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Management of Sunflower Powdery Mildew and Alternariaster Leaf Spot: Harnessing the Potential of Combined New Fungicide Molecules

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Authors' contributions

This work was carried out in collaboration among all authors. Author CPM did data curation and Investigated the study. Authors CRJB, KSS and MSU wrote reviewed and edited the manuscript. Authors SDN CRJB and KMS supervised the study and did data Validation. Author KMS and CPM conceptualized the study, did formal analysis and data visualization. Authors KSS and MSU conceptualized the study and did data curation. Authors CPM and Divyashree did data curation and wrote the original draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The study investigates the efficacy of seed treatment with Fluxapyroxad FS @ 1.5 g/kg seed followed by foliar sprays of various fungicide combinations in managing powdery mildew and *Alternariaster* leaf spot diseases in sunflower. Conducted over three Kharif seasons (2021-2023), the trials consistently demonstrated the superior performance of Fluopyram 17.7% + Tebuconazole 17.7% (400 SC) @ 1 ml/L in reducing disease incidence and severity. In Kharif 2021, this treatment recorded the lowest incidence of *Alternariaster* leaf spot (7.36%) and powdery mildew (4.52%), outperforming other treatments. Similar trends were observed in Kharif 2022 and 2023, with Fluopyram + Tebuconazole maintaining the lowest disease severities (7.39% and 2.95% for powdery mildew, respectively). Notably, the study found no significant differences in yield components across treatments, though the highest yields were consistently recorded in the treatment combining Fluxapyroxad seed treatment with Fluopyram + Tebuconazole foliar spray, achieving yields of 2124.67 kg/ha in Kharif 2022 and 2157.33 kg/ha in Kharif 2023. These results indicate that integrated disease management using these fungicide combinations can effectively control both diseases in sunflower, particularly under humid weather conditions, without adversely affecting crop yield.

Keywords: Sunflower; alternariaster leaf spot; powdery mildew; disease severity; fungicides.

1. INTRODUCTION

Sunflower is an important oilseed crop as it contains good quality oil with pleasant flavour and excellent keeping quality when refined. The oil is rich in Linoleic acid (62.5%) and is recommended as dietary constituent to heart patients. Sunflower oil is also used in industrial production of soaps, cosmetics, paints, lubricants, plastics, etc. Its seed cake is an important by product which is used as concentrates for cattle, pigs, sheep, goat and poultry as it is a protein rich feed (40-50%). Thus, sunflower being a multipurpose oil seed crop, naturally the demand for crop is increasing tremendously. These demands resulted into extensive cultivation of sunflower over large areas leading to development of diseases in the crop which has considerable impact on grain yield of sunflower.

"Diseases are one of the major constraints in successful sunflower cultivation". [1] Over 80 pathogens occurr on sunflower. In Karnataka, the major diseases of sunflower are necrosis virus, *Alternaria* blight, powdery mildew, rust, collar rot and downy mildew. Among these *Alternaria* blight caused by *Alternaria helianthi* (Hansf.) [2] has been considered as a potentially destructive disease in many parts of sunflower growing countries [3] and also in some regions of Karnataka [4]. In India, powdery mildew caused by (*Erysiphe cichocearum*) was first reported on sunflower in 2008 [5]. "A field survey on powdery mildew in seven districts of Karnataka recorded 30–74 % disease severity" [6-7].

Alternaria leaf blight is recognized as a major disease in more humid areas. Favorable weather may result in yield losses up to 62 per cent which occurred during 1988 in Karnataka [8]. The disease occurred with incidence as high as 95-100 per cent due to heavy rains during flowering and grain filling stage of the crop [8,9]. It appears on all parts of the crop severely during favourable weather conditions. Powdery mildew is worldwide in distribution, but greatest severity is observed in the tropics, where it appears during advanced senescence at the flowering or post flowering stages [10]. The disease primarily affects the leaves, flowers, and head. It appears as a white, powdery fungal growth on the affected parts, leading to reduced photosynthetic area and reduced oil content. The disease thrives in warm, humid conditions and can cause considerable yield losses if not managed properly through cultural practices and fungicide applications. Disease losses due to powdery mildew was reported as much as 70 per cent with significant reduction in oil quantity (17%) and quality (33%) [11].

