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Management of Alternariaster leaf spot and sunflower necrosis disease by using plant defense inducers

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Abstract
Plants are found to be infected by various microbial organisms such as fungus, virus, and bacteria which threaten their survival or reduce growth of the plants. In response to pathogen attack, plants have evolved several strategies to counteract pathogen infection. There are changes in plants physiology of plants after microbial attack results in active induced defense mechanisms. These active defense mechanisms refer as induced resistance, which occur after infection of plants by the pathogen and provide protection against subsequent attack of pathogen. Systemic acquired resistance (SAR), which is induced by inoculation of virulent or non-virulent pathogen and Salicylic acid dependent. Therefore, the present experiment was aimed at use of plant defense inducers for the management of *Alternariaster* leaf spot and Sunflower necrosis disease. Our results indicate that Seed treatment with salicylic acid @ 100 ppm followed by foliar spray of salicylic acid @ 100 ppm at 30 and 45 days after sowing have contributed more yield 1576 kg/ha and B:C ratio 1.54 with least *Alternariaster* leaf spot 20.93% and necrosis diseases 6.37% followed by Seed treatment with salicylic acid @ 50 ppm followed by foliar spray of salicylic acid @ 50 ppm at 30 and 45 days after sowing have contributed more yield 1413 kg/ha and B:C ratio 1.28 with least *Alternariaster* leaf spot 26.43% and necrosis diseases 11.16%. whereas highest *Alternariaster* leaf spot 57.19% and necrosis diseases 19.89% were recorded in control.

Keywords: Alternariaster, spot, sunflower, necrosis, plant, defense

Introduction
Sunflower is an important oilseed of our country. It is one of the fastest growing annual oilseed crops in India. In India area under sunflower crop was 1.29 lakh hectares with production of 1.03 lakh tones and yield of 802 kg ha-1 (Anon, 2019) [3]. Sunflower suffers on the account of many diseases caused by fungi, bacteria and viruses. Among these diseases Alternariatster leaf spot and sunflower necrosis diseases are most important in India. The major constraint in profitable sunflower cultivation is the susceptibility to *Alternariaster* leaf and stem blight caused by *Alternariaster helianthi*. The disease appears in Karnataka, Uttar Pradesh, Maharastra, Bihar, Andhra Pradesh, Haryana and Tamil nadu and causes 27 to 80 per cent reduction in seed yield. It significantly reduces both seed yield and oil content besides leading to germination losses (Reddy and Gupta, 1977; Hiremath *et al.*, 1990) [11, 5]. The yield losses caused due to sunflower necrosis disease were reported to the extent of 30- 100 per cent (Rao *et al.*, 2000) [9]. It is considered as one of the threatening diseases because of its fast-spreading nature and severity (Nagaraju, *et al.*, 1998) [8]. The sunflower necrosis disease is initiated as necrosis of part of the leaf lamina followed by various types of necrosis and mosaic mottling symptoms (Ajith Prasad *et al.*, 2004). Plants are constantly confronted with numerous biotic stresses. In agriculture, pests and pathogens lead to crop losses between 20 and 30% annually (Savary *et al.*, 2019) [12] To prevent infection, plants have developed an elaborate defence system that is activated upon the recognition of pathogen-associated molecular patterns (PAMPs) or pathogen effectors, leading to PAMP-triggered immunity (PTI) and effector-triggered immunity (ETI), respectively (Bigeard, *et. al.*, 2015) [4] Plant resistance can also be induced through the application of plant resistance inducers (PRIs), which can be either chemical agents, extracts from plants or microbes (Alexandersson *et. al.*, 2016] [2], or non-pathogenic microbes, including mycorrhizal fungi, plant growth-promoting rhizobacteria or fungi, and other microbes used as biopesticides. Thus, the objective of the present work was to evaluate plant defense inducers for the management of alternariaster leaf spot and sunflower necrosis disease.

Material and Methods

Field trials were conducted during Kharif seasons of 2019 and 2021 to evaluate the efficacy of plant defense inducers for the management of alternariaster leaf spot and sunflower necrosis disease of sunflower at MARS, Raichur.

