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 (*Solanum 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 (*Solanum 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 protective food because it has high nutritive value and its availability round the year. India ranks second in the area as well as in production of tomato after China. It has 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, pickles, ketchup etc. Its juice and pulp is easily digestable and promote digestive secretion as well as help in blood purification. Its 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 in crop, improper and inadequate supply of nutrients and lack of adoption of new improved production technologies. It is prone to attack by several disease causing agents like fungal, bacterial, nematode and viral diseases. The root rot disease complex caused by *R. solani* and *M. javanica* is collectively an important disease complex particularly in Haryana. The crop is prone to attack from early sowing to maturity, meaning thereby that the disease can appear at any stage of crop growth from nursery beds to fields after the transplanting of seedlings. However, an early stage of crop is highly susceptible to disease complex. It has been reported to cause a loss of 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 of the plants than their individual effect. Their association takes a heavy toll and is responsible for poor stand of the crop. The *Rhizoctonia 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. 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 fungicides or nematicides. 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 towards chemicals. In addition to the target pests, they are harmful to the beneficial micro-organisms in the rhizosphere, contaminate soil, water and accumulate in plant parts. So, it was felt to explore other methods to have root rot disease 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 the most popular variety of tomato Hisar Arun (Selection 7).

The Carbendazim 50WP used as a seed dressing fungicide (2g/kg seed), mustard cake used as a soil organic amendment (2g/kg soil), *T. harzianum* used as biocontrol agent (10g/kg soil) and *G. mosseae* (200 sporocarps/kg soil) were selected to conduct the experiment and were used in different combinations as per treatments detail given below. The organic amendments and biocontrol agents were added in the soil one week before sowing and both pathogens were inoculated in sterilized soil two days before sowing in ratio of *R. solani* @ 1000 mg/kg soil and *M. javanica* @ 1000 J_2/kg soil. The Check 1 (with both pathogens) and check 2 (with no pathogens) 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) having three replications of each treatment and the crop was irrigated at regular interval to maintain proper moisture level. The pre and post emergence mortality was recorded up to 30 days after sowing. The statistical analysis was done using opstat [5].

The treatments detail:

T_1= Mustard cake alone-MC (Soil application)

T_2= Carbendazim 50WP alone (Seed treatment)

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

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

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

T_6= Carbendazim 50WP (Seed treatment) + *T. harzianum* (Soil application)

T_7= Carbendazim 50WP (Seed treatment) + *G. mosseae* (Soil application)

T_8= Mustard cake (Soil application) + *T. harzianum* (Soil application)

T_9= Mustard cake (Soil application) + *G. mosseae* (Soil application)

T_{10}= *T. harzianum* (Soil application) + *G. mosseae* (Soil application)

T_{11}= Carbendazim 50 WP (Seed treatment) + Mustard cake (Soil application) + *G. mosseae* (Soil application)

T_{12}= Carbendazim 50 WP (Seed treatment) + Mustard cake (Soil application) + *T. harzianum* (Soil application)

T_{13}= Carbendazim 50 WP (Seed treatment) + Mustard cake (Soil application) + *T. harzianum* (Soil application) + *G. mosseae* (Soil application)

T_{14}= Check 1 (With pathogens)

T_{15}= Check 2 (No pathogen)

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

3. RESULTS AND DISCUSSION

The data presented in Table 1 revealed that a significantly low disease incidence of 10.5 per cent was found when seeds were dressed with Carbendazim 50WP @ 2g/kg seed and sown in soil incorporated with *T. harzianum* (10g/kg soil), *G. mosseae* (200 sporocarps/kg soil) and mustard cake (2g/kg soil) as compared to check 1(63.3%). In other words, the treatments integration resulted in 83.4 per cent root rot disease complex management up to 30 days after sowing. It was followed by a disease incidence of 13.7 per cent when three best treatments were combined together *i.e.* Carbendazim dressed seeds (2g/kg seed) were sown in soil incorporated with *T. harzianum* (10g/kg soil) and mustard cake (2g/kg soil) revealing a total of 78.4 per cent disease control. The total disease incidence of 16.8 per cent was noticed when the other three treatments were combined together *i.e.* Carbendazim 50WP dressed seeds (2g/kg seed) were sown in soils incorporated with *G. mosseae* (200 sporocarps/kg soil) and mustard cake (2g/kg soil) and the disease control was 73.5 per cent (Table 1, Fig. 1).

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, and 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 incorporated with mustard cake (2g/kg soil) and *G. mosseae (*200 sporocarps/kg soil). The per cent disease control was 62.9 per cent in treatments of incorporation of mustard cake (2g/kg soil) and *T. harzianum* (10g/kg soil) were used. The least disease control of 36.8 per cent was observed when *G. mosseae* was incorporated in soil at the rate of 200 sporocarps/kg soil. The findings in the present study are in agreement that integration of Carbendazim and *T. viride* significantly reduced root diseases in cotton [6]. The root rot caused by *R. solani* was successfully managed by the integrated use of fungicides and fungal antagonists in *Gypsophila paniculata* [7]. The integration of *T. harzianum* filterate and oxamyl suppressed the nematode population by 90 per cent in soybean [8]. The use 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 on integration of treatments are required for the better root rot disease management in various crops and directly corroborate with our findings on root rot disease complex management in integrated way. The soil incorporation of mustard cake, *G. mosseae* and *T. harzianum* might have influenced the growth and multiplication of root rot disease complex pathogens directly or indirectly by modifying the rhizosphere environment of tomato plant making it unfavourable for the growth and multiplication of pathogens and resulted in the maximum disease control.

