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Integrated disease management of *Curvularia* leaf spot of maize (*Zea mays* L.)

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Abstract

Maize is the most resourceful crop with wider compliance in varied agroecologies around the World. The present studies were conducted in the Experiment Field of the Department of Plant Pathology at Central Research Farm, SHUATS, Prayagraj, (UP.) during Rabi 2022 and 2023, found the result after spraying during Rabi 2022, the minimum percent disease incidence of *Curvularia* leaf spot of maize was recorded in T₁₇-*Trichoderma harzianum* (ST) + *Pseudomonas fluorescens* (ST) (29.19%) followed by T₂₀-*Bacillus subtilis* (FS) + *Ampelomyces quisqualis*(ST) + *Trichoderma harzianum* (ST) (30.86%), T₂-Metiram + Pyraclostrobin (FS) (31.49%), T₁₅-*Pseudomonas fluorescens* (ST) + Curcumin extract (FS) (33.47%), T₃-*Trichoderma virens* (ST) (36.02%), T₁₆-*Aspergillus niger* (FS) + *Azotobacter chroococcum* (ST) (36.09%), T₄-*Bacillus subtilis* (FS) + *Ampelomyces quisqualis* (ST) (36.90%) also at par with each other's which significantly reduce the incidence as compared to rest of the treatments. During Rabi 2023 after spraying the minimum percent disease incidence of *Curvularia* leaf spot of maize was recorded in T₁₇-*Trichoderma harzianum* (ST) + *Pseudomonas fluorescens* (ST) (32.20%) followed by T₂₀-*Bacillus subtilis* (FS) + *Ampelomyces quisqualis*(ST) + *Trichoderma harzianum* (ST) (33.87%), T₂-Metiram + Pyraclostrobin (FS) (34.50%), T₁₅-*Pseudomonas fluorescens* (ST) + Curcumin extract (FS) (36.48%), T₃-*Trichoderma virens* (ST) (39.03%), T₁₆-*Aspergillus niger* (FS) + *Azotobacter chroococcum* (ST) (39.10%), T₄-*Bacillus subtilis* (FS) + *Ampelomyces quisqualis* (ST) (39.91%) also at par with each other's which significantly reduce the incidence as compared to rest of the treatments.

Keywords: Bio-agents, botanicals, *Curvularia lunata*, fungicides, and maize

Introduction

Maize (*Zea mays* family Poaceae) is a cereal crop plant that produces grain that is used for cooking, roasting, grinding, frying and crushing to prepare different food items and is high yielding, easy to process, readily digested and cheaper than other cereals. Maize is an imperative crop and all parts of plant have monetary value; the grain, leaves, stalks, tassel and cob can be used to prepare large variety of food and non-food products, animal feed, industrial products such as biofuels, snacks foods and alcohol production (Shiferaw *et al.*, 2011) [6]. In India, maize is the third most vital food crop after rice and wheat. It is cultivated throughout the year in different parts of the country for diverse purposes as well as grain, fodder, green cobs, baby corn, sweet corn, popcorn and industrial purposes etc. The main maize producing states are Karnataka, Madhya Pradesh, Bihar, Tamilnadu, Telangana, Maharashtra, Andhra Pradesh, Uttar Pradesh, Rajasthan (Anonymous, 2017) [2]. Maize is susceptible to several bacterial, viruses, nematode and fungal diseases, out of which leaf spot of maize caused by *Curvularia lunata* is one of the most destructive disease and causes up to 60% losses (Huang *et al.*, 2004; Akinbode, 2010) [5, 1]. The range of yield losses is 10.10% to 48.62. Studies on survival and spread of the pathogen need to be worked out to understand the disease cycle and to break the infection chain at appropriate time in order to manage the disease effectively. Host plant resistance is considered as most practical, feasible and economical method of plant disease management. Hence, it is most important to carry out screening of genotype/variety to identify sources of resistance and also resistant composites and hybrids under different maturity groups. Effective management of this disease by a single method may not be possible. Hence, it is necessary to develop an integrated disease management strategy by combining fungicides, bioagents, botanicals practices as efficient components.

In the present study attempt was made to develop and study the *in vivo* antifungal activity of plant extracts, bioagents and chemical based formulation against *Curvularia lunata* the causal organism of leaf spot of maize for management of this disease.

