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# Field Evaluation of Fungicides for the Management of Purple Blotch Disease of Onion Seed Crop Caused by *Alternaria porri*

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## Abstract

Purple blotch, caused by Alternaria porri (Ellis) Cif., is a major disease affecting onion seed production. A field experiment was conducted at the Research Farm of the Department of Plant Pathology, Junagadh Agricultural University, Junagadh, to evaluate the efficacy of eight fungicidal treatments against purple blotch in the 'Pilipati' onion cultivar, with an untreated control included for comparison. The experiment was laid out in a randomised block design with three replications. Onion bulbs were planted on 2 December 2025, and artificial inoculation was carried out on 5 January 2026. Fungicides were applied at disease onset, followed by two additional applications at 15-day intervals. Disease intensity was assessed seven days after the final spray, and seed yield was

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recorded at harvest. All fungicidal treatments were associated with lower disease intensity and higher seed yield than the untreated control. Tebuconazole 50 + trifloxystrobin 25 WG at 0.1 per cent recorded the lowest disease intensity (12.48%) and highest seed yield (670 kg ha$^{-1}$). Azoxystrobin 18.2 + tebuconazole 18.30 SC at 0.025 per cent recorded 17.28% disease intensity and a seed yield of 657 kg ha$^{-1}$ and was statistically comparable to the former treatment. The untreated control recorded 68.49% disease intensity and 428 kg ha$^{-1}$ seed yield. These findings indicate that the two leading fungicide combinations provided comparatively favourable disease and seed-yield outcomes under the conditions of this field trial.

*Keywords: Onion seed crop; purple blotch; Alternaria porri; fungicide evaluation; disease intensity; seed yield; Pilipati cultivar; randomised block design.*

## 1. Introduction

Onion (*Allium cepa* L.) is one of the oldest and most important vegetable crops cultivated worldwide and belongs to the family *Amaryllidaceae* (formerly *Alliaceae*). The genus *Allium* comprises more than 700 species distributed across tropical, subtropical and temperate regions of the world (Fritsch & Friesen, 2002). Onion is a biennial crop with a chromosome number of 2n = 16 and is predominantly cross-pollinated. It is generally cultivated as an annual crop for its edible bulb, which is a modified stem. Owing to its characteristic flavour, pungency and aroma, onion is popularly known as the "Queen of the Kitchen" (Griffiths *et al.*, 2002). Besides its culinary importance, onion possesses remarkable nutritional and medicinal value owing to the presence of sulphur-containing compounds, flavonols and antioxidants such as quercetin, which exhibit antimicrobial, anti-inflammatory, anti-cholesterol, antioxidant and anticancer properties (Griffiths *et al.*, 2002). India is the world's second-largest producer of onions after China, producing more than 30 million tonnes annually from about 1.7-1.9 million hectares under cultivation (Directorate of Economics and Statistics, 2023). Major onion-producing states include Maharashtra, Gujarat, Madhya Pradesh, Karnataka, Rajasthan, Uttar Pradesh, Bihar, Andhra Pradesh and Tamil Nadu. Despite its economic importance, onion production is severely constrained by several biotic stresses. Among the important diseases affecting onion are black mould (*Aspergillus niger*), downy mildew (*Peronospora destructor*), stemphylium blight (*Stemphylium vesicarium*), basal rot (*Fusarium oxysporum* f. sp. *cepae*) and purple blotch caused by *Alternaria porri* (Ellis) Cif. Among these, purple blotch is considered one of the most destructive diseases of onion throughout the world. Under favourable conditions, symptoms of purple blotch on onion leaves initially appear as tiny (2-3 mm in diameter) water-soaked lesions that rapidly develop white centres. These lesions enlarge, coalesce, develop concentric zones and turn brown to purple, extending upwards and downwards (Verma & Sharma, 1999). Depending on the cultivar, environmental conditions and disease severity, yield losses ranging from 2.5 to 97 per cent have been reported (Sahoo *et al.*, 2020). It is necessary to develop effective disease management strategies that minimise yield losses while ensuring profitable onion seed production.

