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Evaluation of Novel Fungicide for the Management of Soybean Anthracnose Disease and Yield Loss Estimation

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ABSTRACT

Background: Soybean anthracnose is currently a severe threat to India's soybean cultivation. There is limited information about estimated yield loss due to anthracnose and foliar fungicide application for its management.

Methods: A novel fungicide, Picoxystrobin 7.05 per cent + Propiconazole 11.71 per cent (w/w) was evaluated for two consecutive years (2018 and 2019) in three different concentrations as a foliar application in combination with commercially available fungicides as standard checks to identify an alternative fungicide for management of soybean anthracnose disease. The yield loss was estimated from the data observed for two years in a row.

Result: After three foliar applications of the novel fungicide, Picoxystrobin 7.05 per cent + Propiconazole 11.71 per cent w/w @ 0.20 per cent, the maximum disease control (PDC), the lowest disease index (PDI) and the area under the disease progress curve (AUDPC) were obtained. The maximum gross return was obtained following three foliar applications of Picoxystrobin 22.52 per cent (w/w) SC @ 0.08 per cent, but the maximum B:C ratio was estimated with foliar application of Hexaconazole 5.00 per cent EC @ 0.100 per cent. Anthracnose severity was found to be negatively correlated with soybean grain yield (r = -0.91). In every 1% increase in anthracnose disease severity reduced soybean yield by 115 kg per hectare.

Key words: Anthracnose, Fungicides, Management, Soybean, Yield loss.

INTRODUCTION

Soybean (*Glycine max* L.) is an asatic leguminous crop, secures the first rank in terms of per hectare protein production among the field crops (Hartman *et al.* 2011). Apart from protein, it provides nearly half of the world's edible oil Singh *et al.* (2021). Being a highly quality protein rich source, soybean is used for human and animal feed. It has also industrial and commercial value due to its antioxidant properties (Nataraj *et al.* 2019).

In India, there have been a number of issues posed by various biotic and abiotic streses in soybean cultivation. Anthracnose is caused by *Colletotrichum truncatum* (Schwein.) Andrus and W.D. Moore has recently been emerged as one of the most significant constraints in soybean cultivation (Singh *et al.* 2021). Soybean crop is susceptible to this disease at all growth stages. It affects pre and post-emergence stages resulting in the poor plant stand. Disease initiates as lesions on cotyledons, later on progresses to stem and leaves. Infected leaves show veinal necrosis, infected stem shows brown discoloration which further results in blackening due to abundant acervuli production. Infected pods have brown spots that progress to blackening once acervuli formed. It hampers seed filling, resulting in pod blanking, when disease severity gets high. Ideal weather conditions ideal for disease development are leaf wetness for more than 12 hours and a temperature of less than 35°C (Hartman *et al.* 2015). In the top eight soybean-producing countries (USA, China, Brazil, Argentina, India, Bolivia, Canada and Paraguay), anthracnose is estimated to have caused a yield loss of 25.4 million tones (mt). According to Wrather *et al.* (2010), China had the greatest yield loss (16.6 mt) followed by the USA (4.9 mt) and India (1.17 mt). Sharma *et al.* (2014) have reported soybean grain yield losses ranging from 16-25% due to anthracnose alone.

Due to the coincidence of pod filling stage with favourable climatic conditions such as continuous raining and temperatures between 26 and 35°C, Madhya Pradesh, the India's largest soybean producing state, experiences high severity of soybean anthracnose. This leads to the initiation and acceleration of both primary and secondary infection of soybean anthracnose Nataraj *et al.* (2020). In India, there are only a few reports on anthracnose management using fungicides.

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Now, only eight authorized and recommended fungicides are available to farmers after the Government of India banned many fungicides. Therefore, it was the need of the hour to assess newer and effective molecules for the better management of anthracnose. Therefore, the current study aimed to evaluate the efficacy of a new fungicide for The effective management of anthracnose and estimating yield loss owing to anthracnose in field.

