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Efficiency of foliar application of strobilurin and triazole fungicides spray against target leaf spot and frogeye leaf spot of soybean

Vivek Kumar Vishwakarma, Vijay Kumar Kashyap, Moly Saxena and Pramod Kumar Fatehpuriya

Abstract
Target leaf spot (TLS) and Frogeye leaf spot (FLS) caused by (*Corynespora cassiicola* and *Cercospora sojina* Hara). The most important fungal diseases of Soybean [*Glycine max* (L.) Merrill].All the strobilurin and triazole fungicides and combinations fungicides were found significantly effective in controlling Target leaf spot (TLS) and frogeye leaf spot (FLS) diseases of soybean. Significantly minimum TLS incidence was recorded in treatment pyraclostrobin + mefentrifluconazole + fluxapyroxad which was at par to azoxystrobin + tebuconazole + prochloraz followed by prochloraz + tebuconazole, hexaconazole, Carbendazim + mancozeb, tebuconazole + sulphur, tebuconazole and pyraclostrobin. Significantly minimum FLS incidence was recorded in treatment pyraclostrobin + mefentrifluconazole + fluxapyroxad, which was at par to azoxystrobin + tebuconazole + prochloraz followed by prochloraz + tebuconazole, hexaconazole, carbendazim + mancozeb, tebuconazole + sulphur, tebuconazole and pyraclostrobin.

Keywords: *Corynespora cassiicola* and *Cercospora sojina* Hara, strobilurin and triazole fungicides

Introduction
Soybean [*Glycine max* (L.) Merrill] is a legume crop and is the second largest after groundnut oilseed in India. It is growing in diverse agro-climatic conditions. Soybean ranks first among the oilseeds in the world and contributes for nearly 25% of the world's total oil and fats production. The USA leads in terms of area and production of soybean, while India ranks fourth in area and fifth in production in the world. USA, Argentina, Brazil, China and India are the major producers of soybean accounting for 90 percent of world production. Productivity of soybean in India (830 kg/ha) is less than global (2800 kg/ha) average due to abiotic and biotic stresses (Anno. 2019).

Strobilurins are an important class of fungicides that come from the discovery of *Strobilurus tenacellus*, the mushroom fungus that causes wood-rotting. This isolated natural fungicide is thought to be used to protect the fungus against microbes in the decomposition of the wood. The discovery of strobilurins led scientist to isolate and produce synthetic strobilurins by chemically altering the compound to be able to tolerate sunlight (Vincelli, 2012) [5].

The fungicide group, demethylation inhibitors (DMI), which contain the triazole fungicides, was introduced in the mid-1970s. Triazoles consist of numerous members, of which several are labelled or are in the process of being labelled for use on field crops like – cyproconazole, flusilazole, flutriafol, metconazole, myclobutanil, propiconazole, prothioconazole, tebuconazole, and tetraconazole.

Azoxystrobin, azoxystrobin + cyproconazole, carbendazim, difenoconazole, flutriafol, pyraclostrobin + epoxiconazole, tebuconazole, methyl thiophanate, methyl thiophanate + flutriafol, trifloxystrobin + cyproconazole, trifloxystrobin + propiconazole are recommended for target spot and frogeye leaf spot control soybean (Anno, 2007). However, fungicides from benzimidazole, triazoles and strobilurins groups recommended for the control of this disease have presented low efficacy in the field (Godoy *et al.*, 2012) [3]. Succinate dehydrogenase inhibitors (SDHI) fungicides have been used to control white mold [*Sclerotinia sclerotiorum* (Lib) de Bary], Asian soybean rust and target spot in Brazilian soybean fields (Meyer 2013) [4].

Materials and Methods

Experimental site

The field experiments were conducted during *Kharif* 2018 at the experimental field of Department of Plant Pathology, R.A.K. College of Agriculture, Sehore (M.P.).

Isolation, Purification and Identification of pathogen

Small pieces of infected tissue (2-3mm in length) frogeye leaf spot were cut at the junction of diseased and healthy portion with the help of disinfected blade after surface sterilizing with alcohol. These bits were surface sterilized in 0.1 per cent mercuric chloride solution ($HgCl_2$) for 30 seconds followed by three washing with sterilized distilled water in Petriplates under aseptic conditions using laminar air flow. These bits were then dried by placing on sterilized blotting paper. Five bits were transferred aseptically to the sterile Petri plates containing potato dextrose agar (PDA) medium. Inoculated Petri plates were incubated at 25 ± 2 ℃ for five to seven days and examined at frequent intervals to see the growth of the fungus/conidia developing from different pieces.