In both the diseases high inoculum in the field coinciding with favourable environmental conditions lead to early infections causing severe losses. Regarding symptoms, the disease appears in the form of whitish powdery patches in Powdery mildew and as dark necrotic spots in *Alternaria*, both appear on leaves, stem, petioles and also on capitulum. The use of fungicides has become an inevitable method for controlling of the disease in the absence of resistant cultivars over large areas. Often, commonly used

fungicides fail to give satisfactory control of the diseases under field conditions, particularly during the humid weather conditions. Therefore, it is essential to find out potent fungicides, which would be effective in controlling the disease. In the present study, combination fungicide products were used in the field to test the efficacy under natural weather conditions against powdery mildew and Alternaria leaf spot of Sunflower. Loss of powdery mildew mentioned in above with [11].

2. MATERIALS AND METHODS

Management of the diseases was carried out in the experimental plot located at Zonal Agriculture Research Station, GKVK, University of Agriculture Sciences, Bangalore, Karnataka during the late *Kharif* (July – August) season. The trials were carried out for three seasons 2021, 2022 and 2023. Seven treatments were laid out with three replications. The trial was carried out in RCBD design with plot size of 4.2X3.0M^2. The susceptible Hybrid KBSH 44 was sown after seed treatment with fluxapyroxad FS @ 1.5g/kg (except for untreated check), 1kg of seeds was taken in seed pan to which 1.5ml of the suspension was added completely and the pan was rotated around so the seeds are uniformly covered with the chemical. The treated seeds were shade dried for one hour and then sown and spray was taken during the initiation of disease symptoms. Two sprays were given at fortnight interval for the effective disease reduction. Observations were carried out on the per cent disease severity (Incidence is literal, scientific research and recording the diseases fall under severity), seed yield and B:C ratio. Disease incidence was rated based on the scale provided (IIOR, Hyderabad technical compendium). Periodically observations were recorded based on the lesion symptoms and graded following the standard scale. Disease scoring (0-9 scale) for *Alternariaster* leaf spot, similarly Powdery mildew severity is recorded by scoring the per cent leaf area covered by the

Table 1. Severity of *Alternariaster* leaf spot disease measured by percentage leaf area coverage and visual rating scale (0-9) on upper portion of leaves

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 spot-like appearance covering 26-50% of leaf area
9	Highly Susceptible (HS)	Spots uniformly dark brown, coalescing covering 51% or above of leaf area

Table 2. Powdery mildew severity scoring system based on leaf area coverage and disease reaction

Score	Reaction	Leaf area covered
0	Immune	No symptoms on the leaf
1	Highly resistant (HR)	Powdery mildew specks covering 1% or less leaf area.
3	Resistant (R)	Powdery lesions covering 1-10% of leaf area.
5	Moderately resistant/ Moderately susceptible (MR/MS)	Enlarged powdery lesions covering 11-25% of leaf area.
7	Susceptible (S)	Powdery lesions coalesce to form big patches covering 26-50% of leaf area.
9	Highly susceptible (HS)	Powdery patches covering: 51% or more of leaf area and defoliation occur

disease on leaves and on upper portion of leaves through visual observation using a rating scale of 0-9 scale (Table 1 and Table 2). Seed yield for each treatment (three replications) was averaged and converted to per hectare. Benefit cost ratio was calculated based on the excess cost incurred due to spraying and more seed yield reflected in terms of benefit.

3. RESULTS

Seed treatment with Fluxapyroxad FS @ 1.5g/kg seed followed by foliar sprays with different combined fungicides was carried out to study their effect on powdery mildew and *Alternariaster* leaf spot disease.

During *Kharif* 2021 seed treatment with T_1 fluxapyroxad FS @ 1.5g/kg seed followed by foliar spray with Fluopyram 17.7% + Tebuconazole17.7% (400 SC) @ 1 ml/L (T_1) recorded lowest incidence of *Alternariaster* leaf spot disease (7.36%) followed by T_2 - Seed treatment with Fluxapyroxad FS @ 1.5g/kg seed followed by foliar sprays with A zoxystrobin 18.2% + Difenconazole 11.4% SC @1ml /L – 11.23% **(**Table 1). Powdery mildew was also lowest in T_1 (4.52%) followed by T_6 (7.19%) - spray of myclobutanil 10% WP @ 0.5 g /L

The trial conducted during *Kharif* 2022, spraying with Fluopyram 17.7%+ Tebuconazole17.7% (400 SC) @ 1 ml/L (T_1)was the best treatment revealing good management of the powdery mildew disease with PDI of 7.39% followed by spray with Myclobutanil 10% WP @ 0.5 g /L (9.49%) (Table 4). Whereas, T_1 was also effective against *Alternaria* leaf spot with reduced disease severity of 4.28 per cent and followed by the next best treatment, spray with Azoxystrobin 18.2% + Difenconazole 11.4% SC @1ml /L (9.32%).

