

Efficacy of Seed Treatment and Foliar Application of New-Generation Fungicides for the Management of Anthracnose Caused by *Colletotrichum Truncatum* in Soybean

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Abstract

Anthracnose caused by *Colletotrichum truncatum* (Schw.) Andrus and Moore is one of the most destructive diseases of soybean in India, resulting in considerable yield losses. The present investigation was conducted during Kharif 2023 at JNKVV, Jabalpur (Madhya Pradesh), to evaluate the field efficacy of four fungicides (eight treatments) applied as seed treatment (ST), foliar spray (FS), and their combinations for the management of soybean anthracnose. All fungicidal treatments significantly reduced disease severity, disease incidence, pod infection and Area Under Disease Progress Curve (AUDPC), while improving plant health and grain yield over the untreated control. Among the treatments, T8 [ST Penflufen 13.28% w/w + Trifloxystrobin 13.28% w/w @ 1.25 ml kg⁻¹ seed + FS Tebuconazole 10% + Sulphur 65% WG @ 2 g l⁻¹ water] recorded the lowest anthracnose severity (5.37%) compared with the untreated control (23.33%). This treatment was followed by T7 [ST Penflufen 13.28% w/w + Trifloxystrobin 13.28% w/w @ 1.25 ml kg⁻¹ seed + FS Carbendazim 12% + Mancozeb 63% @ 2 g l⁻¹ water] (5.93%) and T6 [ST Carboxin 37.5% + Thiram 37.5% DS @ 2.5 g kg⁻¹ seed + FS Tebuconazole 10% + Sulphur 65% WG @ 2 g l⁻¹ water] (6.76%), which were statistically at par with T8. The highest plant stand was recorded with seed treatment of Penflufen 13.28% w/w + Trifloxystrobin 13.28% w/w (79.52%) compared with the untreated control (67.62%). Maximum grain yield was obtained in T8 (1310.53 kg ha⁻¹) followed by T7 (1278.87 kg ha⁻¹). Seed treatment combined with foliar application of fungicides also significantly improved plant growth parameters and seed weight over the untreated control. The study demonstrated that integration of seed treatment with Penflufen + Trifloxystrobin and foliar application of Tebuconazole + Sulphur or Carbendazim + Mancozeb provides effective management of soybean anthracnose under field conditions.

Key words: Anthracnose, pod blight, Soybean, Fungicides, Seed treatment, foliar spray, efficacy

Introduction

Soybean (*Glycine max* (L.) Merrill), commonly known as the “Chinese pea” or “golden bean”, is native to eastern Asia. China was the first country to domesticate soybean, followed by its cultivation in several Asian countries, and subsequently in America, Africa, and Europe (Hosseini *et al.*, 2023). At present, soybean is widely cultivated across different regions of the world. It is one of the most economical and readily available sources of high-quality protein (40%), carbohydrates (35%), edible vegetable oil (19%), minerals, and several other essential nutrients (Uikey *et al.*, 2022; Banerjee *et al.*, 2023). Soybean has become one of the most important agricultural commodities, contributing nearly 25% of the global edible oil production and about two-thirds of the world’s protein concentrate used in animal, poultry, and fish feed (Agarwal *et al.*, 2013; Amrate *et al.*, 2023a). In India, particularly under

the rainfed agro-ecosystems of central and peninsular regions, soybean has emerged as a major rainy season crop. During 2023–24, soybean occupied an area of 125.61 lakh hectares in India. Among the soybean-growing states, Madhya Pradesh ranked first with 53.35 lakh ha, followed by Maharashtra (50.72 lakh ha), Rajasthan (11.44 lakh ha), Karnataka (4.11 lakh ha), Gujarat (2.66 lakh ha), and Telangana (1.89 lakh ha) (FAOSTAT, 2023). Although soybean production and productivity have increased considerably in India as well as globally, crop production continues to be constrained by several biotic and abiotic stresses. Among these, diseases remain one of the major factors responsible for substantial yield losses every year (Rajput *et al.*, 2021; Kavanshree *et al.*, 2023; Amrate *et al.*, 2023b).

