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Management of Grape Downy Mildew under Field Conditions Using Fungitoxicants

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ABSTRACT

Downy mildew is destructive and yield limiting disease in grapes incited by a biotrophic fungi *Plasmopara viticola*. Owing to aggressive virulence in pathogen the development of resistance against the fungicides is early. To cater this need, efforts were made to evaluate newer fungicides against grape downy mildew during two seasons (*rabi/ summer* 2021-22 and 2022-23), at college of Horticulture, Bagalkot, Karnataka. Of the different treatments in both seasons the combi fungitoxicant, mandipropamid and zoxamide revealed lowest disease index (DI) of 13.02 per cent and 12.70 per cent with higher grape yield of 18.07 t/ha and 19.05 t/ha, respectively. Thus, this combi fungicide may be included in integrated downy mildew management schedule in grape cultivation.

Keywords: Disease, Fungitoxicants, Grapes, Mandipropamid + Zoxamide, *Plasmopora viticola,*

INTRODUCTION

In India, grape (*Vitis vinifera* L.) is commercially cultivated in Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu (Ramya and Subbarayappa, 2017). Grape production is hindered by numerous biotic stresses of which downy mildew disease is more detrimental and yield limiting. Downy mildew of grapes incited by biotrophic fungi *Plasmopara viticola,* is highly destructive disease under disease conducive environment it infects leaves, tender shoots, young flower buds, and berries leading to crop loss of 50-100 percent (Sawant and Sawant, 2010). Previously attempt was made to combat the disease through genetic resistance as the pathogen was so aggressive that resistance did not last for long time (Gessler *et al,* 2011). The management of grape downy mildew was heavily relied on usage of synthetic fungicides. Of which the copper compounds are indiscriminately used (Caffi *et al,* 2010) which has led to accumulation of heavy metals to the toxic level in the soil and environment. Further, the soil properties and micro-flora also affected which intern has adverse effect on grape production (Martinez *et al*, 2012). Additionally, the fungicides employed to curb the disease in field have narrow mode of action against the oomycetes *P. viticola* which resulted in low efficacy within short time due to resistance deployment in pathogen (Toffolatti *et al*, 2024) which necessitates the need of alternate chemicals to manage this deadly disease in field. Hence, the present study was conducted to evaluate different fungitoxicants under field conditions for sustainable management of grape downy mildew throughout the grape growing season.

MATERIALS AND METHODS

Experimental location and growth conditions

The field trials were conducted at College of Horticulture, Bagalkot (Karnataka) for assessing the bio-efficacy of fungitoxicants against of grape downy mildew for two consecutive seasons (*rabi/ summer* 2021-22 and 2022-23). The experimental plot soil was sandy loam and susceptible grape hybrid was raised as per the package of practice of University of Horticultural Sciences, Bagalkot (Karnataka).

Treatment

The experiment was carried out in randomized block design (RBD) which consisted of five treatments and in each treatment, four replications were maintained. In each treatment two foliar sprays of fungitoxicants were imposed at 15 days' gap and the first spray was taken up on-set of disease in grape. The details of treatment were as T_1- foliar application of Mandipropamid 25% w/w + Zoxamide 24% w/w WG

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Table 1: Details of fungitoxicants used.

Common name	Product name	Supplier	Dosage (%)	Mode of action	FRAC code
Mandipropamid 25% w/w + Zoxamide 24% w/w WG	Miravis duo	Syngenta	0.05	Cell wall biosynthesis of fungi and tubulin polymerization or cyto skeleton and motor protein	H5 B3
Mandipropamid 23.4 % w/w(25% w/v) SC	Revus	Syngenta	0.30	Cell wall biosynthesis of fungi	H5
Zoxamide 240 SC	Zoxium®	Avima	0.10	Tubulin polymerization or cyto skeleton and motor protein	B3
Cymoxanil 8% + Mancozeb 64% WP	Curzate	Corteva	0.30	Multi-site contact activity	- -
Fluopicolide 4.44% + Fosetyl Aluminium 66.67%WG	Profiler®	Bayer	0.30	Delocalisation of spectrin -like proteins and host plant defence induction	B 5 P-07

Table 2: Effect of fungitoxicants on grape downy mildew under field conditions.

