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# Refinement of Technology for the Management of Collar Rot in Apple

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**A B S T R A C T**

Collar rot in apple caused by *Phytophthora cactorum* is a major threat to the successful cultivation of crop. The incidence of disease is 13.27 per cent in Shimla and 8.31 per cent in Kinnaur districts of Himachal Pradesh. On farm trials for two consecutive years were conducted to assess and refine the existing technology for the management of the disease by integrating agrochemicals with *Trichoderma viride* which included three drenchings in rainy season with following treatments $T_1$ [metalaxyl (8%) + mancozeb (64%) @0.5%], $T_2$ [mancozeb (75%) @ 0.5%], $T_3$ [*Trichoderma viride* @0.5%], $T_4$ [one drenching with metalaxyl (8%) + mancozeb (64%) @0.5% followed by two drenchings with *Trichoderma viride* @0.5%], $T_5$ [one drenching with mancozeb (75%) @ 0.5% followed by two drenchings with *Trichoderma viride* @0.5%] and $T_6$ [Control/farmers' practice]. Beside fungicide drenching, cultural practices were improved i.e. improvement in water drainage system in tree basin, opening of collar region of affected plant and removal of infected portion of roots with application of Chaubatia paste on open cuts. Among all the treatments, maximum percent lesion healing i.e. 37.65 per cent and 33.80 per cent in 1st year of treatment, 60.77 per cent and 55.60 per cent healing in second year of treatment was observed in plants drenched with $T_4$ [one drenching with metalaxyl (8%) + mancozeb (64%) @0.5% followed by two drenchings with *Trichoderma viride* @0.5%] in Kinnaur and Shimla districts, respectively.

## Introduction

In Himachal Pradesh apple is being cultivated over 1,11,896 ha with annual production of 4,68,134 MT (Anoymous, 2017). Though, cultivation of apple has revolutionized the socio-economic status of Himachal Pradesh farmers, yet the productivity of apple is 4.18 MT/ha (Anonymous, 2017) which is relatively very low in comparison to global productivity of 16.88 MT/ha (FAO, 2016). Different factors are responsible for low productivity of apple among these diseases play an important role. Apple crop falls prey to wide range of fungal, bacterial and viral pathogens, where collar rot of apple caused by *Phytophthora cactorum* is one of the most important soil borne diseases following white root rot of apple (Gupta *et al.*, 2004). In India, collar rot was first reported from Himachal Pradesh in

1960 (Anonymous, 1961) and is well established that collar rot disease of pome and stone fruit trees including apple was primarily caused by *Phytophthora cactorum* (Utkhede, 1986). The incidence of disease was up to 48 per cent in the orchards of Shimla and Kinnaur districts of Himachal Pradesh. Keeping in view the aforesaid information a survey was conducted in two districts and refinement of existing technology was carried out through on farm testing.

## Materials and Methods

A survey was conducted in different locations of Kinnaur and Shimla districts to record incidence of collar rot and orchards were selected to conduct location specific trials in both the districts. The disease incidence was recorded by randomly selecting about 50 plants in an orchard and using the following formula

$$\text{Disease incidence (\%)} = \frac{\text{No. of plants showing collar rot symtoms}}{\text{Total number of plants observed}} \times 100$$

To manage the disease, factors *viz.* heavy soils, faulty basin preparation and Northern aspect that are representing the specific microclimatic conditions were considered. To create awareness among farmers about proper management practices as basin preparation *viz.* improving water drainage, avoidance of flood irrigation and orchard floor management; training programmes were organized in the surveyed areas of the districts. Method demonstrations on the basin management were given to the farmers to avoid moisture retention in collar region and improving moisture maintenance in feeding zone. Floor management by manual weeding in basin area of the tree from time to time (May-August) was also demonstrated, that helped in reducing the humidity in collar region and improving the aeration in the orchard.

Keeping in view the losses resulted due to the disease, on farm trials (OFTs) at five locations in Kinnaur district (two each in Kalpa and Nichar blocks, one in Pooh block), and Shimla district (Two in Chirgaon, one each at Rohru, Jubbal and Kotkhai) were conducted to assess and refine the existing technology for management of the disease by integrating agrochemicals with *Trichoderma viride* which included three drenchings in rainy season in two consecutive years with following treatments $T_1$ [metalaxyl (8%) + mancozeb (64%) @0.5%], $T_2$ [mancozeb (75%) @ 0.5%], $T_3$ [*Trichoderma viride* @0.5%], $T_4$ [one drenching with metalaxyl (8%) + mancozeb (64%) @0.5% followed by two drenchings with *Trichoderma viride* @0.5%], $T_5$ [one drenching with mancozeb (75%) @ 0.5% followed by two drenchings with *Trichoderma viride* @0.5%] and $T_6$ [Control/farmers' practice] during 2010-11 and 2011-12 in farmers' field.

