cake (MC) at 2g/kg soil	10.0 (18.4)	23.3 (28.8)	33.3	47.4
Carbendazim 50WP at 2g/kg seed	13.3 (21.1)	20.0 (26.6)	33.3	47.4
T. harzianum (TH) at 10g/kg soil	10.0 (18.4)	26.7 (31.0)	36.7	42.0
*G. mosseae (*GM) *at* 200 sporocarps/kg soil	13.3 (21.1)	26.7 (31.0)	40.0	36.8
Carbendazim 50WP at 2g/kg seed + MC at 2g/kg soil	06.8 (13.7)	13.3 (21.1)	20.1	68.2

Carbendazim 50WP at 2g/kg seed + TH at 10g/kg soil	06.8 (13.7)	16.7 (23.9)	23.5	62.8
Carbendazim 50WP at 2g/kg seed + GM at 200 sporocarps/kg soil	10.0 (18.4)	20.0 (26.6)	30.0	52.6
MV at 2g/kg soil + TH at 10g/kg soil	06.8 (13.7)	16.7 (23.9)	23.5	62.9
MC at 2g/kg soil + GM at 200 sporocarps/kg soil	06.8 (13.7)	20.0 (26.6)	26.8	57.7
TH at 10g/kg soil + GM *at* 200 sporocarps/kg soil	10.0 (18.4)	20.0 (26.6)	30.0	52.7
Carbendazim 50 WP at 2g/kg seed + GM at 200 sporocarps/kg soil+ MC at 2g/kg soil	06.8 (13.7)	10.0 (18.4)	16.8	73.5
Carbendazim 50 WP at 2 g/kg seed + MC at 2g/kg soil+ TH at 10g/kg soil	03.7 (08.9)	10.0 (18.4)	13.7	78.4
Carbendazim 50 WP at 2g/kg seed + MC at 2g/kg soil+TH at 10g/kg soil+ GM at 200 sporocarps/kg soil	03.7 (08.9)	(06.8) (13.7)	10.5	83.4
Check-1 (*R. solani* and *M. javanica* inoculated simultaneously)	23.3 (28.8)	40.0 (39.2)	63.3	-
Check-2 (No pathogens)	00.0 (4.05)	00.0 (4.05)	00.0	-
CD at 5%	(7.2)	(5.8)	-	-

*Average of three replications; Figures in parenthesis are angular transformed values