Materials & Methods

The proposed study was conducted in the Experiment Field of the Department of Plant Pathology at Central Research Farm, SHUATS, Prayagraj, (UP.) during Kharif 2022 and 2023

Results & Discussion

In-vivo management of *Curvularia* leaf spot of maize using bioagents, plant extracts and fungicides (Rabi 2022)

Before spray the minimum percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₂-Metiram + Pyraclostrobin (FS) (30.74%) followed by T₃-*Trichoderma virens* (ST) (32.66%), T₄-*Bacillus subtilis* (FS) + *Ampelomyces quisqualis* (ST) (33.87%) also at par with each other's which significantly reduce the incidence as compared to rest of the treatments. Percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₉-*Ampelomyces quisqualis* (FS) + *Cestrum nocturnum* (FS) (36.01%) followed by T₆-*Trichoderma harzianum* (ST) + *Azotobacter chroococcum* (ST) (39.37%), T₁₁-*Azospirillum lipoferum* (ST) + *Moringa oleifera* (FS) (39.92%), T₅-*Trichoderma viride* (ST) + *Terminalia arjuna* (FS) (42.99%), T₁₂-*Paecilomyces lilacinus* (FS) + Cycloheximide (FS) (43.85%), T₈-*Lawsonia inermis* (FS) (49.07%), T₁₀-*Rauvolfia serpentina* (FS) (49.43%), T₇-*Bacillus subtilis* (FS) + *Pseudomonas fluorescens* (ST) (52.40%) respectively, which significantly reduce the percent disease incidence as compared to control (57.87%). Kotramma, (2015) evaluated various fungicides against *C. lunata* the causal agent of *Curvularia* leaf spots in maize. Among the eight systemic fungicides, myclobutanil 10% WP, hexaconazole 5% EC, tebuconazole 25.9% EC and propiconazole 25% EC recorded 100 percent inhibition of mycelial growth, at all the concentration.

After first spray the minimum percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₂-Metiram + Pyraclostrobin (FS) (31.41%) followed by T₃-*Trichoderma virens* (ST) (34.59%), T₄-*Bacillus subtilis* (FS) + *Ampelomyces quisqualis* (ST) (35.28%) also at par with

each other's which significantly reduce the incidence as compared to rest of the treatments. Percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₉-*Ampelomyces quisqualis* (FS) + *Cestrum nocturnum* (FS) (36.96%) followed by T₆-*Trichoderma harzianum* (ST) + *Azotobacter chroococcum* (ST) (41.00%), T₅-*Trichoderma viride* (ST) + *Terminalia arjuna* (FS) (43.88%), T₁₂-*Paecilomyces lilacinus* (FS) + Cycloheximide (FS) (47.52%), T₈-*Lawsonia inermis* (FS) (50.81%), T₁₀-*Rauvolfia serpentina* (FS) (52.08%), T₇-*Bacillus subtilis* (FS) + *Pseudomonas fluorescens* (ST) (54.11%) respectively, which were significantly reduce the percent disease incidence as compared to control (68.14%). The effectiveness of the systemic fungicide hexaconazole 5 EC against the fungus *C. clavata* were assessed *in vitro* by Sneha and Satya Prasad (2014) at various concentrations, namely 50, 100, 150, and 200 ppm. The mycelial growth of the fungi decreased as the fungicide concentration increased. There were noticeable growth inhibition at a dosage of 200 ppm.

After second spray the minimum percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₂-Metiram + Pyraclostrobin (FS) (31.49%) followed by T₃-*Trichoderma virens* (ST) (36.02%), T₄-*Bacillus subtilis* (FS) + *Ampelomyces quisqualis* (ST) (36.90%) also at par with each other's which significantly reduce the incidence as compared to rest of the treatments. Percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₉-*Ampelomyces quisqualis* (FS) + *Cestrum nocturnum* (FS) (37.86%) followed by T₆-*Trichoderma harzianum* (ST) + *Azotobacter chroococcum* (ST) (41.59%), T₁₁-*Azospirillum lipoferum* (ST) + *Moringa oleifera* (FS) (42.54%), T₁₂-*Paecilomyces lilacinus* (FS) + Cycloheximide (FS) (50.09%), T₈-*Lawsonia inermis* (FS) (51.95%), T₁₀-*Rauvolfia serpentina* (FS) (52.80%), T₇-*Bacillus subtilis* (FS) + *Pseudomonas fluorescens* (ST) (54.70%) respectively, which significantly reduce the percent disease incidence as compared to control (71.83%). Aparna *et al.* (2017) assessed how well different fungicides worked against *C. lunata*. Among all the systemic, non-systemic and combi products evaluated, complete inhibition were achieved in tridemorph, propiconazole, dithaneM45, carbendazim + mancozeb, tricyclozole + mancozeb and zineb + hexaconazole and minimum inhibition (10.17%) were recorded in carbendazim T_{0.1} percent while 65.33 mm radial mycelial growth were recorded in control.

