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Evaluation of bio-efficacy and phytotoxicity of BAS 751 01 F SC against early blight disease of tomato

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Abstract
Early blight disease in tomato is destructive in nature and reduces fruit yield. Fungicides were used to control early blight disease but still early blight disease occurs. Hence, for in search of good alternative fungicide to control early blight disease, field experiment on efficacy of BAS 751 01 F SC against early blight disease was conducted in *kharif season* of 2017-18 and 2018-19. There were 7 treatments with six fungicides and control. Observations on per cent disease index (PDI), fruit yield and phytotoxicity of fungicides on tomato were recorded. In both 2017-18 and 2018-19, BAS 751 01 F SC with a.i.(g) of 200 @ 500 ml or g/ 500 – 750 litres of water was found superior in reducing disease severity (22.12 % mean PDI) over other fungicides used. In 2017-18 and 2018-19, BAS 751 01 F SC with a.i.(g) of 200 @ 500 ml or g/ 500 – 750 litres of water treated plants produced higher yield of tomato fruits (19.41 t/ha, 19.80 t/ha) over other fungicides. BAS 751 01 F SC with a.i.(g) of 200 @ 500 ml or g/ 500 – 750 litres of water were not toxic to tomato plant in kharif season of 2017-18 and 2018-19. The results concluded that use of BAS 751 01 F SC with a.i.(g) of 200 @ 500 ml or g/ 500 – 750 litres of water resulted in reducing disease severity and improved yield.

Keywords: Bio-efficacy, phytotoxicity, BAS 751 01 F SC, blight disease, tomato

Introduction
Tomato (*Lycopersicon esculentum* Mill.) is grown in Karnataka as important vegetable crop. Tomato is infected by *Alternaria solani* during its growth. This plant pathogen produces early blight disease in tomato which is destructive in nature and consequently reduces fruit yield of tomato. Several fungicides have been tested to control early blight disease in tomato (Sharma *et al.* 2018, Tiwari *et al.*, 2004; Yadav and Dabbas, 2012; Sahu *et al.*, 2013 and Saxena *et al.* 2016, Patel, and Chaudhary, 2010) [6, 7, 9, 4, 5, 3] but still early blight disease in tomato occurs and causes reduction in yield and economic loss to the farmers. Hence, in order to find out the good alternative fungicide to control early blight disease in tomato, the field experiment on the evaluation of bio-efficacy and pytoxicity of BAS 751 01 F SC against early blight disease of Tomato was conducted.

Materials and methods
Field experiment was conducted to evaluate the bio-efficacy and phytotoxicity of BAS 751 01 F SC against early blight disease of tomato in farmer's field at Kakol village in Ranebennur taluk, Haveri district during *kharif* season in the year 2017-18 and 2018-19. Tomato variety used for the study was Arka Samrath. The soil type was black soil. The thirty days old tomato plants were transplanted at the spacing of 90 cm x 75 cm. The plot size was 20 meter square. The tomato crop was grown under irrigated condition. The experiment was conducted in randomized block design with seven treatments and three replications. The treatments were T1: BAS 751 01 F SC with a.i.(g) of 120 @ 300 ml or g/ 500 – 750 litres of water, T2 : BAS 751 01 F SC with a.i.(g) of 160 @ 400 ml or g/ 500 – 750 litres of water, T3 : BAS 751 01 F SC with a.i.(g) of 200 @ 500 ml or g/ 500 – 750 litres of water, T4 : BAS 750 02 F 400g/l SC with a.i.(g) of 100 @ 250 ml or g/ 500 – 750 litres of water, T5 : Pyraclostrobin 20% WG with a.i.(g) of 100 @ 500 ml or g/ 500 litres of water, T6 : Mancozeb 75% WP with a.i.(g) of 1500 @ 2000 ml or g/ 500 litres of water and T7: Untreated control

