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Original Research Paper

Management of *Alternaria* leaf blight (*Alternaria polianthi*) of tuberose (*Agave amica*)

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ABSTRACT

Tuberose (*Agave amica*) is a perennial bulbous crop widely cultivated across the globe for its attractive and sweetly scented flowers used for loose flower, cut flower, perfume manufacture, essential oil production, and decoration. *Alternaria* leaf blight disease caused by *Alternaria polianthi* is a major limitation in tuberose cultivation. A field experiment was formulated to evaluate six fungicides against *Alternaria polianthi* causing leaf blight in tuberose. Results indicated that Difenconazole 25EC was the most effective with disease severity (11.13) compared to other treatments, followed by Tebuconazole 2DS. Tebuconazole 2DS and Azoxystrobin 23SC were the most effective in increasing the number of flowers per spike and spike length. Difenconazole 25EC also showed high effectiveness, particularly in spike length.

Keywords: Disease reduction, flower yield, fungicides, leaf blight

INTRODUCTION

Tuberose (*Agave amica*), family Asperagaceae, is a perennial bulbous crop widely cultivated across the globe for its attractive and sweetly scented flowers, which are highly valued in the floriculture industry and used for various purposes such as perfume manufacture, essential oil production, and decoration (Sadhukhan et al., 2022). It is grown extensively in India for its beautiful, fragrant white flowers and is highly valued for both loose and cut flowers. In India, tuberose is cultivated in an area of 21.13‘000 hectare with 91.42‘000 MT of loose flower and 102.20‘000 MT of cut flower production (Ministry of Agriculture and Farmer’s Welfare, 2022-23). The delightful fragrance attributed to the presence of geraniol, nerol, benzyl alcohol, eugenol, and methyl anthranilate.

Important diseases recorded in India on tuberose are *Sclerotium*-rot caused by *Sclerotium rolfsii* (Das, 1961), leaf blight due to *Alternaria polianthi* (Mariappan et al., 1977), *Phoma polianthis* (De, 2013) and *Lasiodiplodia theobromae* (Durgadevi & Sankaralingam, 2012). *Alternaria* leaf blight disease caused by *Alternaria polianthi* is a major limitation in tuberose cultivation, causing significant yield losses, affecting both quality and quantity of flowers.

The disease is characterized by the appearance of circular to irregular shaped lesions on the leaves, which can range in colour from brown to black (Timmer et al., 2003). These lesions can rapidly coalesce, leading to the blighting and drying of the leaves, which can significantly impact the overall growth and yield of the tuberose plants (Sadhukhan et al., 2022). The development and severity of *Alternaria* leaf blight in tuberose is influenced by a variety of environmental factors, particularly temperature and humidity. Warm, humid conditions with temperatures ranging from 20°C to 30°C are known to be conducive for the growth and proliferation of the *Alternaria* pathogen, leading to the rapid spread of the disease across tuberose fields (Timmer et al., 2003). The disease can also lead to a reduction in the size of the tuberose plants and, in severe cases, can result in the premature dropping of the flowers and buds (Sadhukhan et al., 2022).

While cultural and biological approaches are important components of a comprehensive disease management strategy, research has demonstrated that the strategic application of fungicides can provide an additional layer of protection against *Alternaria* leaf blight in tuberose. Fungicides containing active ingredients such as chlorothalonil, mancozeb or carbendazim have been found to be effective in controlling the disease, particularly when applied at the first signs of symptoms or during periods of high disease pressure (Abdel Ghany & Bakri, 2019). The literature review

indicated that applying four foliar sprays of azoxystrobin (0.1%) at 15-day intervals, beginning at the onset of the disease, was the most effective method and led to the lowest disease severity (Mazumder et al., 2016). Also advanced breeding lines of tuberose were also assessed for resistance to *Alternaria polianthi* leaf blight disease (Bharati et al., 2021). Among these, only the line IIHR-4 demonstrated tolerance to *Alternaria polianthi*.

It is crucial, however, to rotate fungicides with different modes of action to prevent the development of fungicide resistance and to minimize the risk of chemical residues in the harvested flowers. With this approach, a field experiment was formulated to evaluate six fungicides against *Alternaria polianthi* causing leaf blight in tuberose.

MATERIALS AND METHODS

The field evaluation was conducted at the research facility available at ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka during 2018 to 2021. The experiment was carried out during the *kharif* season of each year to assess the efficacy of both contact and systemic fungicides in managing *Alternaria* leaf blight in tuberose.