Anthracnose, caused by *Colletotrichum truncatum* (Schw.) Andrus and Moore, is regarded as one of the

most destructive diseases of soybean in India (Khare and Chacko, 1983; Rajput *et al.*, 2021; Amrate *et al.*, 2023b). The disease primarily infects stems and petioles during the early stages of crop growth and later spreads to pods, although pod infection alone may also occur under favourable conditions. Initial symptoms appear as dark necrotic lesions on stems, followed by pod blight during pod development (Figure 1). At advanced stages, infected tissues bear black acervuli with characteristic dark setae, which serve as distinguishing features of the pathogen (Faske *et al.*, 2014; Sharma *et al.*, 2011; Amrate *et al.*, 2023b) (Figure 1). In recent decades, anthracnose has become increasingly prevalent in almost all soybean-growing regions of India (Amrate *et al.*, 2023b; Rajput *et al.*, 2021). In central India, the disease occurs regularly and severely affects many soybean genotypes, including popular cultivars such as JS 93-05 and JS 95-60. Similar incidences of anthracnose and pod blight have also been reported from northern and southern India (Bhatt *et al.*, 2022; Kavanshree *et al.*, 2023).

Anthracnose can infect soybean from the seedling stage to crop maturity and may cause yield losses ranging from 16 to 25% (Wrather *et al.*, 2010). Owing to its seed-borne nature, the pathogen may establish infection during the initial stages of crop growth and subsequently develop into severe epidemics under favourable environmental conditions. Although the development of resistant cultivars remains the most sustainable approach for disease management, most of the currently cultivated high-yielding varieties and advanced breeding lines are susceptible to anthracnose (Nataraj *et al.*, 2020; Rajput *et al.*, 2021; Amrate *et al.*, 2023b).

Previous studies have demonstrated that timely application of suitable fungicides can effectively reduce the severity of soybean anthracnose and pod blight under field conditions (Amrate *et al.*, 2018; Rajput *et al.*, 2022). In addition, recent *in vitro* studies have shown promising efficacy of several new-generation fungicides against *C. truncatum* (Mandloi *et al.*, 2023; Raghuwanshi *et al.*, 2025). However, information on their performance under field conditions, particularly as integrated seed treatment and foliar spray combinations, is still limited. Therefore, the present investigation was undertaken to evaluate the efficacy of selected new-generation fungicides, applied individually and in combination, for the management of soybean anthracnose and their effect on disease severity, plant health, and grain yield under field conditions.

Material and Methods

Experimental details

The present investigation was carried out at the experimental field of the All India Coordinated Research Project (AICRP) on Soybean, BSP Unit, Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur, Madhya Pradesh, during the Kharif season of 2023. The experimental site is situated at 23°12'30" N latitude and 79°56'40" E longitude. A total of nine treatments, including one untreated control, were evaluated in three replications using a Randomized Block Design (RBD). Four fungicides recommended for soybean cultivation in India were evaluated for their field efficacy against anthracnose. Among these, Carboxin 37.5% + Thiram 37.5% DS (Vitavax Power) and Penflufen 13.28% w/w + Trifloxystrobin 13.28% w/w (Evergol Xtend) were used as seed treatment fungicides, whereas Tebuconazole 10% + Sulphur 65% WG (Tebsul-75) and Carbendazim 12% + Mancozeb 63% WP (Saaf) were evaluated as foliar spray fungicides. These fungicides were tested individually as well as in different combinations of seed treatment and foliar spray, resulting in eight fungicidal treatment combinations (Table 1). Seed treatment was carried out before sowing, while two foliar sprays were applied at 45 and 60 days after sowing (DAS). Each treatment consisted of a plot measuring 3.0 × 2.0 m² (five rows). The moderately susceptible soybean variety JS 335 was used for the experiment.

Previous investigations have shown that the Jabalpur location regularly experiences moderate to severe anthracnose/pod blight under natural epiphytotic conditions (Rajput *et al.*, 2021; Amrate *et al.*, 2023b; Amrate, 2024; Raghuwanshi *et al.*, 2025). Therefore, this location was considered suitable for evaluating fungicidal efficacy against anthracnose. The crop was sown on 08 July 2023 by following the recommended package of practices for soybean cultivation. Fungicidal seed treatment and foliar sprays were applied according to the experimental schedule.

