Plant Archives Vol. 25, No. 1, 2025 pp. 1715-1718 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.1.248

EFFICACY OF *BACILLUS SUBTILIS* BASED BIO FUNGICIDES (TAEGRO) AGAINST DOWNY MILDEW (*PLASMOPARA VITICOLA* (BERK.AND CURT.) BERL & DE TONY) DISEASE OF GRAPES

Ramesh[1*], Manjunath Hubballi[2] and Raghavendra Achari[3]

[1]Main Horticulture Research and Extension Centre, U.H.S., Bagalkot -587 104, Karnataka, India

[2]Directorate of Research, U.H.S., Bagalkot- 587104, Karnataka, India

[3]College of Horticulture, Munirabad – 583 233, Karnataka, India

*Corresponding author E-mail : ramesh3963@gmail.com

(Date of Receiving-23-02-2025; Date of Acceptance-25-04-2025)

ABSTRACT

A field study was conducted at Horticulture Research and Extension Station, Vijayapur (Tidagundi) on the management of downy mildew disease of grapes using alone or alternative sprays of bio fungicide *Bacillus subtilis* (Taegro) and Metalaxyl 8%+ Mancozeb 68% WP at different concentrations. Alone spray of Metalaxyl 8%+ Mancozeb 68% WP (2.5g/liter) recorded lowest disease incidence and highest marketable fruit yield per plant and per hector. The next best treatment was first seven sprays of Metalaxyl 8%+ Mancozeb 68% WP (2.5g/liter) followed by three sprays of *Bacillus subtilis* bio fungicide (Taegro) (0.370 g/liter). Integration of low-risk fungicide along with bio fungicide will reduce downy mildew disease, input cost and increase in quality of grapes. Alone spray of *Bacillus subtilis* based bio fungicides (Taegro) at different concentration were not so effective, but it was effective when used in integration with any of the low-risk fungicide.

Key words: Downy mildew, Metalaxyl 8%+ Mancozeb 68% WP, *Bacillus subtilis*, Grapes

Introduction

Grape (*Vitis vinifera* L.) is one among the most delicious, refreshing and nourishing fruits of the world andit is one of the earliest fruits grown by man. Grape was originated in Armenia near the Caspian Sea in Russia, from where it spread westward to Europe and eastward to Iran and Afghanistan. Grape was introduced in India in 1300 AD by invaders from Iran and Afghanistan.The Introduction of grapes into South India seems to have yet another course. The grape was introduced at Melapatti, a village near Krishnagiri in Salem district of Tamilnadu by a French priest in 1832. A little later, a French Jesuit priest to Fr.Larney at Michel Patti village in Madurai district introduced it in 19th century and it was introduced in Karnataka during the same period.It is a temperate crop which has got adapted to sub-tropical climate of peninsular India.Famous Indian medicine scholars, Sasruta and Charaka during 1356-1220 BC mentioned the medicinal properties of grapes in their book *'Sasruta Samhita'* and *'Charaka Samhita'*. Kautilya in his *'Arthashastra'* written about type of land suitable for grape cultivation. The berries are a good source of sugars and minerals like Ca, Mg, Fe and vitamins like B1, B2 and C. The major grape-growing states of India are Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu.Approximately 71% of the world?s harvest is processed into wine, 27% is consumed fresh and 2% is dried for raisins. However, in India, 90% of the grape is used for table purpose, even though wine making has made strides. The rest of the grape is used mostly for raisin.

Now days the major Constance in grape production is biotic stress. Among the biotic stress downy mildew is major and it was caused by obligate fungal pathogen *Plasmopara viticola* (Berk.and Curt.) Berl & de Tony.The disease occurs on flower buds, young shoots,

leaves and berries during wet and warm weather (Sawant and Sawant, 2012). During fruiting season, crop losses can range from 30 per cent to cent per cent, if rainfall occurs during early growth to fruit set stages. Infections on clusters can also occur in absence of rain if dew is formed at night (Sawant *et al*., 2010).Many fungicides are available for management of disease but it is increase cost inputs and affect berry quality. Hence, to reduce the cost inputs and eco-friendly managements of disease, the bio-fungicides can be included in integrated disease management.

