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Evaluation of Bio-efficacy of *Bacillus subtilis* Based Bio-fungicide (*Taegro*) Against Powdery Mildew Disease of Grapes

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Abstract

Grape (*Vitis vinifera* L.) is an important cash crop in India and powdery mildew is a major biotic disease which causes severe loss in yield and quality of grapes. An field experiments was conducted during the fruiting season of October–March 2016-17 to study the efficacy of *Bacillus subtilis* based bio fungicides (Taegro) against powdery mildew diseases of grapes. Alone eight sprays of triadimefon 75% WP at 1g/liter recorded lowest powdery mildew disease 7.47 PDI. First five sprays of triadimefon 75% WP at 1g/liter followed by three sprays of *Bacillus subtilis* based bio fungicides (Taegro) at 0.370g/liter and alone first five sprays of Triadimefon 75% WP at 1g/liter reduced the PDI of 11.43 and 12.27 respectively. Alone eight sprays of *Bacillus subtilis* based bio fungicides (Taegro) at 0.185, 0.370 and 0.50 g/liter recorded the PDI of 25.03, 22.93 and 22.43 respectively. Under low to moderate disease pressure conditions, the efficacy of Triadimefon 75% WP at 1g/liter and *Bacillus subtilis* based bio fungicides (Taegro) at 0.370g/liter in controlling powdery mildew was on par with alone spray of Triadimefon 75% WP at 1g/liter. The management of powdery mildew disease by using fungicides which increases the input cost and affect berry quality. Under high disease pressure condition, *Bacillus subtilis* based bio fungicides (Taegro) were not so effective when used alone, but was effective when used in integration with fungicide sprays.

Keywords: Grapes, *Bacillus subtilis;* Triadimefon 75% WP; Powdery Mildew

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Introduction

Grape (*Vitis vinifera* L.) is one of the finest fruits and the healthiest food and it is considered one of the most popular and common fruits in the world. Taxonomically, grapes belong to the family Vitaceae which is classified into two sub-genera, Euvitis (2n=38) Planch and Muscadinia (2n=40) Planch [1]. Most cultivated grape varieties belong to *Vitis vinifera* L., which originated in Eurasia and spread by man all the way through the world. Grapes fruits are rich source of minerals like calcium and iron and vitamins A, C and B1 and B2 that can contribute to a balanced healthy life. In addition, it has commendable medicinal qualities and has been used in naturotheropy for centuries. The flavonoids present in grapes act as antioxidants and reduce the damage caused by full radicals. Due to its medicinal properties, grape juice is popularly known as 'nectar of the gods'. The grape was introduced to India in 1300 AD by Muslim invaders from Iran and Afghanistan [2]. Grapevine is grown in over 80 countries across 7.2 million hectares, producing approximately 74.7 million tons annually [3]. In India, grape is cultivated on about 1.58 lakh hectares, with an annual production of 3.4 million tons and a productivity of 21.5 tones/ha [4].

The major threat in grape production is powdery mildew (*Erysiphe necator* Schw) disease and it affects all green succulent tissues. The disease is quite severe in India and foliar infections reduce the photosynthetic activity of grapevines [5], while fruit infections impair wine characteristics or reduce the yield and market value of table grapes [6]. Infections on the pedicle lead to shriveling of the clusters during storage reducing the shelf life [7]. The disease is favored by warm, humid and cloudy weather [8].

Material and Methods

A field 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 powdery 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/triadimefon 75% WP) with three replications at sprayed weekly interval 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 powdery 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 required quantity of water to obtain spray solution of desired concentrations. Observations were recorded at before first spray and later at 5 days after 3rd, 5th and 8th spray. The disease incidence on leaves and bunches were recorded by using 0-4 scale [9].

