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Efficacy of novel antifungal molecules against powdery mildew (*Erysiphe polygoni* DC.) of coriander

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ABSTRACT

The powdery mildew disease of Coriander (Coriandrum sativum L.) is caused by Erysiphe polygoni DC. It has become a serious and widespread problem in most of the region of India, including Rajasthan. In vivo experiment was conducted for three seasons (2017-18 to 2019-20) to investigate the efficacy of six new molecules, Azoxystrobin 23% SC (0.1%), Propineb 70% WP (0.2%), Tebuconazole 25.9% EC (0.1%), Sulphur 80% WP (0.2%), Hexaconazole 5% SC (0.1%), Propiconazole 25% EC (0.1 %) along with control against coriander powdery mildew on the popular variety RCr-728. Each new generation fungicides were applied twice at 15-day intervals on coriander crop and data on disease intensity and yield were taken 10 days after the last spray. All the new molecule was found effective and minimized the disease severity and increased the yield significantly over the control. New molecules fungicides hexaconazole 5% SC (0.1%) was found effective in diminishing the disease (15.27%) and increasing seed yield (15.88 q ha^{-1}) compared to 72.06 % disease severity and 11.37 q ha^{-1} seed yield in the untreated control. The benefit-cost ratio of hexaconazole 5% SC was highest (4.75). The effect of treatments on volatile oil content (%) and test weight was found non-significant.

Keywords: *Powdery mildew, fungicides, volatile oil, test weight, seed yield, coriander and Erysiphe polygoni.*

INTRODUCTION

Coriander (*Coriandrum sativum* L.) is an excellent aromatic, erect type annual herb with smooth leaves and taproot system, which belongs to the Umbelliferae or Apiaceae family [6]. The origin place of this herb is eastern Mediterranean region, from where it reaches to India and remaining part of the world [7]. Coriander is a seed spice which is also known as 'Dhania' in the Hindi mother tongue, while in another dialect of the country, it is known by different terminology like, 'Khophir in Gujarati, 'Dhane' in Bengali, 'Dhaniyalu' in Telgu and 'Kustumbari' in Sanskrit. Since ancient times, coriander has been used in medicine and food industries because of presence of medicinal molecule and oils in its leaves and dried seeds [14]). It has various bioactive compounds, *viz*., oil (16.1%), protein (14.1%), carbohydrate (21.6%), fibers (32.6%), minerals (4.4%) and leaves are rich source of vitamin A containing 5200 to 12,000 IU per 100g [16].

India produced 2.01 MT seed spices from about 2 M ha area with an annual productivity of 10 q ha during the year 2022-23. India exported raw and value-added products of seed spices to 30 countries and earned export revenue of Rs ~ 5500 crores [3]. Among seed spices, India is the largest producer, consumer and exporter of coriander in the world. During 2023-24, it was grown on an area of 0.56 million ha with a total production of 0.76 million tonnes [4].

The coriander crop suffers by many pests and diseases. Among the diseases powdery mildew which is caused by *Erysiphe polygoni* DC, causes yield losses [9]. It reduces the quality of seeds and yield up to 15-40 per cent [26]. Under favourable conditions losses reaches up to above 50 percent. Recently, the intensity of disease has increased due to changing in production practices, especially with the use of high yielding late maturing varieties [24]. Management of this disease by antifungal compounds is effective method.

Since, wettable sulphur is commonly used for management of powdery mildew. With a view to find out an alternative new generation antifungal chemical, this investigation was carried out.

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Materials and Methods

The experimental trial was conducted under ICAR-AICRP on Spices at Agronomy Research Farm, SKN College of Agriculture, SKN Agriculture University, Jobner, Jaipur (Rajasthan) during three rabi seasons (2017-18 to 2019-20). The experiment was conducted in randomized block design (RBD) with three replications. Sowing of coriander var. RCr-728 with seed rate of 10-12 kg per hectare was done in the month of November. In the crop geometry, spacing between row to row and plant to plant was kept as 30 x 10 cm. Six fungicides were used to check their efficacy with control (Table 1). Two foliar sprays of each fungicide were applied. First foliar spray was applied immediately after the initiation of the disease and second spray at 10 days after first spray. The observations on the powdery mildew disease intensity were recorded from 10 randomly selected plants by using using 0-4 rating scale (Table 2) [2] [10]. Disease intensity (PDI), disease control (PDC) and yield increase over control were calculated by using following formula:

