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# Management of Late Leaf Spot of Groundnut by Different Fungicides and Their Impact on Yield

[1]Bharat Chandra Nath, [1]J. P. Singh, [2]Seweta Srivastava and [1]R. B. Singh
[1]Department of Mycology and Plant Pathology, Institute of Agricultural Sciences,
Banaras Hindu University, Varanasi-221 005, Uttar Pradesh, India
[2]Regional Plant Quarantine Station, Kolkata-700 097, West Bengal, India

**Abstract:** *In vitro* experiments were carried out with *Phaeoisariopsis personata* isolate to determine its sensitivity/tolerance to different fungicides viz., Tebuconazole (0.05%), Tebuconazole (0.10%), Tebuconazole (0.15%), Tebuconazole (0.20%), Tebuconazole (0.40%), Folicur (0.10%) and Mancozeb (0.30%) using poisoned food technique both in solid and liquid medium. In the solid medium method, visual observation was taken 20 days after inoculation of the pathogen. There was no significant difference among the different fungicides in their efficacy against *P. personata*, compared to control. In case of liquid medium the observations were taken after 25 days of inoculation and the results are presented. There was significant difference between the fungicides in per cent inhibition against the mycelial growth of the pathogen, *P. personata*. Among all the fungicides, Tebuconazole 0.4% (87.97%t) showed maximum inhibition followed by Tebuconazole 0.2% (85.24%) and Tebuconazole 0.15% (83.50%), among these Tebuconazole 0.15% was found to be optimum. Application of fungicidal sprays influenced the development of *Cercospora* leaf spot and reduced its intensity. Among these applications of different fungicides, Tebuconazole (0.15%) gave best result and reduced the disease intensity to 52.42%. Area under disease progress curve (AUDPC) greatly varied among different fungicidal treatments and showed significant difference in yield data. Impact of fungicides used for disease control was apparent on yield per plot. Tebuconazole (0.15%) gave best result and increased yield up to 67% as compared to 39% increase by Tebuconazole (0.10 %).

**Key words:** Peanut, *Phaeoisariopsis personata*, leaf spot disease, management, fungicides

## INTRODUCTION

Groundnut (*Arachis hypogea* L.) also known as peanut or earthnut or money nut is a member of family Papilionaceae, largest and most important of the three divisions of Leguminosae. The botanical name of groundnut, *Arachis hypogaea* L., is derived from two Greek words, *Arachis* (arachos) meaning a 'weed' and *hypogaea* meaning 'below ground'. According to botanist, a more popular name for groundnut would be ground pea because groundnut is a pea and not a nut. The term 'nut' has perhaps been added, since the pea has a shell and flavour similar to the shells of many true nuts. It is native to South America, originated between Southern Bolivia and Northern Argentina, from where it spread throughout the new world. Groundnut was introduced in India by around 16th century by the Portuguese. It is grown under a wide range of environmental conditions encompassing latitudes between 40° South and 40° North of the equator. It occupies first place in order of importance out of the all the oil seed crops growing in India. In India, it is grown over an area of 8 million ha with an annual production of 7.5 million tonnes. A production of 83.32 lakh tonnes has been recorded during 2003-04 (Hegde, 2005). There are a few economically important foliar fungal diseases, such as early and late leaf spots, commonly called as tikka diseases and groundnut rust. Early leaf spot caused by *Cercospora arachidicola* and late leaf spot caused by *Phaeoisariopsis personata* are commonly present wherever groundnut is grown. As the area under groundnut is predominant in kharif (rainy) season (81%), the foliar diseases like late leaf spot and rust may cause yield losses up to 50% in the semi-arid tropics. In India, late leaf spot is more severe than early leaf spot (Ghewande, 1990; Anonymous, 1993). It causes severe defoliation and reduces pod yields by more than 50% if the crop is not protected with chemicals (Shew *et al*., 1988). The fungicides are the most common tools for controlling disease losses. In recent years, there has been growing concern in indiscriminate use of fungicides because they are potentially hazardous to environment

**Corresponding Author:** Seweta Srivastava, Regional Plant Quarantine Station, Kolkata-700 097, West Bengal, India

and chemical residues in the soil adding to the pollution. These factors have led to the search for new and innovative approaches for plant disease management.

## MATERIALS AND METHODS

Experiment was conducted in year 2010-2011 in the Department of Mycology and Plant Pathology, Banaras Hindu University, Varanasi.