Experimental details: The experiments were laid out on beds of 4.2× 3.0 (12.6 sq m) size in a randomized complete block design (RCBD) with nine treatments and three replications each with a spacing of 60 × 30 cm. The sunflower hybrid KBSH-44, which is susceptible to alternariaster leaf spot and sunflower necrosis disease was used with following treatments:

Table 1: Show the Treatment details

Sl. No.	Treatments	Treatment details
1	T_1	Seed treatment with Salicylic acid (SA) @ 50 ppm
2	T_2	Seed treatment with Salicylic acid (SA) @ 100 ppm
3	T_3	T1+ Foliar spray of Salicylic acid (SA) @ 50 ppm at 30 days and 45 DAS
4	T_4	T2+ Foliar spray of Salicylic acid (SA) @ 100 ppm at 30 days and 45 DAS
5	T_5	T1+ Foliar spray of Mono potassium phosphate (1%) at 30 and 45 DAS
6	T_6	T2+ Foliar spray of Mono potassium phosphate (1%) at 30 and 45 DAS
7	T_7	T1+ Foliar spray of Sodium propionate (1%) at 30 and 45 DAS
8	T_8	T2+ Foliar spray of Sodium propionate (1%) at 30 days and 45 DAS
9	T_9	Control

Observations Recorded

Observations on *Alternariaster* leaf spot disease was recorded after the first appearance of the disease by recording the number of lesions, lesion size per leaf and grade them following the standard scale given by Mayee and Datar (1986) [7].

Table 2: Disease Scoring (0-9 scale)

Score	Reaction	Leaf area covered
0	Immune	No symptoms on the leaf
1	Highly resistant (HR)	Small, circular, scattered brown spots covering 1% or less of the leaf area
3	Resistant (R)	Spots enlarging, dark brown in colour covering 1-10% of leaf area
5	Moderately resistant/Moderately susceptible (MR/MS)	Spots enlarging, dark brown in colour, target like appearance covering 11-25% of leaf area
7	Susceptible (S)	Spots dark brown, coalescing with target like appearance covering 26-50% of leaf area
9	Highly Susceptible (HS)	Spots uniformly dark brown, coalescing covering 51% or above of leaf area

Percent Disease Index

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

$$\text{PDI (\%)} = \frac{\text{Summation of all numerical ratings}}{\text{Total number of plants x maximum rating scale observed}} \text{x } 100$$

Sunflower Necrosis Disease

Observations on type of symptoms, time taken for local and systemic infection, per cent disease incidence (PDI) and disease severity (DS) were recorded.

$$\text{PDI (\%)} = \frac{\text{Number of plants infected}}{\text{Total number of plants}} \text{x } 100$$

Results and Discussion

The present investigation was carried out using plant defense inducers to manage alternariaster leaf spot and necrosis disease of sunflower. The results indicated that the least percent disease index of *Alternariaster* leaf spot (20.93%) and necrosis (6.37%) per cent with highest yield of 1576.2 kg/ha and highest B:C ratio of 1.54 was recorded in T_4 (Seed treatment with salicylic acid @ 100 ppm + Foliar spray of salicylic acid @ 100 ppm at 30 and 45 days after sowing) followed by T_3 (Seed treatment with salicylic acid @ 50 ppm foliar spray of salicylic acid @ 50 ppm at 30 and 45 days after sowing) which recorded *Alternariaster* leaf spot (26.43%) and necrosis (11.16%) with yield of 1413 kg/ha and B:C ratio of 1.28 during *Kharif* 2021 (Table 4). The results obtained during *Kharif* 2020 ans 2021 followed similar trend as observed during *Kharif*, 2019. T_4 (Seed treatment with salicylic acid @ 100 ppm + Foliar spray of salicylic acid @ 100 ppm at 30 and 45 days after sowing) recorded least percent disease index of *Alternariaster* leaf spot (22.77%) and necrosis (7.39%) per cent with highest yield of 1519 kg/ha and highest B:C ratio of 1.45 followed by T_3 (Seed treatment with salicylic acid @ 50 ppm foliar spray of salicylic acid @ 50 ppm at 30 and 45 days after sowing) which recorded *Alternariaster* leaf spot (31.69%) and necrosis (11.44%) with yield of 1416 kg/ha and B:C ratio of 1.28 (Table 3). Similarly, levels of SA in bark extracts from different poplar cultivars correlated with the ability of the cultivar toresist infection by the fungal pathogen *Dothiciza populea* (Pukacka, 1980) [10]. SA was also shown to be toxic to many pathogens, including *Colletotrichum falcatum*, *Fusarium oxysporum* (Singh, 1978) [14] and *Agrobacterium tumefaciens* (Saint-Pierre *et al.*, 1984). Since exogenous application of SA to tobacco induced many of the responses associated with viral attack, endogenous levels of SA were monitored in TMV-infected tobacco (Malamy *et al.*, 1990) [6]. In a TMV-resistant cultivar, endogenous SA levels rose at least 20-fold in the inoculated leaves. The increase was specific to the resistance response, since no change in SA levels occurred in a nearly isogenic, susceptible cultivar upon TMV infection.