[1]PEM= Pre-emergence mortality, [2]POEM= Post-emergence mortality

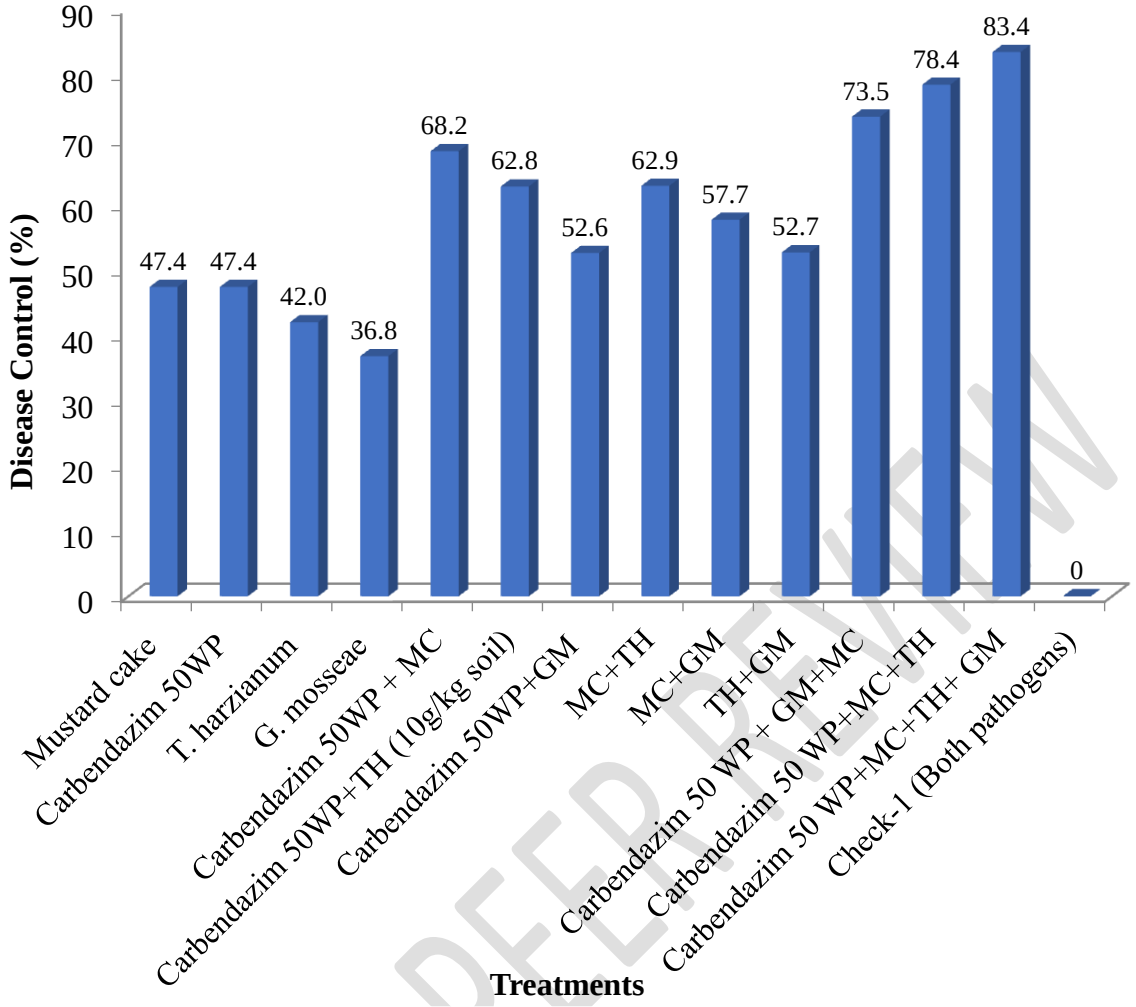

Fig. 1. Impact of different treatments and their combinations on root rot disease complex in tomato cv. Hisar Arun (Selection 7)

All the treatments significantly reduced pre and post-emergence mortality as compared to check 1. The tomato seeds dressed with Carbendazim 50WP alone provided only 47.4 per cent disease control, whereas, seeds dressed with Carbendazim 50WP and sown in mustard cake incorporated soil provided 68.2 per cent disease control. The seeds treated with Carbendazim 50WP and sown in *G. mosseae* incorporated soil provided 52.6 per cent disease control. A disease control of 57.7 per cent was recorded when soil was amended with mustard cake at 2g/kg soil and *G. mosseae* at 200 sporocarps/kg soil. The disease control of

62.9 per cent was achieved in the treatment of incorporation of mustard cake at 2g/kg soil and *T. harzianum* at 10g/kg soil. The least disease control of 36.8 per cent was noticed in the treatment when *G. mosseae* was incorporated in soil at the rate of 200 sporocarps/kg soil. The present findings are in agreement with some other workers. The integration of treatments like Carbendazim and *T. viride* significantly reduced root diseases in cotton [6]. The root rot caused by *R. solani* was also successfully managed by the integrated use of fungicides and fungal antagonists in *Gypsophila paniculata* [7]. The use of *T. harzianum* filterate and oxamyl suppressed the nematode population by 90 per cent in soybean [8]. The application of oxamyl or chicken manure with NPK, *T. harzianum* or *Bacillus thuringiensis* significantly controlled root rot disease incidence and severity by 100 per cent in eggplant [9]. Their observations directly corroborate with our study that integration of seed dressing with fungicides and soil application of biocontrol agents and/or organic amendments is a better option for soil borne root rot disease management in various field crops. In the present study, the integration of seed or soil treatments acted synergistically and provided maximum control of root rot disease complex. The soil amendments with mustard cake, *G. mosseae* and *T. harzianum* might have influenced the rhizosphere microflora of tomato plant which might have been unfavourable for infection and further development of pathogens and ultimately gave higher disease control.

4. CONCLUSION

The seed dressing with Carbendazim at 2g/kg seed, soil incorporation of *T. harzianum* at 10g/kg soil, *G. mosseae* at 200 sporocarps/kg soil and mustard cake at 2g/kg soil acted synergistically when treatments were given before sowing. The root rot disease complex of tomato cv. Hisar Arun (Selection 7) was found to be reduced from 63.3 per cent to 10.5 per cent with the integration of treatments.

DISCLAIMER

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

REFERENCES

1. Kaur C, Kapoor HC. Antioxidant activity in tomato: A function of genotype. In: Preedy VR, Watson RR, editors. Tomatoes and tomato products: nutritional, medicinal and therapeutic Properties. 6th ed. USA: Science Publishers; 2008.
2. Cavene AK, Campbell JK, Zaripheh S, Jeffery EH, Erdman JW. The tomato as a functional food. Journal of Nutrition. 2005;135(5):1226-1230.
3. Mehta N, Gupta DC. Influence of culture media on the pathogenic behavior of Rhizoctonia solani and Rhizoctonia bataticola on various host plants. Plant Disease Research. 1992;7:245-247.
4. Walia KK, Gupta DC. Interaction of Rhizoctonia solani and Meloidogyne javanica on tomato. Plant Disease Research. 1994;9:82-84.
5. https://www.hau.ac.in/page/o-p-stat.
6. Mathivanan N, Srinivasail K, Chellaiah S. Evaluation of Trichoderma viride and carbendazim for integrated management of root diseases in cotton. Indian Journal of Microbiology.1997;37:107-108.

7. Garces de GE, Orozco de AM, Sara P, Carvajal LM, Sarmiento CI. Management of Pythium sp. and Rhizoctonia solani Kuhn in rooting benches of Gypsophila paniculata L. Agronomía Colombiana.1994;11(2):158-163.
8. El-Sherif AG, Ismail AF. Integrated management of Meloidogyne incognita infecting soybean by certain organic amendments, Bacillus thuringiensis, Trichoderma harzianum and oxamyl with reference to NPK and total chlorophyll status. Plant Pathology Journal. 2009;8(4):59-164.
9. Osman HA, Ameen HH, Mohamed M, El-Mohamedy R, Elkelany US. Field control of Meloidogyne incognita and root rot disease infecting eggplant using nematicide, fertilizers and microbial agents. Egyptian Journal of Biological Pest Control. 2018;28(1):40.