Field site was selected based on incidence of *Alternaria* leaf blight and employed a randomized complete block design with seven treatments [control, without fungicide treatment, chlorothalonil 75WP (2 g/L), metiram 70WP (2 g/L), difenconazole 25EC (0.5 ml/L), tebuconazole 2DS (1 g/L), carbendazim 50WP (1 g/L), azoxystrobin 23SC (0.03 ml/L)] with three replications. The experiment was laid out in a plot dimensions of 10 m x 10 m with plant spacing of 45 cm x 10 cm. The susceptible variety Arka Shringar was used. Other agronomical practices were carried out as per the schedule for tuberose.

The fungicides were applied at 7 days interval from the time of first appearance of the disease. Total 4 sprays were applied and observations were recorded on disease severity, disease reduction and yield parameters.

Disease severity was assessed using a standardized scale (Table 1). Evaluation was conducted at regular intervals (every 10 days) throughout the growing season to track disease progression and control effectiveness (Snedecor & Cochran, 1967).

Per cent disease index (PDI) = (sum of all individual disease rating/number of observed leaf × maximum disease rating) × 100

The disease severity 1-5 scale was used to score disease.

Table 1 : Scale description of per cent disease severity

Scale	Per cent leaf area infected
0	No visible symptoms
1	1-5 per cent leaves infected
2	6-10 per cent leaves infected
3	11-25 per cent leaves infected
4	26-50 per cent leaves area infected
5	>50 per cent leaves area infected

(0-5 scale, Narayanappa & Chandra, 1984)

Data collected included disease severity, crop yield, and quality. Statistical analysis was performed using ANOVA, to determine the efficacy of each fungicide treatment. The effectiveness of each fungicide was evaluated based on its ability to control *Alternaria* leaf blight and improve crop yield. Data were analysed for consistency across the three years to ensure reliable conclusion.

RESULT AND DISCUSSION

Of late *Alternaria* leaf blight caused by the fungus *Alternaria polianthi* is a significant disease affecting the cultivation of tuberose. The disease symptoms appear in the months of June to January. It was reported for the first time by Mariappan et al. (1977). The disease starts from the tip of the leaves and slowly advances towards the leaf length. The symptoms on the leaves appear as leaf blight. The leaf becomes flaccid and starts dropping (Fig. 1). This disease affects photosynthetic ability, reduces the flower and bulb yield, in severe cases it may lead to complete defoliation and death of the plant (Gossen et al., 2016).

Fig. 1 : *Alternaria polianthi* symptoms on leaf and tuberose stalk, *conidia* (20 mm)

Table 2 : Evaluation of different fungicides against leaf blight disease in tuberose under field condition

Treatment	Disease severity (%)				
	2018-19	2019-20	2020-21	Pooled mean	PDR*
Control	28.71 (32.37)	30.56 (33.58)	35.30 (36.47)	31.52 (34.14)	-
Chlorothalonil 75WP	15.75 (23.27)	20.75 (27.11)	23.75 (29.18)	20.08 (26.52)	36.29
Metiram 70WP	18.13 (25.14)	15.13 (22.90)	20.13 (26.67)	17.79 (24.90)	43.55
Difenconazole 25EC	7.73 (16.12)	15.32 (23.05)	10.36 (16.12)	11.13 (18.43)	64.68
Tebuconazole 2DS	9.52 (17.88)	8.12 (18.79)	18.36 (25.38)	12.00 (20.68)	61.92
Carbendazim 50WP	12.93 (21.04)	21.78 (27.83)	21.78 (27.83)	18.83 (25.56)	40.26
Azoxystrobin 23SC	5.82 (13.92)	15.45 (23.16)	25.59 (30.40)	15.62 (22.49)	50.44
SEm±	1.41	1.36	1.36	1.37	-
CD at 5%	4.27	2.27	2.27	2.93	-

* PDR = Percent disease reduction

Chlorothalonil and metiram are contact fungicides and has multi-site activity, effects on a wide range of enzymes involved in respiration, energy production and other cellular activities of fungi. Difenconazole, carbendazim and tebuconazole are systemic fungicides and azoxystrobin is a strobilurin fungicide as quinone outside inhibitor (Nuryani et al., 2022). Difenconazole and tebuconazole are DMI, carbendazim is a benzimidazole. Difenconazole, tebuconazole, carbendazim and azoxystrobin has site specific mode of action blocking specific enzymes or biochemical pathways (Raju & Mudunuri, 2020). The pooled data analysis also revealed the significant difference in effect of fungicides in disease management.