Observations recorded

Percent disease incidence

Anthracnose incidence was recorded from 40 randomly selected plants in each replication at 30, 45, 60 and 75 DAS. The per cent disease incidence was calculated using the following formula:

Percent Disease Incidence (%)

= (Number of diseased plants / Total number of plants observed) × 100

At physiological maturity, 100 pods from each replication were examined for anthracnose lesions, and per cent pod infection was calculated.

Percent disease index (PDI)

Disease severity was assessed on the same 40 randomly selected plants at 30, 45, 60 and 75 DAS. Plants were critically examined for anthracnose symptoms on leaves, leaf veins, petioles, stems and pods. Disease severity was recorded using the partially modified 0–9 disease rating scale described by Mayee and Datar (1986), as adopted by Rajput *et al.* (2021) and Amrate *et al.* (2023b). The disease rating scale used for PDI calculation is presented in Table 2. Each plant was assigned an infection rating according to the proportion of plant parts affected by anthracnose.

The Per cent Disease Index (PDI) was calculated according to Wheeler (1969) using the following formula:

PDI (%)

= (Sum of all disease ratings / Number of observations × Maximum disease rating) × 100

Area Under Disease Progress Curve (AUDPC)

The periodic disease severity (PDI) observations recorded at different crop growth stages were used to calculate the Area Under Disease Progress Curve (AUDPC) following the method described by Jeger (2004).

$AUDPC = \sum [(Y_i + Y_{i+1})/2] \times (t_{i+1} - t_i)$

where,

Y_i = Disease severity (%) at the i th observation

t_i = Time (days)

n = Total number of observations

Plant health and yield parameters

The effect of fungicidal treatments on plant health was assessed by recording plant stand, plant height, number of branches, number of pods per plant, 100-seed weight and grain yield. Plant stand was recorded at 21 DAS. A total of 70 seeds were sown per square metre, and the number of established plants was counted from two

randomly selected 1 m² areas in each plot. The per cent plant stand was calculated using the following formula:

Percent Plant Stand (%) = (Number of plants established / Number of seeds sown) × 100

Plant height, number of branches and number of pods per plant were recorded from five randomly selected plants from each treatment at harvest, and their mean values were calculated. Grain yield was recorded on a plot basis, expressed in grams, and later converted into kg ha⁻¹. The 100-seed weight was also recorded separately from each replication after harvest.

Avoidable yield loss

Avoidable yield loss was estimated based on grain yield obtained under protected and unprotected conditions using the following formula:

Percent Avoidable Yield Loss (%)

= [(YP – YU) / YP] × 100

where,

YP = Yield under protected condition

YU = Yield under unprotected condition

Results

Effect of fungicidal treatments on anthracnose severity

Disease severity was recorded at 30, 45, 60 and 75 days after sowing (DAS). No anthracnose symptoms were observed in any of the treatments at 30 DAS. However, disease development was evident from 45 DAS onwards, and significant differences among the treatments were recorded during subsequent observations. At 45 DAS, only those treatments receiving seed treatment (T1, T2, T5, T6, T7 and T8) significantly reduced disease severity compared with the untreated control. As the crop advanced, disease severity increased in all treatments; however, the rate of disease development varied considerably depending upon the fungicidal treatment (Table 3, Figure 2).

Among all the treatments, T8 [ST Penflufen 13.28% w/w + Trifloxystrobin 13.28% w/w @ 1.25 ml kg⁻¹ seed + FS Tebuconazole 10% + Sulphur 65% WG @ 2 g l⁻¹ water] proved to be the most effective, recording the lowest anthracnose severity of 1.30% and 5.37% at 60 and 75 DAS, respectively, compared with 9.26% and 23.33% in the untreated control (Figure 1). The

next best treatments were T7 [ST Penflufen 13.28% w/w + Trifloxystrobin 13.28% w/w @ 1.25 ml kg⁻¹ seed + FS Carbendazim 12% + Mancozeb 63% @ 2 g l⁻¹ water] and T6 [ST Carboxin 37.5% + Thiram 37.5% DS @ 2.5 g kg⁻¹ seed + FS Tebuconazole 10% + Sulphur 65% WG @ 2 g l⁻¹ water], which recorded disease severity of 5.93% and 6.76%, respectively, at 75 DAS. However, T8 and T7 were statistically at par with each other. A similar trend was observed for Area Under Disease Progress Curve (AUDPC). The lowest AUDPC was recorded in T8 (63.88), followed by T7 (70.83), T6 (81.25) and T5 (94.44), whereas the untreated control recorded the highest AUDPC (345.83). These results clearly indicate that the combined application of seed treatment and foliar spray was more effective in suppressing disease development than their individual application (Table 3).

