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REDUCING POWER AND FERRIC REDUCING ANTIOXIDANT POWER OF SOME CULTIVARS OF SAFFLOWER UNDER THE PATHOGENESIS OF FOLIAR FUNGAL DISEASE COMPLEX

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ABSTRACT

In the present investigation, reducing power and ferric reducing antioxidant power (FRAP) of healthy and infected leaves of safflower cultivars (Nari-38, Nari-6, Nari-H-23 and Nari-NH-1) were analyzed under the pathogenesis of foliar fungal disease complex involving Alternaria leaf spot, Cercospora leaf spot, Ramularia leaf spot, Rust and Powdery mildew. The reducing power and FRAP of infected leaves extract were increased significantly over healthy leaves in all safflower cultivars except Nari-38. The reducing power and FRAP of infected leaves extract of Nari-6 was found higher than all the tested healthy and infected leaves extracts as well as standard Ascorbic acid. The significant increase in reducing power and FRAP in infected leaves of Nari-6, Nari-H-23 and Nari-NH-1 over healthy leaves indicates that they have a good source of antioxidants to increase the resistance capacity against foliar fungal disease complex while slightly increase reducing power and declined FRAP in infected leaves of Nari-38 over healthy leaves indicates that it was susceptible to foliar fungal disease complex.

KEYWORDS:*Safflower, reducing power, FRAP, foliar fungal disease complex.*

INTRODUCTION –

Safflower (*Carthamus tinctorius*, L.) belongs to family Asteraceae, cultivated mainly for its seeds, which yield edible oil. Safflower is an important rabi oilseed crop of spiny and non spiny nature. It is being a drought tolerant crop, grown under resending moisture condition in the states of Maharashtra, Karnataka and some extent in Andhra Pradesh (Padmavathi, 2005). Safflower is grown mostly in black soils in southern (deccan) plateau region of India during the post rainy (Rabi) season, primarily as a rainfed oilseed crop. However, the year wise area and production of safflower at global, national, state and district level indicates that the cultivated area and production declined year after year may be due to changing climatic conditions and several abiotic and biotic stresses; one of them is fungal disease complex. Plant diseases where more than one pathogen is involved in the infection process are commonly termed as "complex" since their diagnosis and subsequent control are more complicated. In nature different fungal pathogens cause diseases on a common host plant which may develop simultaneously and can infect the same host at a time. Co-occurring fungal pathogens may affect each other, through antagonism and/or synergism. However the incidence of co-occurrence of different foliar fungal pathogens at a time in safflower is unknown. In the present investigation, the occurrence of foliar fungal disease complex involving *Alternaria* leaf spot, *Cercospora* leaf

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spot, *Ramularia* leaf spot, Rust and Powdery mildew on safflower cultivars is novel. Therefore, the attempt has been made to study antioxidant potential in terms of reducing power and FRAP in safflower cultivars to uncover the possible underlying mechanisms of resistance against foliar fungal disease complex.

MATERIAL AND METHODS:-

Healthy and leaves infected with foliar fungal disease complex from selected cultivars of safflower namely Nari-38 (spiny variety), Nari-6 (non-spiny variety), Nari-H-23 (spiny hybrid) and Nari-NH-1 (non-spiny hybrid) were used for reducing power and FRAP analysis.

EXTRACT PREPARATION:-

Healthy and infected leaves extract was prepared by the method suggested by Taylor et al., (1996). Both healthy and infected leaves of all safflower cultivars were air dried at room temperature to constant weights. The dried leaves materials were ground separately to powder. Two hundred grams of each ground leaves materials were shaken separately in methanol for 48 hrs on an orbital shaker. Extracts were filtered using a Buckner funnel and Whatman No. 1 filter paper. Each filtrate was concentrated to dryness under reduced pressure at 400C using a rotary evaporator. Each extract was resuspended in methanol to make 50 mg/ml stock solution. The respective methanolic leaves extract were used for estimation of reducing power and FRAP.

The reducing power of the healthy and infected leaf extracts was determined according to the method of Oyaizu (1986). The ferric reducing antioxidant power (FRAP) in the extract of healthy and infected leaves was determined by a modified method of Benzie and Strain (1996).

RESULT AND DISCUSSIONS:-

Table I and Fig. I showed the reducing activities of healthy and infected leaves extracts of safflower cultivars in comparison with ascorbic acid as standard under the pathogenesis of foliar fungal disease complex. The higher the absorbance of the reaction mixture, the higher would be the reducing power. In this assay, the ability of respective leaves extracts to reduce Fe3+ to Fe2+ is determined. It is observed that reducing power increased in infected leaves extract over healthy leaves extract in all cultivars. In variety, the maximum increase of reducing power in infected leaves extract is reported in nonspiny Nari-6 (4.91%) as compared to spiny Nari-38 (2.59%) over healthy leaves extract. Among the hybrids, nonspiny Nari-NH-1 exhibited maximum increase (31.12%) of reducing power in infected leaves extract as compared to spiny Nari-H-23 (22.32%) over healthy leaves extract. The reducing power of respective extracts of nonspiny variety Nari-6 is found to be higher than all the tested healthy and infected leaves extracts as well as reference compound (Ascorbic acid).