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

Figure 1

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

Tr.No.	Treatments	Formulation/dosage	Weekly application sequence	Powdery mildew Disease (PDI)				% Reduction over control after 8th spray	Productivity (markatable fruit yield)		Increase in productivity (times than control)
				Before first spray	5 days after 3rd spray	5 days after 5th spray	5 days after 8th spray		kg/plant	t/ha	
1	Control	--	--	2.23(8.59)*	19.57(26.26)	25.40(30.26)	33.97(35.65)		0.89	2.02(8.17)	---
2	Triadimefon 75% WP	1.00 g/l	ABCDEFGH	2.23(8.59)	8.07(16.50)	9.13(17.58)	7.47(15.86)	78.01	5.24	13.25(21.35)	6.56
3	*Bacillus subtilis* (commercial formulation)	2.00 ml/l	ABCDEFGH	2.23(8.59)	15.20(22.95)	23.37(28.90)	28.47(32.25)	16.19	1.62	4.14(11.74)	2.04
4	*Taegro*	0.185 g/l	ABCDEFGH	2.23(8.59)	14.80(22.63)	15.67(23.32)	25.03(30.02)	26.32	1.45	4.96(12.87)	2.46
5	*Taegro*	0.370 g/l	ABCDEFGH	2.23(8.59)	13.53(21.58)	14.50(22.38)	22.93(28.61)	32.50	2.99	6.12(14.32)	3.03
6	*Taegro*	0.500 g/l	ABCDEFGH	2.23(8.59)	11.97(20.24)	12.80(20.96)	22.43(28.26)	33.97	3.10	7.72(16.13)	3.82
7	Triadimefon 75% WP *Taegro*	1.00 g/l0.370 g/l	ABCDEFGH	2.23(8.59)	8.50(16.95)	10.43(18.84)	11.43(19.76)	66.35	5.56	11.90(19.99)	5.69
8	Triadimefon 75% WP	1.00 g/l	ABCDE	2.23(8.59)	8.50(16.95)	10.43(18.84)	12.27(20.50)	63.88	5.41	10.55(18.96)	5.17
9	Triadimefon 75% WP *Taegro*	1.00 g/l0.370 g/l	ACEBDFGH	2.23(8.59)	8.27(16.71)	11.63(19.93)	17.67(24.86)	47.98	3.42	8.86(17.31)	4.39
10	Triadimefon 75% WP	1.00 g/l	ACE	2.23(8.59)	8.27(16.71)	13.37(21.45)	19.47(26.18)	42.68	3.29	7.58(15.98)	3.75
	SEM±			**NS**	**0.24**	**0.38**	**0.51**			**0.47**	
	CDat5%			**NS**	**0.70**	**1.14**	**1.53**			**1.40**	
	CV%			**NS**	**3.54**	**4.51**	**4.42**			**25.55**	

* Figures in parenthesis are angular transformed value

Further, the scored data were converted into Per cent Disease Index (PDI) of plants using formula given by [10].

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

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

Alone sprays of *Bacillus subtilis* based bio fungicides (Taegro) at 0.185, 0.370 and 0.50 g/liter when applied as eight weekly sprays reduced the progress of powdery mildew disease by 26.32%, 32.50% and 33.97% with a PDI of 25.03, 22.93 and 22.43 respectively when compared to untreated control (33.97 PDI) at five days after 8th spray. Alone eight sprays of triadimefon 75% WP at 1g/liter reduced the progress of powdery mildew disease by 78.01% with a PDI of 7.47 per cent. First five sprays of triadimefon 75% WP at 1g/liter followed by three sprays of *Bacillus subtilis* based bio fungicides (Taegro) at 0.370g/liter and alone first five sprays of triadimefon 75% WP at 1g/liter reduced the progress of powdery mildew disease by 66.35% and 63.88% with a PDI of 11.43 and 12.27 respectively. Both these two treatments were statistically on par with each other (table

1).

Alone eight sprays of triadimefon 75% WP at 1g/liter recorded highest productivity of 13.25 tons/ha which was on par with treatment first five sprays of triadimefon 75% WP at 1g/liter followed by three sprays of *Bacillus subtilis* based bio fungicides (Taegro) at 0.370g/liter (11.90 tons/ha). However, the treatment triadimefon 75% WP at 1g/liter followed by three sprays of *Bacillus subtilis* based bio fungicides (Taegro) at 0.370g/liter was statistically on par with five sprays of triadimefon 75% WP at 1g/liter (10.55 tons/ha). Alone eight sprays of *Bacillus subtilis* based bio fungicides (Taegro) at 0.185, 0.370 and 0.50 g/liter concentration recorded productivity of 4.96, 6.12 and 7.72 tons/ha respectively. The yields in these treatments were increased 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 Alone eight sprays of triadimefon 75% WP at 1g/liter, five sprays of triadimefon 75% WP at 1g/liter followed by three sprays of *Bacillus subtilis* based bio fungicides (Taegro) at 0.370g/liter and alone five sprays of triadimefon 75% WP at 1g/liter respectively (Table 1).

This agrees with the findings [11] reported that bio-agents *Ampelomyces quisqualis*, *Trichoderma harzianum* and *Saccharomyces cerevisiae* can be use as alternative to chemicals fungicides for control of powdery mildew disease of grapes. DR-38, DR-39, TL-171, DRo-198, TS-204, TS-205, and DR-219 strains of *Bacillus sp* can reduce downy mildew, powdery mildew and anthracnose disease of grapes [12]. [13] reported that application of chlorine dioxide (Agro Rakshak) at 150 ppm was found effective in controlling powdery mildew of grapes. Pre-harvest treatment of grapes with *T. harzianum* 5R will increases fruit freshness and overcome many postharvest diseases [14].

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