$$\text{PDI} = \frac{\text{Sum of all numerical ratings}}{\text{No. of leaves observed X maximum rating}} \times 100$$

$$\text{\% Disease control (PDC)} = \frac{\text{PDI in control - PDI in treatment}}{\text{PDI in control}} \times 100$$

$$\text{Yield increase (\%)} = \frac{\text{Yield in treatment - Yield in check}}{\text{Yield in check}} \times 100$$

Results and Discussion

Data on per cent disease intensity (PDI) and per cent disease control are given in table 3. Coriander seed yield, economics, residue, test weight and volatile oil were also notified under various fungicidal molecules are given in table 4, 5, 6, 7 and fig.1, respectively.

The results clearly indicated that the disease severity was significantly low in all the treated plots compared to the control plot after two sprays during the years 2017-18 to 2019-20. Efficacy of fungicidal molecules on percent disease intensity, all the treatments minimize the disease severity as compared to untreated control. In all the three years (2017-18, 2018-19 and 2019-20) hexaconazole 5% SC at 0.1% found imposing in managing coriander powdery mildew with minimum per cent disease intensity (PDI) of 13.33 %, 21.67 % and 10.80 % followed by propiconazole 25% EC 0.1 % concentration with (16.67 %, 28.33 % and 16.70 %), wettable sulphur 80% WP 0.2% (35.00 %, 23.33 % and 20.80 %), azoxystrobin 23% SC 0.1 % (25.00 %, 31.67 % and 21.97 %) and tebuconazole 25.9 % EC, 0.1% (31.67 %, 36.67 % and 30.07 %) PDI, respectively. The propineb70 % WP, 0.2 % recorded (41.67 %, 41.67 % and 34.50 %) percent disease severity as against (68.33 %, 71.67 % and 76.17 %) percent disease severity in untreated control treatment, respectively during the year 2016-17 to 2018-19.

The results of pooled data analysis showed significant difference in per cent disease intensity as compared to untreated control. It is revealed (Table 3 and Fig.1), that hexaconazole 5% SC could significantly minimize the per cent disease intensity (15.27%) as compared to rest of fungicides and it reduces 78.81 per cent disease over control. Another best molecule was propiconazole 25% EC which noted 20.57% disease intensity and 71.45 per cent reduction of disease over control. Similar trends also showed by azoxystrobin 23% SC, Sulphur 80 % WP and tebuconazole 25.9% EC with 26.21, 26.38 and 32.80 per cent disease intensity and minimize the disease to a range of 63.63, 63.39 and 54.48 per cent over control, respectively. The molecule propineb 70% WP was least effective in controlling the powdery mildew disease which showed 39.28 per cent PDI and 45.49 per cent reduction of disease over control.

Similar results, also showed by Hexaconazole 5% SC against powdery mildew of okra [21] [5] [28], in pea [27], in sunflower [1], in coriander [24] [20] and the results obtained during the present study are in agreement with these findings.

In all the treatments seed yield (q ha^{-1}) was increase as compared to untreated control. The results showed in table 4 and in figure 1 indicated that all treatments significantly increased the coriander yield ranging from 10.87 to 39.69 per cent as compared to untreated control. During the year 2016-17, 2017-18 and 2018-19 significantly the highest seed yield of 15.314, 15.139 and 17.183 q ha^{-1} were observed in the treatment of hexaconazole 5% SC and it was found statistically at par with propiconazole 25% EC (15.048, 13.519 and 16.702 q ha^{-1}), wettable sulphur (12.038, 14.722 and 15.496 q ha^{-1}) and azoxystrobin 23% SC (12.724, 13.102 and 15.012 q ha^{-1}) during the year 2016-17, 2017-18 and 2018-19 rabi seasons and tebuconazole 25.9% EC (13.009 q ha^{-1}) and propineb 70% WP (12.778 q ha^{-1}) in the year 2017-18. The lowest yield was found in untreated control 10.133, 11.806 and 12.163 q ha^{-1}, respectively in the year 2016-17 to 2018-19.

