Evaluation of SAAF Fungicide for the Chemical Control of Major Diseases of Chilli (Capsicum annuum L.)

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Abstract
A field experiment was conducted from October 2011 to January 2012 at Tamil Nadu Agricultural University (TNAU) to evaluate the bio-efficacy and crop safety of SAAF against major fungal diseases of chilli (Capsicum annuum L.), particularly leaf spot, powdery mildew, and anthracnose or fruit rot. These diseases are among the most important production constraints in chilli cultivation because they reduce leaf area, affect fruit quality, and cause considerable yield losses when not properly managed. The trial compared different doses of SAAF with standard fungicidal checks and an untreated control under field conditions. Three foliar sprays were applied at ten-day intervals beginning from the appearance of disease symptoms, and disease intensity was recorded after each spray. Disease severity on leaves and fruits was expressed as percent disease index, while yield, benefit-cost ratio, and phytotoxicity symptoms were also assessed. The results indicated that SAAF at 562.5 g a.i./ha, equivalent to 750 g/ha formulation, effectively controlled leaf spot, powdery mildew, and anthracnose/fruit rot in chilli. This dose was statistically at par with the higher dose of SAAF and produced better yield than most other treatments. SAAF at 750 g/ha recorded a yield of 14.85 t/ha and a benefit-cost ratio of 1:5.03, while the higher dose recorded only a marginally greater response. No phytotoxic symptoms were observed up to 1125 g a.i./ha (1500 g/ha), which is double the effective dose. The study therefore suggests that SAAF at 750 g/ha is an effective, safe, and economically viable option for managing major chilli diseases.

Keywords: Chilli, SAAF, Leaf spot, Anthracnose, Powdery mildew, Fungicide efficacy

1. Introduction

Chilli (Capsicum annuum L.) is one of the most important vegetable and spice crops cultivated in Asia and many other parts of the world. It is widely valued for its use as a vegetable, spice, condiment, and source of natural colour and pungency. India is among the leading producers and consumers of chilli, and the crop plays an important role in domestic markets as well as export earnings. In Tamil Nadu, chilli is cultivated under diverse agro-climatic conditions; however, productivity is often limited by pest and disease pressure.

Crop losses caused by plant diseases remain a major challenge in chilli production. Fungal diseases can attack both foliage and fruits, thereby reducing photosynthetic efficiency, marketable yield, fruit quality, and farmers' income. Since chilli is a high-value crop, effective and economical disease management is essential for sustaining production and ensuring better returns to growers.

Among the diseases affecting chilli, leaf spot, powdery mildew, and anthracnose or fruit rot are particularly destructive. Anthracnose, caused mainly by Colletotrichum capsici, is common in chilli-growing regions and can cause severe fruit infection, dieback, and post-harvest losses. Powdery mildew, caused by Leveillula taurica, results in defoliation and poor fruit development, while leaf spot weakens the crop and reduces overall plant vigour.

Leaf spot symptoms generally appear as circular lesions with grey centres and reddish-brown margins. As the disease progresses, lesions may enlarge and develop a characteristic dark ring and yellow halo, producing a frog-eye appearance. The pathogen survives on infected seed, crop debris, and soil-borne residues, making repeated disease occurrence common under favourable field conditions.

Powdery mildew is also a serious constraint in chilli cultivation. It causes white powdery growth, leaf yellowing, defoliation, and reduction in fruit size and number. Severe infection can result in substantial yield losses, particularly when the disease appears during the reproductive stage of the crop.

Several fungicides, including carbendazim and mancozeb, have been used for the management of fungal diseases in chilli and other crops. Carbendazim is a systemic benzimidazole fungicide, while mancozeb is a broad-spectrum protective fungicide with multi-site action. Although these fungicides have shown efficacy against different fungal

pathogens, the use of single molecules may not provide broad and consistent control against multiple diseases occurring simultaneously.

Mancozeb is particularly useful as a protective fungicide against a wide range of fungal diseases in horticultural and field crops. It adheres well to plant surfaces and provides preventive protection. However, under high disease pressure, combined or more effective formulations may be required to manage multiple pathogens and improve disease control efficiency.

In view of the need for effective and economical disease management, the present investigation was carried out to evaluate the performance of SAAF, a fungicide formulation of United Phosphorus Limited, Mumbai, against major diseases of chilli under field conditions.