Material and Methods

An experiment was conducted three years old vein orchard at Horticulture Research and Extension Station, Vijayapur (Tidagundi) to study the bio-efficacy of *Bacillus subtilis* based bio fungicides (Taegro) against downy mildew diseases of grapes. It was conducted in randomized block design with ten treatments (consisting of alone or alternative sprays of *Bacillus subtilis* bio fungicides/Metalaxyl 8%+ Mancozeb 68% WP ten spray at weekly interval) with three replications during 2016-17. The veins were supplied with organic fertilizer in the form of vermin-compost and inorganic chemical fertilizer as per recommendation mentioned in package of practices for Horticultural crops, UHS, Bagalkot. Three rows for each replication with five plants in a row were selected. The three plants in middle row excluding the terminal vines on each side were selected for the recording observation. The treatments were initiated at the first disease appearance stage (DAS) of downy mildew disease. The required quantity of fungicide/bio-agent as per treatments were measured out/weighed with measuring cylinder/balance and suitable dissolved in a requisite quantity of water to obtain spray solution of desired concentrations. Observations were recorded at before first spray and later at 5 days after 4rd,7th and 10th spray. The disease incidence on leaves and bunches were recorded by using 0-4 scale (Horsfall and Heuberger, 1942: Horsfall and Barratt, 1986).

Disease rating/ Grade	Per cent area (leaves/ bunch) covered/infected
0	No disease/ infection
1	<25% area covered/infected
2	26-50% area covered/infected
3	51-75% area covered/infected
4	>75% area covered/infected

Further, the scored data were converted into Per cent Disease Index (PDI) of plants using formula given by McKinney (1923).

$$\text{Per cent Disease Index (PDI)} = \frac{\text{Sum of numerical rating}}{\text{Number of bunches or leaves observed}} \times \frac{100}{\text{Max. rating}}$$

The data was suitably transformed and analyzed statistically. The marketable fruit yield in terms of kilograms per vine and later converted to tonner per hectare and analyzed statistically.

Results and Discussion

The bio-efficacy of *Bacillus subtilis* based bio fungicides (Taegro) on downy mildew and fruit yield of grapes presented in tables 1

The bio-efficacy of *Bacillus subtilis* based bio fungicides (Taegro) on downy mildew disease of grapes

Alone ten sprays at weekly interval of Metalaxyl 8%+ Mancozeb 68% WP 2.5 g/liter reduced the progress of downy mildew disease by 90.03% and PDI of 1.61per cent which statistically on par with First seven sprays of Metalaxyl 8%+ Mancozeb 68% WP 2.5 g/liter followed by three sprays of *Bacillus subtilis* based bio fungicides (Taegro) @ 0.370g/liter (1.61 PDI and 90.03% disease reduction over control).however, the treatment First seven sprays of Metalaxyl 8%+ Mancozeb 68% WP 2.5 g/liter followed by three sprays of *Bacillus subtilis* based bio fungicides (Taegro) @ 0.370g/liter statistically superior over alone seven sprays of Metalaxyl 8%+ Mancozeb 68% WP 2.5 g/liter (3.19 PDI). *Bacillus subtilis* based bio fungicides (Taegro) @ 0.370g/liter when applied total six sprays at weekly interval alternated with Metalaxyl 8%+ Mancozeb 68% WP 2.5 g/liter recorded PDI of 4.13 and 80.62per cent reduction over control which was significantly superior over the treatment Metalaxyl 8%+ Mancozeb 68% WP 2.5 g/liter alone sprayed at every fortnight (5.17 PDI and 67.99 % disease reduction over control).Alone sprays of *Bacillus subtilis* based bio fungicides (Taegro) @ 0.185, 0.370 and 0.50 g/liter when applied as ten weekly sprays reduced the progress of downy mildew disease by 32.69%, 40.74% and 45.08% with PDI of 10.87, 9.57 and 8.87 respectively when compared to untreated control (16.15 PDI) at five days after 10th spray.

Yield

Alone ten sprays of Metalaxyl 8%+ Mancozeb 68% WP 2.5 g/literrecorded highest yield of 13.25 tons/ha which was significantly on par withfirst seven sprays of Metalaxyl 8%+ Mancozeb 68% WP 2.5 g/liter followed by four sprays of *Bacillus subtilis* based bio fungicides (Taegro) @ 0.370g/liter (11.90 tons/ha). however, the treatment first seven sprays of Metalaxyl 8%+ Mancozeb 68% WP 2.5 g/liter followed by four sprays of *Bacillus*

Table 1: Bio-efficacy of *Bacillus subtilis* based bio-fungicide (*Taegro*) against downy mildew disease of Grapes (2016-17)