Results of pooled analysis of three years revealed that highest seed yield was recorded in hexaconazole 5% SC at 0.1% (15.879 q ha^{-1}) which other statistically at par with propiconazole 25% EC (15.090 q ha^{-1}) and Sulphur 80% WP (14.086 q ha^{-1}). However, the minimum yield was found in the untreated control (11.367 q ha^{-1}).

A maximum per cent increase in yield over untreated control was also observed in the treatment of hexaconazole 5% SC (39.69%) followed by propiconazole 25% EC (32.73%), wettable sulphur (23.92%), azoxystrobin 23% SC (19.76%), tebuconazole 25.9% EC (15.11%) and propineb 70% WP (10.87%), respectively. Similar type of findings were also reported in pea crop by [15] [25] [11]; in fenugreek by [12]; in mungbean by [18]; in okra by[23] [8]; in mustard by [19] [22] [17]; in sunflower by [13] and in coriander by [20].

Benefit: Cost ratio, the economics of different molecules for the management of powdery mildew of coriander recorded the maximum benefit cost ratio of 4.75 in the treatment of hexaconazole 5% SC 0.1 per cent followed by propiconazole 25% EC (4.41) and wettable sulphur (4.22) (Table 5 and fig. 1). Similar findings were also reported in mustard crop by [8], in coriander by [20] and in mustard by [17].

Minimum level of the pesticides residues (1.32 ppm) in the coriander seed with foliar application of Hexaconazole 5% SC at the initial occurrence of the powdery mildew and another spray at 10-15 days after first spray was recorded below critical limit, that is fixed by various agencies (*i.e.,* EU, CODEX & Japan).

Results of a pooled analysis of three years showed that no significant difference was observed in test weight of coriander seeds in all the treatments (Table 6). However, maximum test weight was found with Hexaconazole 5% SC (4.64 g), followed by Propiconazole 25% EC (4.43 g), Sulphur 80% WP (4.38 g), Azoxystrobin 23% SC (4.23 g) and control (3.79 g).

Per cent increase in test weight was maximum in the treatment of Hexaconazole 5% SC (22.38%) followed by Propiconazole 25% EC (17.01%), Sulphur 80% WP (15.71%), Azoxystrobin 23% SC (11.52%), Tebuconazole 25.9% EC (8.36%) and Propineb 70% WP (4.77%) over untreated control. The same findings were also reported by [20] [17].

Among the fungicides tested, Hexaconazole 5% SC noted the maximum volatile oil content of 0.50 per cent and it is superior with Propiconazole 25% EC (0.48%) and Sulphur 80% WP (0.46%). In all the three years, all the fungicides increased volatile oil content excepts in the year 2017-18 for Propiconazole 25% EC and in 2018-19 for Azoxystrobin 23% SC (Table 7).

Accordingly, the maximum per cent increase in volatile oil content (17.71%) was noted in the treatment of Hexaconazole 5% SC followed by Propiconazole 25% EC (12.84%), Sulphur 80% WP (10.04%), Azoxystrobin 23% SC (5.22%), Tebuconazole 25.9% EC (4.69%) and Propineb 70% WP (1.77%) over untreated control. The present study was in near conformity with the results reported by [20] in coriander.

Conclusion

A Spray of Hexaconazole 5% SC (0.1%) are cost-effective and emphatic for the control of powdery mildew on coriander. This molecule also promotes growth, seed yield, test weight and volatile oil content of plants by preventing disease caused by *Eryshipe polygoni* DC.

