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Efficacy of plant leaf extracts and bio-agent against leaf blight of Safflower caused by *Alternaria carthami*

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Abstract
An experiment was conducted to evaluate the effect of four plant leaf extract, one bioagent and one fungicide (treated control) *in-vivo* against *Alternaria carthami* causing leaf blight of safflower. The plant leaf extracts and bio-agent found effective *in-vivo* were tested against the alternaria leaf blight of safflower under field condition during *rabi season* 2016-2017 minimum plant disease intensity (%) was observed in Datura (30.97%) followed by Lantana (34.18%), Neem (37.30%), Eucalyptus (42.45%), *Trichoderma harzianum* (46.36%) as compared to the treated control SAAF (22.82%) and Untreated Control (56.73%) on *Alternaria carthami*.

Keywords: Safflower, *Alternaria carthami*, Plant leaf extracts, Bio-agent, Fungicide.

Introduction
Safflower (*Carthamus tinctorious* L) is an important oilseed crop, belonging to the family Asteraceae and believed to be native of Afghanistan. In India, it is most commonly known as Kardai in Marathi and Kusum in Hindi. The important safflower growing countries are: India, Mexico, USA, Argentina, Canada, China, Spain, Italy, Turkey, Iraq, Iran, Egypt, Ethiopia and Sudan. Presently, India is the largest producer of safflower in the world followed by U.S., Mexico and China. In India it is mainly grown in Maharashtra, Karnataka, and part of Andhra Pradesh, Madhya Pradesh, Orissa, Uttar Pradesh and Bihar.

The total area under safflower in the world is about 936,875 hectare with the yield of 825 (Kg/ha.) and production 733,852 tones. (FAO, 2015). India is the largest grower of safflower with an area of 0.69 million hectares, production of 0.55 million tones and the average productivity of 791 kg/ha. In India area, production and productivity of safflower recorded during 2014-15 were 174.9('000 hectare), 90.1('000 tones) and 515kg/ha, respectively. In Uttar Pradesh safflower is cultivated on an area of 3.0 ('000 hectares), and production of 4.0 ('000 tonnes) with an average productivity of 13.33 q/ha (Ministry of Agriculture & Farmers Welfare, Govt. of India 2014).

The safflower production in India is limited because of the hard spiny nature of the crop. Production and productivity of safflower in India is less then compared to other countries because of biotic and abiotic factors. Among the biotic agents, major diseases are caused by fungal pathogens *viz.,* Alternaria leaf spot (*Alternaria carthami*), Fusarium wilt (*Fusarium oxysporum* f. Sp. *carthami*), Ramularia leaf spot (*Ramularia carthami*), Root rot (*Phytophthora drechsleri)* and Rust (*Puccinia carthami*). Minor diseases include Bacterial leaf blight (*Pseudomonas syringae*), viral diseases; Cucumber mosaic virus, Lettuce mosaic virus, Tobacco mosaic virus and Root knot nematode (*Meloidogyne incognita*). Among the diseases, leaf spot is the most important and destructive disease of safflower caused by *Alternaria carthami* and is a serious threat to successful cultivation of safflower. The disease was reported for the first time from India by (Chowdhury, 1944) [8] at Pune. This disease plays an important role in safflower cultivation and causes 25-60 per cent yield loss every year (Singh and Prasad, 2005) [2].

Alternaria leaf spot symptoms appeared as circular, dark brown to black lesions with concentric rings that resemble a target pattern. Some lesions have distinct yellow halos on young plants. Lesions generally do not cross major leaf veins, and become angular in shape as the age. Under favorable conditions, several lesions coalesce, leading to necrosis and withering of entire leaves. Stem lesions begin as dark flecks that enlarge to form large elliptical to diamond-shaped sunken lesions. Large, blackened stem lesions can girdle plants and cause stem breakage (Howard and David 2007) [1].

Materials and Methods

The experiment was conducted in a Randomized Block Design with three replication and seven treatments at the experimental site of the Department of Plant Pathology, central research field, Sam Higginbottom University of Agriculture, Technology & Sciences Allahabad, during the Rabi season of 2016-17.