MATERIALS AND METHODS

Efficacy of novel fungicide under field conditions

A well-known soybean variety, JS 20-29 susceptible to anthracnose was selected to study the efficacy of a new combi fungicide, Picoxystrobin 7.05% + Propiconazole 11.71% w/w (E.I. Dupont India Pvt Ltd, India) along with different commercially available fungicides against soybean anthracnose during *kharif* seasons of 2018 and 2019 under hot spot conditions at ICAR-Indian Institute of Soybean Research (ICAR-IISR), Indore. Experiment was conducted in a triplicate manner using randomized block design with seven treatments and one control. To know the minimum effective concentration of Picoxystrobin 7.05% + Propiconazole 11.71% w/w, three concentrations *i.e.*, 0.175 %, 0.200% and 0.225% were selected for foliar application. As per recommendation of ICAR-IISR, Indore, other treatments were selected as Picoxystrobin 22.52% w/w SC @ 0.08%, Propiconazole 25% w/w EC @ 0.1%, Pyraclostrobin 20% w/w WG @ 0.1%, Hexaconazole 5% EC @ 0.1% and control was untreated. The experiment was sown in a plot size of 20.25 m^2 consisting 9 rows of 5 m length with 45 cm row space in broad bed furrow system. Foliar spray of each treatment was given thrice, each at 30 days after sowing (DAS), 45 DAS and 60 DAS. Agronomic and entomological package of practices were followed as per ICAR, 2009.

Effect of fungicides on yield and economics

Disease severity was visually observed at five days after each fungicidal spay and ten days after last spray with pre-transformed disease rating scale of 0-9 Sajeesh *et al.* (2014), where 0= no observable symptoms, 1= 1% leaves and pod area covered with spots or necrosis, 3= 1.1 to 10% area covered, 5 = 10.1 to 25% area covered, 7 =25.1 to 50% area covered, 9 = more than 50% area covered. Disease was observed on 10 randomly selected and pre tagged plants at 15 DAS. Percent disease index (PDI), per cent disease control (PDC) and area under disease progress curve (AUDPC) were calculated (Dangi *et al.*, 2019; Rajput and Harlapur, 2015). Yield of soybean was taken at the time of harvest. To identify most economical and effective treatment, benefit cost ratio was also calculated (Hingole *et al.* 2017). Avoidable Yield Loss (AYL) was calculated as per the formula

$$\frac{YP - YU}{YP} \times 100$$

Where

YP = Yield under protected condition.

YU = Yield under unprotected condition (Hingole *et al.* 2017).

Disease severity was correlated with yield obtain in experiment field. Statical analysis was carried out using SAS application.

RESULTS AND DISCUSSION

Efficacy of novel fungicide under field conditions

All the treatments were found significantly effective against soybean anthracnose during both the years. During 2018, after first foliar application, minimum PDI (45.24%) was observed with the treatment Hexaconazole 5% EC @ 0.1% with maximum PDC (32.76%) over the control (67.29%) at 35 days after sowing (DAS) (Table 1 and 2). After second and third foliar application of fungicides, Picoxystrobin 22.52% w/w SC @ 0.08% was found most effective in management of soybean anthracnose with minimum PDI 35.12% and maximum PDC 48.89% over the control (68.72%) at 50 DAS; minimum PDI 27.87% and maximum PDC 60.04% over the control (69.74%) at 65 DAS; minimum PDI 24.25% and maximum PDC 66.91% over the control (73.29%) at 70 DAS. Cumulatively during 2018, three foliar applications of fungicide, Picoxystrobin 22.52% w/w SC @ 0.08% was the most effective in the management of soybean anthracnose with minimum AUDPC 2055.37, maximum PDC 51.69% and minimum PDI 33.70% over the control (69.76%) (Table 1, 2 and 3).

During 2019, after first foliar spray at 35 DAS, maximum PDC (20.15%) was observed with Hexaconazole 5% EC @ 0.1% showing the minimum PDI 59.44% over the control (74.44%). After second and third foliar applications of fungicides, Picoxystrobin 7.05% + Propiconazole 11.71% @ 0.2% was found the most effective for management of anthracnose with maximum PDC (34.07%) and minimum PDI (50.54%) over the control (76.66%) at 50DAS; the maximum PDC (38.63%) and the minimum PDI (49.44%) over the control (80.56%) at 65 DAS; and the maximum PDC (56.88%) and the minimum PDI (38.33%) over the control (88.89%) at 70 DAS. Cumulatively during 2019, three foliar applications of novel fungicide Picoxystrobin 7.05% + Propiconazole 11.71% w/w @ 0.2% was found the most effective treatment for the management of soybean anthracnose with the minimum AUDPC (2931.57), the maximum PDC (37.10%) and the minimum PDI (50.41%)over the control (80.14%) (Table 1, 2 and 3).