Eight fungicides as described above were used in this study. Experiment was conducted in the field during *kharif* season 2018-19**.** The seeds of cultivar JS- 9560 were sown in plots and replicated thrice. The first spray was given just after the appearance of target and frogeye leaf spot. The second spraying was done after 10 days interval. The observations on seven days after each spray disease incidence of both diseases were recorded by using 0-9 scale according to Singh *et al.* (1982) and percent disease index was calculated by the formula of Wheeler (1969) [6] worked out.

Where

1. No lesions
2. 1% leaf area covered with lesion
3. 1.1-10% leaf area cover with lesion
4. 10.1– 25% of the leaf area covered no defoliation, little damage
5. 25.1– 50% leaf area covered, some leaf drop, death of a few plant damage conspicuous.
6. More than 50% leaf area covered, lesion very common on all plants, defoliation common, and death of plant common, damage more than 50%.

Percent disease index (PDI) was computed by applying the formula mentioned below:

$$PDI = \frac{\text{Sum of individual ratings}}{\text{No. of leaves examined}} \times \frac{100}{\text{Max disease rating}}$$

Experimental details

Design	: Randomized block design
Plot size	: 5 x 3 m^2
Row to row	: 30 cm
Plant to plant	: 5 cm
Variety	: JS- 9560
No. of row	: 10
Date of sowing	: 02/07/2018
Treatment	: 09
Replication	: 03

Table 1: Fungicides

S. No	Treatments	Dosage/ha^{-1}
T_1	Pyraclostrobin 20%WG	500gm
T_2	Tebuconazole 25.9% EC	750ml
T_3	Prochloraz 26.7%+Tebuconazole13.3%EW	1000ml
T_4	Azoxystrobin5.6+Tebuconazole10%+Prochloraz20%	1250ml
T_5	Mefentrifluconazole + Pyraclostrobin + Fluxapyroxad	500ml
T_6	Tebuconazole10%WP +Sulphur 65%WG	1250gm
T_7	Carbendazim 12%+ Mancozeb 63%WP	500gm
T_8	Hexaconazole 5%EC	500ml
T_9	Control	Water spray