Field investigations have demonstrated variation in susceptibility to purple blotch among onion genotypes, indicating that cultivar response is an important consideration when interpreting disease-management trials (Nanda *et al.*, 2016; Arunakumara & Satyanarayana, 2024). Separately, genetic variability among onion genotypes has been evaluated for horticultural traits (Pujar *et al.*, 2019). Recent biochemical research has also examined host responses to purple blotch and approaches to induced resistance, reinforcing the importance of considering host-pathogen interactions alongside fungicide performance (Asghar *et al.*, 2025). Recent genomic characterisation of *Alternaria porri* provides additional pathogen-level context for purple blotch research, without directly evaluating fungicide efficacy in the field (Sharma *et al.*, 2024). Greenhouse investigations of yeast-based biocontrol have also examined an alternative approach to reducing purple blotch severity in onion (Abo-Elyousr *et al.*, 2024).

Earlier field experiments have compared systemic and contact fungicides for managing purple blotch, with treatment efficacy varying across experimental settings (Rao *et al.*, 2015; Saini & Raj, 2022). Field studies have also examined the interaction of cultivar selection and fungicide application frequency, suggesting that single-location comparisons should be interpreted in their specific agronomic context (Mengesha *et al.*, 2022). A recent onion seed-crop field study likewise compared fungicide-based treatments using both purple blotch severity and seed yield as outcomes (Nikam *et al.*, 2026). Separate laboratory evaluations of fungicides against *Alternaria alternata* on groundnut included several active ingredients considered here, but their findings should not be directly extrapolated to *A. porri* on onion under field conditions (Pathak *et al.*, 2026).

However, findings from different cultivars, pathogens, and experimental conditions do not directly establish the relative performance of the selected fungicides for management of purple blotch and seed yield in the 'Pilipati' onion seed crop at Junagadh. A cultivar- and site-specific comparison under field conditions is therefore warranted.

Considering the economic importance of onion and the yield losses associated with purple blotch, the present study was conducted to evaluate the efficacy of different fungicides against this disease under field conditions.

## 2. Material and Methods

A field trial was conducted at the Research Farm of the Department of Plant Pathology, Junagadh Agricultural University, Junagadh, to evaluate the efficacy of eight fungicides under field conditions. The '*Pilipati*' variety of onion was used for the study. Eight fungicidal treatments and one untreated control were arranged in a randomised block design (RBD) with three replications (Table 1). Plant spacing was maintained at 45 cm × 30 cm, with a gross plot size of 5.0 m × 2.25 m and a net plot size of 3.80 m × 1.35 m. The plots were manually fertilised (76:60:50 kg N:$P_2O_5$:$K_2O$ ha$^{-1}$). Onion bulbs were planted on 2 December 2025, and standard agronomic practices were followed. For artificial inoculation after planting, a pathogen spore suspension was prepared in sterilised distilled water, and the concentration was adjusted to $1 \times 10^6$ conidia/ml. The artificial conidial suspension was sprayed on 5 January 2026.

## 2.1 Application of Treatment

Fungicides were sprayed at the initial appearance of disease, followed by two further sprays at 15-day intervals. An untreated control was maintained simultaneously without fungicide application. The details of fungicides are given in Table 1.