Combined result of both the years, 2018 and 2019, revealed that at Hexaconazole 5% EC @ 0.1% at 35 DAS was found the most effective in anthracnose management with the maximum PDC (26.46%) and the minimum PDI (52.34%) over the control (70.87%). After second and third foliar applications of fungicides, Picoxystrobin 7.05% + Propiconazole 11.71% w/w @ 0.2% was found the most effective with the maximum PDC (34.82%) and the minimum PDI (47.41%) over the control (72.69%) at 50 DAS; the maximum PDC (44.78%) and the minimum PDI (41.83%) over the control (75.15%) at 65 DAS; the maximum PDC

Table 1: Effect of foliar application of fungicide on PDI of soybean anthracnose.

Treatment	Dose	PDI (%) at 35 DAS			PDI (%) at 50 DAS			PDI (%) at 65DAS			PDI (%) at 70 DAS			Mean PDI(%)		
	(%)	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
Picoxystrobin 7.05% + Propiconazole 11.71% w/w	0.175	65.57^{g}	63.89^{bc}	64.73	42.77^{de}	60.52^{c}	51.65	32.58^{c}	55.56^{b}	44.07	29.48^{c}	45.00^{b}	37.24	42.60	56.24	49.42
Picoxystrobin 7.05% + Propiconazole 11.71% w/w	0.200	60.43^{f}	63.33^{b}	61.88	44.28^{f}	50.54^{a}	47.41	34.22^{d}	49.44^{a}	41.83	29.54^{cd}	38.33^{a}	33.94	42.12	50.41	46.26
Picoxystrobin 7.05% + Propiconazole 11.71% w/w	0.225	59.14^{e}	65.00^{b-d}	62.07	45.52^{g}	50.54^{a}	48.03	35.25^{d-f}	49.44^{a}	42.35	30.12^{c-e}	38.33^{a}	34.23	42.51	50.83	46.67
Picoxystrobin 22.52% w/w SC	0.080	47.57^{b}	70.56^{g}	59.07	35.12^{a}	68.54^{d-f}	51.83	27.87^{a}	66.67^{c}	47.27	24.25^{a}	61.67^{d}	42.96	33.70	66.86	50.28
Propiconazole 25% w/w EC	0.100	50.14^{c}	67.78^{e}	58.96	40.27^{c}	68.44^{de}	54.36	35.22^{de}	69.44^{d}	52.33	32.27^{f}	63.89^{ef}	48.08	39.48	67.39	53.43
Pyraclostrobin 20% w/w WG	0.100	50.79^{cd}	68.22^{ef}	59.51	42.22^{d}	57.34^{b}	49.78	36.17^{e-g}	55.56^{b}	45.87	32.49^{fg}	52.22^{c}	42.36	40.42	58.34	49.38
Hexaconazole 5% EC	0.100	45.24^{a}	59.44^{a}	52.34	37.52^{b}	66.62^{d}	52.07	30.17^{b}	66.67^{c}	48.42	27.54^{b}	62.22^{de}	44.88	35.12	63.74	48.92
Untreated Control		67.29^{h}	74.44^{h}	70.87	68.72^{h}	76.66^{g}	72.69	69.74^{h}	80.56^{e}	75.15	73.29^{h}	88.89^{g}	81.09	69.76	80.14	74.95
SEm±		0.48	0.89		0.38	0.96		0.41	0.78		0.43	0.81				
CD at 5%		1.43	1.89		1.13	2.04		1.22	1.66		1.28	1.73				
CV		1.58	2.46		1.57	2.83		2.01	2.34		2.27	2.64				

Table 2: Effect of foliar application of fungicide on PDC of soybean anthracnose.