Table 1: Management of *Curvularia* leaf spots using different bioagents, plant extracts and fungicides *in-vivo* condition (Rabi 2022)

Treatments	Details	Percent Disease Incidence			Yield kg/ha B:C ratio	
		Before Spray	After first Spray	After Second Spray		
T ₁	Control	57.87	68.14	71.83	2770.15	2.64
T ₂	Metiram + Pyraclostrobin (FS)	30.74	31.41	31.49	2731.95	2.58
T ₃	<i>Trichoderma virens</i> (ST)	32.66	34.59	36.02	2789.75	2.66
T ₄	<i>Bacillus subtilis</i> (FS) + <i>Ampelomyces quisqualis</i> (ST)	33.87	35.28	36.90	2760.42	2.63
T ₅	<i>Trichoderma viride</i> (ST) + <i>Terminalia arjuna</i> (FS)	42.99	43.88	45.15	2722.84	2.67
T ₆	<i>Trichoderma harzianum</i> (ST) + <i>Azotobacter chroococcum</i> (ST)	39.37	41.00	41.59	2713.17	2.57
T ₇	<i>Bacillus subtilis</i> (FS) + <i>Pseudomonas fluorescens</i> (ST)	52.40	54.11	54.70	2704.34	2.51
T ₈	<i>Lawsonia inermis</i> (FS)	49.07	50.81	51.95	2785.88	2.64
T ₉	<i>Ampelomyces quisqualis</i> (FS) + <i>Cestrum nocturnum</i> (FS)	36.01	36.96	37.86	2668.06	2.57
T ₁₀	<i>Rauvolfia serpentina</i> (FS)	49.43	52.08	52.80	2643.96	2.52
T ₁₁	<i>Azospirillum lipoferum</i> (ST) + <i>Moringa oleifera</i> (FS)	39.92	41.83	42.54	2672.65	2.57
T ₁₂	<i>Paecilomyces lilacinus</i> (FS) + Cycloheximide (FS)	43.85	47.52	50.09	2671.28	2.57
	C. D. at 5%	8.23	5.64		6.91	
	SE(m)±1	2.74	1.88		2.30	

Evaluation of bioagents, plant extracts and fungicides against *Curvularia* leaf spot in-vivo (Rabi 2023)

At before spray the minimum percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₂-Metiram + Pyraclostrobin (FS) (32.02%) followed by T₃-*Trichoderma virens* (ST) (33.94%), T₄-*Bacillus subtilis* (FS) + *Ampelomyces quisqualis* (ST) (35.15%) also at par with each other's which significantly reduce the incidence as compared to rest of the treatments. Percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₉-*Ampelomyces quisqualis* (FS) + *Cestrum nocturnum* (FS) (37.29%) followed by T₆-*Trichoderma harzianum* (ST) + *Azotobacter chroococcum* (ST) (40.65%), T₁₁-*Azospirillum lipoferum* (ST) + *Moringa oleifera* (FS) (41.20%), T₅-*Trichoderma viride* (ST) + *Terminalia arjuna* (FS) (44.27%), T₁₂-*Paecilomyces lilacinus* (FS) + Cycloheximide (FS) (45.13%), T₈-*Lawsonia inermis* (FS) (50.34%), T₁₀-*Rauvolfia serpentina* (FS) (50.71%), T₇-*Bacillus subtilis* (FS) + *Pseudomonas fluorescens* (ST) (53.68%) respectively, which significantly reduce the percent disease incidence as compared to control (61.15%). Several fungicides were tested by Kotramma (2015) against *C. lunata*, the causative agent of *Curvularia* leaf spots in maize. Myclobutanil 10% WP, hexaconazole 5% EC, tebuconazole 25.9% EC, and propiconazole 25% EC are the eight systemic fungicides. found that mycelial growth were completely inhibited at all concentrations.