Effect of fungicidal treatments on disease incidence and pod infection

The per cent disease incidence at 75 DAS and pod infection at physiological maturity also differed significantly among the treatments. The lowest disease incidence was recorded in T8 (15.83%), followed by T7 (17.50%), whereas the untreated control recorded the highest disease incidence (47.50%) (Table 4). Similarly, the lowest pod infection was observed in T8 (13.00%), followed by T7 (14.67%) and T6 (15.33%), while the untreated control recorded 35.33% pod infection. The treatments T7 and T8 were statistically at par with each other for both disease incidence and pod infection. Overall, the integration of seed treatment with foliar fungicidal application markedly reduced disease incidence as well as pod infection under field conditions (Table 4).

Effect of fungicidal treatments on plant health and yield attributes

Plant stand recorded at 21 DAS was significantly higher in all treatments involving seed treatment (T1, T2, T5, T6, T7 and T8), whereas foliar spray alone (T3 and T4) did not significantly improve plant stand over the untreated control. The plant stand varied from 67.62% in the untreated control to 80.95% in T7 (Table 5). However, all seed treatment-based fungicidal treatments were statistically at par with each other. Plant height was significantly higher in T7 (53.48 cm) followed by T8 (53.20 cm) compared with the untreated control (48.31 cm). The number of branches per plant did not differ significantly among the treatments, although T8 recorded the highest value (2.25) compared with the untreated control (2.02). The number of pods per plant was significantly higher in T7 (20.36) followed by T8 (19.62) compared with the untreated control (15.53). Likewise, the 100-seed weight was significantly higher in T8 (11.11 g) followed closely by T7 (11.03 g) compared with the

untreated control (9.71 g), indicating the positive influence of fungicidal treatments on crop health and seed development.

Grain yield was also significantly influenced by fungicidal treatments. The highest grain yield was recorded in T8 (1310.53 kg ha⁻¹) followed by T6 (1283.90 kg ha⁻¹) and T7 (1278.87 kg ha⁻¹), whereas the untreated control produced 982.23 kg ha⁻¹. Similarly, the highest avoidable yield loss was recorded in T8 (25.05%), followed by T6 (23.49%), T7 (23.19%) and T5 (21.83%). The higher yield obtained under these treatments corresponded well with the reduction in disease severity and improved plant health parameters (Table 5).

Discussion

Colletotrichum truncatum has emerged as one of the most important constraints in soybean production, affecting the crop at various growth stages from seed germination to maturity. The disease causes considerable reduction in plant health and ultimately results in substantial yield losses. In the present investigation, seed treatment and foliar spray, applied individually as well as in combination, were evaluated under field conditions for the management of soybean anthracnose. Their effect on disease severity, plant health and grain yield was also assessed. Among the different treatments, T8 (ST Penflufen 13.28% w/w + Trifloxystrobin 13.28% w/w @ 1.25 ml kg⁻¹ seed + FS Tebuconazole 10% + Sulphur 65% WG @ 2 g l⁻¹ water), followed by T7 (ST Penflufen 13.28% w/w + Trifloxystrobin 13.28% w/w @ 1.25 ml kg⁻¹ seed + FS Carbendazim 12% + Mancozeb 63% @ 2 g l⁻¹ water), was found to be the most effective, as it recorded the lowest anthracnose severity at both 60 and 75 DAS compared with the untreated control. Seed treatment with Carboxin 37.5% + Thiram 37.5% DS also showed good efficacy in reducing disease severity under field conditions.