Tr. No.	Treatments	Formulation/dosage	Weekly application sequence	Downy mildew Disease (PDI)				% Reduction over control after 10th spray	Productivity (marketable fruit yield)		Increase in productivity (times than control)
				Before first spray	5 days after 4th spray	5 days after 7th spray	5 days after 8th spray		kg/plant	tons/ha	
1	Control	--	--	2.44 (8.99)*	14.92 (22.72)	15.83 (23.45)	16.15 (23.70)	----	1.28	2.02 (8.17)	---
2	Metalaxyl 8%+ Mancozeb 68%	2.50 g/l	ABCDEFGH IJ	2.44 (8.99)	8.58 (17.03)	5.87 (14.02)	1.61 (7.29)	90.03	6.23	13.25 (21.35)	6.56
3	*Bacillus subtilis* (commercial formulation)	2.00 ml/l	ABCDEFGH IJ	2.44 (8.99)	13.86 (21.87)	12.93 (21.07)	11.98 (20.25)	25.82	2.04	4.14 (11.74)	2.04
4	*Taegro*	0.185 g/l	ABCDEFGH IJ	2.44 (8.99)	13.68 (21.70)	11.26 (19.61)	10.87 (19.25)	32.69	1.86	4.96 (12.87)	2.46
5	*Taegro*	0.370 g/l	ABCDEFGH IJ	2.44 (8.99)	12.50 (20.70)	9.87 (18.31)	9.57 (18.02)	40.74	3.32	6.12 (14.32)	3.03
6	*Taegro*	0.500 g/l	ABCDEFGH IJ	2.44 (8.99)	11.31 (19.65)	9.43 (17.88)	8.87 (17.33)	45.08	3.32	7.72 (16.13)	3.82
7	Metalaxyl 8%+ Mancozeb 68% *Taegro*	2.50 g/l 0.370 g/l	ABCDEFG HIJ	2.44 (8.99)	8.60 (17.05)	5.46 (13.51)	1.61 (7.29)	90.03	6.17	11.90 (19.92)	5.69
8	Metalaxyl 8%+ Mancozeb 68%	2.50 g/l	ABCDEFG	2.44 (8.99)	9.54 (17.99)	5.46 (13.51)	3.19 (10.29)	80.25	6.11	10.55 (18.96)	5.17
9	Metalaxyl 8%+ Mancozeb 68% *Taegro*	2.50 g/l 0.370 g/l	ACEG BDFGHIJ	2.44 (8.99)	8.46 (16.90)	6.96 (15.30)	4.13 (11.73)	80.62	3.47	8.86 (17.31)	4.39
10	Metalaxyl 8%+ Mancozeb 68%	2.50 g/l	ACEG	2.44 (8.99)	8.66 (17.11)	12.07 (20.33)	5.17 (13.14)	67.99	3.32	7.58 (15.98)	3.75
			SEM±	**NS**	**0.12**	**0.13**	**0.14**			**0.47**	
			CD@5%	**NS**	**0.35**	**0.38**	**0.42**			**1.40**	
			CV%	**NS**	**1.83**	**2.44**	**4.69**			**25.55**	

* Figures in parenthesis are angular transformed value

subtilis based bio fungicides (Taegro) @ 0.370g/liter was statistically superior over seven sprays of Metalaxyl 8%+ Mancozeb 68% WP 2.5 g/liter (10.45 tons/ha). Alone sprays of *Bacillus subtilis* based bio fungicides (Taegro) @ 0.185, 0.370 and 0.50 g/liter recorded yield of 4.96, 6.12 and 7.72 tons/ha respectivelyand the yields in these treatments were found from 2.04, 3.03 and 3.82 times more than the untreated control. Increasing yield over untreated control was achived 6.56, 5.69 and 5.17 times in treatments ten sprays of Metalaxyl 8%+ Mancozeb 68% WP 2.5 g/liter, seven sprays of Metalaxyl 8%+ Mancozeb 68% WP 2.5 g/liter followed by three sprays of *Bacillus subtilis* based bio fungicides (Taegro) @ 0.370g/liter and seven sprays of Metalaxyl 8%+ Mancozeb 68% WP 2.5 g/liter.

This is in agreement with the findings of Mahesh R. Ghule and Indu S. Sawant (2017), reported that *Fusarium pseudonygamai* (MCC 1346) bio-agent was found highly effective in downy mildew disease management. It produces glucanase enzyme as result reducing sporangial production and also gave better disease control on both leaves and bunch under field condition.Pre-harvest foliar applications with *T. asperelloides* strain 5R (earlier reported as *T. harzianum*) manage many post-harvestdisease and also enhance shelf life of grapes (Sawant and Sawant, 2010).Mahesh *et al.*(2018)Achieved best disease management and higher yield of grapes by integrating soil application ofmicroorganisms (*Bacillus* TS-45, *Bacillus* DR-92, *T. asperelloides* (NAIMCC-F- 01812) and *T. asperelloides* strain 5R) with foliar applications of APSP and chitosan along with need based application of low risk fungicides.

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