**Table 1. Fungicides used for the management of purple blotch disease of onion under field condition**

| Tr. No. | Fungicides | Conc. (%) | Quantity of fungicides/ 10 litre of water |
|---|---|---|---|
| $T_1$ | Copper oxychloride 50 WP | 0.150 | 30 g |
| $T_2$ | Difenoconazole 25 EC | 0.025 | 10 mL |
| $T_3$ | Propiconazole 25 EC | 0.025 | 10 mL |
| $T_4$ | Tebuconazole 25.9 EC | 0.025 | 9.65 mL |
| $T_5$ | Azoxystrobin 18.2 + Difenoconazole 11.4 SC | 0.050 | 16.89 mL |
| $T_6$ | Azoxystrobin 18.2 + Tebuconazole 18.30 SC | 0.025 | 6.84 mL |
| $T_7$ | Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L SC | 0.025 | 0.50 mL |
| $T_8$ | Tebuconazole 50 + Trifloxystrobin 25 WG | 0.100 | 13.33 g |
| $T_9$ | Control | - | - |

## 2.2 Assessment of Per cent Disease Intensity (PDI)

Using a 0–5 rating scale (Table 2) described by Sharma (1986), disease intensity was assessed seven days after the final spray using 10 tagged plants randomly selected from each treatment.

The per cent disease index (PDI) was calculated using the following formula of Wheeler (1969).

$$\text{PDI} = \frac{\text{Sum of individual disease ratings}}{\text{Totel no. of plants assessed x Maximum rating}} \text{ x } 100$$

**Table 2. Disease rating scale for purple blotch of onion (Sharma, 1986)**

| Score | Description |
|---|---|
| 0 | No visible symptoms |
| 1 | A few spots towards the tip covering less than 10 per cent of leaf area |
| 2 | Several dark purplish brown patches covering less than 20 per cent of leaf area |
| 3 | Several patches with paler outer zone covering up to 40 per cent of leaf area |
| 4 | Long streak covering up to 75 per cent of leaf area or breaking of leaves or stalk from center |
| 5 | Complete drying of the leaves or breaking of the leaves or stalk from base |

The per cent disease control (PDC) was calculated using the following formula described by Chester (1959)

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$$\text{Disease control (\%)} = \frac{\text{P. D. I. in check} - \text{P. D. I. in treatment}}{\text{P. D. I. in check}} \text{x } 100$$

The yield was recorded in kg $ha^{-1}$ at the time of harvest. The per cent increase in yield in each treatment over the control was calculated using the following formula.

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

## 2.3 Statistical Analysis

Statistical analysis was carried out using the standard method described by Panse and Sukhatme (1985).

Comparative field evidence indicates that the relative performance of fungicides against purple blotch may depend on the active ingredient, host cultivar and trial conditions. Rao *et al.* (2015) evaluated fungicidal treatments in two cropping seasons, while Saini and Raj (2022) investigated fungicide efficacy in relation to disease progression and onion seed yield. Arunakumara and Satyanarayana (2024) further documented differences in cultivar reactions and fungicide performance. Accordingly, the treatment ranking observed in the present experiment is best interpreted as specific to the tested variety, doses and field conditions.

## 3. Results and Discussion

The present study was conducted to evaluate the efficacy of different fungicides against purple blotch of onion under field conditions. The results presented in Table 3, Figures 1 and 2, and Plate 1 demonstrated that all fungicidal treatments reduced disease intensity and increased seed yield compared with the untreated control. Among the fungicides evaluated, tebuconazole 50 + trifloxystrobin 25 WG @ 0.1 per cent recorded the minimum disease intensity (12.48%) and achieved a reported disease control of 81.78 per cent. Its disease intensity was statistically comparable to that of azoxystrobin 18.2 + tebuconazole 18.30 SC @ 0.025 per cent, which recorded 17.28 per cent disease intensity and a reported disease control of 74.77 per cent. The next effective treatment was azoxystrobin 18.2 + difenoconazole 11.4 SC @ 0.05 per cent, which recorded 23.10 per cent disease intensity and 66.27 per cent reported disease control, followed by fluxapyroxad 250 g $L^{-1}$ + pyraclostrobin 250 g $L^{-1}$ SC (25.85%) with 62.26 per cent

reported disease control. Tebuconazole 25.9 EC recorded 29.18 per cent disease intensity and 57.40 per cent reported disease control, followed by difenoconazole 25 EC (33.74%) and propiconazole 25 EC (38.15%), which recorded 50.74 and 44.30 per cent reported disease control, respectively. Copper oxychloride 50 WP was comparatively less effective, recording 42.20 per cent disease intensity and 38.39 per cent reported disease control, whereas the maximum disease intensity (68.49%) was observed in the untreated control.