Treatments	Dosage	Disease Index (%) at 10 days after different sprays		
		Pre spray	I spray	II spray
I season (*rabi/ summer* 2021-22)				
Mandipropamid + Zoxamide	0.5 ml	1.47 (6.97)	9.96 (18.39)	13.02 (21.16)
Mandipropamid	0.8 ml	1.54 (7.13)	13.19 (21.31)	22.71 (28.47)
Zoxamide	0.6 g	1.74 (7.58)	14.52 (22.41)	24.62 (29.76)
Cymoxanil + Mancozeb	4 g	1.39 (6.77)	15.44 (23.13)	26.69 (31.12)
Fluopicolide + Fosetyl Aluminium	2.5 g	1.74 (7.58)	12.67 (20.86)	22.89 (28.60)
Control	-	1.32 (6.60)	24.12 (29.42)	75.44 (60.32)
S.Em±	-	0.237	0.625	1.208
CD (0.05)	-	*NS*	1.875	2.288
II season (*rabi/ summer* 2022-23)				
Mandipropamid + Zoxamide	0.5 ml	1.51 (7.06)	8.62 (17.08)	12.70 (20.89)
Mandipropamid	0.8 ml	1.07 (5.94)	14.24 (22.18)	22.11 (28.06)
Zoxamide	0.6 g	1.61 (7.29)	15.44 (23.15)	24.15 (29.45)
Cymoxanil + Mancozeb	4 g	1.33 (6.63)	16.10 (23.67)	26.05 (30.71)
Fluopicolide + Fosetyl Aluminium	2.5 g	1.47 (6.97)	13.37 (21.46)	22.78 (28.52)
Control	-	1.22 (6.34)	31.91 (34.41)	79.33 (62.99)
S.Em±	-	0.211	0.686	0.605
CD (0.05)	-	*NS*	2.057	3.085

@ 0.5 ml/l; T_2 - Mandipropamid 23.4 % w/w (25% w/v) SC @ 0.8ml/l; T_3 - Zoxamide 240 SC @ 0.6 g/l; T_4 - Cymoxanil 8% + Mancozeb 64% WP @ 4g/l; T_5 – Fluopicolide 4.44% + Fosetyl Aluminium 66.67%WG @ 2.5g/l; T_6 - Control.

Disease assessment of grape downy mildew

The downy mildew disease severity in each treatment was recorded prior to initiation of experiment and after ten days of each spray. The disease severity was assessed by using 0-4 severity scale (Horsfall and Barrate, 1986) (0 – no disease; 1 – up to 25 % infected leaf area; 2 – 26 to 50 infected leaf area; 3 - 51 to75 infected leaf area; 4 - >75 % infected leaf area). The % disease index (PDI) was calculated by using the formula, Disease index (%) = [Sum of all individual ratings/ (number of plants examined x maximum grade in score)] x 100 (Vincent, 1947).

Table 3: Effect of fungitoxicants on grape berry yield during *rabi/ summer* 2021-22 and 2022-23

Treatments	Dosage	Yield (t/ha)		Increase in yield over control (%)	
		2021-22	2022-23	2021-22	2022-23
Mandipropamid + Zoxamide	0.5 ml	18.07	19.05	82.97	83.99
Mandipropamid	0.8 ml	14.67	15.27	70.29	72.13
Zoxamide	0.6 gm	14.13	15.56	67.79	69.56
Cymoxanil + Mancozeb	4 g	15.21	16.85	65.08	67.16
Fluopicolide + Fosetyl Aluminium	2.5 g	15.47	16.48	70.05	71.28
Control	-	10.84	11.10	-	-
SE.m. ±		0.773	0.714	-	-
CD (0.05)		2.321	2.137	-	-

Table 4: Phytotoxicity assessment of fungitoxicant spray on grape

Treatments	Phytotoxicity observations						
	Leaf injury on tips	Stunting	Necrosis	Chlorosis	Vein clearing	Wilting	Epinasty/ Hyponasty
I season (*rabi/ summer* 2021-22)							
Mandipropamid + Zoxamide	-	-	-	-	-	-	-
Mandipropamid	-	-	-	-	-	-	-
Zoxamide	-	-	-	-	-	-	-
Cymoxanil + Mancozeb	-	-	-	-	-	-	-
Fluopicolide + Fosetyl Aluminium	-	-	-	-	-	-	-
II season (*rabi/ summer* 2022-23)							
Mandipropamid + Zoxamide	-	-	-	-	-	-	-
Mandipropamid	-	-	-	-	-	-	-
Zoxamide	-	-	-	-	-	-	-
Cymoxanil + Mancozeb	-	-	-	-	-	-	-
Fluopicolide + Fosetyl Aluminium	-	-	-	-	-	-	-