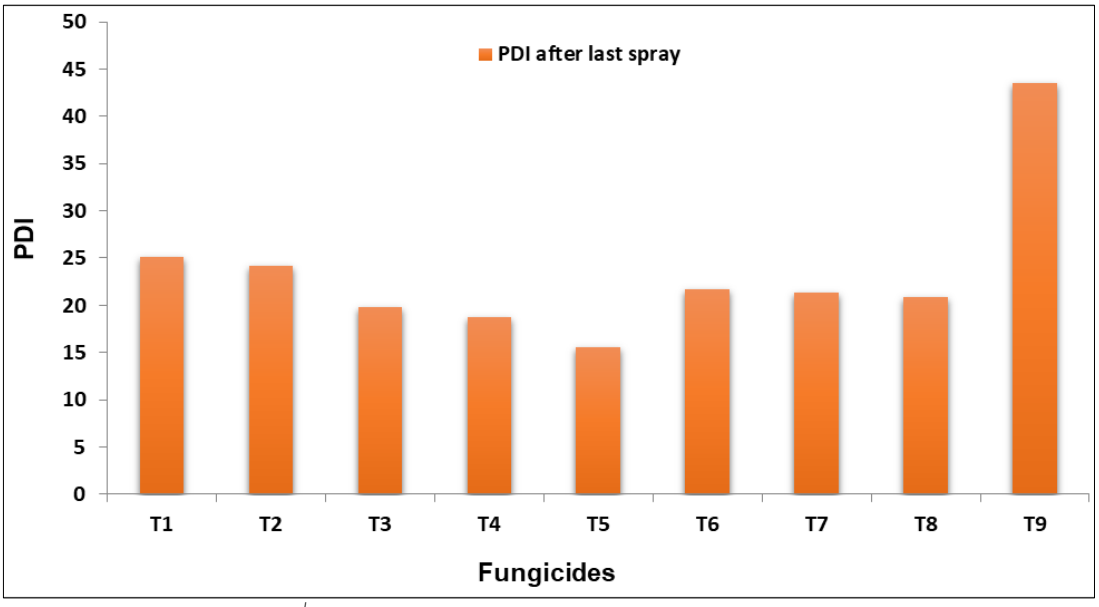
Results and Discussion

Efficiency of foliar application of strobilurin and triazole fungicides spray against target leaf spot and frogeye leaf spot of soybean: Eight fungicides including strobilurin and triazole fungicides were evaluated to find out their efficacy against target and frogeye leaf spot in field. It is evident from the table 1 & fig.1that all the eight fungicides significantly controlled the TLS as compared to control (43.57%). Significantly minimum TLS incidence was recorded in treatment pyraclostrobin + mefentrifluconazole + fluxapyroxad (15.55%), which was at par to azoxystrobin + tebuconazole + prochloraz (18.80%) followed by prochloraz + tebuconazole (19.83%), hexaconazole (20.88%), carbendazim + mancozeb (21.31%), tebuconazole + sulphur (21.69%), tebuconazole (24.11%) and pyraclostrobin (25.11%). However, pyraclostrobin + mefentrifluconazole +fluxapyroxad, prochloraz + tebuconazole, hexaconazole, carbendazim + mancozeb, tebuconazole + sulphur, were at par to each other. Tebuconazole and pyraclostrobin were equally effective in controlling the disease.

Table 1: Percent target leaf spot incidence in foliar application of fungicides including strobilurin and triazole fungicides

S. No	Treatment	Pre-treated PDI*	PDI after last spray*
T_1	Pyraclostrobin20% WG @ 500gm/ha	33.51	25.11 (30.03) **
T_2	Tebuconazole10% @ 750ml/ha	33.79	24.11 (29.36) **
T_3	Prochloraz26.7%+Tebuconazole13.3% EW @ 1000ml/ha	33.51	19.83 (26.40) **
T_4	Azoxystrobin5.6%+Tebuconazole10%+ Prochloraz20% @ 1250ml/ha	32.40	18.80 (25.65) **
T_5	Pyraclostrobin + Mefentrifluconazole + Fluxapyroxad 400g/l SC@500ml/ha	30.97	15.55 (23.14) **
T_6	Tebuconazole10% + Sulphur65% WG @ 1250gm/ha	37.93	21.69 (27.74) **
T_7	Carbendazim + Mancozeb @ 500gm/ha	34.65	21.31 (27.43) **
T_8	Hexaconazole5% EC @ 500ml/ha	32.46	20.88 (27.18) **
T_9	Control (water spray)	32.80	43.57 (41.28) **
	SE(m) ± 1	-	1.37
	CD at 5%	NS	4.14

* Average of three replications



** Data in parentheses shows √Arcsine transformation

Fig 1: Target leaf spot of soybean in strobilurin and triazole fungicides application

T_1 – Pyraclostrobin
T_2 – Tebuconazole
T_3 – Prochloraz + Tebuconazole
T_4 – Azoxystrobin+ Tebuconazole + Prochloraz
T_5 – Pyraclostrobin+ Mefentrifluconazole +fluxapyroxad
T_6 – Tebuconazole+ Sulphur
T_7 – Carbendezim+ Mancozeb
T_8 – Hexaconazole
T_9 – control

Table 2: Incidence of frogeye leaf spot of soybean in foliar application of fungicides including strobilurin and triazole fungicides

S. No	Treatment	Pre-treated PDI*	PDI after last spray*
T_1	Pyraclostrobin20% WG @ 500gm/ha	15.77	9.27
T_2	Tebuconazole 10% @ 750ml/ha	16.13	8.47
T_3	Prochloraz26.7%+Tebuconazole13.3% EW @ 1000ml/ha	13.73	7.55
T_4	Azoxystrobin5.6%+Tebuconazole10%+ Prochloraz20% @ 1250ml/ha	12.64	5.48
T_5	Pyraclostrobin + Mefentrifluconazole + Fluxapyroxad 400g/l SC@500ml/ha	15.64	4.51
T_6	Tebuconazole10% + Sulphur65% WG @ 1250gm/ha	16.26	7.97
T_7	Carbendazim + Mancozeb @ 500gm/ha	13.65	7.81
T_8	Hexaconazole 5% EC @ 500ml/ha	14.14	7.63
T_9	Control (water spray)	13.14	17.61
	SE(m) ± 1	_	0.86
	CD at 5%	NS	2.62