Trial conducted during *Kharif* 2023 recorded lowest disease severity of leaf spot (7.66%) and powdery mildew (2.95%) in seed treatment with Fluxapyroxad FS @ 1.5 g/kg seed followed by foliar sprays with Fluopyram 17.7%+ Tebuconazole17.7% (400 SC) @ 1 ml/L. This was followed by seed treatment with Fluxapyroxad FS @ 1.5 g/kg seed followed by foliar sprays with Myclobutanil 10% WP @ 0.5 g /L (4.69%) for powdery mildew and Azoxystrobin 18.2% + Difenconazole 11.4% SC @1ml /L (9.47%) for leaf spot (Table 3).

The trial conducted for three seasons revealed the efficient management of the severely emerging diseases in sunflower using the new fungicide combined molecules. Fluopyram 17.7%+ Tebuconazole 17.7% (400 SC) recorded the lowest severity of both the diseases over three season trials. Two sprays of the fungicide molecules at fortnight interval were sufficient to manage both the diseases in the dryland crop during humid weather conditions.

Significant difference was not noticed in yield component among the different treatments. Yield was higher in the T_1 but statistically not much difference between treatments compared to control which was statistically lower yield compared to T_1. But highest yield was recorded in T_1 - Seed treatment with fluxapyroxad FS @ 1.5g/kg seed followed by foliar spray with fluopyram 17.7%+ tebuconazole17.7% (400 SC) @ 1 ml/L (2124.67 kg/ha) during *Kharif* 2022 and *Kharif* 2021 (2153 kg/ha) compared to control. Similarly, during *Kharif* 2023 not much difference among the treatments was recorded in seed yield and highest was in T_1 (2157.33kg/ha) (Table 3).

4. DISCUSSION

“The fungicide management of foliar diseases for the last decade, has been based on the use of demethylation inhibitors (DMI, Group 3), Triazole fungicides, and quinone outside inhibitors (QoI or Strobilurins, Group 11 fungicides)” [12].

This shows that fluxapyroxad was an effective fungicide for seed treatment in sunflower by protecting it upto 30-45 days after sowing from the fungal diseases. The chemical protects the crop upto 30days effectively for the disease that appears 30DAS spray has to be taken after the disease appearance. Fluopyram, a new succinate dehydrogenase inhibiting fungicide (SDHI), registered for use in pistachio for the control of *Alternaria* late blight (ALB) as products premixed with demethylation inhibitor (DMI) tebuconazole was effective against strains showing Boscalid resistance [13]. “*Alternaria* leaf spot, maximum per cent disease control occurred when the apple crop was sprayed with Fluopyram 200 + Tebuconazole 200 SC at a concentration of 0.0625 per cent (94.55 %) followed by Fluopyram 200 + Tebuconazole 200 SC at 0.05 per cent (89.42%) concentration and 0.0375 per cent (86.55 %), respectively” [14]. There is no use of combination products in managing fungal diseases in sunflower or other oilseed crop.

Table 3. Effect of different fungicide treatments on *Alternariaster* leaf spot, powdery mildew, seed yield, and benefit-cost ratio in sunflower (during *kharif* 2021)