The present findings are in agreement with earlier reports. Subedi *et al.* (2015) also reported that foliar application of Carbendazim 12% + Mancozeb 63% @ 2.5 g l⁻¹ recorded lower PDI, followed by Mancozeb. Similarly, Amrate *et al.* (2018) reported that seed treatment with Carboxin 37.5% + Thiram 37.5% @ 2 g kg⁻¹ seed followed by two foliar sprays of Thiophanate methyl 70% WP @ 0.1% at 55 and 70 DAS was superior in reducing pod infection compared with the untreated control. The present results are further supported by earlier findings. Rana *et al.* (2020) reported that Trifloxystrobin + Penflufen was the most effective treatment in reducing disease severity, decreasing the Per cent Disease Index (PDI) and Area Under Disease Progress Curve (AUDPC), and improving grain yield. Likewise, Wasule *et al.* (2022) observed that seed treatment with Carboxin + Thiram @ 2 g kg⁻¹ seed followed by foliar spray of

Thiophanate methyl @ 0.1% recorded the lowest disease index and pod infection. Agam *et al.* (2019) reported that Carbendazim @ 0.1% provided the highest control of anthracnose (76.78%), followed by Tebuconazole @ 0.1% (63.35%), Propiconazole @ 0.1% (60.05%) and Hexaconazole @ 0.1% (49.71%). Similarly, Rajput *et al.* (2022) reported that Picoxystrobin 7.05% + Propiconazole 11.71% w/w @ 0.2% was the most effective treatment for the management of soybean anthracnose. They further reported that foliar application of Hexaconazole 5% EC @ 0.1% was the most economical treatment, whereas Picoxystrobin 22.52% SC @ 0.08% was the best for enhancing soybean yield.

In the present study, seed treatment with both fungicides proved effective in reducing pre- and post-emergence mortality. Plant stand at 21 DAS was significantly improved in all seed treatment-based treatments (T1, T2, T5, T6, T7 and T8), except T3 (FS Carbendazim 12% + Mancozeb 63% @ 2 g l⁻¹ water) and T4 (FS Tebuconazole 10% + Sulphur 65% WG @ 2 g l⁻¹ water), when compared with the untreated control. Plant height, number of pods per plant and 100-seed weight were also significantly higher in the fungicide-treated plots. The highest grain yield was

recorded in T8 (ST Penflufen 13.28% w/w + Trifloxystrobin 13.28% w/w @ 1.25 ml kg⁻¹ seed + FS Tebuconazole 10% + Sulphur 65% WG @ 2 g l⁻¹ water), followed by T6 (ST Carboxin 37.5% + Thiram 37.5% DS @ 2.5 g kg⁻¹ seed + FS Tebuconazole 10% + Sulphur 65% WG @ 2 g l⁻¹ water), compared with the untreated control.

The present findings are also supported by previous reports. Wasule *et al.* (2022) observed that seed treatment with Carboxin + Thiram @ 2 g kg⁻¹ seed followed by foliar application of Thiophanate methyl @ 0.1% improved seed germination, seed weight and grain yield. Similar findings were reported by Amrate *et al.* (2018), who observed improved seed germination and grain yield following seed treatment with Carboxin 37.5% + Thiram 37.5% and foliar application of Thiophanate methyl. The fungicides evaluated in the present study, particularly Carboxin + Thiram and Penflufen + Trifloxystrobin, have also been reported as effective seed dressers against *Macrophomina phaseolina* causing charcoal rot of soybean (Sagarika *et al.*, 2023). Therefore, these fungicidal combinations may also be useful for the management of other seed- and soil-borne diseases, thereby contributing to better protection and productivity of soybean.

