

## Evaluation of Bio-efficacy and Phytotoxicity of Noval Fungicides against Purple Blotch of Onion

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### Authors' contributions

This work was carried out in collaboration among all authors. Author MRR carried out the research work and wrote the protocol. Author DKH designed the study and supervise the work. Author BHK managed the literature searches and performed statistical analysis. Author AK managed the analysis and wrote the first draft of manuscript. All authors read and approved the final manuscript.

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### ABSTRACT

An experiment for the management of purple blotch of onion (*Allium cepa* L.) caused by *Alternaria porri* (Ellis) was carried out in Hanumanamatti research farm, College of Agriculture, Hanumanamatti, University of Agricultural Sciences, Dharwad, during 2017-18 and 2018-19. There were three fungicides combinations tested *in vivo*, i.e. Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC at 75, 100 and 125 a.i, along with individual molecules Pyraclostrobin 20% WG at 100 a.i, Fluxapyroxad 300 g/L SC at 62.5 a.i and Difenconazole 25% EC at 25 g a.i/100 litre of water and Mancozeb 75% WP 1125-1500 g against the purple blotch disease of onion. Out of the seven different fungicides combination or individual molecules, application of Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 200 mL/ha has significantly decreased the purple blotch of onion disease. Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @150 mL/ha was found safer to onion crop without causing any type of phytotoxicity effect.

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## 1. INTRODUCTION

Onion (*Allium cepa* L.) is the important vegetables and widely cultivated as bulb crops in almost all countries in the world including India. The chief component, which is responsible for the pungency in onion is an alkaloid "Allylpropyl disulphide". In India, onion is grown in an area of 1.02 million ha with a production of 14.82 m tonnes and productivity of 14.61 tonnes per ha. The prominent onion growing states are Maharastra, Gujarat, Uttar Pradesh, Orissa, Karnataka, Tamil Nadu and Andhra Pradesh. In Karnataka, it occupies an area of 0.15 m ha with the production of 2.38 m tonnes and productivity of 16.05 t ha<sup>-1</sup> [1]. Several factors have been identified for the low productivity of onion in India. The most important factors are diseases such as the purple blotch, downy mildew, Stemphylium blight, basal rot and storage rots, in addition to the non-availability of varieties resistant to biotic and abiotic stresses. Among the foliar diseases, the purple blotch is one of the most destructive diseases, commonly prevailing in almost all onion growing pockets of the world, which causes heavy loss in onions under field conditions. The purple blotch of onion caused by *Alternaria cepulae* was observed for the first time in Karnataka [2]. However, there was little attention and it was not recognized as a major foliar and inflorescence disease until recently, since then, it is considered as one of the important diseases. The disease was described as "purple blotch onion", caused by fungus, *Alternaria porri* [3].

Ponnappa [4] studied *in vitro* efficacy of fungicides against onion leaf blight caused by *A. cepulae* and reported that mancozeb (Dithane M-45), Aureofungin and Duter showed complete inhibition at 0.2% concentration. Gupta et al. [5] reported that mancozeb (Dithane M-45) was the most effective in inhibiting the growth of *Alternaria porri* under *in vitro* conditions. Sastrahidayat (1995) reported that difenconazole (0.8 mL/litre) inhibited the growth of *Alternaria porri* under laboratory condition. Huq et al. [6] evaluated five fungicides, iprodione 0.2% (Rovral) mancozeb 0.2%, cuprovit 0.2%, copper oxychloride and propineb 0.2% (Antracol) for inhibition of growth of *Alternaria porri*. They reported that Rovral gave the best inhibition of growth followed by mancozeb. Chetana [7] reported that under *in vitro* evaluation studies, mancozeb (Indofil M-45) and difenconazole

(score) were found to cause the best effectiveness against the *Alternaria porri*. Shilpa [8] evaluated the systemic fungicides at different concentration, combi product of iprodione and carbendazim at 400 ppm registered 92.20% inhibition of the pathogen followed by tricyclazole (85.80%) However, among the non-systemic tested fungicides, iprodione was found effective in all the tested concentration *i.e.* 50, 100, 200 and 400 ppm. Kareem [9] reported that all the four fungicides *viz.*, difenconazole, mancozeb, copper oxychloride and chlorothalonil were significantly effective in inhibiting the mycelial growth and spore germination of *Alternaria porri* under *in vitro* conditions.