* Average of three replications

The data in table 2 shows that fig.2that all the eight fungicides significantly controlled the FLS as compared to control (17.61%). Significantly minimum FLS incidence was recorded in treatment pyraclostrobin + mefentrifluconazole +fluxapyroxad (4.51%), which was at par to azoxystrobin + tebuconazole+ prochloraz (5.48%) followed by prochloraz + tebuconazole (7.55%),hexaconazole (7.63%), carbendazim + mancozeb (7.81%), tebuconazole + sulphur (7.97%), tebuconazole (8.47%) and pyraclostrobin(9.27%). However, pyraclostrobin + mefentrifluconazole +fluxapyroxad, prochloraz + tebuconazole, hexaconazole, carbendazim + mancozeb, tebuconazole + sulphur, were at par to each other. Tebuconazole and pyraclostrobin were equally effective in controlling the disease.

1. Pyraclostrobin

2. Tebuconazole

3. Prochloraz + Tebuconazole

4. Azoxystrobin+ Tebuconazole + Prochloraz

5. Pyraclostrobin + Mefentrifluconazole + Fluxapyroxad

6. Tebuconazole+ Sulphur

Plate 1: General view of the effect of fungicides spray in experimental plots

7. Carbendazim + Mancozeb

8. Hexaconazole

Control

Plate 2: General view of the effect of fungicides spray in experimental plots

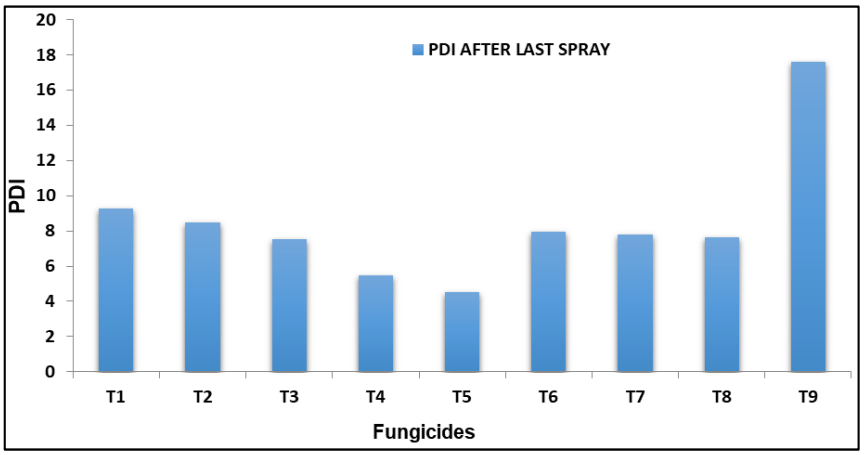


Fig 2: Frogeye leaf spot of soybean in strobilurin and triazole fungicides application

T_1 – Pyraclostrobin
T_2 – Tebuconazole
T_3 – Prochloraz + Tebuconazole
T_4 – Azoxystrobin+ Tebuconazole+ Prochloraz
T_5 - Pyraclostrobin+ Mefentrifluconazole+ fluxapyroxad
T_6 – Tebuconazole + Sulphur
T_7 – Carbendezim+ Mancozeb
T_8 – Hexaconazole
T_9 – Control

All the strobilurin and triazole fungicides and combinations fungicides were found significantly effective in controlling Target leaf spot (TLS) and frogeye leaf spot (FLS) diseases of soybean. Significantly minimum TLS incidence was recorded in treatment pyraclostrobin + mefentrifluconazole + fluxapyroxad which was at par to azoxystrobin + tebuconazole + prochloraz followed by prochloraz + tebuconazole, hexaconazole, carbendazim + mancozeb, tebuconazole + sulphur, tebuconazole and pyraclostrobin.
Significantly minimum FLS incidence was recorded in treatment pyraclostrobin + mefentrifluconazole + fluxapyroxad, which was at par to azoxystrobin + tebuconazole + prochloraz followed by prochloraz + tebuconazole, hexaconazole, carbendazim + mancozeb, tebuconazole + sulphur, tebuconazole and pyraclostrobin.

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