Data obtained were subjected to analysis by following Gomez and Gomez (1984). Least significant difference (LSD) at 5 per cent level was calculated.

## Results and Discussion

A perusal of the data presented in Table 1 revealed that the disease was prevalent in all surveyed blocks of both the districts. Disease incidence ranged between 0.0 to 48.0 per cent in two districts. Maximum disease incidence (48.0%) was recorded at Rangori village of Rampur Bushehr block followed by Mauli (46.0%) in Jubbal and Kotkhai of Shimla district. However, minimum disease incidence (0.0%) was recorded in Peja (Chirgaon), Kandyali and Jar (Narkanda), and Rushkalang and Dubling (Pooh). Among blocks, the highest disease incidence was recorded in Jubbal and Kotkhai (31.20 %) followed by Rampur Bushehr (28.0%) whereas the least incidence was recorded in Pooh (3.3%).

**Table.1** Prevalence of collar rot of apple in Shimla and Kinnaur districts of Himachal Pradesh

| S. No. | Shimla District | Disease Incidence (%) | S. No. | Kinnaur District | Disease Incidence (%) |
|---|---|---|---|---|---|
| | **Jubbal and Kotkhai** | | | **Nichar** | |
| 1. | Mauli | 46.0 | 35. | Bari | 20.0 |
| 2. | Graug | 20.0 | 36. | Sungra | 8.0 |
| 3. | Kharapathar | 30.0 | 37. | Puje | 16.0 |
| 4. | Shari | 32.0 | 38. | Katgaon | 10.0 |
| 5. | Ruhil Dhar | 28.0 | 39. | Kafnu | 4.0 |
| | **Mean** | **31.20** | | **Mean** | **11.6** |
| | **Chirgaon** | | | **Kalpa** | |
| 6. | Peja | 0.0 | 40. | Powari | 12.0 |
| 7. | Sandhasu | 10.0 | 41. | Reckong Peo | 4.0 |
| 8. | Devidhar | 8.0 | 42. | Telangi | 6.0 |
| 9. | Masali | 6.0 | 43. | Pangi | 8.0 |
| 10. | Jara | 4.0 | 44. | Roghi | 20.0 |
| | **Mean** | **5.60** | | **Mean** | **10.0** |
| | **Rohru** | | | **Pooh** | |
| 11. | Kasaini | 20.0 | 45. | Skiba | 10.0 |
| 12. | Barasali | 10.0 | 46. | Rispa | 4.0 |
| 13. | Summer Kot | 2.0 | 47. | Rushkalang | 0.0 |
| 14. | Bhaloon Kainchi | 10.0 | 48. | Pooh | 2.0 |
| 15. | Anu Basa | 6.0 | 49. | Rarang | 4.0 |
| | **Mean** | **9.6** | 50. | Dubling | 0.0 |
| | **Chopal** | | | **Mean** | **3.3** |
| 16. | Maraug | 20.0 | | **Mean Kinnaur** | **8.31** |
| 17. | Gorli | 30.0 | | | |
| 18. | Chopal | 24.0 | | | |
| 19. | Nerva | 12.0 | | | |
| 20. | Kedi | 6.0 | | | |
| | **Mean** | **18.4** | | | |
| | **Theog** | | | | |
| 21. | Sandhu | 6.0 | | | |
| 22. | Matyana | 16.0 | | | |
| 23. | Guthan | 20.0 | | | |
| 24. | Kaleend | 12.0 | | | |
| | **Mean** | **13.5** | | | |
| | **Narkanda** | | | | |
| 25. | Kandyali | 0.0 | | | |
| 26. | Ekantbari | 2.0 | | | |
| 27. | Mohen | 4.0 | | | |
| 28. | Jar | 0.0 | | | |
| | **Mean** | **1.5** | | | |
| | **Nankhari** | | | | |
| 29. | Delath | 10.0 | | | |
| 30. | Kandreri | 30.0 | | | |
| 31. | Surad Bangla | 2.0 | | | |
| | **Mean** | **14.0** | | | |
| | **Rampur Bushehr** | | | | |
| 32. | Gopalpur | 24.0 | | | |
| 33. | Sarahan | 12.0 | | | |
| 34. | Rangori | 48.0 | | | |
| | **Mean** | **28.0** | | | |
| | **Mean Shimla** | **13.27** | | | |