Trt. No.	Treatment	*Alternariaster* leaf spot (%)	Powdery mildew (%)	Seed yield (Kg/ha)	B:C ratio	Increment B:C ratio (IBCR)
T_1	Seed treatment with fluxapyroxad FS @ 1.5g/kg seed followed by foliar sprays with fluopyram 17.7%+ tebuconazole17.7% (400 SC) @ 1 ml/L (First spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	7.36 (15.74)	4.52 (12.27)	2153 (46.41)	0.74	628.38
T_2	Seed treatment with fluxapyroxad FS @ 1.5g/kg seed followed by foliar sprays with azoxystrobin 18.2% + difenconazole 11.4% SC @1ml /L (First spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	11.23 (19.58)	16.8 (24.20)	2113 (45.97)	0.73	582.19
T_3	Seed treatment with fluxapyroxad FS @ 1.5g/kg seed followed by foliar sprays with boscalid 25.2% + pyraclostrobin 12.8% WG @ 1g/L (First spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	12.29 (20.52)	9.42 (17.87)	2010 (44.84)	0.70	460.00
T_4	Seed treatment with fluxapyroxad FS @ 1.5g/kg seed followed by foliar spray with dimethomorph 12% + pyraclostrobin 6.7% @1.5 g/L (First spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	18.75 (25.66)	11.52 (19.84)	2197 (46.88)	0.68	748.53
T_5	Seed treatment with fluxapyroxad FS @ 1.5g/kg seed followed by foliar spray with picoxystrobin 7.05%+ propiconazole 11.71% SC @ 2 g/L (First spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	14.68 (22.53)	10.1 (18.53)	1973 (44.42)	0.71	401.41
T_6	Seed treatment with fluxapyroxad FS @ 1.5g/kg seed followed by foliar sprays with myclobutanil 10% WP @ 0.5 g /L (First spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st	20.42 (26.86)	7.19 (15.55)	1865 (43.19)	0.68	260.29

Trt. No.	Treatment	*Alternariaster* leaf spot (%)	Powdery mildew (%)	Seed yield (Kg/ha)	B:C ratio	Increment B:C ratio (IBCR)
	spray)					
T_7	Control	23.98 (29.32)	22.12 (28.06)	1688 (41.09)	-	
	CV(%)	5.66	2.19	12.56		
	SEm+/-	0.98	0.73	0.745		
	CD@5%	0.507	9.93	1.439		

Table 4. Effect of different fungicide treatments on *Alternariaster* leaf spot, powdery mildew, seed yield, and benefit-cost ratio in sunflower (during *kharif* 2022)

Treatments		Powdery mildew *(%)*	*Alternariaster* leaf spot (%)	Seed yield (kg/ha)	B:C ratio	Increment B:C ratio (IBCR)
T_1	Seed treatment with Fluxapyroxad FS @ 1.5 g/kg seed followed by foliar sprays with Fluopyram 17.7%+ Tebuconazole17.7% (400 SC) @ 1 ml/L (first spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	7.39 (15.68)	4.28 (11.89)	2124.67 (46.10)	0.85	295.69
T_2	Seed treatment with Fluxapyroxad FS @ 1.5 g/kg seed followed by foliar sprays with Azoxystrobin 18.2% + Difenconazole 11.4% SC @1ml /L (first spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	14.72 (22.48)	9.32 (17.75)	2096.33 (45.79)	0.81	275.31
T_3	Seed treatment with Fluxapyroxad FS @ 1.5 g/kg seed followed by foliar sprays with Boscalid 25.2% + Pyraclostrobin 12.8% WG @ 1g/L (first spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	21.19 (27.40)	18.60 (25.54)	2036.67 (45.13)	0.64	255.22
T_4	Seed treatment with Fluxapyroxad FS @ 1.5 g/kg seed followed by foliar spray with Dimethomorph 12% + Pyraclostrobin 6.7% @1.5 g/L (first spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	20.80 (27.12)	19.64 (26.31)	2011.33 (44.85)	0.68	202.94

Treatments		Powdery mildew *(%)*	*Alternariaster* leaf spot (%)	Seed yield (kg/ha)	B:C ratio	Increment B:C ratio (IBCR)
T_5	Seed treatment with Fluxapyroxad FS @ 1.5 g/kg seed followed by foliar spray with Picoxystrobin 7.05%+ Propiconazole 11.71% SC @ 2 g/L (first spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	15.75 (23.35)	16.97 (24.31)	2066.67 (45.47)	0.80	241.68
T_6	Seed treatment with Fluxapyroxad FS @ 1.5 g/kg seed followed by foliar sprays with Myclobutanil 10% WP @ 0.5 g /L (first spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	9.49 (19.77)	12.33 (20.51)	2068.33 (45.48)	0.79	246.84
T_7	Control	28.79 (30.52)	25.19 (30.10)	1873.33 (43.28)		
	CV (%)	8.538	7.77	17.168		
	CD @ 5%	2.532	2.137	96.783		
	Sem (+/-)	0.896	0.744	38.584		