Type of Sprayer used to spray fungicides was Knap sack sprayer fitted with flood jet. Tomato crop was sprayed with fungicides at different stages of growth as per treatments. The first spray was given at flower formation stage. Subsequent 2 sprays were given at the interval of 15 days during *kharif season* of 2017-18 and 2018-19. Early blight disease severity was recorded in 5 plants for each plot at 30 and 45 days after transplanting (DAT) on 0 - 5 standard rating scale (0: No symptoms on the leaf, 1: 0-5 per cent area infected and covered by spot, no spot on petiole and branches, 2: 6-20 per cent leaf area infected and covered by spot, some spots on petiole and branches, 3: 21-40 per cent leaf area infected and covered by spot, spots also seen on petiole, branches, 4: 41-70 per cent leaf area infected and covered by spot, spots also seen on petiole. braches, stem and 5 : More than 71 per cent leaf area infected and covered by spot, spots also seen on petiole, branch, stem, fruits) and the scale was converted into disease severity (Per cent Disease Index i.e. PDI) using the formula given by wheeler (1969) [8]. Observations on fruit yield per plot were recorded. The data on disease severity and fruit yield were analysed statistically and presented (Gomez and Gomez, 1986) [2].

$$PDI = \frac{\text{Sum of the individual disease ratings}}{\text{Number of fruits/leaves observed}} X \frac{100}{\text{Maximum disease rating value}}$$

Phytotoxic effects of BAS 751 01 F 400 g/l SC

Field experiment was conducted in the field to study the phytotoxic effect of BAS 751 01 F 400 g/l SC on tomato in *kharif season* in the year 2017-18 and 2018-19. The treatments included were T1: BAS 751 01 F SC with a.i.(g) of 200 @ 500 ml or g/ 500 – 750 litres of water, T2: BAS 751 01 F SC with a.i.(g) of 400 @ 1000 ml or g/ 500 – 750 litres of water and T3: untreated control with three replications. Phytotoxic symptoms of BAS 751 01 F 400 g/l SC such as leaf tips and surface injury, wilting, necrosis, epinasty and hyponasty on plants were observed on 1st day, 3rd day, 5th day, 7th day and 10th day after spray. The phytotoxic symptoms were recorded on 0-10 scale (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 and 10 : 91-100 % phytotoxicity) (CIB 1989) [1]. For this five plants were selected at random from each treatment and the total number of leaves and those showing phyto-toxicty were counted. The data collected were converted into percentage. The extent of phyto-toxicty was recorded.

Results and Discussion

Percent disease index and fruit yield

The results of the study showed that BAS 751 01 F 400 g/l SC, Pyraclostrobin 20% WG and Mancozeb 75% WP were found effective in reducing the disease index of early blight in tomato over untreated control in *kharif* season of 2017-18 and 2018-19 (Tables 1 and 2). However, among the different fungicides, BAS 751 01 F SC with a.i.(g) of 200 @ 500 ml or g/ 500 – 750 litres of water was found more effective in reducing the disease index of early blight in tomato in *kharif* season of 2017-18 and 2018-19. In 2017-18, BAS 751 01 F SC with a.i.(g) of 200 @ 500 ml or g/ 500 – 750 litres of water was found superior in reducing disease severity (22.12 % mean PDI) where as other fungicides BAS 751 01 F SC with a.i.(g) of 160 @ 500 ml or g/ 500 – 750 litres of water, BAS 751 01 F SC with a.i.(g) of 120 @ 500 ml or g/ 500 – 750 litres of water, BAS 750 02 F 400g/l SC with a.i.(g) of 100 @ 250 ml or g/ 500 – 750 litres of water, Pyraclostrobin 20% WG with a.i.(g) of 100 @ 500 ml or g/ 500 litres of water and Mancozeb 75% WP with a.i.(g) of 1500 @ 2000 ml or g/ 500 litres of water showed 24.55, 26.19, 27.88, 29.9, and 30.89 % mean PDI respectively. The maximum mean early blight disease severity (PDI) was recorded in untreated control plants (mean PDI of 48.37) (Table 1). In 2018-19, BAS 751 01 F SC with a.i.(g) of 200 @ 500 ml or g/ 500 – 750 litres of water was found superior in reducing disease severity (21.30 % mean PDI) where as other fungicides BAS 751 01 F SC with a.i.(g) of 160 @ 500 ml or g/ 500 – 750 litres of water, BAS 751 01 F SC with a.i.(g) of 120 @ 500 ml or g/ 500 – 750 litres of water, BAS 750 02 F 400g/l SC with a.i.(g) of 100 @ 250 ml or g/ 500 – 750 litres of water, Pyraclostrobin 20% WG with a.i.(g) of 100 @ 500 ml or g/ 500 litres of water and Mancozeb 75% WP with a.i.(g) of 1500 @ 2000 ml or g/ 500 litres of water showed 23.28, 25.29, 26.73, 28.94, and 29.97 % mean PDI respectively. The maximum mean early blight disease severity (PDI) was recorded in untreated control plants (mean PDI of 45.37) (Table 2).

