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SCREENING OF MARIGOLD GERMPLASM AND MANAGEMENT AGAINST ALTERNARIA LEAF BLIGHT (ALTERNARIA TAGETICA)UNDER FIELD CONDITIONS IN PUNJAB

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Abstract

Efficacy of six different fungicides and botanicals were evaluated against Alternaria tagetica, a pathogen posing a significant threat to marigold production.The study involved field screening of marigold germplasm during 2022 & 2023, where the percent disease index of Alternaria blight was recorded in both the years. The screening data indicated that Pusa arpita and Pusa deep showed highly susceptible reaction to the disease with an incidence of 68.19 and 66.01percent.In contrast Arka bhanu exhibited a moderately resistant reaction with an incidence of 18.19 percent. Out of six fungicides tested Alternaria blight, tebuconazole 50% +trifloxystrobin 25 % WG was found highly effective with percent disease index of (10.00%) *closely followed by tebuconazole 25.9% EC* (13.22%) *and azoxystrobin 23% SC* (15.92%)*when sprayed at @ 0.5% conc. Maximum disease was obtained in .Chlorothalonil 75% WP(39.41%)when sprayed @0.2%conc.Similarly, in case of botanicals extracts of Allium sativum and Azadirachta indica were found effective with a percent disease index of (19.89 and 25.71percent).Highest yield and no of flowers per plant was also observed in plant treated with tebuconazole 50% +trifloxystrobin 25 % WG in fungicides and Allium sativum extract in case of botanicals. Overall, the findings underscored the potential of integrated disease management strategies involving fungicides and botanicals to mitigate the Alternaria leaf blight in marigold.*

1. INTRODUCTION

Marigold is a member of the family Asteraceae and has gained importance as a viable commercial flower crop. Two popularly grown species of marigold are African or Mexican marigold (*Tagetes erecta* L.) and French marigold (*Tagetes patula* L.), which originated in Mexico and South Africa, respectively. Marigold flowers are known for their wide spectrum of attractive colors, shapes, and sizes and have gained popularity in India due to their adaptability and ease of cultivation. Marigolds are widely used for garden decoration, making garlands for religious and social functions, and are also valued for their medicinal properties (Satapathy and Sahoo, 2022).

Some common fungal disease which cause heavy losses in the yield are Alternaria leaf spot (*Alternaria tageticola*), Wilt (*Fusarium oxysporum*) and Damping off(Pythium sp). Out of these leaf blight incited by *Alternaria tagetica* is the most serious and prevalent all over the country (Rao,2006;Yadav*et al*., 2019) . During this disease brown necrotic spots are formed on leaves, which coalesce and increase in size at latter stage of infection the entire foliage gets wilted,, resulting in poor vegetative growth. According to an estimate the disease resulted in a loss of flower yield up to 55-60% in Punjab (Jarwar *et al*., 2021and Singh and Mehta,2016).Environmental factors such as high moisture, temperature ranging from 25°C to 28°C, and the presence of free water contribute to the severity of the disease. High moisture conditions also provide favourable environment for the pathogen to thrive. These conditions create an ideal setting for *Alternaria* to infect and spread within the marigold plants. The coexistence of *Alternaria tagetica* further complicates the situation, making leaf blight diseases a major limitation for high-yielding marigold varieties (Akoijam and Chandel,2017 and Mailem and Singh,2018).

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To address these challenges, farmers and researchers need to implement proper management strategies, including use of disease-resistant varieties, timely application of fungicides and monitoring the disease for early signs as to mitigate the impact of diseases on commercial marigold cultivation. Further research avenues indicate potential for eco friendly disease management in marigold by using plant extracts, thereforerestrictriting its spread(Subhendhu *et al*., 2004 and Marchande *et al*., 2020).