- No phytotoxicity

Phytotoxicity assessment of fungitoxicants spray and yield

Observations of phytotoxicity evaluation were recorded by visual observations for phytotoxicity symptoms *viz.,* leaf injury on tips/ surface, necrosis, stunting, chlorosis, vein clearing, wilting, epinasty and hyponasty at 1, 3, 5, 7 and 10 days after each spray following 0-10 scale, where: 0 = no phytoxicity, 1 = 1-10%, 2 = 11-20%, 3 = 21-30%, 4 = 31-40%, 5 = 41-50%, 6 = 51-60%, 7=61-70%, 8=71-80%, 9=81-90%, 10=91-100% (Kabade, 2022).Yield of grapes was recorded plot wise at each harvest and pooled data of all pickings have been presented in terms of t/ha.

RESULTS AND DISCUSSION

Grape downy mildew caused by biotrophic fungi *Plasmopara viticola,* is highly destructive and yield limiting disease under conducive environment and capable of inducing 50 to 100 percent crop loss to the growers (Sawant and Sawant, 2010). The genetic resistance in grape cultivars failed to curb the downy mildew menace due to aggressive virulence of the pathogen (Gessler *et al,* 2011) which made the synthetic fungicides the principle means of disease control in filed (Caffi *et al,* 2010). The narrow mode of action of the fungicides employed to curb the disease in field resulted in low efficacy within short time due to

resistance deployment in pathogen (Toffolatti *et al*, 2024) indicating the need of alternate chemicals for sustainable management of this deadly disease in field. Hence, the present study conducted to evaluate different fungitoxicants under field conditions for sustainable management of grape downy mildew throughout the grape growing season.

Mandipropamid + Zoxamide, a combi fungitoxicant resulted lowest disease index (DI) at the end of the experiment in both seasons (*rabi/ summer* 2021-22 and 2022-23) recording 13.02 per cent and 12.70 per cent of DI in first and second season, respectively (Table 2) and resulted higher grape yield of 18.07 t/ha and 19.05 t/ha in first and second season, respectively against control recording 10.84 t/ha and 11.10 t/ha. Consequently, increasing the per cent yield as 82.97 per cent and 83.99 per cent in first and second season, respectively at terminal stage of the field experiment (Table 3). Further, Fluopicolide + Fosetyl Aluminium was the next best with respect to enhanced disease severity and improved yield for two foliar sprays of fungitoxicants imposed at 15 days' gap. Similarly, the individual fungitoxicants (Mandipropamid and zoxamide) were capable to arrest the disease severity in field in both the seasons but, they performed better in combination. None of the fungicides exhibited any visible phytotoxicity symptoms at their recommended dosage in both the seasons (Table 4). The higher efficacy of Mandipropamid + Zoxamide in managing the grape downy mildew was well documented by early researchers (Massi *et al,* 2020; Dolzhenko *et al*, 2021). Similarly, the higher efficacy of Fluopicolide + Fosetyl Aluminium are in line with findings of Mohapatra *et al* (2011) and Kiran *et al* (2022).

The highest bio-efficacy of fungitoxicant, Mandipropamid + Zoxamide in grape downy mildew management is due to its unique mode of action against fungus. Gradual ingress of Mandipropamid (CAA-Carboxylic acid amides group) into plant tissues inhibits phospholipid biosynthesis in pathogen cell wall and protects the lower surface of leaves which provides for anti-sporulation and curative effect. Further, Zoxamide (benzamide group) having protective action which interfere and inhibit β-tubulin protein assembly thereby prevents normal mitotic cell division in plant fungal pathogens (Dolzhenko *et al*, 2021).

CONCLUSION

Based on the research highlights, combi fungitoxicant Mandipropamid and Zoxamide can be designated as protective fungitoxicants which interferes in fungal respiratory functions and mitigates the financial strains on farmers by minimizing the need for multiple fungitoxicant applications throughout the grape growing season against pathogens of the oomycetes class and peronosporomycetes.

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