These findings were in agreement with results of previous experiments wherein fungicides used to control plant diseases (Sharma *et al.* 2018, Sahu *et al.*, 2013 and Saxena *et al.* 2016) [6, 4, 5]. Fungicidal treatments reduced the disease intensity of early blight disease of tomato and among different fungicidal applications, application of carbendazim 12 % + mancozeb 63 % WP @ 0.2 % (18.77) recorded the lowest percent disease intensity followed by difenoconazole 25 EC @ 0.025 % (20.59) and propiconazole 25 EC @ 0.025 % (21.52) (Sharma *et al.*, 2018) [6]. Maximum disease reduction in tomato was recorded in tomato plants treated with Onestar 23 % SC and Amistar 23 % SC (69–71 % recorded) (Saxena *et al.*, 2016) [5]. Fungicide, Pristine 38%WG @ 64+126g a.i. /ha (31.88%) significantly reduced the disease followed by maccani 16%WG @ 60+180g a.i./ha (33.31%) (Sahu *et al.*, 2013) [4]

Tomato plants treated with fungicides produced significantly higher yield compared to untreated control plants in both 2017-18 and 2018-19. The increased fruit yield due to fungicide treatment of tomato plants grown during *kharif* season of 2017-18 was 19.41 t/ha (BAS 751 01 F SC with a.i.(g) of 200 @ 500 ml or g/ 500 – 750 litres of water), 18.60 t/ha (BAS 751 01 F SC with a.i.(g) of 160 @ 400 ml or g/ 500 – 750 litres of water,), 18.27 t/ha (BAS 751 01 F SC with a.i.(g) of 120 @ 300 ml or g/ 500 – 750 litres of water), 17.83 t/ha (BAS 750 02 F 400g/l SC with a.i.(g) of 100 @ 250 ml or g/ 500 – 750 litres of water),17.20 t/ha (Pyraclostrobin 20% WG with a.i.(g) of 100 @ 500 ml or g/ 500 litres of water), 16.36 t/ha (Mancozeb 75% WP with a.i.(g) of 1500 @ 2000 ml or g/ 500 litres of water) over the untreated control 13.55 t/ha. In 2018-19 also, similar trend of 2017-18 in the increased fruit yield due to fungicide treatment was observed. The increased fruit yield due to fungicide treatment in *kharif* season of 2017-18 was 19.80 t/ha (BAS 751 01 F SC with a.i.(g) of 200 @ 500 ml or g/ 500 – 750 litres of water), 18.63 t/ha (BAS 751 01 F SC with a.i.(g) of 160 @ 400 ml or g/ 500 – 750 litres of water,), 18.30 t/ha (BAS 751 01 F SC with a.i.(g) of 120 @ 300 ml or g/ 500 – 750 litres of water), 17.85 t/ha (BAS 750 02 F 400g/l SC with a.i.(g) of 100 @ 250 ml or g/ 500 – 750 litres of water),17.80 t/ha (Pyraclostrobin 20% WG with a.i.(g) of 100 @ 500 ml or g/ 500 litres of water), 16.72 t/ha (Mancozeb 75% WP with a.i.(g) of 1500 @ 2000 ml or g/ 500 litres of water) over the untreated control 13.82 t/ha.