Table 3: Evaluation of plant defense inducers for the management of diseases of sunflower (*kharif*, 2021)

Treatment details		Germination (%)	Vigour Index	*Alternariaster* leaf blight (PDI %)	Necrosis (PDI %)	Yield kg/ha	B:C Ratio
T1	Seed treatment with salicylic acid @ 50 ppm	94	2030	37.84 (37.94)	13.30 (21.31)	1312	1.17
T2	Seed treatment with salicylic acid @ 100 ppm	98	2274	35.51 (36.54)	12.84 (20.92)	1357	1.24
T3	T_1 + foliar spray of salicylic acid @ 50 ppm at 30 and 45 days after sowing	99	2525	31.69 (34.24)	11.44 (19.62)	1416	1.28
T4	T_2 + Foliar spray of salicylic acid @ 100 ppm at 30 and 45 days after sowing	99	2752	22.77 (28.29)	7.39 (15.51)	1519	1.45
T5	T_1 + foliar spray of mono potassium phosphate (1%) at 30 and 45 days after sowing	95	2081	40.22 (39.35)	14.54 (22.36)	1283	1.04
T6	T_2 + foliar spray of mono potassium phosphate (1%) at 30 and 45 days after sowing	96	2035	38.52 (38.30)	13.62 (21.60)	1300	1.06
T7	T_1+ foliar spray of sodium propionate (1%) at 30 and 45 days after sowing	97	2115	44.18 (41.63)	14.36 (22.24)	1286	0.98
T8	T_2 + foliar spray of sodium propionate (1%) at 30 and 45 days after sowing	95	2119	49.97 (44.97)	14.77 (22.56)	1155	0.78
T9	Control	90	1791	70.04 (57.07)	17.66 (24.73)	924	0.65
	S.Em±			2.66	1.54	91.34	
	CD (P=0.05)			7.99	4.60	273.85	
	CV			11.59	12.54	12.33	

Table 4: Evaluation of plant defense inducers for the management of diseases of sunflower (*kharif*, 2019-2021)

Treatment details		Germination (%)	Vigour Index	*Alternariaster* leaf blight (PDI %)	Necrosis (PDI %)	Yield kg/ha	B:C Ratio
T1	Seed treatment with salicylic acid @ 50 ppm	94.13	1973.9	30.78 (33.68)	12.08 (20.21)	1238	1.05
T2	Seed treatment with salicylic acid @ 100 ppm	95.67	2147.2	30.43 (33.48)	13.05 (21.17)	1229	1.03
T3	T_1 + foliar spray of salicylic acid @ 50 ppm at 30 and 45 days after sowing	97.33	2460.2	26.43 (30.87)	11.16 (19.42)	1413	1.28
T4	T_2 + Foliar spray of salicylic acid @ 100 ppm at 30 and 45 days after sowing	98.33	2484.6	20.93 (27.05)	6.37 (14.53)	1576	1.54
T5	T_1 + foliar spray of mono potassium phosphate (1%) at 30 and 45 days after sowing	95.40	2079.5	32.68 (34.86)	13.97 (21.91)	1324	1.10
T6	T_2 + foliar spray of mono potassium phosphate (1%) at 30 and 45 days after sowing	95.87	2051.6	35.94 (36.82)	12.78 (20.89)	1294	1.05
T7	T_1+ foliar spray of sodium propionate (1%) at 30 and 45 days after sowing	96.50	2112.9	37.57 (37.78)	14.06 (22.01)	1292	0.99
T8	T_2 + foliar spray of sodium propionate (1%) at 30 and 45 days after sowing	95.43	2070.6	41.42 (40.05)	14.61 (22.44)	1175	0.81
T9	Control	88.87	1739.4	57.19 (49.15)	19.89 (26.42)	956	0.71
	S.Em±			1.47	1.26	56.58	
	CD (P=0.05)			4.40	3.77	169.64	
	CV			7.07	10.36	7.67	

Benefit cost ratio gives information on whether the technology is economically viable in the farmers' fields or not. Hence, benefit cost ratio is an important parameter for recommendation of any treatment for successful control of plant diseases. In the present study, highest benefit (1.54) was obtained in T_4 (Seed treatment with salicylic acid @ 100 ppm + Foliar spray of salicylic acid @ 100 ppm at 30 and 45 days after sowing). Hence, this treatment can be considered for the management of alternariaster leaf spot and necrosis disease of sunflower.

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