***In vitro* evaluation by poison food technique:** *In vitro* efficacy of fungicides against the pathogen was evaluated by poisoned food technique (Nene and Thapliyal, 2000) in both solid and liquid media. Details of the fungicides *i.e.,* their formulations and doses used in the present investigation were presented in Table 1.

**Solid medium:** To 50 mL of sterilized distilled water, required quantity of fungicide was added and mixed thoroughly. This solution was poured into 50 mL of sterilized cool molten double strength peanut leaf oatmeal agar medium, mixed thoroughly and poured into Petri plates. Fungal mycelial bits from 20 days old culture were streaked in 1 cm diameter circle at the centre and then incubated at 25±1°C. Three replications were maintained for each fungicide. Medium without fungicide was kept as control. Since the growth of the pathogen was very slow, the inhibition in the growth of the pathogen over control was taken based on visual observation but not on radial growth.

**Liquid medium:** To 50 mL of sterilized potato dextrose broth medium, required quantity of fungicide was added and mixed thoroughly. Then a mycelial bit of the pathogen was inoculated to each flask. The flask in which only pathogen was inoculated, kept as control and they are incubated at 25±1°C. The dry weight of the mycelia from each flask was taken at 25 days after inoculation.

The percent reduction in mycelial growth of the test pathogen was calculated using the following formula:

$$I=\frac{C-T}{C}\times 100$$

Where:

I = Per cent reduction in growth of fungal pathogen
C = Mycelial dry weight of pathogen in control (mg)
T = Mycelial dry weight of pathogen in treatment (mg)

**Field experiment:** Field experiment was conducted during kharif season (July-October) in 2010, at Nakahara village of Mirzapur district. Different concentration of fungicide as Tebuconazole 500, 1000, 1500, 2000 and 4000 ppm, Folicur 1000 ppm and Mancozeb 3000 ppm were used to test their efficacy against leaf spot. The first Spray was given 45 days after sowing. Each treatment was replicated three times and the leaf spot susceptible variety Kaushal was used for this experiment.

**Method of sowing and layout:** Sowing was done on 12th of July' 2010. The soil of field was sandy loam and well drained. The field was prepared by ploughing thrice and leveling. The seeds were sown in the plots as per the layout along with the recommended dosage of fertilizer.

**Days of first appearance of disease and collection of data:** First appearance of disease symptom was seen 45 days after sowing and collection of data at 15 days interval after first disease appearance.

**Determination of per cent disease index:** Percent disease index (PDI) was calculated on 15 days interval using the following formula:

$$PDI=\frac{\text{Sum of all ratings}}{\text{Total No. of observation}\times\text{Maximum disease score}}\times 100$$

For the estimation of disease incidence (Fig. 1) leaves were seen from each plot in each replication and the

Table 1: Details of the fungicides used in the present investigation against *Phaeoisariopsis personata*

| | | Doses ($ha^{-1}$) | | | |
|---|---|---|---|---|---|
| Treatment | Fungicide | a.i. | Formulation (L $ha^{-1}$) | Water (L $ha^{-1}$) | Dosage (mL $L^{-1}$) |
| T1 | Tebuconazole | 0.063 | 0.25 | 500 | 0.5 |
| T2 | Tebuconazole | 0.125 | 0.5 | 500 | 1.0 |
| T3 | Tebuconazole | 0.1875 | 0.75 | 500 | 1.5 |
| T4 | Tebuconazole | 0.25 | 1.0 | 500 | 2.0 |
| T5 | Tebuconazole | 0.50 | 2.0 | 500 | 4.0 |
| T6 | Folicur | 0.125 | 0.5 | 500 | 1.0 |
| T7 | Mancozeb | | 1.5 kg | 500 | 3 g |
| T8 | Control | - | Water spray | 500 | - |