4. CONCLUSION

The present findings are concluded with remarks that seed dressing with Carbendazim (2g/kg seed) and soil incorporation of *T. harzianum* (10g/kg soil), *G. mosseae* (200 sporocarps/kg soil) and soil amendments with mustard cake (2g/kg soil) acted synergistically and significantly reduced the root rot complex disease of tomato cv. Hisar Arun (Selection 7) caused by concomitant occurrence of *R. solani* and *M. javanica* from 63.3 per cent to 10.5 per cent.

COMPETING INTERESTS 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.

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

Treatments	*** Percent Disease Incidence**		**Total mortality (%)**	**Disease control (%)**
	[1]PEM (%)	**[2]POEM (%)**		
Mustard cake (MC) (2g/kg soil)	10.0 (18.4)	23.3 (28.8)	33.3	47.4
Carbendazim 50WP (2g/kg seed)	13.3 (21.1)	20.0 (26.6)	33.3	47.4
T. harzianum (TH) (10g/kg soil)	10.0 (18.4)	26.7 (31.0)	36.7	42.0
G. mosseae (200 sporocarps/kg soil)	13.3 (21.1)	26.7 (31.0)	40.0	36.8
Carbendazim 50WP (2g/kg seed) + Mustard cake (2g/kg soil)	06.8 (13.7)	13.3 (21.1)	20.1	68.2
Carbendazim 50WP (2g/kg seed) + *T. harzianum* (10g/kg soil)	06.8 (13.7)	16.7 (23.9)	23.5	62.8
Carbendazim 50WP (2g/kg seed) + *G. mosseae* (200 sporocarps/kg soil)	10.0 (18.4)	20.0 (26.6)	30.0	52.6
Mustard cake (2g/kg soil) + *T. harzianum* (10g/kg soil)	06.8 (13.7)	16.7 (23.9)	23.5	62.9
Mustard cake (2g/kg soil) + *G. mosseae* (200 sporocarps/kg soil)	06.8 (13.7)	20.0 (26.6)	26.8	57.7
T. harzianum (10g/kg soil) + *G. mosseae* (200 sporocarps/kg soil	10.0 (18.4)	20.0 (26.6)	30.0	52.7
Carbendazim 50 WP (2g/kg seed) + *G. mosseae* (200 sporocarps/kg soil)+ Mustard cake (2g/kg soil)	06.8 (13.7)	10.0 (18.4)	16.8	73.5
Carbendazim 50 WP (2 g/kg seed) + Mustard cake (2g/kg soil)+ *T. harzianum* (10g/kg soil)	03.7 (08.9)	10.0 (18.4)	13.7	78.4
Carbendazim 50 WP (2g/kg seed) + Mustard cake 2g/kg soil)+*T. harzianum* (10g/kg soil)+ *G. mosseae* (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 pathogen)	00.0 (4.05)	00.0 (4.05)	00.0	-
CD at 5%	7.2	-	-	-

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

PEM= Pre-emergence mortality, POEM= Post-emergence mortality

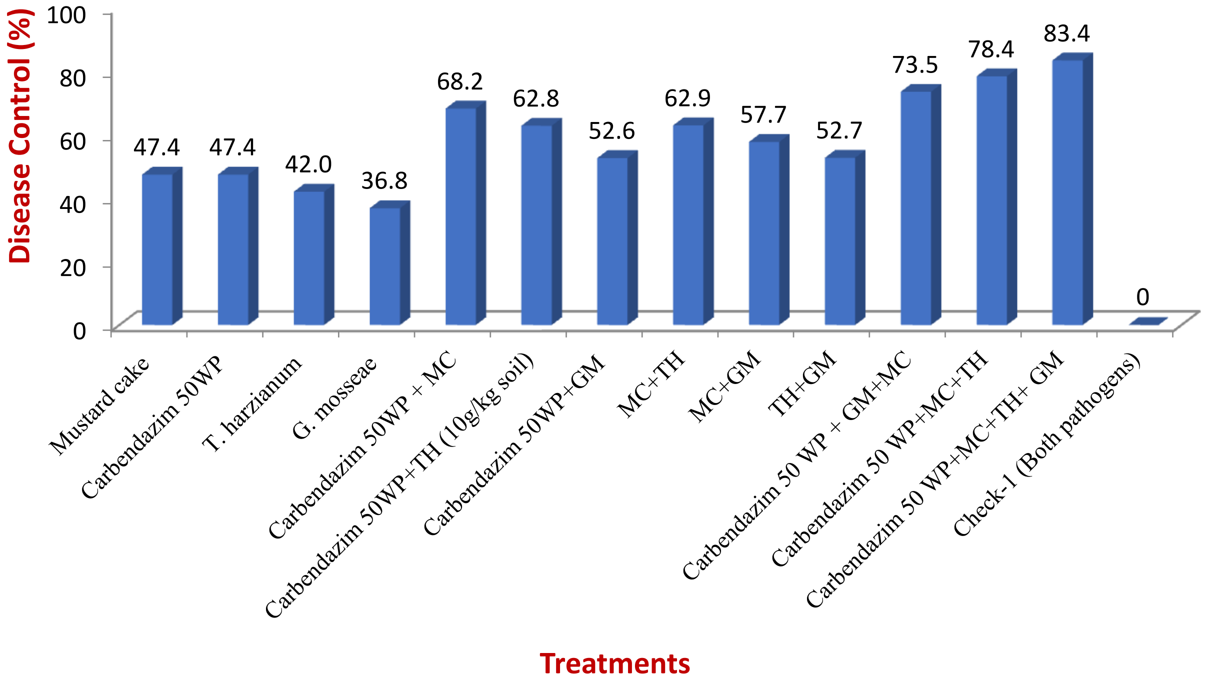

Fig. 1. The effect of different treatments and their combinations on per cent root rot disease complex control in tomato cv. Hisar Arun (Selection 7)