After first spray the minimum percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₂-Metiram + Pyraclostrobin (FS) (32.74%) followed by T₃-*Trichoderma virens* (ST) (35.92%), T₄-*Bacillus subtilis* (FS) + *Ampelomyces quisqualis* (ST) (36.61%) also at par with each other's which were significantly reduce the incidence as compared to rest of the treatments. Percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₉-*Ampelomyces quisqualis* (FS) + *Cestrum nocturnum* (FS) (38.29%) followed by T₆-*Trichoderma harzianum* (ST) + *Azotobacter chroococcum* (ST) (42.33%), T₁₁-*Azospirillum lipoferum* (ST) + *Moringa oleifera* (FS) (43.16%), T₅-*Trichoderma viride* (ST) + *Terminalia arjuna* (FS) (45.21%), T₁₂-*Paecilomyces lilacinus* (FS) + Cycloheximide (FS) (48.85%), T₈-*Lawsonia inermis* (FS) (52.14%), T₁₀-*Rauvolfia serpentina* (FS) (53.41%), T₇-*Bacillus subtilis*

(FS) + *Pseudomonas fluorescens* (ST) (55.44%) respectively, which significantly reduce the percent disease incidence as compared to control (66.47%). According to Tekade *et al.* (2017), *Curvularia lunata* were found to be susceptible to the effects of several fungicides, including Carbendazim (0.1%), Curzate M-8 (0.2%), Topsin M (0.2%), Chlorothalonil (0.2%), Metalaxyl (0.2%), Tridemorph (0.1%), Propiconazole (0.1%), Mancozeb (0.2%), Copper oxychloride (0.3%), Thiram (0.3%), Carbendazim + Mancozeb (0.2%), Tricyclazole + Mancozeb (0.2%), and Zineb + Hexaconazole (0.2%).

After second spray the minimum percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₂-Metiram + Pyraclostrobin (FS) (34.50%) followed by T₃-*Trichoderma virens* (ST) (39.03%), T₄-*Bacillus subtilis* (FS) + *Ampelomyces quisqualis* (ST) (39.91%) also at par with each other's which significantly reduce the incidence as compared to rest of the treatments. Percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₉-*Ampelomyces quisqualis* (FS) + *Cestrum nocturnum* (FS) (40.87%) followed by T₆-*Trichoderma harzianum* (ST) + *Azotobacter chroococcum* (ST) (44.60%), T₁₁-*Azospirillum lipoferum* (ST) + *Moringa oleifera* (FS) (45.55%), T₅-*Trichoderma viride* (ST) + *Terminalia arjuna* (FS) (48.16%), T₁₂-*Paecilomyces lilacinus* (FS) + Cycloheximide (FS) (53.10%), T₈-*Lawsonia inermis* (FS) (54.96%), T₁₀-*Rauvolfia serpentina* (FS) (55.81%), T₇-*Bacillus subtilis* (FS) + *Pseudomonas fluorescens* (ST) (57.71%) respectively, which significantly reduce the percent disease incidence as compared to control (73.84%). Five plant extracts, one fungicide, and one bioagent were assessed by Dubey *et al.* (2020) both *in vitro* and in the field. He discovered that *Trichoderma viride* inhibited mycelium growth by 55.77% and Mancozeb inhibited it by 69.35% at 0.25%. Neem leaf extract were shown to be most effective at 10% conc. and 40% conc. (40.60%) in plant extract. Mencozeb were shown to be effective at 0.25% and reduce disease by 35.85% in field conditions. *Trichoderma viride* were found to be effective at 2% and reduce disease infection by 49.12%. Neem leaf extract were shown to be 45.70% at 10% effective in disease management, while eucalyptus extract were 45.95% at 10%.

Table 2: Management of *Curvularia* leaf spots using different bioagents, plant extracts and fungicides in-vivo condition (Rabi 2023)