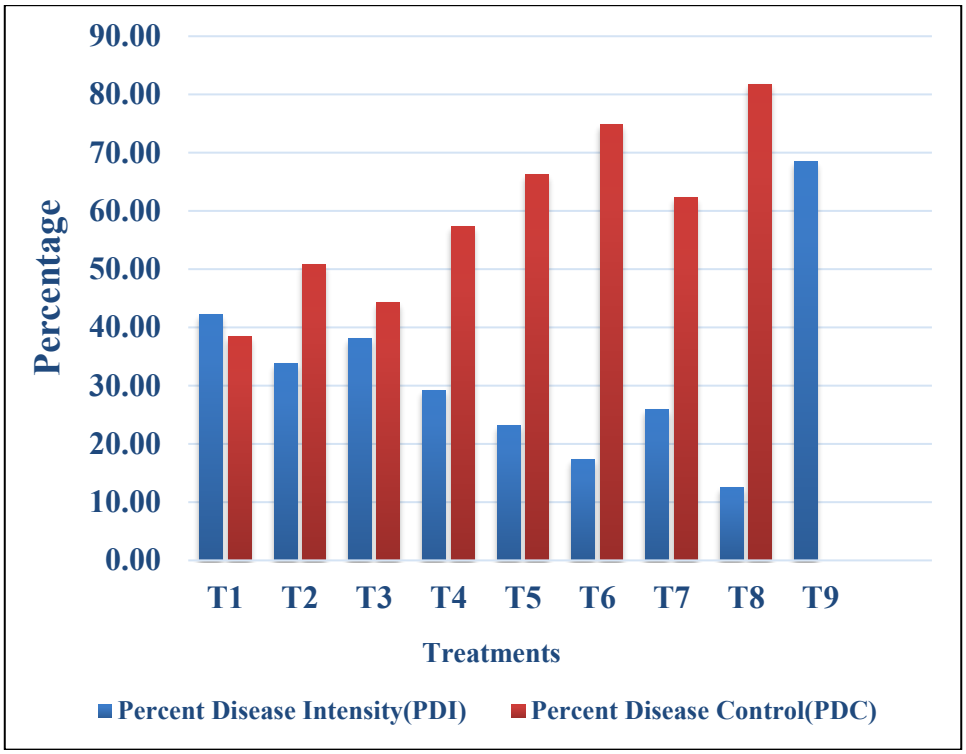



**Fig. 1. Per cent disease intensity and per cent disease control of purple blotch of onion as influenced by different fungicides under *in vivo* condition**

**Table 3. Per cent disease intensity and seed yield of onion as influenced by different fungicides**

| Tr. No. | Treatments | Concen-tration (%) | Per cent disease intensity | Per cent disease control | Seed yield (kg/ha) | Seed yield increase over control (%) |
|---|---|---|---|---|---|---|
| $T_1$ | Copper oxychloride 50 WP | 0.150 | 40.51 (42.20) | 38.39 | 492 | 14.95 |
| $T_2$ | Difenoconazole 25 EC | 0.025 | 35.51 (33.74) | 50.74 | 533 | 24.53 |
| $T_3$ | Propiconazole 25 EC | 0.025 | 38.14 (38.15) | 44.30 | 507 | 18.46 |
| $T_4$ | Tebuconazole 25.9 EC | 0.025 | 32.69 (29.18) | 57.40 | 547 | 27.80 |
| $T_5$ | Azoxystrobin 18.2 + Difenoconazole 11.4 SC | 0.050 | 28.72 (23.10) | 66.27 | 602 | 40.65 |
| $T_6$ | Azoxystrobin 18.2 + Tebuconazole 18.30 SC | 0.025 | 24.56 (17.28) | 74.77 | 657 | 53.50 |
| $T_7$ | Fluxapyroxad 250 g/L + Pyraclostrobin 250 g/L SC | 0.025 | 30.56 (25.85) | 62.26 | 568 | 32.71 |
| $T_8$ | Tebuconazole 50 + Trifloxystrobin 25 WG | 0.100 | 20.68 (12.48) | 81.78 | 670 | 56.54 |
| $T_9$ | Control | - | 55.85 (68.49) | 0 | 428 | 0 |
| S. Em. ± | | | 2.19 | | 34.93 | |
| C. D. at 5 % | | | 6.35 | | 101.54 | |
| C. V. % | | | 11.08 | | 10.88 | |