Treatment	Dose	PDC (%) at 35 DAS			PDC (%) at 50 DAS			PDC (%) at 65 DAS			PDC (%) at 70 DAS			Mean PDC (%)		
	(%)	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
Picoxystrobin 7.05% + Propiconazole 11.71% w/w	0.175	2.56	14.17	8.36	37.76	21.05	29.41	53.28	31.03	42.16	59.78	49.38	54.58	38.93	29.82	34.06
Picoxystrobin 7.05% + Propiconazole 11.71% w/w	0.200	10.19	14.92	12.56	35.56	34.07	34.82	50.93	38.63	44.78	59.69	56.88	58.29	39.63	37.10	38.27
Picoxystrobin 7.05% + Propiconazole 11.71% w/w	0.225	12.11	12.68	12.40	33.76	34.07	33.92	49.46	38.63	44.04	58.90	56.88	57.89	39.07	36.58	37.74
Picoxystrobin 22.52% w/w SC	0.080	29.31	5.21	17.26	48.89	10.59	29.74	60.04	17.24	38.64	66.91	30.62	48.77	51.69	16.57	32.91
Propiconazole 25 % w/w EC	0.100	25.49	8.95	17.22	41.40	10.72	26.06	49.50	13.80	31.65	55.97	28.12	42.05	43.41	15.91	28.71
Pyraclostrobin 20% w/w WG	0.100	24.52	8.36	16.44	38.56	25.20	31.88	48.14	31.03	39.58	55.67	41.25	48.46	42.06	27.21	34.12
Hexaconazole 5% EC	0.100	32.76	20.15	26.46	45.40	13.10	29.25	56.74	17.24	36.99	62.42	30.00	46.21	49.43	20.47	34.74
Untreated control		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 3: Effect of foliar application of fungicide on AUDPC of soybean anthracnose, grain yield, increase yield (IY) %and AYL (%) of soybean.

Treatment	Dose	AUDPC			Yield (q/ha)			IY (%)			AYL (%)		
	(%)	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
Picoxystrobin 7.05% + Propiconazole 11.71% w/w	0.175	2680.30	3173.15	2926.72	16.54^{bc}	15.86^{a}	16.20	13.37	34.86	22.91	11.79	25.85	18.64
Picoxystrobin 7.05% + Propiconazole 11.71% w/w	0.200	2591.00	2931.57	2761.28	16.67^{b-d}	15.97^{a}	16.32	14.26	35.80	23.82	12.48	26.36	19.24
Picoxystrobin 7.05% + Propiconazole 11.71% w/w	0.225	2589.10	2973.32	2781.21	16.53^{b}	15.88^{a}	16.21	13.30	35.03	22.95	11.74	25.94	18.67
Picoxystrobin 22.52% w/w SC	0.080	2055.37	3612.97	2834.17	19.34^{h}	15.14^{a}	17.24	32.56	28.74	30.80	24.56	22.32	23.55
Propiconazole 25 % w/w EC	0.100	2290.42	3575.22	2932.82	16.97^{bcde}	14.14^{b}	15.56	16.31	20.24	18.02	14.02	16.83	15.27
Pyraclostrobin 20% w/w WG	0.100	2345.97	3251.75	2798.86	17.04^{b-f}	14.71^{b-d}	15.88	16.79	25.09	20.45	14.38	20.05	16.98
Hexaconazole 5% EC	0.100	2064.35	3307.55	2685.95	17.92^{c-g}	14.64^{bc}	16.28	22.82	24.49	23.52	18.58	19.67	19.04
Untreated Control		3593.67	4038.72	3816.20	14.59^{a}	11.76^{a}	13.18	0.00	0.00	0.00	0.00	0.00	0.00
SEm±				0.65	0.48								
CD at 5%				1.38	1.03								
CV				7.04	5.97								

(58.29%) and the minimum PDI (33.94%) over the control (81.09%) at 70DAS. Overall, three foliar sprays of Picoxystrobin 7.05% + Propiconazole 11.71% w/w @ 0.2 % was found the most effective in management of soybean anthracnose with the maximum PDC (38.27%) and the minimum PDI (46.26%) over the control (74.95%). Interestingly, the minimum AUDPC (2685.95) was observed with application of Hexaconazole 5% EC @ 0.1%.