Treatments	Details	Percent Disease Incidence			Yield kg/ha	B:C ratio
		Before Spray	After first Spray	After Second Spray		
T ₁	Control	61.15	66.47	73.84	2670.45	2.54
T ₂	Metiram + Pyraclostrobin (FS)	32.02	32.74	34.5	2781.55	2.58
T ₃	<i>Trichoderma virens</i> (ST)	33.94	35.92	39.03	2681.64	2.66
T ₄	<i>Bacillus subtilis</i> (FS) + <i>Ampelomyces quisqualis</i> (ST)	35.15	36.61	39.91	2768.45	2.63
T ₅	<i>Trichoderma viride</i> (ST) + <i>Terminalia arjuna</i> (FS)	44.27	45.21	48.16	2732.84	2.67
T ₆	<i>Trichoderma harzianum</i> (ST) + <i>Azotobacter chroococcum</i> (ST)	40.65	42.33	44.6	2714.19	2.57
T ₇	<i>Bacillus subtilis</i> (FS) + <i>Pseudomonas fluorescens</i> (ST)	53.68	55.44	57.71	2744.14	2.51
T ₈	<i>Lawsonia inermis</i> (FS)	50.35	52.14	54.96	2786.88	2.64
T ₉	<i>Ampelomyces quisqualis</i> (FS) + <i>Cestrum nocturnum</i> (FS)	37.29	38.29	40.87	2461.06	2.57
T ₁₀	<i>Rauvolfia serpentina</i> (FS)	50.71	53.41	55.81	2542.96	2.52
T ₁₁	<i>Azospirillum lipoferum</i> (ST) + <i>Moringa oleifera</i> (FS)	41.2	43.16	45.55	2672.65	2.57
T ₁₂	<i>Paecilomyces lilacinus</i> (FS) + Cycloheximide (FS)	45.13	48.85	53.1	2671.28	2.57
	C. D. at 5%	4.65	5.98		4.22	
	SE(m)±1	1.52	1.99		1.40	

Evaluation of bioagents, plant extracts and fungicides against *Curvularia* leaf spot in-vivo (pooled data)

At before spray the minimum percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₂-Metiram + Pyraclostrobin (FS) (31.38%) followed by T₃-*Trichoderma virens* (ST) (33.30%), T₄-*Bacillus subtilis* (FS) + *Ampelomyces quisqualis* (ST) (34.51%) also at par with each other's which significantly reduce the incidence as compared to rest of the treatments. Percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₉-*Ampelomyces quisqualis* (FS) + *Cestrum nocturnum* (FS) (36.65%) followed by T₆-*Trichoderma harzianum* (ST) + *Azotobacter chroococcum* (ST) (40.01%), T₁₁-*Azospirillum lipoferum* (ST) + *Moringa oleifera* (FS) (40.65%), T₅-*Trichoderma viride* (ST) + *Terminalia arjuna* (FS) (43.63%), T₁₂-*Paecilomyces lilacinus* (FS) + Cycloheximide (FS) (44.49%), T₁₀-*Rauvolfia serpentina* (FS) (50.07%), T₇-*Bacillus subtilis* (FS) + *Pseudomonas fluorescens* (ST) (53.04%) respectively, which significantly reduce the percent disease incidence as compared to control (59.61%). Jewaliya *et al.* (2021) assessed the effectiveness of various fungicides against *Alternaria alternata* and found that, out of all treatments, tebuconazole 50% + trifloxystrobin 25% WG had the highest mycelial growth inhibition (94.17%). After first spray the minimum percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₂-Metiram + Pyraclostrobin (FS) (32.74%) followed by T₃-*Trichoderma virens* (ST) (35.25%), T₄-*Bacillus subtilis* (FS) + *Ampelomyces quisqualis* (ST) (35.94%) also at par with each other's which significantly reduce the incidence as compared to rest of the treatments. Percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₉-*Ampelomyces quisqualis* (FS) + *Cestrum nocturnum* (FS) (37.62%) followed by T₆-*Trichoderma harzianum* (ST) + *Azotobacter chroococcum* (ST) (41.66%), T₁₁-*Azospirillum lipoferum* (ST) + *Moringa oleifera* (FS) (42.49%), T₅-*Trichoderma viride* (ST) + *Terminalia arjuna* (FS)

(44.54%), T₁₂-*Paecilomyces lilacinus* (FS) + Cycloheximide (FS) (48.18%), T₈-*Lawsonia inermis* (FS) (51.47%), T₁₀-*Rauvolfia serpentina* (FS) (52.74%), T₇-*Bacillus subtilis* (FS) + *Pseudomonas fluorescens* (ST) (54.77%) respectively, which significantly reduce the percent disease incidence as compared to control (67.30%). The effectiveness of 19 fungicides against *Aspergillus flavus*-induced aflatoxin production in wheat were investigated by Kumar *et al.* (2022). They discovered that Azoxystrobin + difenoconazole, fluopicolide + propamocarb, propiconazole, and azoxystrobin demonstrated 100% inhibition of the fungus *Aspergillus flavus* compared to the control at 500 ppm, 1000 ppm, and 1500 ppm concentrations.