The effectiveness of different treatments in managing disease severity is summarized in Table 2 and Fig. 2. The pooled mean per cent disease severity varied significantly across treatments. The control exhibited the highest disease severity (31.52%), increasing from 28.71% in 2018-19 to 35.30% in 2020-21. In contrast, Chlorothalonil 75 WP demonstrated a lower pooled mean severity (20.08%) with a per cent disease reduction (PDR) of 36.29 compared to the control. Tebuconazole 70WP had a pooled mean severity of 12% and a PDR of 61.92%, indicating a notable reduction in disease severity. The most effective treatment was Difenconazole 25EC, which recorded the lowest pooled mean severity at 11.13% and the highest PDR of 64.68. These results indicate that Difenconazole 25EC was the most effective treatment, significantly reducing disease severity, followed by Tebuconazole 2DS.

The number of flowers per spike varied significantly across treatments (Fig. 3). The control recorded lowest pooled mean (37.42) flowers per spike compared to treated plants. Tebuconazole 2DS recorded highest pooled mean (43.26) flowers per spike, demonstrating consistent performance across all seasons. Carbendazim 50WP and Azoxystrobin 23SC also performed well, with pooled means of 42.19 and 43.12 flowers per spike, respectively. The number of spikes per plant showed varied responses to the treatments. The control recorded lowest pooled mean (8.83) spikes per plant. Difenconazole 25EC and Tebuconazole 2DS both achieved high pooled means (11.74 and 11.73) spikes per plant, respectively. Difenconazole 25EC produced the longest pooled mean spike length (71.40 cm), ranging from 71.33 cm (2018-19) to 70.42 cm (2020-21), while, control recorded shortest pooled mean length (54.32 cm), with considerable variation over the years.