Effect of fungicides on yield and economics

Foliar application of fungicides influenced soybean grain yield significantly in both the years (Table 3 and 4). During 2018, maximum soybean seed yield of 19.34 q/ha over the control (14.59q/ha), with maximum yield enhancement 32.56%, maximum AYL 24.56%, maximum gross return 71751.4 Rs/ha with 3.59 Benefit to Cost (B:C) ratio was obtained after foliar application of Picoxystrobin 22.52% w/w SC @ 0.08%, whereas maximum BC ratio 4.05 was obtained after foliar application of Hexaconazole 5% EC @ 0.1% over the control (3.61).

During 2019, maximum soybean grain yield 15.97 q/ha over the control (11.76q/ha) with maximum yield enhancement 35.80%, maximum AYL 26.36%, maximum gross return Rs 59248.7/ha with 2.84 as BC ratio was obtained after foliar application of Picoxystrobin 7.05% + Propiconazole 11.71% w/w @ 0.2%, was statistically on par with Picoxystrobin 7.05% + Propiconazole 11.71% w/w @ 0.175% (15.86 q/ha), Picoxystrobin 7.05% + Propiconazole 11.71% w/w @ 0.225% (15.88 q/ha) and Picoxystrobin 22.52% w/w SC @ 0.080% (15.14 q/ha) in term of soybean grain yield. Interestingly, maximum B:C ratio 3.31 was again obtained after foliar application of Hexaconazole 5% EC @ 0.1% over the control (2.91).

From pooled analysis of both the years, maximum yield 17.24 q/ha over the control (13.18 q/ha) with maximum yield enhancement 30.80%, maximum AYL 23.55%, maximum gross return 63960.4 Rs/ha with 3.20 as B:C ratio was obtained after foliar application of Picoxystrobin 22.52% w/w SC @ 0.08%, whereas maximum BC ratio 3.68 was obtained after foliar application of Hexaconazole 5% EC @ 0.1% over the control (3.26). The B:C ratio was less compared to control in all tested fungicides, except Hexaconazole 5% EC @ 0.1% and Propiconazole 25%w/w EC @0.1%.

During 2018 and 2019, a strong negative correlation was observed between soybean anthracnose severity and yield during 2018 (r = -0.87**) and 2019 (r = -0.92**) and for combined years (r = - 0.91**) (Fig 1, 2 and 3). Through linear regression analysis, it was found that for every 1% increase in soybean severity resulted in reduction of soybean yield by 0.103 q/ha during 2018 and 0.128 q/ha during 2019 and 0.115 collectively in both the years.

In the current study, three foliar application of Picoxystrobin 7.05% + Propiconazole 11.71% w/w @ 0.2% was found most significant in reduction of soybean anthracnose severity whereas, three foliar applications of Picoxystrobin 22.52% (w/w) SC @ 0.08% found most

Table 4: Economic analysis of foliar application of fungicides against soybean anthracnose.

Treatment	Dose (%)	CF (Rs/ha)	SC	TFC	TCOC	Gross return (Rs/ ha)			BC ratio		
						2018	2019	Mean	2018	2019	Mean
Picoxystrobin 7.05% + Propiconazole 11.71% w/w SC	0.175	1575	450	4725	20175	61363.4	58840.6	60102.0	3.04	2.92	2.98
Picoxystrobin 7.05% + Propiconazole 11.71% w/w SC	0.200	1800	450	5400	20850	61845.7	59248.7	60547.2	2.97	2.84	2.90
Picoxystrobin 7.05% + Propiconazole 11.71% w/w SC	0.225	2025	450	6075	21525	61326.3	58914.8	60120.6	2.85	2.74	2.79
Picoxystrobin 22.52% w/w SC	0.080	1520	450	4560	20010	71751.4	56169.4	63960.4	3.59	2.81	3.20
Propiconazole 25 % w/w EC	0.100	700	450	2100	17550	62958.7	52459.4	57709.1	3.59	2.99	3.29
Pyraclostrobin 20% w/w WG	0.100	1850	450	5550	21000	63218.4	54574.1	58896.3	3.01	2.60	2.80
Hexaconazole 5% EC	0.100	325	450	975	16425	66483.2	54314.4	60398.8	4.05	3.31	3.68
Untreated control	-	0	0	0	15000	54128.9	43629.6	48879.3	3.61	2.91	3.26