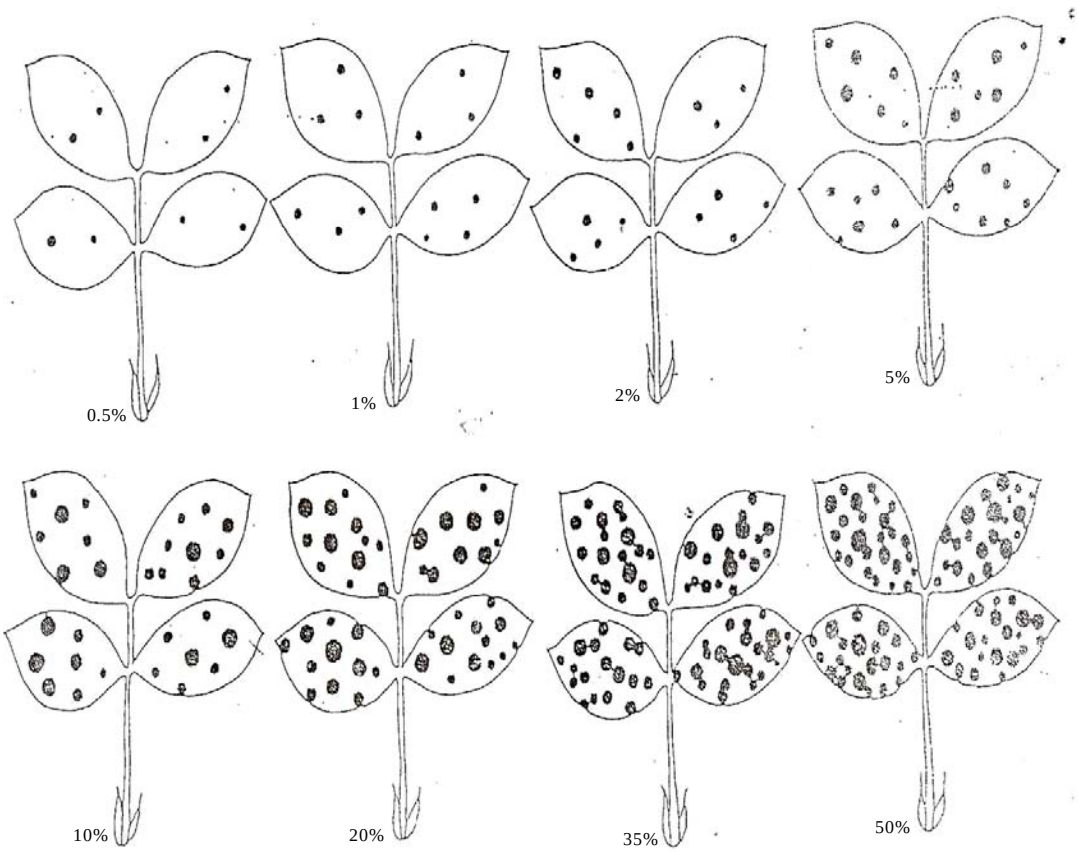


Fig. 1: Standardized pictorial chart showing percent necrotic area caused by late leaf spot disease

Table 2: Description of leaf spot rating scale (1-9) (Subrahmanyam *et al*., 1995)

| Leaf spot score | Description | Disease severity (%) |
|---|---|---|
| 1 | No disease | 0 |
| 2 | Lesions largely on lower leaves; no defoliation | 1-5 |
| 3 | Lesions largely on lower leaves; very few lesions on middle leaves; defoliation of some leaflets evident on lower leaves | 6-10 |
| 4 | Lesions on lower and middle leaves, but severe on lower leaves; defoliation of some leaflets evident on lower leaves | 11-20 |
| 5 | Lesions on all lower and middle leaves; over 50%defoliation of lower leaves | 21-30 |
| 6 | Lesions severe on lower and middle leaves; lesions on top of leaves but less severe; extensive defoliation of lower leaves; defoliation of some leaflets evident on middle leaves | 31-40 |
| 7 | Lesions on all leaves but less severe on top leaves; defoliation of all lower and some middle leaves | 41-60 |
| 8 | Defoliation of all lower and middle leaves; lesions severe on top leaves and some defoliation of top leaves evident | 61-80 |
| 9 | Defoliation of almost all leaves leaving bare stems; some leaflets may be present, but with severe leaf spots | 81-100 |

disease was recorded using modified 9 point scale showed in Table 2 (Subrahmanyam *et al*., 1995).