Table 1: Treatment details of fungicides used in field condition and

Treatments	Fungicides
T1	ST Carboxin 37.5%+Thirum 37.5% DS@ 2.5g/kg seed
T2	ST Penflufen 13.28% w/w + Trifloxystrobin 13.28%w/w @ 1.25ml/kg seed
T3	FS Carbendazim 12% + Mancozeb 63 %@ 2g/lit water
T4	FS Tebuconazole 10% + Sulphur 65% WG @ 2g/lit water
T5	ST Carboxin 37.5% + Thirum 37.5% DS@ 2.5g/kg seed and FS Carbendazim 12% + Mancozeb 63 %@ 2g/lit water
T6	ST Carboxin 37.5% + Thirum37.5% DS@ 2.5g/kg seed and FS Tebuconazole 10% + Sulphur 65% WG @ 2g/lit water
T7	ST Penflufen 13.28% w/w + Trifloxystrobin 13.28% w/w @ 1.25ml/kg seed and FS Carbendazim 12% + Mancozeb 63 %@ 2g/lit water
T8	ST Penflufen 13.28% w/w + Trifloxystrobin 13.28% w/w @ 1.25ml/kg seed and FS Tebuconazole 10% + Sulphur 65% WG @ 2g/lit water
T9	Control

*Seed Treatment (ST) was done at the time of sowing, and Foliar Spray(FS) was done at 45 and 60 days after sowing

Table 2. Rating of Anthracnose used for calculation of per cent disease index

Rating	Visual assessment
0	No symptoms on leaf/petioles/stem/pods
1	A few lesion /necrosis covering upto 1% of plant's part
3	Scattered lesion/necrosis covering >1.0to 10% of plant's part
5	Necrotic lesion well developed prominent covering >10 to 25 % of plant part
7	Large necrotic area/lesion covering >25% to 50 % of plant's part
9	Severe necrosis covering >50% of plant' part to plant death

Table 3: Effect of fungicidal application on severity of anthracnose in soybean during Kharif 2023

S.No.	Treatments	Percent Disease Index (%)				AUPDC*
		30DAS	45DAS	60DAS	75DAS	
T1	ST Carboxin 37.5%+Thirum 37.5% DS@ 2.5g/kg seed	0.00	0.74 (3.99)	5.65 (13.67)	14.54 (22.38)	204.86
T2	ST Penflufen 13.28% w/w + Trifloxystrobin 13.28%w/w @1.25ml/kgseed	0.00	0.19 (1.43)	4.07 (11.55)	12.50 (20.69)	157.63
T3	FS Carbendazim 12% + Mancozeb 63 %@ 2g/lit water	0.00	2.13 (8.34)	5.37 (13.38)	11.57 (19.87)	199.30
T4	FS Tebuconazole 10% + Sulphur 65% WG @ 2g/lit water	0.00	1.57 (7.12)	3.98 (11.49)	10.09 (18.50)	159.02
T5	ST Carboxin 37.5%+Thirum37.5% DS@ 2.5g/kg seed and FS Carbendazim 12% + Mancozeb 63 %@ 2g/lit water	0.00	0.65 (4.45)	2.13 (8.37)	7.04 (15.37)	94.44
T6	ST Carboxin 37.5%+Thirum37.5% DS@ 2.5g/kg seed and FS Tebuconazole 10% + Sulphur 65% WG @ 2g/lit water	0.00	0.37 (2.75)	1.67 (7.24)	6.76 (15.05)	81.25
T7	ST Penflufen 13.28% w/w + Trifloxystrobin13.28%w/w@ 1.25 ml/kg seed and FS Carbendazim 12%+ Mancozeb 63 %@2g/lit water	0.00	0.56 (3.44)	1.20 (6.16)	5.93 (14.07)	70.83
T8	ST Penflufen 13.28% w/w + Trifloxystrobin 13.28%w/w @1.25ml/kgseed and FS Tebuconazole 10% + Sulphur 65% WG @ 2g/lit water	0.00	0.28 (2.441)	1.30 (5.335)	5.37 (13.38)	63.88
T9	Control	0.00	2.13 (8.34)	9.26 (17.68)	23.33 (28.86)	345.83
	C.D.	N.A.	4.098	3.615	1.506	39.660
	SE(m)±	N.A.	1.355	1.196	0.498	13.116
	CV	N.A.	49.908	19.636	4.617	14.847

ST= Seed treatment, FS= Foliar spray at 45th and 60th day after sowing.