Table 1: Detail of Treatments

Treatments	Concentration
Control	-
Carbendazim 12% + Mancozeb 63%	0.2 %
Trichoderma harzianum @ 10g/kg (St) + *Trichoderma harzianum* @ 10*g*/l (Fs)	10 %
Datura leaf extract	10 %
Lantana leaf extract	10 %
Neem leaf extract	10 %
Eucalyptus leaf extract	10 %

Here St = Seed treatment
Fs = Foliar spray

Disease assessment

Plant Disease Incidence (PDI) of Alternaria blight on leaves was assessed at 15 days intervals after incidence of 5 marked plants per plot on leaves. The assessments were started when foliage or all the open leaves had infected. Disease Severity of leaves was determined by the diagrammatic keys according to the scale described by (Singh 2004) [3], per cent of the surface of the leaves affected by leaf blight. The infection on leaves were graded in 0-9 scale on the basis of severity of infection on leaves and pod i.e. the percentage ratio of infected area with the total area of leaves.

Table 2: The scales for disease assessment were as follows

Grade	Per cent leaf area covered	Reaction
0	No infection or '0' infection	Immune
1	less than 1% leaf area damage	Highly resistant
3	1 to 5% leaf area damage	Resistant
5	6 to 25 % leaf area damage.	Moderately resistant/Susceptible
7	26 to 50 % leaf area damage	Moderately susceptible
9	More than 50 % leaf area damage	Highly susceptible

Disease intensity

Per cent disease intensity was recorded at 45, 60 and 75 days after incidence of leaf blight. The initial infections or incidence were recorded in the experimental field at 45 days after sowing.

Per cent Disease Index (PDI) was calculated by using formula given by (Singh, 2004) [3].

$$\text{Per cent disease intensity} = \frac{\text{Sum of total rating}}{\text{No. of leaves observed} \times \text{Maximum grade}} \times 100$$

Applications of treatment

Talcum based formulation of *Trichoderma harzianum*, Allahabad was used for field experiment. Before applying the talcum based formulation of *Trichoderma harzianum* in the field the colony-forming unit (c.f.u) was checked in the laboratory. Seed treatment @ 10g/kg of *Trichoderma harzianum* was used. Foliar spray of *Trichoderma harzianum* was at 45-50 DAS@10 g\l of water (Rathi, 2009) [6].

SAAF (Carbendazim 12% + Mancozeb 63% WP) was used as foliar spray at 45-50 DAS @ 2gm/l of water.

For preparation of leaf extracts fresh leaves from Datura, Neem, Latana and Eucalyptus plant leaves were washed in running tap water followed by washing in distilled water seprately, air dried and cut into pieces of 2-3 cm in length. The tissues were homogenized in distilled water(1:1w/v) using a blender. The mixture was filtered through a two layer of moistened muslin cloth and washed the filter and centrifuged. The supernatant thus obtained was designated as concentrated leaf extract. Leaf extract was used foliar spray @ 10 % (w/v)**.**

Results and Discussion

In vivo evaluation of botanicals and bio-agent

The results presented in Table 6 revealed that all treatments were found significantly superior over the control. Among all the treatments used at 45 and 60 DAS spray, the minimum average plant disease intensity (%) of *Alternaria carthami* was observed in datura (25.57 and 30.97) followed by lantana leaf extract (27.94 and 34.18), neem (31.23 and 37.30) eucalyptus (33.34 and 42.45), *Trichoderma harzianum* (34.56 and 46.36) as compared to the treated control SAAF (19.87 and 46.36) and untreated Control (39.68 and 56.73). All the treatments were found statistically significant over untreated control and among the treatments. Similar result of antifungal effect of botanicals/plant extracts against *Alternaria carthami* and *Alternaria* spp. were reported earlier by several workers Shinde *et al.* (2008), Mesta *et al.* (2009) [10], Ranware *et al.* (2010) [9] and Taware *et al.* (2014) [5].