MATERIAL AND METHODS

Plant material

The disease management studies on Marigold cv 'Punjab Gainda No-1' was conducted at Research farm, Department of Floriculture and Landscaping, Punjab Agriculture University, Ludhiana from 2022-2023. Marigold seedlings were initially raised in an open field and transplanted after 30 days at a spacing of 30 cm x 30 cm, in plot size of 1.25m x 1.25 m The sowing was done in the month of Aug in 2022 and April in 2023.

Isolation and Maintenance

Marigold leaves exhibiting early symptoms of leaf spot were collected from the fields and the fungus was isolated using standard techniques. Later on infected tissues were transferred on the sterile solidified PDA plates, which were kept at 25-30°C in an incubator (Hotchkiss and Baxter,1983). The mycelial growth was obtained within 5 days of the incubation. The cultural characteristics of this fungus were identified with the help of Department of Plant Pathology, Punjab Agriculture University, and Ludhiana. The pure culture was then obtained and kept in the incubator for further study. The pathogencity of fungus was also confirmed by Koch postulates (Chandel *et al*.,2010).

Management for Alternaria blight of marigold

Field experiment was conducted during the winter season of 2022 and the summer season of 2023 to manage leaf blight disease in marigold. All recommended cultural and pest control practices were followed (Mamta *et al*.,2016). The PDI was takenfortnightly after every [Table-1].The cultivar was planted in randomized block design with three replications at 30x30cm spacing on raised bed. The six sprays of different fungicides namely Chlorothalonil 75WP@ 0.2%, Difenoconazole 25% EC @ 0.5%,Tebuconazole 25% EC@0.5%, Tebuconazole50%+ Trifloxystrobin 25% WG@0.5%, WG ,Metiram 70 WP @ 0.1%, Azoxystrobin 23% SC @0.05% and untreated control.Six botanicals namely, *Azadirachta indica extract Allium sativum extract ,Syzygium aromaticum extract* , *Moringa oleifera extract* , *Terminalia arjuna extract* ,*Murraya koenigii extract* @0.2% and untreated control (Akhter and Shamsi,2021; Barnwal *et al*.,2002; and Sharma*et al*.,2021).

Preparation of leaf extracts

Six plants viz., *Azadirachta indica*, *Allium sativum*, *Terminalia arjuna*, *Moringa oleifera*, *Murraya koenigii*and *Syzygium aromaticum* were selected for the study. Fresh healthy plant parts were collected from various locations of Punjab Agricultural University, Ludhiana and confirmed their taxonomical identification. These samples were washed properly to remove soil particles. The leaves were cut into small pieces of equal size and were dried in shade at room temperature for 2-3days. Shade dried leaves were further dehydrated completely in oven at 60°C for 3 hours. The completely dried leaves were powdered. Flower buds of clove and bulbs of garlic were directly powdered and used for extraction purpose. All the samples were extracted *via* maceration extraction method using methanol as solvent. For this, 10g of dried powder was macerated in 50 ml of methanol and water separately at room temperature for 72 hours. The

samples were filtered and the filtrate was concentrated using rotary evaporator. The prepared extract was stored in refrigerator till further use. From the extract prepared required quantities of botanicals were taken for *in vivo*studies (Singh and Tomar, 2012).

Observation of Floral and Yield parameters

Two traits *ie*, Flower yield and Number of flowers/ plants were observed.. The yield of flower was taken in the end. The no of flowers per plant was taken after the crop was harvested. The cultural operations were carried out uniformly as per recommendations for cultivation of marigold. The experiment was carried out in Randomized Block Design (Mamta *et al*.,2016)

RESULTS AND DISCUSSIONS

Screening of marigold cultivars against leaf spot of marigold under field conditions during 2022-23.