CF-Cost of fungicide (Rs/ha), SC-Spraying cost, TFC-Total fungicide cost , TCOC-Total cost of cultivation; Cost of cultivation is 15000 Rs/ha.

effective in enhancing soybean yield gross return and but slightly less in B:C ratio over the control. Application of fungicides resulted in maximum suppression of the soybean anthracnose severity by 51.69 % in 2018, 37.10% in 2019 and cumulative 38.27% in both the years under field conditions, which was not found to be economical in terms of B:C ratio. Cruz *et al.* (2010) also reported that application of different fungicides such as flutriafol and triazoles did not increase the soybean yield significantly in 50% of the total assay and severity of brown spot of soybean was not reduced much. Out of nine different fungicides (flutriafol and triazoles and strobilurines), only one fungicide azoxystrobin + cyproconazole was found to reduced anthracnose disease severity significantly and remaining fungicides were not found to have much impact on soybean yield as well as anthracnose severity (Dias *et al.* 2016). Timing of fungicidal application in relation to initiation of disease plays a vital role in its efficacy. Biotrophic host parasite relationship between susceptible soybean cultivar and soybean anthracnose fungus *C. truncatum* was established way before appearance of symptoms. That lead to nullify the effect of fungicides on diseased portion, therefore severity of soybean anthracnose was not reduced as desired (Klingelfuss and Yorinori, 2001).

The *Colletotrichum* species are often hemi-biotrophic in nature with early infection through biotrophic, later switching over to necrotrophic mode of infection (Bhadauria *et al.* 2011). This switching hemi-biotroph to necrotrophic mode of infection may be the one of the reasons behind low efficacy of fungicides.

The market prices of novel fungicides were also high that contributed to relatively low B:C ratio. The old fungicides like Hexaconazole 5% EC and Propiconazole 25% w/w EC were cheaper and economical for reduction of soybean anthracnose. Application of Hexaconazole 5% EC after 55 days after sowing was effective in management of anthracnose in soybean (Nagaraj *et al.* 2017).

This study quantified soybean yield loss due to anthracnose, which is potential threat to Indian soybean production. Anthracnose severity and grain yield was significantly negatively correlated in both the years ($r = -0.91^{**}$). Total 115 kg/ha of soybean grain yield was going to be reduced with 1% increase in soybean anthracnose severity. Dias *et al.* (2016) also reported that each 1% of increase in soybean anthracnose severity led to reduction in soybean grain yield by 95 kg/ha.

Madhya Pradesh state is having maximum area and production of soybean in India, whereas, soybean anthracnose is number one disease in term of severity in Madhya Pradesh. Soybean production is under serious threat as anthracnose severity is increasing day by day. Soybean was grown in 5.51 mha in Madhya Pradesh during 2019 (Soybean monitor, 2020), which means 1% increase in anthracnose severity can lead to cause loss of 0.63 mt (1.6% of total production) of soybean grain yield of Madhya Pradesh. As efficacy of fungicides was low in management of soybean anthracnose and soybean is growing in rainy

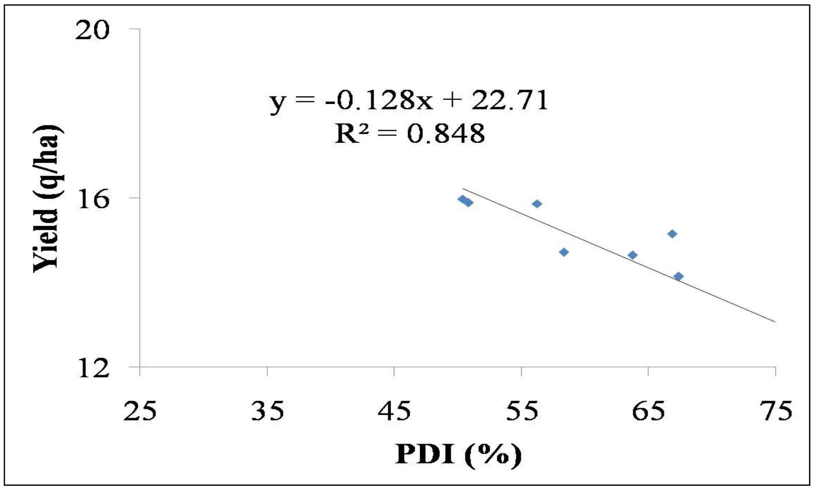

Fig 1: Regression analysis of soybean anthracnose severity and grain yield in fungicidal treated plot during 2018.