Percent disease index at different interval was used to calculate the area under disease progress curve (AUDPC) by following the formula of Shaner and Finney (1977):

$$nAUDPC = \sum^{n} \left[\frac{(Yi+1+Yi)}{2}\right][Xi+1-Xi]$$

Where:

Yi = Disease severity (per cent) at ith observation
Xi = Time (days) at ith observation
n = Total no. of observation

**Yield per plot:** At maturity pods of each treatment were harvested by digging of the plants with the help of spades and khurpies. The uprooted plants were brought to threshing floor and stripped off the plants and took the fresh weight. After complete drying for 3-5 days dry weight were taken. Both fresh weight and dry weight was taken in kg.

**Statistical analysis:**

Plot size = 4×5 m$^2$
Season = kharif
Date of sowing = 12-07-2010
Design = RBD
No. of treatment = 8
No. of replication = 3
T1 = 0.05% Tebuconazole
T2 = 0.1% Tebuconazole
T3 = 0.15% Tebuconazole
T4 = 0.2% Tebuconazole
T5 = 0.4% Tebuconazole
T6 = 0.1% Folicur
T7 = 0.3% Mancozeb
T8 = water spray

## RESULTS

***In vitro* evaluation of efficacy of fungicides against the pathogen:** In the solid medium method, visual observation was taken 20 days after inoculation of the pathogen. There was no significant difference among the different fungicides in their efficacy against *P. personata*, compared to control.

In case of liquid medium the observations were taken after 25 days of inoculation and the results are presented in Table 3. There was significant difference between the fungicides in percent inhibition against the mycelial growth of the pathogen, *P. personata*. Among all the fungicides, Tebuconazole 0.4% (87.97%t) showed maximum inhibition followed by Tebuconazole 0.2% (85.24%) and Tebuconazole 0.15% (83.50%), among these Tebuconazole 0.15% was found to be optimum.

**Percent disease index (PDI):** Table 4 showed that different fungicidal sprays influenced the development of Cercospora leaf spot and reduced its intensity. Among these applications of different fungicides, Tebuconazole (0.15%) gave best result and reduced the disease intensity to 52.42%.

Table 5 revealed the area under disease progress curve (AUDPC) greatly varied among different fungicidal treatments and showed significant difference in yield data.

**Yield per plot:** Impact of fungicides used for disease control was apparent on yield per plot was revealed in Table 6. Tebuconazole (0.15%) gave best result and increased yield up to 67% as compared to 39% increase by Tebuconazole (0.10 %).

## DISCUSSION

Singh and Singh (1977) evaluated five fungicides (Bavistin, Brestan-60, Blitox-50, Diathane M-45 and Diathane Z-78) against leaf spot caused by *Cercospora canescens* and reported carbendazim as most effective in controlling the diseases along with the highest yield followed by Brestan-60 and Blitox-50. They found Breston was phytotoxic even at 0.05 percent concentration.

Lalithakumari *et al*. (1984) studied the effect of systematic fungicides on the physiological response of

Table 3: In vitro evaluation of the efficacy of different fungicides on mycelial growth of *Phaeoisariopsis personata* on potato dextrose broth medium

| Treatment | Fungicide | Concentration (%) | Mycelial dry weight (mg) | Percent inhibition over control |
|---|---|---|---|---|
| T1 | Tebuconazole | 0.05 | 315 | 60.92 |
| T2 | Tebuconazole | 0.1 | 215.33 | 73.33 |
| T3 | Tebuconazole | 0.15 | 133.67 | 83.50 |
| T4 | Tebuconazole | 0.2 | 119 | 85.24 |
| T5 | Tebuconazole | 0.4 | 97.33 | 87.97 |
| T6 | Folicure | 0.1 | 219 | 72.83 |
| T7 | Mancozeb | 0.3 | 221.33 | 72.58 |
| T8 | Control | - | 806.33 | |
| | C. D. (0.01) | | 28.69605 | |
| | SEM (0.01) ± | | 6.948221 | |

Table 4: Efficacy of different fungicides on development of late leaf spot disease incited by *Phaeoisariopsis personata*