Different genotypes obtained from major AICRP centres were evaluated against leaf blight at Research Farm, Department of Floriculture and Landscaping, PAU, Ludhiana in the year 2022 and 2023. The results of table 2 indicate that genotypes viz., Arka Bhanu gave moderately resistant reaction whereas other cultivars namely, Arka Abhi,Arka Shubha, Arka Vibha,Bidhan, Bihar Marigold -113, Pusa Basanti Gainda, Pusa Bahar, Pusa Narangi Gainda, Bidhan Marigold-4, CGFM-1gave moderately susceptible reaction. Five genotype *viz*Hisar Jafri.KAU M-1, KAU M-2, KAU M-46 and Bidhan Kali Gainda gave susceptible reaction. Two varieties Pusa Deep and Pusa Arpita gave highly susceptible reaction. The Punjab Gainda No.1 used as control which gave moderately susceptible reaction in both the years.

Out of eighteen genotypes Arka Bhanu followed by Arka Vibha, Bidhan Marigold-4, Arka Shubha performed better than control. However, other genotypes like Hisar Jafri.KAU M-1, KAU M-2, KAU M-46 and Bidhan Kali Gainda performed poorly. These results align with the findings of (Dhiman and Arora (1983) Marchande*et al*. (2020); Chandel and Kumar (2017) and Wu and Wu (2019).

Effect of Fungicides in management of Alternaria leaf Spot

The field experiments was conducted during 2022-23 and 2023-24 to manage Alternaria blight of marigold . Pooled data in Table-3 indicated that minimum disease percent disease index was observed in plants treated with tebuconazole 50 +trifloxystrobin 25 WG (10.00%) followed by tebuconazole 25.9% EC (13.22%), azoxystrobin 23% SC (15.92%), in both the seasons respectively. Percent disease index in case of difenoconazole 25% EC(25.24%) and metiram 70 %WP (26.42%)were at par. Chlorothalonil 75% WP was found least responsive with a disease severity of (39.41 %). Maximum disease severity of (44.66%) was recorded in untreated plot. However, in both the seasons all the treatments were found significantly superior to control. Maximum percent disease control was observed in plants treated with Tebuconazole 50% +Trifloxystrobin 25 % WG(77.60%)and minimum in plants treated with Chlorothalonil 75% WP (11.73%)These findings are consistent with (Akhter and Shamsi(2021); Anand(2021); Chandel and Kumar(2017);Shindhe *et al*. (2018) and Singh*et al*. (2006).

Flower yield per plant (g)

Flower yield varied from 434.26 to 514.47 gm/plant and 281.60 to 390.55 gm/plant in 2022 and 2023 respectively. Pooled data indicated that maximum yield was observed in plant treated with tebuconazole 50 +trifloxystrobin 25 WG (452..51g/plant) and minimum yield was observed in Chlorothalonil 75% WP (388.9. g/plant). However, all the treatment was significantly superior to control in which minimum yield was obtained. Similar findings were reported by Anand (2021);Chaupoo and Kumar(2020) and Singh and Mehta(2016).

Numbers of flower per plant

The average flower number also varied significantly, the maximum . in Plant treated with tebuconazole 50 +trifloxystrobin 25 WG (139.00) and minimum in plants treated Chlorothalonil 75% WP (105.0). This may be due to variation in number of ray florets. These findings are consistent with Anand(2021);Chaupoo and Kumar (2020) and Jash *et al*. (2004).

Effect of Botanicals in management of Alternaria leaf Spot

Alcoholic extracts of six botanicals viz., *Allium sativum, Azadirachta indica, Moringa oleifera, Murraya koenigii, Syzygium aromaticum and Terminalia arjuna* was used to manage Alternaria blight of marigold in 2022 and 2023. The results in table -4 revealed that all the botanicals tested were significantly superior over control. However, minimum percent disease index disease of 19.89% was observed in plants treated with *Allium sativum extract* followed by *Azadirachta indica* extract (25.71%), *Moringa oleifera* extract30.65%), *Syzygium aromaticum* extract (34.25%), *Murraya koenigii* extract (39.04%), In case of botanicals maximum disease severity was observed in plants treated with *Terminalia arjuna extract* (40.66%), which was found least responsive. In case of untreated plotspercent disease index was at par with the control plot (41.83%) in both the seasons. However, all treatments were found significantly superior to control in 2022-23 and 2023-24. Percent disease control did not reflect as disease index of various botanicals were very closeThese results collaborates with findings of (Chandel and Kumar (2017); Khanna and Chandra(1972);Waghmare (2014);Mahapatra and Das (2013); Satapathy and Sahoo (2022) and Singh and Tomar(2012).