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Table 1: Details of molecules used against powdery mildew disease of coriander

Treatment	Common name	Concentration	Trade Name
T_1	Azoxystrobin 23% SC	0.1%	Amistar 23%
T_2	Propineb 70% WP	0.2%	Antracol 70 % WP
T_3	Tebuconazole 25.9% EC	0.1%	Folicur 25.9% EC
T_4	Sulphur 80% WP	0.2%	Sulfex 80% WP
T_5	Hexaconazole 5% SC	0.1%	Avon Plus 5% SC
T_6	Propiconazole 25% EC	0.1 %	Tilt 25% EC
T_7	Untreated Control	-	-

Table 2: Rating scale parameter used for the calculation of disease intensity in coriander

Rating	Symptoms
0.0	Healthy/ No. incidence
1.0	Presence of Whitish small spots on the leaves
2.0	Presence of Whitish growth covering the entire leaves
3.0	Presence of Whitish growth on leaves and stems
4.0	Presence of Whitish growth on leaves, stems and umbels

Table 3: Efficacy of new molecules on powdery mildew disease of coriander

Sr. No.	Treatments	Per cent disease intensity (PDI)				% Disease control (PDC)
		2016-17	2017-18	2018-19	Pooled Mean	
1	Tebuconazole 25.9% EC @ 0.1%	31.67 (34.13) *	36.67 (37.26)	30.07 (33.23)	32.80 (34.90)	54.48
2	Propineb 70% WP @ 0.2%	41.67 (40.18)	41.67 (40.20)	34.50 (35.95)	39.28 (38.79)	45.49
3	Azoxystrobin 23% SC @ 0.1 %	25.00 (29.91)	31.67 (34.23)	21.97 (27.92)	26.21 (30.78)	63.63
4	Wettable sulphur 80% WP @ 0.2%	35.00 (36.22)	23.33 (28.86)	20.80 (27.09)	26.38 (30.87)	63.39
5	Hexaconazole 5% SC @ 0.1%	13.33 (21.14)	21.67 (27.60)	10.80 (19.14)	15.27 (22.90)	78.81
6	Propiconazole 25% EC @ 0.1%	16.67 (24.04)	28.33 (32.14)	16.70 (24.09)	20.57 (26.94)	71.45
7	Untreated Control	68.33 (55.80)	71.67 (57.98)	76.17 (60.92)	72.06 (58.10)	-
C.D. at 5%		**5.29**	**5.27**	**4.17**	**2.84**	
C.V. (%)		**8.53**	**8.03**	**7.11**	**4.54**	

**Figures in parenthesis are angular transformed values*

Table 4: Bio efficacy of new molecules spray on seed yield

S. No.	Treatments	Seed yield (q ha^{-1})				Yield increase (%)
		2016-17	2017-18	2018-19	Pooled Mean	
1	Tebuconazole 25.9% EC @ 0.1%	12.191	13.009	14.056	13.085	15.11
2	Propineb 70% WP @ 0.2%	11.924	12.778	13.107	12.603	10.87
3	Azoxystrobin 23% SC @ 0.1 %	12.724	13.102	15.012	13.613	19.76
4	Wettable sulphur 80% WP @ 0.2%	12.038	14.722	15.496	14.086	23.92
5	Hexaconazole 5% SC @ 0.1%	15.314	15.139	17.183	15.879	39.69
6	Propiconazole 25% EC @ 0.1%	15.048	13.519	16.702	15.090	32.73
7	Untreated Control	10.133	11.806	12.163	11.367	-
C.D. at 5%		**2.76**	**2.64**	**2.82**	**2.00**	
C.V. (%)		**12.17**	**11.02**	**10.69**	**8.20**	

Table 5: Economics of coriander seed yield against powdery mildew disease

Treat. no.	Seed Yield (Kg ha^{-1})	Gross return (₹ ha^{-1})	Total Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C Ratio
T_1	1308.52	130850.00	36000.00	94850.00	3.63
T_2	1260.30	126030.00	34720.00	91310.00	3.63
T_3	1361.26	136130.00	39250.00	96880.00	3.47
T_4	1408.55	140860.00	33340.00	107520.00	4.22
T_5	1587.86	158790.00	33460.00	125330.00	4.75
T_6	1508.96	150900.00	34200.00	116700.00	4.41
T_7	1136.72	113670.00	33000.00	80670.00	3.44

Price of Coriander = ₹100/- kg^{-1} Tebuconazole 25.9% EC = ₹ 300/- 100 ml^{-1}
Propineb 70% WP = ₹ 215/- 250 gm^{-1} Azoxystrobin 23% SC = ₹ 625/- 100 ml^{-1}
Wettable Sulphur 80% WP = ₹ 170/- Kg^{-1} Hexaconazole 5% SC = ₹ 115/- 250 ml^{-1}
Propiconazole 25% EC = ₹ 300/- 250 ml^{-1} Labour cost = ₹ 200/-/man/day^{-1}

Table 6: Bio-efficacy of new molecules applied for management of powdery mildew disease of coriander on test weight (gm).