*AUDPC was calculated from severity of anthracnose at 30,45,60 and 75 DAS

Table 4: Effect of fungicidal treatments on overall percent incidence and pod infection of anthracnose in field during 2023

S. No.	Treatments	Per cent Plant incidence	*Per cent pod affected
T1	ST Carboxin 37.5%+Thirum 37.5% DS@ 2.5g/kg seed	34.17 (35.75)	22.33 (28.16)
T2	ST Penflufen 13.28% w/w + Trifloxystrobin 13.28%w/w @1.25ml/kg seed	32.50 (34.73)	20.00 (26.55)
T3	FS Carbendazim 12% + Mancozeb 63 %@ 2g/lit water	31.67 (34.22)	18.33 (25.33)
T4	FS Tebuconazole 10% + Sulphur 65% WG @ 2g/lit water	29.17 (32.64)	17.33 (24.58)
T5	ST Carboxin 37.5%+Thirum 37.5% DS@ 2.5g/kg seed and FS Carbendazim 12% + Mancozeb 63 %@ 2g/lit water	20.83 (27.13)	15.67 (23.22)
T6	ST Carboxin 37.5%+Thirum 37.5% DS@ 2.5g/kg seed and FS Tebuconazole 10% + Sulphur 65% WG @ 2g/lit water	21.67 (27.72)	15.33 (23.02)
T7	ST Penflufen 13.28% w/w + Trifloxystrobin 13.28%w/w @1.25ml/kg seed and FS Carbendazim 12% + Mancozeb 63 %@ 2g/lit water	17.50 (24.68)	14.67 (22.45)
T8	ST Penflufen 13.28% w/w + Trifloxystrobin 13.28%w/w @1.25ml/kg seed and FS Tebuconazole 10% + Sulphur 65% WG @ 2g/lit water	15.83 (23.42)	13.00 (21.11)
T9	Control	47.50 (43.54)	35.33 (36.45)
	C.D.	2.618	2.320
	SE(m)±	0.866	0.767
	CV	4.755	5.180

Table 5: Effect of fungicidal application on plant stand, growth parameters and grain yield of soybean

S.No.	Treatments	Plant stand at 21 days (%)	Plant height(cm)	No. of branches per plant	No. of pods per plant	100 seed weight (gm)	Seed yield (kg/h)	Avoidable yield loss (%)
T1	STCarboxin 37.5%+Thirum 37.5% DS@ 2.5g/kg seed	77.62 (61.76)	49.68	2.12	16.23	10.08	1,094.47	10.25
T2	ST Penflufen 13.28% w/w + Trifloxystrobin 13.28%w/w @1.25ml/kg seed	79.52 (63.09)	51.15	2.06	16.13	10.14	1,111.67	11.66
T3	FS Carbendazim 12% + Mancozeb 63 %@ 2g/lit water	66.67 (54.73)	49.23	2.14	16.97	10.11	1,174.47	16.36
T4	FS Tebuconazole 10% + Sulphur 65% WG @ 2g/lit water	68.10(55.60)	48.83	2.03	17.23	10.14	1,181.10	16.83
T5	ST Carboxin 37.5%+Thirum 37.5% DS@ 2.5g/kg seed and FS Carbendazim 12% + Mancozeb 63 %@ 2g/lit water	77.14(61.44)	51.56	2.34	19.80	10.85	1,256.67	21.83
T6	ST Carboxin 37.5%+Thirum 37.5% DS@ 2.5g/kg seed and FS Tebuconazole 10% + Sulphur 65% WG @ 2g/lit water	78.57(62.43)	51.09	2.15	19.17	10.80	1,283.90	23.49
T7	ST Penflufen 13.28% w/w + Trifloxystrobin 13.28%w/w @1.25ml/kg seed and FS Carbendazim 12% + Mancozeb 63 %@ 2g/lit water	80.95(64.10)	53.48	2.10	20.36	11.03	1,278.87	23.19
T8	ST Penflufen 13.28% w/w + Trifloxystrobin 13.28%w/w @1.25ml/kg seed and FS Tebuconazole 10% + Sulphur 65% WG @ 2g/lit water	79.05(62.78)	53.20	2.25	19.62	11.11	1,310.53	25.05
T9	Control	67.62(55.32)	48.31	2.02	15.53	9.71	982.23	
	C.D.	3.257	2.802	N/A	2.508	0.663	117.225	
	SE(m) ±	1.077	0.994	0.102	0.829	0.219	38.767	
	CV	3.103	3.185	8.251	8.029	3.635	5.662	

Figure in parenthesis are angular transformed values



Figure 1. Anthracnose/pod blight affected soybean plants in experimental field.