Flower yield per plant (g/plant)

Pooled data indicated that maximum yield was observed in plant treated with *Allium sativum* extract 446.56 g/plant and *Azadirachta indica* extract(401.63 g/plant).Minimum yield was observed in plants treated with *Terminalia arjuna* extract (350.50 g/plant) in both the years. However, all the treatment was significantly superior to control in which minimum yield was obtained. Similarresult were reported byAnand(2021); Waghmare (2014)and Waghe *et al*. (2015).

Numbers of flower per plant

The average flower number also varied significantly, the maximum in Plant treated with *Allium sativum* extract.(126.00) and minimum in plants treated *Terminalia arjuna* extract (100.00). This may be due to variation in number of ray florets. Similar observations were reported by Yadav *et al*. (2019); Waghmare (2014) and Sharma *et al*. (2021).

CONCLUSION

Based on the present study, it can be concluded that among the eighteen cultivars screened 'Arka bhanu' gave moderately resistant reaction and Pusa deep and Pusa arpita gave highly susceptible reaction to Alternaria blight.All the fungicides and botanicals tested reduced the disease. However, tebuconazole 50% +trifloxystrobin 25 % WG was found highly effective with percent disease index of (10.00%) followed by tebuconazole 25.9% EC (13.22%) and azoxystrobin 23% SC (15.92%) when sprayed at @ 0.5% conc. Highest yield (452.51g/plant) with a disease control of 77.60 percent in tebuconazole 50% +trifloxystrobin 25 % WG. Minimum percent disease index was obtained in plants treated with *Allium sativum* (19.89%) followed by *Azadirachta indica* (25.71%). .Field experiments also underscored the potential of integrated disease management strategies involving *Allium sativum* and tebuconazole + trifloxystrobin25 % WG in inhibiting the disease.

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Table 1: Severity of the disease was determined by using 0-5 scale (Hotchkiss and Baxter, 1983)

Disease rating	Host response	Symptoms/Disease severity
0	HR	No symptoms on leaf
1	R	Spots covering 1-10% of the leaf area
2	MR	Spots covering 11-20% of the leaf area
3	MS	Spots covering 21-30% of the leaf area
4	S	Spots covering 31-40% of the leaf area
5	HS	Spots covering 40-50% of the leaf area

Percent disease index (PDI) = $\frac{Sum\ of\ numerical\ rating}{No.\ of\ leaves \times Max.\ disease\ rating\ observed} \times 100$

Table 2: Evaluation of different cultivars of marigold against leaf spot of marigold during the year 2023-24