Overall, data revealed that BAS 751 01 F SC with a.i.(g) of 200 @ 500 ml or g/ 500 – 750 litres of water was found

effective and superior in increasing the tomato fruit yield due to reduction of PDI over other formulations. The increased fruit yield due to fungicide application was due to control of early blight disease which might have resulted in better development of foliage of tomato and consequently higher fruit yield in plants. These results were in agreement with previous experiments wherein the increased fruit yield of tomato in plants treated with various fungicides was reported (Sharma *et al.*, 2018., Saxena *et al.*, 2016 and Sahu *et al.*, 2013) [6, 4, 5]. Among different fungicides, the highest yield of tomato fruits was recorded with carbendazim 12 % + mancozeb 63 % WP @ 0.2 % (35257 kg/ha) followed by propiconazole 25 EC @ 0.025 % (32328 kg/ha) and difenoconazole 25 EC @ 0.025 % (32202 kg/ha) (Sharma *et al.*, 2018) [6]. Fungicidal treatments (Onestar 23 % SC and Amistar 23 % SC) enhanced yield by 1.39 fold (Saxena *et al.*, 2016) [5]. Increase in the fruit yield of tomato due to application fungicide of Pristine 38%WG @ 64+126g a.i. ha) (33.50 tonnes/ha) and of maccani 16%WG @ 80+ 240g a.i./ha) (32.44 tonnes/ha) as compared to a maximum disease (76.2%) and minimum yield of only 21.15 tonnes/ha in control was reported (Sahu *et al.*, 2013) [4]. This information could be used in disease management program for controlling early blight of tomato.

Phyto-toxicity study

Phyto-toxicity studies of BAS 751 01 F SC with a.i. (g) of 200 @ 500 ml or g/ 500 – 750 litres of water and BAS 751 01 F SC with a.i.(g) of 400 @ 1000 ml or g/ 500 – 750 litres of water revealed that these were not toxic to tomato plant in *kharif* season of 2017-18 and 2018-19 (Tables 3 and 4). There were no visual symptoms of phyto-toxicty in terms of leaf tips and surface injury, wilting, necrosis, epinasty and hyponasty on tomato plants treated with BAS 751 01 F SC with a.i.(g) of 200 @ 500 ml or g/ 500 – 750 litres of water (T1) and BAS 751 01 F SC with a.i.(g) of 400 @ 1000 ml or g/ 500 – 750 litres of water (T2) on 1st day, 3rd day, 5th day, 7th day and 10th day after spray This study indicated that BAS 751 01 F SC with a.i.(g) of 200 @ 500 ml or g/ 500 – 750 litres of water or BAS 751 01 F SC with a.i.(g) of 400 @ 1000 ml or g/ 500 – 750 litres of water could be be used to control early blight of tomato safely without being toxic to plant. The similar observations on fungicidal phyto-toxicty were reported in previous experiments (Sahu *et al.*, 2013; Saxena *et al.*, 2016) [4, 5].

Table 1: Evaluation of bio-efficacy of BAS 751 01 F SC against early blight disease of tomato during 2017-18

Tr. No	Treatment Details	a.i.(g)	Dosage/ha Formulation (g or ml)	Water volume (L)	% diseases PDI			Mean	Yields (t/ha)
					Before spray	I spray	II spray		
T1	BAS 751 01 F SC	120	300	500-750	31.79 (34.32)	29.11 (32.65)	23.26 (28.83)	26.19	18.27
T2	BAS 751 01 F SC	160	400	500-750	31.58 (34.19)	28.12 (32.02)	20.97 (27.25)	24.55	18.60
T3	BAS 751 01 F SC	200	500	500-750	30.74 (33.67)	25.67 (30.44)	18.57 (25.52)	22.12	19.41
T4	BAS 750 02 F 400 g/l SC	100	250	500-750	32.34 (34.65)	29.33 (32.79)	26.43 (30.94)	27.88	17.83
T5	Pyraclostrobin 20% WG	100	500	500	32.75 (34.90)	31.57 (34.18)	28.23 (32.09)	29.9	17.20
T6	Mancozeb 75% WP	1500	2000	750	32.32 (34.64)	32.00 (34.45)	29.77 (33.06)	30.89	16.36
T7	Untreated Control	-	-	-	32.52 (34.76)	39.67 (39.03)	57.07 (49.06)	48.37	13.55
	SEm±				0.39	1.74	1.58		0.89
	CD(0.05)				1.20	5.38	4.87		2.74

Figures in parenthesis indicate arcsine values.