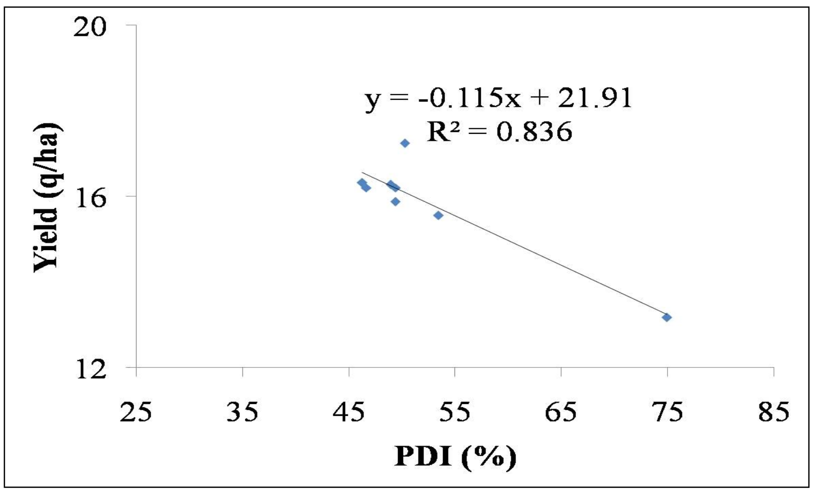

Fig 2: Regression analysis of soybean anthracnose severity and grain yield in fungicidal treated plot during 2019.

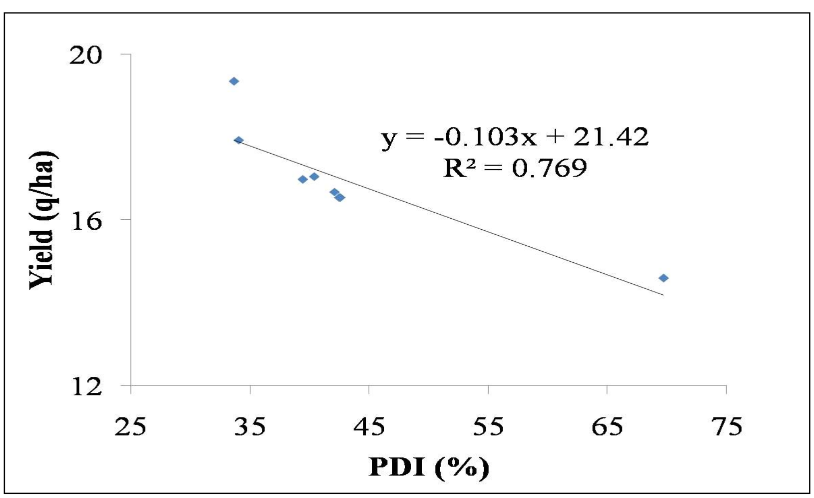

Fig 3: Regression analysis of soybean anthracnose severity and grain yield in fungicidal treated plot during combined years 2018 and 2019.

season. Therefore, management of soybean anthracnose should not be based on foliar application of fungicide alone, but integration of different agronomic methods such as growing of resistant variety, use of crop rotation, maintaining suitable plant population size and balanced use of fertilizer will provide synergetic effect in appropriate and effective management of soybean anthracnose.

CONCLUSION

Foliar application of novel fungicide, Picoxystrobin 7.05% + Propiconazole 11.71% w/w @ 0.2% was found to be the best treatment for the management of soybean anthracnose and can be used as an alternative fungicide if the market price of fungicide gets reduced. Nevertheless, use of combination-fungicides may be promoted to delay the development of resistance in pathogen. Foliar application of Hexaconazole 5% EC @ 0.1% is the most economical fungicide for the management of anthracnose, whereas, foliar application of Picoxystrobin 22.52% (w/w) SC @ 0.08% is the best in enhancing yield of soybean. It was estimated that 1% increase in disease severity leads to 115 kg/ha soybean grain yield loss.

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