| Treatments | Fungicides | Percent disease intensity (PDI) | Percent disease decreased | Dry weight (kg/20 m$^2$ plot) | Yield (Quintal ha$^{-1}$) | Percent increase in Yield |
|---|---|---|---|---|---|---|
| T1 | Tebuconazole 0.05% | 27.93 | 18.17 | 4.23 | 21.16 | 27.00 |
| T2 | Tebuconazole 0.10% | 21.39 | 37.33 | 4.65 | 23.16 | 39.00 |
| T3 | Tebuconazole 0.15% | 16.24 | 52.42 | 5.56 | 27.83 | 67.00 |
| T4 | Tebuconazole 0.20% | 16.09 | 52.85 | 5.60 | 28.00 | 68.00 |
| T5 | Tebuconazole 0.40% | 13.75 | 59.71 | 5.63 | 28.16 | 69.00 |
| T6 | Folicur 0.01% | 22.29 | 34.69 | 4.60 | 23.00 | 38.00 |
| T7 | Mancozeb 0.3% | 23.33 | 31.64 | 4.53 | 22.66 | 36.00 |
| T8 | Control | 34.13 | | 3.33 | 16.66 | 0.1 |
| | C. D. (0.05) | 3.469954 | | | | |
| | | 0.865111 | | | | |
| | SEM ± | 1.144007 | | | | |
| | | 0.285218 | | | | |

Table 5: Correlation between area under disease progress curve and yield

| Treatment | Fungicides | AUDPC Mean | Dry wt. (kg) per plot | Yield (Quintal/ha) | Yield (Kg ha$^{-1}$) | (%) increase in yield |
|---|---|---|---|---|---|---|
| T1 | Tebuconazole 0.05% | 823.85 | 4.23 | 21.16 | 2116 | 27.00 |
| T2 | Tebuconazole 0.10% | 553.9 | 4.63 | 23.16 | 2316 | 39.00 |
| T3 | Tebuconazole 0.15% | 431.85 | 5.56 | 27.83 | 2783 | 67.00 |
| T4 | Tebuconazole 0.20% | 375.5 | 5.60 | 28 | 2800 | 68.00 |
| T5 | Tebuconazole 0.40% | 335.15 | 5.63 | 28.16 | 2816 | 69.00 |
| T6 | Folicur 0.01% | 593.55 | 4.60 | 23 | 2300 | 38.00 |
| T7 | Mancozeb 0.3% | 631.65 | 4.53 | 22.66 | 2266 | 36.00 |
| T8 | Control | 1048.1 | 3.33 | 16.66 | 1666 | 0.1 |
| | C.D. (0.05) | 119.7582 | 0.865111 | | | |
| | SEM ± | 39.48303 | 0.285218 | | | |

Table 6: Effect of different fungicides on late leaf spot and various growth and yield parameters of groundnut

| T/Y | Fresh Wt (kg) | Dry Wt (kg) | No. of plants per plot | Yield (Quintal/ha) | (%) increase in yield |
|---|---|---|---|---|---|
| T1 | 6.9 | 4.2 | 204 | 21.16 | 27.00 |
| T2 | 8.3 | 4.6 | 206 | 23.16 | 39.00 |
| T3 | 9.6 | 5.5 | 206 | 27.83 | 67.00 |
| T4 | 9.8 | 5.6 | 201 | 28 | 68.00 |
| T5 | 9.9 | 5.6 | 201 | 28.16 | 69.00 |
| T6 | 8.5 | 4.6 | 200 | 23 | 38.00 |
| T7 | 8.1 | 4.5 | 202 | 22.66 | 36.00 |
| T8 | 5.6 | 3.3 | 200 | 16.66 | |
| | C.D. (0.05) | 0.865111 | | | |
| | SEM± | 0.285218 | | | |

T1 =0.05% Tebuconazole, T2 = 0.1% Tebuconazole, T3 = 0.15% Tebuconazole, T4 = 0.2% Tebuconazole, T5 = 0.4% Tebuconazole, T6 = 0.1% Folicur, T7 = 0.3% Mancozeb, T8 = water spray

groundnut plant against tikka leaf spot and reported Baycor, Bavistin and Bayleton reduced the disease incidence and increase the protein, total nitrogen and phenols and decreased total sugar content. Vyas *et al.* (1986) recommended the application of carbendazim (0.075%) and mancozeb (0.15%) in the middle of August for control of early and late leaf spot of groundnut when the crop is most susceptible to these diseases.

Ahmad (1987) recommended sprays of Bavistin at 20-25 days interval, Diathane M-45 (mancozeb), Diathane Z-78 (zinab) and Difolaton (captafol) at 10-15 days interval and Blitox (copper oxychloride) at 10 days interval for effective control of *Cercospora canescens* on the basis of residual fungitoxicity of these fungicides. Brown *et al.* (1988) studied the fungicidal properties of hexaconazole on apple, coffee and groundnut and excellent activity was demonstrated against *Venturia inequalis, Haemilia vastatrix, Cercospora* sp., *Sclerotium rolfsii* and *Rhizoctonia solani*. Hexaconazole appeared to have an optimum balance of protectant, curative, penetration and besides broad spectrum and translaminar activity.