*Note: Data outside the parentheses are arcsine transformed, whereas inside are re-transformed values*

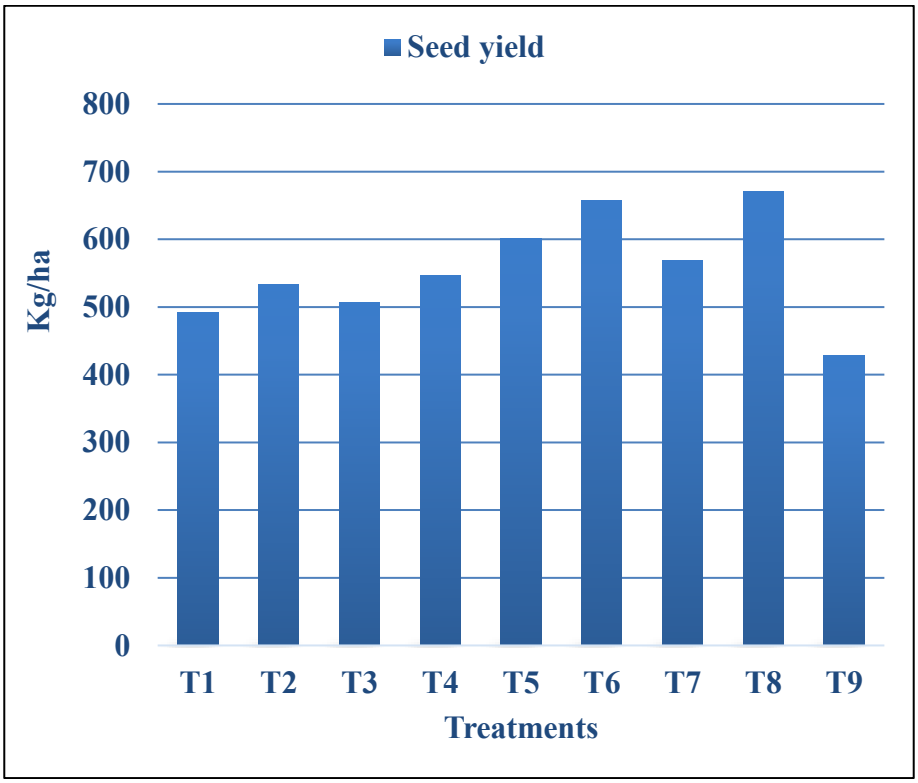



**Fig. 2. Seed yield of onion against purple blotch as influenced by different fungicides**

The observed differences in disease intensity are consistent with the broader evidence that chemical control can suppress purple blotch, although the extent of suppression varies among field experiments (Rao *et al.*, 2015; Saini & Raj, 2022; Arunakumara & Satyanarayana, 2024). The present observations do not, by themselves, establish the physiological mechanism of action or the durability of control across seasons. Such interpretation would require additional observations of epidemic development and evaluation under differing environmental conditions.