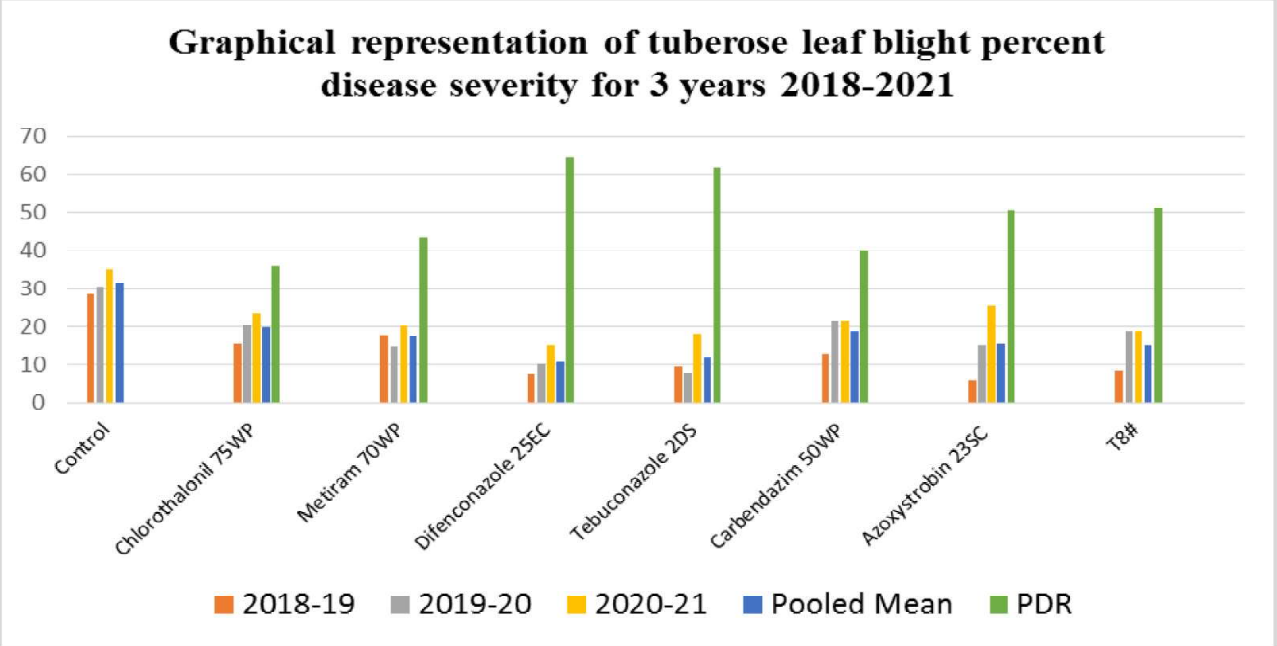

Fig. 2 : Tuberose leaf blight per cent disease severity from 2018 to 2021

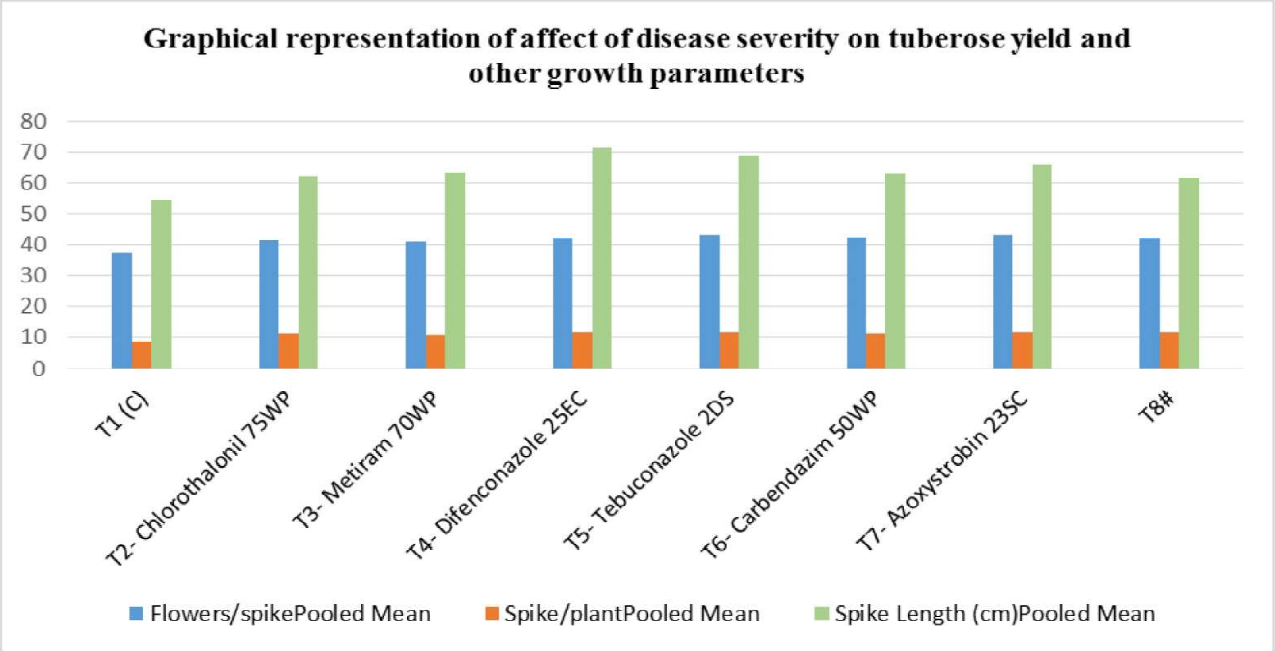

Fig. 3 : Effect of disease severity on tuberose flower yield and spike length

Fungicide application schedule for *Alternaria* leaf blight in tuberose

Early season (planting to early growth)

Chlorothalonil 75 WP (2 g/L) and metiram 70 WP (2 g/L): Foliar application every 10-14 days to provide broad-spectrum protection and help prevent early infections. The fungicides act as a protective fungicide, preventing spores from germinating and establishing infections.

Mid-season (vegetative to flowering)

Difenconazole 25EC (0.5 ml/L) or tebuconazole 2DS (1 g/L) or carbendazim 50WP (1 g/L): Foliar

application 10-14 days interval. These fungicides can be used as preventive and curative spray. It penetrates plant tissues, providing internal protection and controlling existing infections.

Late season (post-flowering to harvest)

Azoxystrobin 23 SC (0.03%): Azoxystrobin is systemic and provides excellent control of *Alternaria* leaf blight. Its application will help manage any remaining disease and protect the crop through to harvest. Adjust the frequency based on disease pressure and weather conditions.

The results from the evaluation of various treatments in managing disease severity and their impact on growth yield parameters over three cropping seasons highlight significant differences in effectiveness among the treatments. Similar results were recorded by Mazumdar et al. (2016), where 4 sprays with azoxystrobin (0.1%) at 15 days interval was proved to be the most effective fungicide with lowest disease severity (10.98) compared to control (34.39). The effectiveness of iprodione (25%) and carbendazim (25%) and difenconazole (0.1%) in reducing leaf spot of tuberose was reported (Sharma & Bhattacharjee, 2002). Ravikumar et al. (2020) reported that four sprays of tebuconazole 0.1% at 15 days interval starting from onset of disease proved to be the most effective in reducing per cent disease index (10.80). Maximum yield and number of flower stalks per square meter area were recorded in Tebuconazole 0.1% (50.90). Tebuconazole @ 0.1% could be used for management of leaf blight and increase the yield of tuberose.

CONCLUSION

Tebuconazole 2DS and azoxystrobin 23SC were the most effective in increasing the number of flowers per spike and spike length. Difenconazole 25EC also showed high effectiveness, particularly in spike length. The results emphasize the importance of selecting effective treatments for disease management, as they have a significant impact on both disease severity and crop yield.

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