Srivastava et al. [10] evaluated four fungicides, copper oxychloride, mancozeb, carbendazim and thiram on purple blotch of onion caused by *Alternaria porri*. Mancozeb gave the highest efficacy in controlling the disease. Sachin and Sharma [11] reported that metalaxil (Ridomil MZ) was most effective in controlling the purple blotch disease of onion caused by *Alternaria porri* followed by hexaconazol, penconazol, difenconazole and mancozeb. So far, there is a need to increase the production of onion in the country to meet export demands. Thus, to increase the further production and productivity of onion, new fungicides have been formulated and used extensively in different parts of the country against purple blotch onion infestations. In this context, the present study was carried out to evaluate the bio-efficacy and phytotoxicity of different new fungicide combinations. The study had a view of proposing new fungicide combinations to minimise effects on purple blotch onion and improve its production and productivity for domestic and international markets.

## 2. MATERIALS AND METHODS

The field experiments were conducted during *kharif* seasons (June to November) of 2017-18 and 2018-19 in Hanumanamatti research farm, College of Agriculture, Hanumanamatti, University of Agricultural Sciences, Dharwad to evaluate the efficacy of different chemicals for the management of purple blotch disease of Onion. The field trials were conducted in a randomized block design (RBD) with three replications along with the control. The details of the chemicals and their concentrations are followed:

**Table 1. Details of fungicides and their concentration in the present investigation**

Tr. No.	Treatment details	Dosage per ha		
		g a.i.	Formulation (mL or g)	Water volume (L)
T1	Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC	75	150	750
T2	Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC	100	200	750
T3	Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC	125	250	750
T4	Pyraclostrobin 20% WG	100	500	750
T5	Fluxapyroxad 300 g/L SC	62.5	209	750
T6	Difenoconazole 25 % EC	25 g.a.i/100 L of water	100 mL/100 L of water	500
T7	Mancozeb 75% WP	1125-1500	1500-2000	750
T8	Control	-	-	-

The purple blotch of onion severity was recorded in 10 plants in each plot at 30 and 45 DAT on 0-5 standard rating scale and the disease index severity (Percent Disease Index *i.e.* PDI) using the formula given by wheeler [12].

$$\text{PDI} = \frac{\text{Sum of all disease Ratings}}{\text{Total no of leaves/bunches assessed} \times \text{Maximum Disease grade}} \times 100$$

The PDI was calculated before spray and after spray at 30 and 45 DAT for both the crop season. The mean PDI and yield q/t were calculated and statistically analyzed.

## 2.1 Phytotoxicity

Phytotoxicity observation was done on 0-10 scale and leaf tips and surface injury, wilting, necrosis, epinasty and hyponasty were studied (Table 2). For phytotoxicity, three treatments including check were taken with four replications (Table 3). Ten plants were selected randomly from each treatment and the total number of leaves and leaves which showed phytotoxicity were counted. The data collected were converted into a percentage. The extent of phytotoxicity was recorded based on following 0-10 score.

**Table 2. Phytotoxicity observations on the basis of 0-10 score**

Score	Phytotoxicity (percent)
0.	No Phytotoxicity
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

## 3. RESULTS AND DISCUSSION

### 3.1 Disease Severity

The results revealed that all the fungicidal treatments were found effective in reducing the disease index of purple blotch onion over control