Sr. No.	Treatments	Test weight (gm)				Increase in test weight (%) over control
		2016-17	2017-18	2018-19	Pooled mean	
1	Tebuconazole 25.9% EC @ 0.1%	3.67	3.95	4.70	4.11	8.36
2	Propineb 70% WP @ 0.2%	3.57	3.76	4.58	3.97	4.77
3	Azoxystrobin 23% SC @ 0.1 %	3.70	4.10	4.88	4.23	11.52
4	Wettable Sulphur 80% WP @ 0.2%	3.87	4.21	5.08	4.38	15.71
5	Hexaconazole 5% SC @ 0.1%	4.27	4.38	5.27	4.64	22.38
6	Propiconazole 25% EC @ 0.1%	3.93	4.27	5.10	4.43	17.01
7	Untreated Control	3.40	3.77	4.20	3.79	-
S.Em.±		**0.22**	**0.19**	**0.27**	**0.17**	
C.D. at 5%		**NS**	**NS**	**NS**	**NS**	
C.V. (%)		**9.94**	**8.10**	**9.68**	**7.00**	

Table 7: Volatile Oil of coriander as influenced by different molecules applied for the management of powdery mildew disease of coriander

Sr. No.	Treatments	Volatile Oil (%)				Volatile Oil increase (%) over control
		2016-17	2017-18	2018-19	Pooled mean	
1	Tebuconazole 25.9% EC @ 0.1%	0.428	0.450	0.460	0.446	4.69
2	Propineb 70% WP @ 0.2%	0.417	0.434	0.450	0.434	1.77
3	Azoxystrobin 23% SC @ 0.1 %	0.440	0.457	0.448	0.448	5.22
4	Wettable sulphur 80% WP @ 0.2%	0.446	0.467	0.494	0.469	10.04
5	Hexaconazole 5% SC @ 0.1%	0.495	0.497	0.514	0.502	17.71
6	Propiconazole 25% EC @ 0.1%	0.478	0.469	0.496	0.481	12.84
7	Untreated Control	0.422	0.425	0.432	0.426	-
S.Em.±		**0.019**	**0.019**	**0.023**	**0.016**	
C.D. at 5%		**NS**	**NS**	**NS**	**NS**	
C.V. (%)		**7.271**	**7.178**	**8.518**	**5.970**	

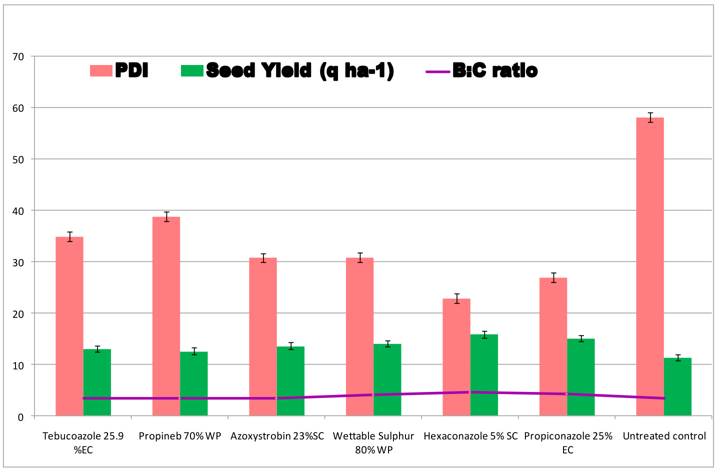

Fig. 1 : Effect of new molecules on PDI, Seed yield (q ha^{-1}) and B:C ratio

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