Preliminary observations indicated that no single conventional fungicide provided equally effective control of all major chilli diseases at the same time. Therefore, evaluation of newer fungicide formulations such as SAAF is important for identifying suitable doses that can provide broad-spectrum disease control, improve yield, and remain safe for the crop.

2. Materials and Methods

The field trial was conducted from October 2011 to January 2012 at Tamil Nadu Agricultural University (TNAU) to evaluate the bio-efficacy of SAAF against major diseases of chilli. Recommended agronomic practices were followed throughout the crop period. The test fungicide was evaluated along with standard fungicidal checks and an untreated control against leaf spot, powdery mildew, and anthracnose or fruit rot on both leaves and fruits. Three foliar sprays were applied at 10-day intervals, beginning from the first appearance of disease symptoms, 33 days after sowing. Observations were recorded on the tenth day after each spray, and the final disease scoring after the third spray was considered as terminal disease intensity. Fifteen leaves from five randomly selected plants per plot were assessed for foliar disease severity, while fruit disease severity was recorded from ten randomly selected fruits per plot at harvest. Disease severity was converted into percent disease index (PDI) using the following formula:

$$PDI = \frac{\text{Sum of numerical values}}{} \times \frac{100}{}$$

Number of leaves/fruits observed Maximum disease rating value

The PDI values were transformed into arcsine values before statistical analysis and were presented with DMRT groupings. For phytotoxicity evaluation, leaves and fruits from all treatments, including the higher SAAF dose of 1500 g/ha, were visually examined for symptoms such as chlorosis, necrosis, leaf injury, wilting, deformation, or abnormal plant growth. Fruit yield from each plot was recorded at every harvest, pooled treatment-wise, converted into tonnes per hectare, and statistically analyzed.

Cost Benefit (C: B) ratio

The benefit-cost ratio for each treatment was calculated using the prevailing local market price of chilli and the cost of inputs used in the experiment, including fungicide cost, spraying cost, and basic cultivation cost.

Table -1: Effect of SAAF on Leaf spot of chilli – Season I and II

Treatments	Product Dose (g or ml ha)	First season		Second season	
		3rd Spray	Percent reduction over control	3rd Spray	Percent reduction over control
SAAF	500	7.61 (16.00)[b]	61.95	8.67 (17.12)[b]	53.56
SAAF	750	4.82 (12.66)[a]	75.90	4.69 (12.38)[a]	74.88
SAAF	1000	4.70 (12.52)[a]	76.50	4.61 (12.38)[a]	75.31
Mancozeb 75% WP	2000	7.20 (15.56)[b]	64.00	8.00 (16.43)[b]	57.15
Carbendazim 50%Wp	300	6.75 (15.06)[b]	66.25	7.64 (16.00[b]	59.08
Hexaconazole 2% SC	3000	10.67 (19.07)[c]	46.65	11.33 (19.65)[c]	39.31
Untreated control	-	20.00 (26.57)[d]	-	18.67 (25.58)[d]	-

CD value (At 5%P)	**1.37**	**2.01**

Values are means of three replications Figures in the parentheses represent arcsine transformed values PDI; Percent disease index
The common letters show non- significant differences among the treatments based on DMRT TDI; Terminal disease intensity

Table -2: Effect of SAAF on powdery mildew of chilli – Season I and II

Treatments	Product Dose (g or ml/ha)	First season				Second season			
		3rd Spray	Percent reduction over control	PDI on Fruits	Percent control	3rd Spray	Percent reduction over control	PDI on Fruits	Percent control
SAAF	500	7.93 (16.34)[b]	58.98	6.00 (14.15)[b]	50.66	9.68 (18.05)[b]	68.75	7.33 (15.71)[b]	48.23
SAAF	750	2.73 (9.51)[a]	85.88	3.63 (10.94)[a]	70.15	4.26 (11.83)[a]	86.25	4.25 (11.83)[a]	69.98
SAAF	1000	2.70	86.03	3.22	73.52	4.00	87.09	4.20	70.34