After second spray the minimum percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₂-Metiram + Pyraclostrobin (FS) (32.99%), followed by T₃-*Trichoderma virens* (ST) (37.52%), T₄-*Bacillus subtilis* (FS) + *Ampelomyces quisqualis* (ST) (38.40%) also at par with each other's which significantly reduce the incidence as compared to rest of the treatments. Percent disease incidence of *Curvularia* leaf spots of maize were recorded in T₉-*Ampelomyces quisqualis* (FS) + *Cestrum nocturnum* (FS) (39.36%) followed by T₆-*Trichoderma harzianum* (ST) + *Azotobacter chroococcum* (ST) (43.09%), T₁₁-*Azospirillum lipoferum* (ST) + *Moringa oleifera* (FS) (44.04%), T₅-*Trichoderma viride* (ST) + *Terminalia arjuna* (FS) (46.65%), T₁₂-*Paecilomyces lilacinus* (FS) + Cycloheximide (FS) (51.59%), T₈-*Lawsonia inermis* (FS) (53.45%), T₁₀-*Rauvolfia serpentina* (FS) (54.30%), T₇-*Bacillus subtilis* (FS) + *Pseudomonas fluorescens* (ST) (56.20%) respectively, which significantly reduce the percent disease incidence as compared to control (72.83%). In their *in vitro* evaluation of fungicide efficacy against *F. oxysporum* f. sp. of wheat, Devkota *et al.* (2023) discovered that tebuconazole 50% + trifloxystrobin 25% WG were the most efficient in inhibiting mycelial growth.

Table 3: Management of *Curvularia* leaf spots by using different bioagents, plant extracts and fungicides in-vivo (average pooled 2022-2023)

Treatments	Details	Percent Disease Incidence			Yield kg/ha	B:C ratio
		Before Spray	After first Spray	After Second Spray		
T ₁	Control	59.51	67.305	72.835	2720.3	2.59
T ₂	Metiram + Pyraclostrobin (FS)	31.38	32.075	32.995	2756.75	2.58
T ₃	<i>Trichoderma virens</i> (ST)	33.3	35.255	37.525	2735.695	2.66
T ₄	<i>Bacillus subtilis</i> (FS) + <i>Ampelomyces quisqualis</i> (ST)	34.51	35.945	38.405	2764.435	2.63
T ₅	<i>Trichoderma viride</i> (ST) + <i>Terminalia arjuna</i> (FS)	43.63	44.545	46.655	2727.84	2.67
T ₆	<i>Trichoderma harzianum</i> (ST) + <i>Azotobacter chroococcum</i> (ST)	40.01	41.665	43.095	2713.68	2.57
T ₇	<i>Bacillus subtilis</i> (FS) + <i>Pseudomonas fluorescens</i> (ST)	53.04	54.775	56.205	2724.24	2.51
T ₈	<i>Lawsonia inermis</i> (FS)	49.71	51.475	53.455	2786.38	2.64
T ₉	<i>Ampelomyces quisqualis</i> (FS) + <i>Cestrum nocturnum</i> (FS)	36.65	37.625	39.365	2564.56	2.57
T ₁₀	<i>Rauvolfia serpentina</i> (FS)	50.07	52.745	54.305	2593.46	2.52
T ₁₁	<i>Azospirillum lipoferum</i> (ST) + <i>Moringa oleifera</i> (FS)	40.56	42.495	44.045	2672.65	2.57
T ₁₂	<i>Paecilomyces lilacinus</i> (FS) + Cycloheximide (FS)	44.49	48.185	51.595	2671.28	2.57
	C. D. at 5%	7.23	4.16		5.91	
	SE(m)±1	2.41	1.38		1.97	

Conclusion

During Rabi 2022 spraying, the lowest percentage of *Curvularia* leaf spot disease incidence in maize was observed in T₂ (Metiram + Pyraclostrobin (FS) (31.49%), T₃ (*Trichoderma virens* (ST) (36.02%), and T₄ (*Bacillus subtilis* (FS) + *Ampelomyces quisqualis* (ST) (36.00%), all of which significantly lower incidence when compared to

the other treatments. The lowest percentage of *Curvularia* leaf spot disease incidence in maize during Rabi 2023 following spraying was observed in T₂ (Metiram + Pyraclostrobin (FS) (34.50%), T₃ (*Trichoderma virens* (ST) (39.03%), and T₄ (*Bacillus subtilis* (FS) + *Ampelomyces quisqualis* (ST) (39.91%), which are all significantly lower than the other treatments.

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