(Table 4). All the chemicals showed significantly minimum percent disease index over control during both the season 2017-18 and 2018-19. Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 250 mL / ha provided superior control (24.60% & 23.70% mean PDI) followed by Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 200 mL per ha (26.46% & 25.79% mean PDI) and the next most effective treatment was Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 150 mL per ha that recorded 28.22% & 27.30% mean PDI but found at par with each other in 2017-18 and 2019-20 respectively. This could be attributed due to fluxapyroxad broad spectrum of activity and it is ability to be a mixing partner of epoxiconazole and pyraclostrobin where that could be used in many crops including fruits, vegetables and cereals [13,14]. The results further revealed that mean maximum purple blotch disease severity (PDI) was recorded in untreated control (71.23% & 69.55% mean PDI) in both kharif season (Table 4). Adaskaveg [15] found that the new Succinate dehydrogenase inhibitors (SDHI) products, fluopyram and fluxapyroxad, are highly effective against powdery mildew but will only be sold as pre-mixtures. Thus the pre-mixtures offer high activity, very consistent performance, and built-in resistance management with two different modes of action for powdery mildew management. Difenconazole 25% EC 1000 mL/ha and Mancozeb 75% WP @ 2000 g/ha were effective in that order. Srivastava et al. [10] evaluated four fungicides, copper oxy chloride, mancozeb, carbendazim and thiram on purple blotch of onion caused by *A. porri*, and found that mancozeb showed the highest efficacy in controlling the disease. Overall, data revealed that the efficacy of Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 250 mL per ha and @ 200 mL per ha against purple blotch disease was found effective and superior

**Table 3. Details of treatment for phytotoxicity studies**

Tr. No.	Treatment Details	Dosage per ha		
		g a.i.	Formulation (mL or g)	Water volume (L)
T1	Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/ 500 SC	125	250	500
T2	Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/ 500 SC	250	500	500
T3	Control	-	-	-

**Table 4. Evaluation of bio-efficacy and phytotoxicity of different fungicides combinations against purple blotch of onion during 2017-18 and 2018-19**

Treatment details	2017-18					2018-19				
	% diseases PDI			Mean	Yields (t/ha)	% diseases PDI			Mean	Yields (t/ha)
	Before spray	I spray	II spray			Before spray	I spray	II spray		
Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 150g/ha	42.13 (40.46)	30.07 (33.25)	26.37 (30.90)	28.22	21.53	41.12 (39.88)	29.10 (32.64)	25.47 (30.30)	27.30	21.18 (27.40)
Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 200g/ha	42.57 (40.72)	28.44 (32.22)	24.48 (29.65)	26.46	22.30	41.03 (39.83)	27.85 (31.85)	23.73 (29.15)	25.79	22.53 (28.34)
Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 250g/ha	42.33 (40.58)	27.07 (31.35)	22.13 (28.06)	24.60	23.93	40.60 (39.58)	26.13 (30.74)	21.26 (27.45)	23.70	23.73 (29.15)
Pyraclostrobin 20% WG @500g/ha	43.24 (41.11)	36.73 (37.30)	34.35 (35.88)	35.54	18.00	40.70 (39.64)	36.47 (37.14)	33.60 (35.42)	35.10	18.12 (25.19)
Fluxapyroxad 300 g/L SC @ 209g/ha	42.72 (40.81)	37.03 (37.48)	35.57 (36.61)	36.30	17.83	40.60 (39.58)	36.25 (37.01)	34.77 (36.13)	35.51	17.77 (24.93)
Difenconazole 25 % EC @ 100 mL/100 L of water/ha	43.53 (41.28)	36.43 (37.12)	30.84 (33.73)	33.64	19.48	40.85 (39.72)	35.30 (36.45)	30.62 (33.59)	32.96	19.65 (26.31)
Mancozeb 75% WP @ 2000g/ha	43.73 (41.39)	36.81 (37.35)	32.87 (34.78)	34.84	18.30	41.05 (39.84)	36.13 (36.94)	31.62 (34.21)	33.88	18.50 (25.47)
Control	43.97 (41.53)	69.23 (56.30)	73.22 (58.83)	71.23	13.25	41.03 (39.83)	68.08 (55.59)	71.02 (57.42)	69.55	13.30 (21.39)
SEm±	2.10	2.25	1.92		1.10	1.32	1.86	1.82		1.18
CD(0.05)	NS	6.82	5.82		3.34	NS	5.63	5.52		3.59