		(9.45)[a]		(10.30)[a]		(11.54)[a]		(11.83)[a]	
Mancozeb 75% WP	2000	12.00 (20.27)[c]	37.92	8.22 (16.64)[c]	32.40	21.51 (27.62)[c]	30.57	10.79 (19.09)[c]	23.80
Carbendazim 50%WP	300	8.67 (17.10)[b]	55.15	6.69 (14.89)[b]	44.98	10.01 (18.43)[b]	67.69	8.73 (17.15)[b]	38.35
Hexaconazole 2% SC	3000	3.85 (11.32)[a]	80.08	4.00 (11.52)[a]	67.11	5.33 (13.35)[a]	82.80	5.25 (13.25)[a]	62.92
Untreated control	-	19.33 (26.08)[d]	-	12.16 (20.36)[d]	-	30.98 (33.74)[d]	-	14.16 (22.06)[d]	-
CD value (At 5%P)		**2.01**		**1.71**		**2.30**		**1.50**	

Values are means of three replications **Figures in the parentheses represent arcsine transformed values PDI; Percent disease index**
The common letters show non- significant differences among the treatments based on DMRT **TDI; Terminal disease intensity**

Table -3: Effect of SAAF on anthracnose or fruit rots of chilli – Season I and II

Treatments	First Season					Second Season			
	Product Dose (g or ml	3rd Spray	Percent reduction over	PDI on Fruits	Percent control	3rd Spray	Percent reduction over	PDI on Fruits	Percent control

	/ha)		control			control		
SAAF	500	6.57 (14.77)[b]	58.94	6.47 (14.65)[b]	51.86	6.00 (14.15)[b]	59.10	5.47 (13.44)[b]	58.60
SAAF	750	4.31 (11.97)[a]	73.06	4.67 (12.38)[a]	65.25	3.44 (10.62)[a]	76.55	3.76 (11.09)[a]	71.54
SAAF	1000	4.30 (11.97)[a]	73.13	4.60 (12.38)[a]	65.77	3.39 (10.47)[a]	76.89	3.70 (11.09)[a]	71.99
Mancozeb 75% WP	2000	7.18 (15.45)[b]	55.13	7.47 (15.86)[b]	44.42	7.33 (15.69)[b]	50.03	5.76 (13.81)[b]	56.40
Carbendazim 50%WP	300	7.39 (15.68)[b]	53.81	7.92 (16.32)[b]	41.07	7.50 (15.84)[b]	48.87	6.16 (14.30)[b]	53.37
Hexaconazole 2% SC	3000	10.61 (19.00)[c]	33.69	9.85 (18.27)[c]	26.71	10.67 (19.05)[c]	27.27	9.67 (18.05)[c]	26.80
Untreated control	-	16.00 (23.58)[d]	-	13.44 (21.47)[-d]	-	14.67 (22.50)[d]	-	13.21 (21.30)[d]	-
CD value (At 5%P)		**1.73**		**1.87**		**1.83**		**1.10**	

Values are means of three replications **Figures in the parentheses represent arcsine transformed values PDI; Percent disease index**

The common letters show non- significant differences among the treatments based on DMRT **TDI; Terminal disease intensity**

Table-5: Effect of SAAF on yield of chillies – Season I and II

Treatments	Product Dose (g or ml/ha)	Yield (t/ha)	Increased Yield over Control
SAAF	500	12.08[b]	51.38
SAAF	750	14.85[a]	86.10
SAAF	1000	15.00[a]	87.96
Mancozeb 75% WP	2000	12.33[b]	54.51
Carbendazim 50%Wp	300	9.67[c]	21.18
Hexaconazole 2% SC	3000	11.97[b]	50.00
Untreated control	-	7.98[d]	-
CD value (At 5%P)		**2.15**	

Values are means of three replications

the common letters show non- significant differences among the treatments based on DMRT

Table - 6: Benefit cost ratio

Treatment	Dose (g or ml/ha)	Yield (kg/ha)	Gross returns (Rs./ha)	Total cost of cultivation (Rs./ha)	Net Returns (Rs./ha)	Benefit : cost ratio
SAAF	500	12080	181200	36575	144625	3.95
SAAF	750	14850	222750	36913	185838	5.03
SAAF	1000	15000	225000	37250	187750	5.04
Mancozeb 75% WP	2000	12330	184950	37400	147550	3.95
Carbendazim 50% WP	300	9670	145050	36215	108835	3.01
Hexaconazole 2% SC	3000	11970	179550	38600	140950	3.65
Untreated Control	-	8980	134700	35000	99700	2.84

- **Price of chilli : Rs. 15/kg**
- **Basic cost of cultivation: Rs. 35000/ha**
- **Cost of insecticide spray: Rs. 900/ha :**
- **Cost of insecticide:**