Seed-yield differences should also be considered alongside disease observations rather than attributed exclusively to a single causal mechanism. Previous field investigations have reported associations between purple blotch management and onion productivity, although their treatment combinations and outcome measures differ (Rao *et al.*, 2015; Saini & Raj, 2022; Mengesha *et al.*, 2022). In particular, the present experiment assessed seed yield, whereas some published studies examined bulb yield; numerical comparisons between these endpoints are therefore inappropriate. The reported yield advantage of the leading treatments warrants confirmation through repeated trials and consideration of input costs before broader recommendations are drawn.






**Plate 1. Evaluation of fungicides against *A. porri* under field condition**
*T8 - Tebuconazole 50 + Trifloxystrobin 25 WG*
*T6 - Control*

Regarding seed yield, tebuconazole 50 + trifloxystrobin 25 WG produced the highest seed yield (670 kg $ha^{-1}$) with a reported 56.54 per cent increase over the control and was statistically comparable to azoxystrobin 18.2 + tebuconazole 18.30 SC (657 kg $ha^{-1}$) and azoxystrobin 18.2 + difenoconazole 11.4 SC (602 kg $ha^{-1}$), which recorded 53.50 and 40.65 per cent reported yield increases over the control, respectively.

The next effective treatment was fluxapyroxad 250 g $L^{-1}$ + pyraclostrobin 250 g $L^{-1}$ SC, which recorded 568 kg $ha^{-1}$ seed yield with 32.71 per cent reported increase over the control, followed by tebuconazole 25.9 EC (547 kg $ha^{-1}$) with 27.80 per cent reported increase over the control. Difenoconazole 25 EC and propiconazole 25 EC produced 533 and 507 kg $ha^{-1}$ seed yield with 24.53 and 18.46 per cent reported increases in yield over the control, respectively, whereas copper oxychloride 50 WP recorded 492 kg $ha^{-1}$ seed yield with 14.95 per cent reported increase over the control.

The present findings were broadly consistent with those of Aujla *et al.* (2013), who reported that trifloxystrobin 25 + tebuconazole 50 WG @ 0.06 per cent provided the highest disease control (85.00%) against purple blotch of onion. Similarly, Veeraghanti *et al.* (2017) found tebuconazole 50 + trifloxystrobin 25 WG @ 0.05 per cent to be highly effective against purple blotch and statistically at par with difenoconazole 25 EC. Likewise, Mandal *et al.* (2020) reported that three foliar sprays of trifloxystrobin 25 + tebuconazole 50 WG @ 0.4 g $L^{-1}$ resulted in the highest disease control (69.50%) against *A. porri*. Chandan *et al.* (2023) observed that azoxystrobin 18.2 + tebuconazole 18.30 SC recorded the minimum disease severity (24.00%) against purple blotch of onion caused by *A. porri*. These findings are consistent with the results obtained in the present investigation.

## 4. Conclusion

Among the fungicides evaluated in the present study, tebuconazole 50 + trifloxystrobin 25 WG @ 0.1 per cent exhibited the lowest disease intensity (12.48%), with a reported disease control of 81.78 per cent. Its effectiveness was statistically comparable to that of azoxystrobin 18.2 + tebuconazole 18.30 SC @ 0.025 per cent, which recorded a disease intensity of 17.28 per cent and reported disease control of 74.77 per cent. Under the field conditions of the present study, both treatments were associated with reduced severity of purple blotch in onion caused by Alternaria porri and increased seed yield compared with the untreated control.

## 5. Limitations

The experiment was conducted with a single onion cultivar at one research farm, and the manuscript does not report evaluation across multiple growing seasons or locations. Consequently, the consistency of treatment performance under other environmental conditions remains uncertain. The study assessed disease intensity and seed yield but did not report economic returns or treatment-related environmental outcomes.

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## Declaration of AI Use

This manuscript was prepared through the intellectual contributions of the author(s) to the study design, data analysis, interpretation of results, and scholarly content. Grammarly and ChatGPT were used solely to assist with grammatical refinement and reference formatting during manuscript revision. The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

## Competing Interests

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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