Sai Gopal and Sreenivasulu (1988) proved that bavistin (50% carbendazim, WP) controlled the leaf spots effectively in both healthy and virus-infected groundnut. Alabi *et al.* (1993) evaluated Benlate, Dithane M-45 and hexaconazole fungicides for their efficiency against foliar diseases of groundnut under field conditions and found hexaconazole fungicide as most effective in controlling the diseases and increase pod and haulm yields.

Brenneman and Culbreath (1994) studied a rainfall based advisory programme with 5 sprays of tebuconazole, a substitute for chlorothalonil against foliar diseases of groundnut and reported higher yields and reduced incidence and/or severity of both foliar and soil borne diseases. Adiver and Anahosur (1995) reported that triazole group of fungicides i.e., tebuconazole and cyperconazole were effective against late leaf spot of groundnut and also reduced colonization of *Sclerotium rolfsii*.

Culbreath *et al.* (1995) reported that both tebuconazole and tank-mix combinations of chlorothalonil+propiconazole provided better control of leaf spotdiseases of peanut than chlorothalonil alone. Iqbal *et al.* (1995) tested different fungicide and calculate the economics of fungicidal spray and they recommended Deconil (chlorothalinol) as best control of *Cercospora canescens*, giving 80% reduction in incidence and 77.4% increase in yield. Mittal (1996) reported that three sprays of carbendazim at 10 day intervals can effectively control the early and late leaf spot of groundnut. Bowen *et al.* (1997) reported that defoliation caused by leaf spots and incidence of southern stem rot (*Sclerotium rolfsii*) was inversely related to number of tebuconazole applications, while yield was directly related to number of tebuconazole applications.

Johnson *et al.* (1998) studied effectiveness of different fungicide for the controlling of late leaf spot of groundnut under rainfed situations, when climate was congenial for the spread of disease, spraying of fungicidal

mixture (mancozeb 0.2% and carbendazim 0.1%) effectively controlled the late leaf spot of groundnut leading to significant increase in pod and haulm yield. They also reported that a single spray of fungicidal mixture containing 1 g carbendazim+2 g mancozeb per liter of water reduced the spread of LLS incidence. This treatment resulted in a significant increase in pod (55%) and haulm (57%) yields besides lowering the leaf drop. Further, it also increased the 100 kernel weight (23%) and net returns (Johnson *et al*., 1999).

Jadeja *et al*. (1999) applied hexaconazole (0.0025%) and difenconazole (0.0125%) at three times on 30, 45 and 60 days old plant to manage leaf spots and rust of groundnut and reported that the fungicides reduced leaf spot and rust disease incidence and increased the yields significantly. Hexaconazole treatment showed 71% increase in pod yield and 87% increase in fodder yield.

Khunti *et al*. (2002) reported that hexaconazole and penconazole significantly reduced the leaf spot (*Cercospora canescens*) and powdery mildew (*Erysiphi polygoni*) in mung bean. Gopal *et al*. (2003) reported that three sprays of difenconazole (0.1%), propiconazole (0.05%) and carbendazim (0.05%)+tridemorph (0.1%) at 30, 50 and 70 DAS significantly increased the pod yield by reducing late leaf spot and rust of groundnut.

Johnson and Subrahmanyam (2003) reported that on groundnut hexaconazole (0.2%) fungicide recorded minimum Percent Disease Index (PDI) of 18.8 (LLS) and 18.5 (Rust) and increased the pod and haulm yields by 43 and 41 per cent, respectively when sprayed two times on 60 and 75 days old plant.

## CONCLUSION

Among all the fungicides used in the present investigation, Tebuconazole (0.15%) gave best result by reducing the disease intensity to 52.42% and increased yield up to 67 per cent as compared to 39% increase by Tebuconazole (0.10%). Application of fungicidal sprays influenced the development of leaf spot and reduced its intensity. Area under disease progress curve (AUDPC) greatly varied among different fungicidal treatments and showed significant difference in yield data. Impact of fungicides used for disease control was apparent on yield per plot.

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