Table 5. Effect of different fungicide treatments on *Alternariaster* leaf spot, powdery mildew, seed yield, and benefit-cost ratio in sunflower (during *kharif* 2023)

Treatments		Powdery mildew *(%)*	*Alternariaster* leaf spot (%)	Seed yield (kg/ha)	B:C ratio	Increment B:C ratio (IBCR)
T_1	Seed treatment with Fluxapyroxad FS @ 1.5 g/kg seed followed by foliar sprays with Fluopyram 17.7%+ Tebuconazole17.7% (400 SC) @ 1 ml/L (first spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	2.95 (9.86)	7.66 (16.02)	2157.33 (46.10)	0.90	243.33
T_2	Seed treatment with Fluxapyroxad FS @ 1.5 g/kg seed followed by foliar sprays with Azoxystrobin 18.2% + Difenconazole 11.4% SC @1ml /L (first spray at the onset of incidence or 45 days after sowing and second	6.66 (14.92)	9.47 (17.81)	2119.67 (45.79)	0.86	210.86

Treatments		Powdery mildew *(%)*	*Alternariaster* leaf spot (%)	Seed yield (kg/ha)	B:C ratio	Increment B:C ratio (IBCR)
	spray 15 days after 1st spray)					
T_3	Seed treatment with Fluxapyroxad FS @ 1.5 g/kg seed followed by foliar sprays with Boscalid 25.2% + Pyraclostrobin 12.8% WG @ 1g/L (first spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	17.44 (24.65)	16.63 (24.03)	2049.33 (45.13)	0.63	176.19
T_4	Seed treatment with Fluxapyroxad FS @ 1.5 g/kg seed followed by foliar spray with Dimethomorph 12% + Pyraclostrobin 6.7% @1.5 g/L (first spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	20.14 (26.65)	20.95 (27.23)	2027.33 (44.85)	0.65	136.92
T_5	Seed treatment with Fluxapyroxad FS @ 1.5 g/kg seed followed by foliar spray with Picoxystrobin 7.05%+ Propiconazole 11.71% SC @ 2 g/L (first spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	12.42 (20.58)	15.70 (23.28)	2076.67 (45.47)	0.71	194.15
T_6	Seed treatment with Fluxapyroxad FS @ 1.5 g/kg seed followed by foliar sprays with Myclobutanil 10% WP @ 0.5 g /L (first spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	4.69 (12.41)	22.07 (28.01)	2105.00 (45.48)	0.84	198.42
T_7	Control	27.99 (31.93)	30.93 (33.78)	1938.33 (43.28)		
	CV (%)	6.835	10.452	16.802		
	CD @ 5%	1.910	3.019	152.488		
	Sem (+/-)	0.678	1.046	53.074		

Note: values in parenthesis are arcsin transformed

Table 6. Pooled analysis

Trt. No.	Treatment	*Alternariaster* leaf spot (%)	Powdery mildew (%)	Seed yield (Kg/ha)	B:C ratio
T_1	Seed treatment with fluxapyroxad FS @ 1.5g/kg seed followed by foliar sprays with fluopyram 17.7%+ tebuconazole17.7% (400 SC) @ 1 ml/L (First spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	6.43 (14.69)	4.95 (12.86)	2145.00 (46.32)	0.74
T_2	Seed treatment with fluxapyroxad FS @ 1.5g/kg seed followed by foliar sprays with azoxystrobin 18.2% + difenconazole 11.4% SC @1ml /L (First spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	10.01 (18.44)	12.73 (20.90)	2109.67 (45.94)	0.73
T_3	Seed treatment with fluxapyroxad FS @ 1.5g/kg seed followed by foliar sprays with boscalid 25.2% + pyraclostrobin 12.8% WG @ 1g/L (First spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	15.84 (23.45)	16.02 (23.59)	2032.00 (45.08)	0.70
T_4	Seed treatment with fluxapyroxad FS @ 1.5g/kg seed followed by foliar spray with dimethomorph 12% + pyraclostrobin 6.7% @1.5 g/L (First spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	19.78 (26.41)	17.49 (24.72)	2078.55 (45.60)	0.68
T_5	Seed treatment with fluxapyroxad FS @ 1.5g/kg seed followed by foliar spray with picoxystrobin 7.05%+ propiconazole 11.71% SC @ 2 g/L (First spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	15.78 (23.41)	12.76 (20.93)	2038.78 (45.16)	0.71
T_6	Seed treatment with fluxapyroxad FS @ 1.5g/kg seed followed by foliar sprays with myclobutanil 10% WP @ 0.5 g /L (First spray at the onset of incidence or 45 days after sowing and second spray 15 days after 1st spray)	18.27 (25.31)	7.12 (15.48)	2012.78 (44.87)	0.68
T_7	Control	26.70 (31.11)	26.30 (30.85)	1833.22 (42.82)	-
	CV(%)	17.24	20.17	14.01	
	SEm+/-	1.604	2.022	47.246	
	CD@5%	4.098	6.031	141.233	