Table 3: Effect of treatments on plant disease intensity at 45, 60 and 75 DAS of safflower

Treatments	Concentration (%)	Disease intensity (%)			
		45 DAS	60 DAS	75 DAS	Mean
Control (Untreated)	-	23.73 (30)*	39.68 (39.04)	56.73 (48.88)	40.04 (39.30)
SAAF	10g/l	16.34 (23.84)	19.87 (26.47)	46.36 (28.53)	19.67 (26.28)
Trichoderma harzianum	10g/l	21.94 (27.93)	34.56 (36.01)	46.36 (42.91)	34.28 (35.61)
Datura leaf extract	10	17.31 (24.58)	25.57 (30.37)	30.97 (33.81)	24.61 (29.58)
Lantana leafextract	10	18.77 (25.81)	27.94 (31.90)	34.18 (35.77)	26.96 (31.16)
Neem leaf extract	10	19.21 (25.99)	31.23 (33.97)	37.30 (37.64)	29.24 (32.53)
Eucalyptus leaf extract	10	20.91 (27.21)	33.34 (35.26)	42.45 (40.81)	32.23 (34.42)
Overall Mean		19.74	30.31	38.83	
S. Ed. (±)		1.03	1.66	1.29	
C. D. (P = 0.05)		2.25	3.62	2.81	

Values are average of three replicate.
*Values in parenthesis are arcsine transformed

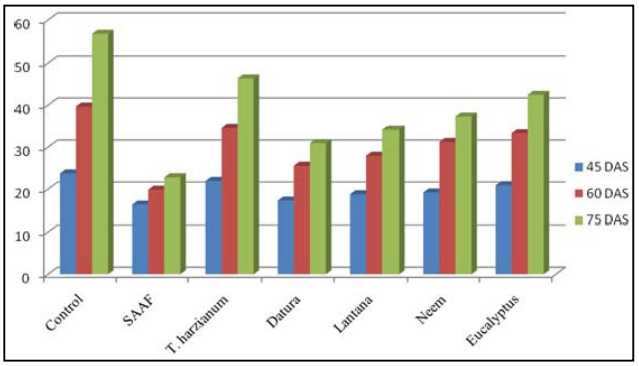

Table 4: Effect of treatments on the yield of safflower (q/ha).

Treatments	Yield (q/ha)
Control (Untreated)	8.2
SAAF	14.6
Trichoderma harzianum	10.8
Datura leaf extract	13.6
Lantana leafextract	12.5
Neem leaf extract	12.1
Eucalyptus leaf extract	11.7
Overal Mean	11.92
S. Ed. (±)	0.14
C. D. (P = 0.05)	0.30

Data are average of three replicates.

The data recorded in table 4.4 and depicted in figure 4.3 showed the response of plant extracts and bio-agents on yield. The highest yield (q/ha) was observed in datura (13.60) followed by lantana (12.50), neem (12.10), eucalyptus (11.70), *T.harzianum* (10.80) as compared to the treated control SAAF (14.60) and untreated control gave the low yield (8.2). All the treatments were found statistically significant over untreated control which gave the lowest yield. However were found non-significant to each other.

Table 5: 7 Economics of the treatments (cost benefit ratio).

Treatment	Yield (q/ha)	Total income (Rs)	Common cost (Rs)	Treatment cost (Rs)	Total cost (Rs)	C:B ratio
Control (Untreated)	8.2	27470	21078	-	21078	1:1.30
SAAF	14.2	47570	21078	1050	22128	1:2.14
Trichoderma harzianum	10.8	36180	21078	600	21678	1:1.66
Datura leaf extract	13.6	45560	21078	400	21478	1:2.12
Lantana leaf extract	12.5	41875	21078	600	21478	1:1.94
Neem leaf extract	12.1	40535	21078	400	21478	1:1.88
Eucalyptus leaf extract	11.7	39195	21078	400	21478	1:1.82

*Income was calculated using minimum support price (MSP) of safflower as Rs.3350/q.

The data recorded in Table 4.7 showed the response of plant extracts and bio-agents on cost to benefit ratio.

The farmer's point of view, the economics of disease management is important. In the present investigation datura and lantana leaf extract has been given highest cost to benefit ratio of (1:2.12) and (1:1.94) respectively over untreated control than any other treatments followed by neem (1:1.88), eucalyptus (1:1.82) and *T. harzianum* (1:1.66). All the treatments are significant over untreated control. However, datura and lantana were recorded highest cost: benefit ratio of (1:2.12) and (1:1.94) as compared to treated control SAAF with (1:2.14). Since present day economists are advising for net return concept, datura and lantana are best treatment in term of cost benefit ratio.

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