(i) SAAF : Rs. 450/kg

(ii) Mancozeb 75% WP: Rs. 250/kg

(iii) Carbendazim 50% WP: 350/kg

3. Results and Discussion

Effect on Leaf spot of chilli *(Cercospora capsici):*

All treatments reduced leaf spot severity compared with the untreated control. However, after the second application, foliar spraying of SAAF at 1000 g/ha recorded the lowest PDI, which was statistically at par with SAAF at 750 g/ha. Both treatments were significantly superior to the remaining fungicidal treatments. Across seasons, SAAF at 750 g/ha and 1000 g/ha consistently achieved higher disease reduction than mancozeb, carbendazim, and hexaconazole. These findings indicate that SAAF provides effective control of leaf spot and can be considered a reliable option for reducing foliar disease pressure in chilli.

Earlier studies have also reported the effectiveness of fungicides such as carbendazim, mancozeb, and combined formulations in reducing foliar disease incidence and improving crop yield. The present results support these findings and further show that SAAF performs well under field conditions, particularly at 750 g/ha and 1000 g/ha.

Effect on Powdery mildew of chilli *(Leviellula taurica):*

Chemical treatments were also effective in reducing powdery mildew compared with the untreated control. SAAF at 1000 g/ha recorded maximum control of powdery mildew and was statistically at par with SAAF at 750 g/ha and the standard check hexaconazole. The disease reduction observed in both seasons confirms that SAAF is effective against powdery mildew on chilli foliage.

Fruit infection data showed a similar trend. SAAF at 1000 g/ha recorded the lowest PDI on fruits, followed closely by SAAF at 750 g/ha. Since the difference between these two doses was not statistically significant, the 750 g/ha dose can be considered more economical and practically suitable. Previous reports on powdery mildew management have demonstrated the usefulness of systemic and protective fungicides; the present study adds that SAAF can also provide strong control under field conditions.

Effect on anthracnose or fruit rot disease of chilli (*Colletotrichum capsici*):

The incidence of anthracnose or fruit rot was significantly reduced by SAAF treatments. Foliar spraying with SAAF at 1000 g/ha recorded the minimum disease severity, but its performance was statistically comparable with SAAF at 750 g/ha. Both doses were superior to the other treatments and the untreated control. The results show that SAAF

effectively reduced disease severity on both foliage and fruits, with disease reduction exceeding 70 percent at the two higher doses.

The superior efficacy of SAAF may be attributed to the combined protective and systemic activity of its active components. Previous studies have reported the effectiveness of carbendazim, mancozeb, and their combined formulations against fungal pathogens affecting chilli and related crops. The present findings are consistent with those reports and demonstrate that SAAF can provide broad-spectrum control of major fungal diseases in chilli.

Phytotoxicity:

SAAF treatments at 500, 750, 1000, and 1500 g/ha were evaluated for phytotoxicity along with the standard checks. No visible phytotoxic symptoms were observed at any dose. The crop stand, leaf colour, fruit development, and plant growth remained normal at all observation stages, including 3, 7, and 10 days after spraying. This indicates that SAAF is safe for chilli up to 1500 g/ha, which is double the effective dose.

Yield:

SAAF at 1000 g/ha produced the highest yield of 15.00 t/ha, which was statistically at par with SAAF at 750 g/ha (14.85 t/ha). These two treatments recorded yield increases of 87.96 and 86.10 percent over the untreated control, respectively. Mancozeb, SAAF at 500 g/ha, and hexaconazole were the next best treatments, while carbendazim recorded comparatively lower yield among the fungicidal treatments. The results clearly show that improved disease control through SAAF application contributed to higher marketable chilli yield.

Cost benefit ratio:

The highest benefit-cost ratios were obtained with SAAF at 1000 g/ha (1:5.04) and SAAF at 750 g/ha (1:5.03), while the untreated control recorded a lower ratio of 1:2.84. Since SAAF at 750 g/ha was statistically comparable with the higher dose for disease control and yield, and produced almost the same economic return, it may be recommended as the optimum dose for practical field use.

4. Conclusion

The field evaluation confirmed that SAAF is effective against leaf spot, powdery mildew, and anthracnose or fruit rot of chilli. SAAF at 750 g/ha provided disease control, yield improvement, and economic return comparable to the higher dose, while showing no phytotoxic effect even at double the effective dose. Therefore, SAAF at 750 g/ha can be recommended as a safe and economical fungicidal option for managing major diseases of chilli under field conditions.

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