S.no	Genotypes	Percent disease index(%).	Avg (PDI)	Disease reaction

		2022	2023		
1	Arka Vibha (IIHR)*	21.87	21.79	21.83	**MS**
2	Arka Shubha(IIHR) *	24.76	23.44	24.10	**MS**
3	Arka Abhi(IIHR) *	27.34	23.22	25.28	**MS**
4	Arka Bhanu(IIHR) *	19.12	17.25	18.19	**MR**
5	Bihar Marigold -113***	27.11	24.11	25.61	**MS**
6	Hisar Jafri****	31.22	30.11	30.67	**S**
7	KAU M-1(KAU)*****	31.57	29.15	30.36	**S**
8	KAU M-2(KAU) *****	34.21	32.22	33.22	**S**
9	KAU M-46(KAU) *****	37.98	38.25	38.12	**S**
10	Pusa Deep (IARI)**	69.89	62.12	66.01	**HS**
11	Pusa Arpita((IARI) **	72.12	64.25	68.19	**HS**
12	Pusa Basanti Gainda**	25.11	23.25	24.18	**MS**
13	Pusa Bahar**	26.11	25.11	25.61	**MS**
14	Pusa Narangi Gainda**	21.20	22.25	21.73	**MS**
15	Bidhan Kali Gainda(BCKV)******	39.32	33.12	36.22	**S**
16	Bidhan Marigold-4(BCKV) ******	23.09	25.15	24.12	**MS**
17	CGFM-1*******	27.09	23.12	25.11	**MS**
18	Punjab Gainda No.1 (LC.)#	25.48	25.22	25.35	**MS**

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Table 3: Evaluation of fungicides against leaf spot of marigold under field conditions during the year 2022-2023

Treatment	Conc.	Per cent disease index		Avg (PDI)	Per cent control (PDC)	Yield (Gram/Plant)			No of Flowers per plant		
		2022	2023			2022	2023	Avg	2022	2023	Avg
***Azoxystrobin* 23%SC**	0.5 ml/l	16.32	15.51	15.92	64.35	492.11	358.00	425.06	133.00	121.00	127.00
***Chlorothalonil* 75% WP**	2.0 gm/l	40.27	38.54	39.41	11.75	456.89	321.00	388.95	113.00	98.00	105.50
***Difenoconazole* 25% EC**	0.5 ml/l	24.52	25.95	25.24	43.08	464.7	355.00	409.85	125.00	110.00	117.50
***Metiram* 70% WG**	1.0 gm/l	26.51	26.33	26.42	40.84	461.49	322.00	391.75	119.00	103.00	111.00
***Tebuconazole*25.9 % EC**	1.0 ml/l	13.19	13.25	13.22	70.33	500.33	366.50	433.42	140.00	125.00	132.50
Tebuconazole 50% +Trifloxystrobin 25 % WG	0.5 gm/l	10.13	9.87	10.00	77.60	514.47	390.55	452.51	145.00	133.00	139.00
Control	-	48.99	40.33	44.66		434.26	281.60	357.93	102.00	87.00	94.50
CD@1%	-	**2.38**	**1.98**	**3.88**		**10.98**	**15.25**	**11.22**	**18.75**	**14.22**	**3.28**

Table 4: Evaluation of fungicides against leaf spot of marigold under field conditions during the year 2022-2023

Treatment	Conc.	Percent disease index		Avg (PDI)	Per cent control (PDC)	Yield (Gram/Plant)			No of Flowers per plant		
		2022	2023			2022	2023	Avg	2022	2023	Avg
***Allium sativum* extract**	2.0 gm/l	20.57	19.21	19.89	52.45	492.11	401.00	446.56	132.00	120.00	126.00
***Azadirachta indica* extract**	2.0 gm/l	27.43	23.98	25.71	38.53	444.25	359.00	401.63	128.00	117.00	122.50
***Murrayakoenigii* extract**	2.0 gm/l	41.41	36.66	39.04	6.66	417.00	302.00	359.50	109.00	101.00	105.00
***Terminalia arjuna* extract**	2.0 gm/l	43.20	38.12	40.66	2.79	401.00	300.00	350.50	102.00	98.00	100.00
***Moringa oleifera* extract**	2.0 gm/l	31.57	29.73	30.65	26.66	422.00	314.00	368.00	122.00	112.00	117.00
***Syzygium aromaticum* extract**	2.0 gm/l	36.26	32.23	34.25	18.12	431.00	332.00	381.50	118.00	105.00	111.50
Control	-	44.40	39.25	41.83		388.12	281.60	334.86	97.00	82.00	89.50
CD@1%	-	2.33	1.32	3.88		10.98	11.25	9.22	16.07	12.22	6.34