**Table 5. Phytotoxicity report of different fungicides combinations against Purple Blotch of onion during 2017-18 and 2018-19**

Day of observation after spray	Sl. No.	Treatment	Phytotoxicity Symptoms				
			Leaf tip and surface injury	Wilting	Vein clearing	Necrosis	Epinasty and hyponasty
1 <sup>st</sup> Day	1.	Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 250 mL/ha	0	0	0	0	0
	2.	Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 500 mL/ha	0	0	0	0	0
	3.	Untreated control	0	0	0	0	0
3 <sup>rd</sup> Day	1.	Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 250 mL/ha	0	0	0	0	0
	2.	Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 500 mL/ha	0	0	0	0	0
	3.	Untreated control	0	0	0	0	0
5 <sup>th</sup> Day	1.	Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 250 mL/ha	0	0	0	0	0
	2.	Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 500 mL/ha	0	0	0	0	0
	3.	Untreated control	0	0	0	0	0
7 <sup>th</sup> Day	1.	Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 250 mL/ha	0	0	0	0	0
	2.	Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 500 mL/ha	0	0	0	0	0
	3.	Untreated control	0	0	0	0	0

Day of observation after spray	Sl. No.	Treatment	Phytotoxicity Symptoms				
			Leaf tip and surface injury	Wilting	Vein clearing	Necrosis	Epinasty and hyponasty
10 <sup>th</sup> Day	1.	Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 250 mL/ha	0	0	0	0	0
	2.	Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 500 mL/ha	0	0	0	0	0
	3.	Untreated control	0	0	0	0	0

comparable to Difenconazole 25% EC and Mancozeb 75% WP. The results obtained are in conformity with the observations of Ponnappa [2] who studied the *in vitro* efficacy of fungicides against onion leaf blight caused by *A. cepulae* and reported that Dithane M-45 showed complete inhibition at 0.2% concentration.

### 3.2 Phytotoxicity

The phytotoxicity result revealed that Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC showed no visual symptoms of phytotoxicity noticed in terms of leaf tips and surface injury, wilting, necrosis, epinasty and hyponasty on onion crops in all the treatment (Table 5). Yadav et al. [16] tested different concentrations of systemic fungicides *in vitro* and revealed that Hexaconazole was found to be the most effective with highest mean inhibition of radial growth (98.21%) followed by Propiconazole (97.32%) and Difenaconazole (91.23%). Wanggikar et al., [17] tested the fungicides and found that Hexaconazole showed cent per cent (100%) inhibition, followed by Difenaconazole (83.91%) and Mancozeb (63.58%). The pre-mixture fungicides were found highly effective in controlling the powdery mildew disease when compared to the individual fungicide spray separately (Table 5). Karaoglanidisa and Karadimosb [18] reported that efficacy of strobilurins increased when mixed with other broad spectrum or contact fungicides in controlling powdery mildew in sugar beet fields.

### 3.3 Yield

Yield data showed that the maximum yield was recorded by Fluxapyroxad 250 g/L +Pyraclostrobin 250 g/L 500 SC @ 250 mL per ha( 23.93 t / ha) followed by Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC C 200 mL per ha (22.30t/ha) and the next best treatment was Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC@ 150 mL/L of water /ha (21.53 t/ha) (Table 4). The least yields were recorded in untreated control (13.25 t/ha). All fungicides significantly increased the yield as compared to untreated control. It has both excellent preventative and curative activity through the inhibition of fungi at several stages of the fungal lifecycle including spore germination, germ tube growth, appresoria formation and mycelial growth [19].

## 4. CONCLUSION

The application of Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L 500 SC @ 200 mL/ha effectively control the purple blotch onion in India. Fluxapyroxad 250 g/L +Pyraclostrobin 250 g/L 500 SC @ 200 mL/ha is safer to onion crop without causing any type of phytotoxic effect.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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