Table 2: Evaluation of bio-efficacy of BAS 751 01 F SC against early blight disease of tomato during 2018-19

Tr. No	Treatment Details	a.i.(g)	Dosage/ha Formulation (g or ml)	Water volume (L)	% diseases PDI			Mean	Yields (t/ha)
					Before spray	I spray	II spray		
T1	BAS 751 01 F SC	120	300	500	30.58 (33.57)	28.30 (32.13)	22.27 (28.15)	25.29	18.30 (25.32)
T2	BAS 751 01 F SC	160	400	500	30.97 (33.81)	27.23 (31.45)	19.32 (27.07)	23.28	18.63 (25.57)
T3	BAS 751 01 F SC	200	500	500	30.80 (33.70)	24.60 (29.73)	17.95 (25.06)	21.30	19.80 (26.42)
T4	BAS 750 02 F 400 g/l SC	100	250	500	30.27 (33.37)	28.27 (32.11)	25.23 (30.15)	26.73	17.85 (24.99)
T5	Pyraclostrobin 20% WG	100	500	500	30.70 (33.64)	30.60 (33.58)	27.27 (31.47)	28.94	17.80 (24.95)
T6	Mancozeb 75% WP	1500	2000	750	30.67 (33.62)	31.37 (34.06)	28.57 (32.30)	29.97	16.72 (24.13)
T7	Untreated Control	-	-	-	30.83 (33.73)	40.03 (39.25)	50.70 (45.40)	45.37	13.82 (21.82)
	SEm±				0.24	1.60	1.55		0.96
	CD(0.05)				0.74	4.91	4.80		2.95

Figures in parenthesis indicate arcsine values.

Table 3: Phytotoxicity effect of BAS 751 01 F SC on tomato grown in field in *kharief* season of 2017-18

Day of observation after spray	Sl. No.	Treatments	Phytotoxicity Symptoms				
			Leaf tips and surface injury	Wilting	Vein clearing	Necrosis	Epinasty and hyponasty
1st Day	1. 2. 3.	BAS 751 01 F @ 500 ml/ha BAS 751 01 F @ 1000 ml/ha Untreated control	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
3rd Day	1. 2. 3.	BAS 751 01 F @ 500 ml/ha BAS 751 01 F @ 1000 ml/ha Untreated control	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
5th Day	1. 2.	BAS 751 01 F @ 500 ml/ha BAS 751 01 F @ 1000 ml/ha	0 0	0 0	0 0	0 0	0 0

	3.	Untreated control	0 0	0 0	0 0	0 0	0 0
7th Day	1. 2. 3.	BAS 751 01 F @ 500 ml/ha BAS 751 01 F @ 1000 ml/ha Untreated control	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
10th Day	1. 2. 3.	BAS 751 01 F @ 500 ml/ha BAS 751 01 F @ 1000 ml/ha Untreated control	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0

0: No Phytotoxicity

Table 4: Phytotoxicity effect of BAS 751 01 F SC on tomato grown in field in *kharief* season of 2018-19

Day of observation after spray	Sl. No.	Treatments	Phytotoxicity Symptoms				
			Leaf tips and surface injury	Wilting	Vein clearing	Necrosis	Epinasty and hyponasty
1st Day	1. 2. 3.	BAS 751 01 F @ 500 ml/ha BAS 751 01 F @ 1000 ml/ha Untreated control	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
3rd Day	1. 2. 3.	BAS 751 01 F @ 500 ml/ha BAS 751 01 F @ 1000 ml/ha Untreated control	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
5th Day	1. 2. 3.	BAS 751 01 F @ 500 ml/ha BAS 751 01 F @ 1000 ml/ha Untreated control	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
7th Day	1. 2. 3.	BAS 751 01 F @ 500 ml/ha BAS 751 01 F @ 1000 ml/ha Untreated control	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
10th Day	1. 2. 3.	BAS 751 01 F @ 500 ml/ha BAS 751 01 F @ 1000 ml/ha Untreated control	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0

0: No Pyhtotoxicity

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