Table 7. Weather data (AVR)

Weather parameters(Average)	Year	Months			
		July	August	September	October
Rainfall	2023	115.2	25.8	194	67.6
Temp. (Max ^{0}C)		28.3	30.5	29.3	30.1
Temp. (Min ^{0}C)		19.6	20.2	19.8	19.5
RH (Max)		81	84	86	87
RH (Min)		61	58	64	57
Rainfall	2022	149.8	211.4	142	361
Temp. (Max ^{0}C)		27.3	27.4	27.7	27.0
Temp. (Min ^{0}C)		18.7	18.6	18.5	16.9
RH (Max)		90	91	90	90
RH (Min)		61	62	59	61
Rainfall	2021	171.6	115.4	166.8	231.6
Temp. (Max ^{0}C)		28	28.4	28	28.1
Temp. (Min ^{0}C)		19.1	18.8	19	18.7
RH (Max)		87	89	91	90
RH (Min)		59	58	58	59

Fluopyram 200 +Tebuconazole 200 – 400 SC at 750 ml/ha concentration were found to be significantly superior over control with incidence of powdery mildew (25.10%) and postharvest disease incidence (15.00%) as compared to other chemical treatments in mango crop. The efficacy of the product, Fluopyram 200 + Tebuconazole 200 SC (Luna Experience), against powdery mildew in pepper was found to be 89 per cent in Timorex Gold assay efficacy against *Leveillula taurica*, and it was safe for use against powdery mildew [15-17]. The fungicide product Fluopyram + Tebuconazole (400 SC) tested in many commercial crops like Mango, apple, pistachio, tomato, grapes, gherkin etc were highly efficient and had safety. Hence, it can be used against Alternaria leaf spot and powdery mildew in sunflower with high disease management efficiency giving good results on yield factor also. Use of such product in large scale under dryland cultivation of food crops in India paves way for ease in disease management at single go for the long term. This is not seed treatment studies it is combination of both seed treatment and spray to manage the disease in the entire crop period.

5. CONCLUSION

The study demonstrates that seed treatment with Fluxapyroxad FS @ 1.5 g/kg followed by foliar sprays with Fluopyram 17.7% + Tebuconazole 17.7% (400 SC) @ 1 ml/L effectively manages powdery mildew and *Alternariaster* leaf spot diseases in sunflower across multiple Kharif seasons. This treatment consistently recorded the lowest disease incidence and severity, outperforming other fungicide combinations. Additionally, the highest seed yields were obtained with this treatment, indicating its efficiency in disease control without negatively impacting crop yield or quality. Two foliar sprays at a fortnight interval were sufficient to manage these diseases under humid weather conditions with high efficiency. Further research could explore the long-term sustainability and environmental impact of these fungicide treatments. Whereas, resistant sunflower sources against the diseases could enhance the overall disease management and reduce dependency on chemical fungicides which could make way for pathogen resistance against fungicides.

This is just a hypothesis statement made not tested and laid out rule. Phytotoxicity was not observed in the sunflower field or other crops tested by me for the dosage given in the treatments. This is just testing not recommending to the farmers as recommendation has to go long process through OFT, FLD and FD etc. extension procedures.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

ETHICAL APPROVAL

All the experimental procedures involving only on plant species were conducted following the University of Agricultural Science, Bangalore institutional guidelines. There are no human and animal subjects/trials conducted in this article and informed consent is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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