**Table.2** Individual and combined effects of agrochemicals with *Trichoderma viride* on the management of collar rot of apple in Kinnaur district

| Treatment | Percent healing of lesion* | |
|---|---|---|
| | Year I | Year II |
| $T_1$ [metalaxyl (8%) + mancozeb (64%) @0.5%] | 36.26 (37.01) | 58.69 (49.99) |
| $T_2$ [mancozeb (75%) @ 0.5%] | 32.61 (34.81) | 48.81 (43.73) |
| $T_3$ [*Trichoderma viride* @0.5%] | 28.44 (32.21) | 46.23 (42.82) |
| $T_4$ [One drenching with metalaxyl (8%) + mancozeb (64%) @0.5% followed by two drenchings with *Trichoderma viride* @0.5%] | 37.65 (37.83) | 60.77 (51.20) |
| $T_5$ [one drenching with mancozeb (75%) @ 0.5% followed by two drenchings with *Trichoderma viride* @0.5%] | 31.20 (33.95) | 52.69 (46.53) |
| $T_6$ [Control/farmers' practice] | 0.00 (0.00) | 0.00 (0.00) |
| $LSD_{0.05}$ | (1.53) | (2.09) |

Figures in parentheses are angular transformations
* Pooled data for five locations

**Table.3** Individual and combined effects of agrochemicals on management of collar rot of apple in Shimla district

| Treatment | Percent healing of lesion* | |
|---|---|---|
| | Year I | Year II |
| $T_1$ [metalaxyl (8%) + mancozeb (64%) @0.5%] | 33.20 (35.14) | 53.00 (46.71) |
| $T_2$ [mancozeb (75%) @ 0.5%] | 29.20 (32.68) | 45.20 (42.22) |
| $T_3$ [*Trichoderma viride* @0.5%] | 28.60 (32.28) | 45.80 (42.57) |
| $T_4$ [One drenching with metalaxyl (8%) + mancozeb (64%) @0.5% followed by two drenchings with *Trichoderma viride* @0.5%] | 33.80 (35.51) | 55.60 (48.24) |
| $T_5$ [one drenching with mancozeb (75%) @ 0.5% followed by two drenchings with *Trichoderma viride* @0.5%] | 29.60 (32.86) | 47.20 (43.38) |
| $T_6$ [Control/farmers' practice] | 0.00 | 0.00 |
| $LSD_{0.05}$ | (2.27) | (3.48) |

Figures in parentheses are angular transformations
* Pooled data for five locations

Comparison of two districts revealed that Shimla district had higher incidence (13.27%) than Kinnaur district (8.31%). High disease incidence in Shimla and low in Kinnaur was due to wet and dry temperate conditions prevailing during peak periods of incidence (July-September), respectively. Similar observations were recorded by Gupta *et al.*, (2004).

The data obtained from on farm trials conducted in five locations of Kinnaur district was pooled and presented in the Table 2. It is evident from the data (Table 2) that $T_4$ [One drenching with metalaxyl (8%) + mancozeb (64%) @0.5% followed by two drenching with *Trichoderma viride* @0.5%] showed maximum per cent healing of the lesion (60.77 %) after second year of progress which was statistically at par (58.69%) with $T_1$ [metalaxyl (8%) + mancozeb (64%) @0.5%] while minimum per cent healing (28.44% in 1st year and 46.23% in second year) was observed in $T_3$.

The data obtained from the on farm trials conducted in Shimla district are pooled and presented in Table 3. Perusal of the data (Table 3) revealed that $T_4$ [One drenching with metalaxyl (8%) + mancozeb (64%)

@0.5% followed by two drenching with *Trichoderma viride* @0.5%] has shown maximum percent healing of the lesion (55.60 %) after second year of progress, this was statistically at par with (53.00%) by $T_1$ [metalaxyl (8%) + mancozeb (64%) @0.5%]. While minimum per cent healing (28.60% in first year 45.80 % in second year) was observed in $T_3$ and $T_2$ (29.20% in first year and 45.20% in second year) which were statistically at par with each other.

Earlier studies indicated that biological control agents are effective in the management of soil borne diseases (Chet, 1987; Bhardwaj and Kumar, 2002) for their ability of mycoparasitism, mycolysis, direct and indirect toxic effects (Ajitha and Lakshmidevi, 2010). Studies have indicated that the fungi not only act as biocontrol agents, but also stimulate plant resistance, plant growth and development resulting in an increase in crop production (Laila Naher 2014; Bastakoti *et al.,* 2017). The biocontrol activity involving mycoparasitism, antibiotics and competition for nutrients, also induces defense responses or systemic resistance responses in plants. These responses are an important part of Trichoderma in biocontrol program. Currently, Trichoderma spp., is being used to control plant diseases in sustainable diseases management systems. The integration of biocontrol agents with agro-chemicals enhances sustainability of the treatment and thus the healing of the plants. Total control of collar rot was obtained under pot culture conditions when application was done 7 days prior to inoculation with pathogen (Sharma *et al.,* 2014).

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