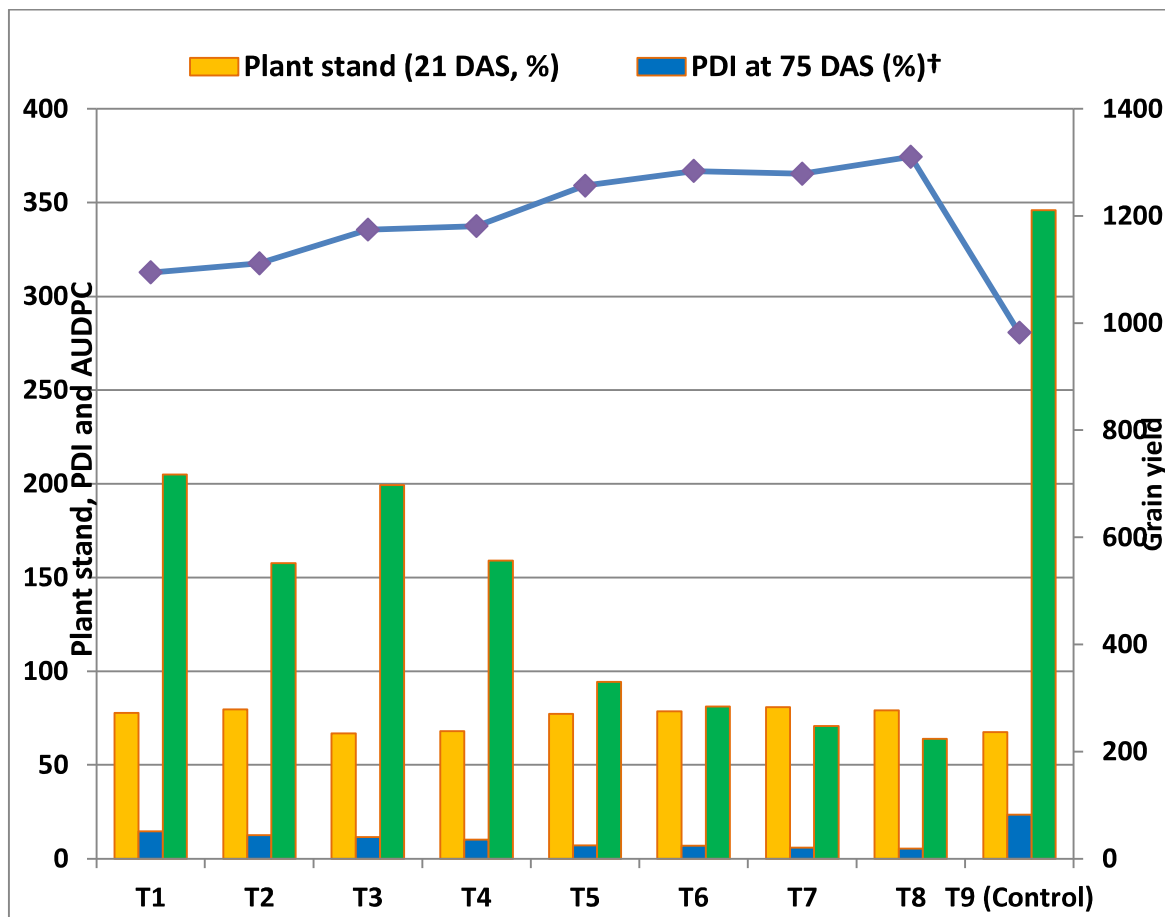


Figure 2. Graphical presentation of summary of experimental findings

Conclusion

Overall, the present study indicated that integration of seed treatment with Penflufen 13.28% w/w + Trifloxystrobin 13.28% w/w and foliar application of Tebuconazole 10% + Sulphur 65% WG or Carbendazim 12% + Mancozeb 63% WP effectively reduced soybean anthracnose and improved grain yield under field conditions. These findings suggest that integrated fungicidal application can be recommended as an effective strategy for the management of soybean anthracnose.

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