Ferric reducing antioxidant power (FRAP) activity of safflower cultivars in response to foliar fungal disease complex is depicted in Table II and Fig. II It is observed that FRAP activity increases in infected leaves extract of all safflower cultivars except spiny variety Nari-38 over healthy leaves extract. In variety, the activity of FRAP increased significantly in infected leaves extract of nonspiny Nari-6 (45.61%) over healthy leaves extract while spiny Nari-38 exhibited reverse trend. Among the hybrids, maximum increase of FRAP is occurred in infected leaves extract of spiny Nari-H-23 (35.20%) as compared to nonspiny Nari-NH-1 (29.19%). The highest FRAP value in infected leaves extract is found in nonspiny variety Nari-6 (3467.38 µmole Fe (II) g-1 dry weight) which is higher than the standard ascorbic acid (2037.78 µmole Fe(II) g-1 dry weight) while least FRAP value is found in spiny variety Nari-38 (1070.27 µmole Fe (II) g-1 dry weight) as compared to other cultivars.

In the present investigation, reducing power increased in infected leaves extract of all safflower cultivars under the pathogenesis of foliar fungal disease complex may be attributed to the hydrogen donating effect of phenolic compounds. This result is in agreement with Kalidindi et al., (2015) who observed that reducing power of the chloroform, methanol, and aqueous extracts of *Annona squamosa* leaves showing antifungal property against *A. alternata, Candia albicans, F. solani, Microsporum Canis* and *Aspergillus niger* were increased with increase in

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Table I. Reducing power property of safflower cultivars under the pathogenesis of foliar fungal disease complex.

Cultivars	Parameters	Concentration µg/ml	Absorbance at 700nm
Nari-38 (Spiny Variety)	Healthy leaves	100	1.693
	Infected leaves	100	1.737 (2.59)
Nari-6 (Non-spiny Variety)	Healthy leaves	100	2.036
	Infected leaves	100	2.136 (4.91)
Nari-H-23 (Spiny Hybrid)	Healthy leaves	100	0.972
	Infected leaves	100	1.189 (22.32)
Nari-NH-1 (Non-spiny Hybrid)	Healthy leaves	100	0.922
	Infected leaves	100	1.209 (31.12)
	Std. Ascorbic acid	100	1.828

(Values are mean ± SD of triplicates. Values in the parentheses indicates per cent increase of reducing power over Healthy leaves)

Table II. Ferric reducing antioxidant power of safflower cultivars under the pathogenesis of foliar fungal disease complex.

Cultivars	Parameters	µmole Fe(II) g^{-1} dry weight
Nari-38 (Spiny Variety)	Healthy leaves	2039.35±38.51
	Infected leaves	1070.27±149.82 (47.52)*
Nari-6 (Non-spiny Variety)	Healthy leaves	2381.22±40.66
	Infected leaves	3467.38±81.11 (45.61)**
Nari-H-23 (Spiny Hybrid)	Healthy leaves	1636.94±187.95
	Infected leaves	2212.27±27.36 (35.20)**
Nari-NH-1 (Non-spiny Hybrid)	Healthy leaves	1264.62±74.82
	Infected leaves	1633.21±27.55 (29.19)**
	Std. Ascorbic acid	2037.78±18.01

(Values are mean ± SD of triplicates. Values in the parentheses indicates **per cent increase or *per cent decrease of FRAP over Healthy leaves)

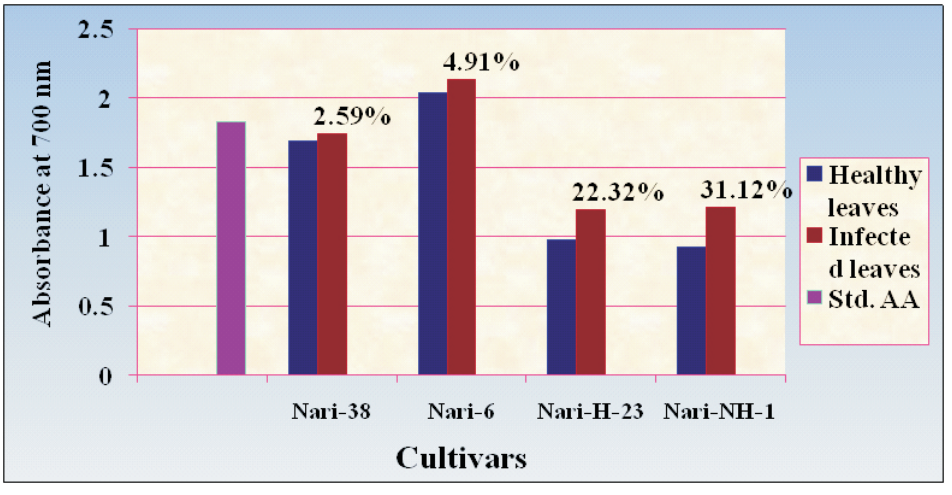

Fig.I. Effect of foliar fungal disease complex on reducing power in cultivars of safflower. (%- indicates per cent increase over healthy leaves).

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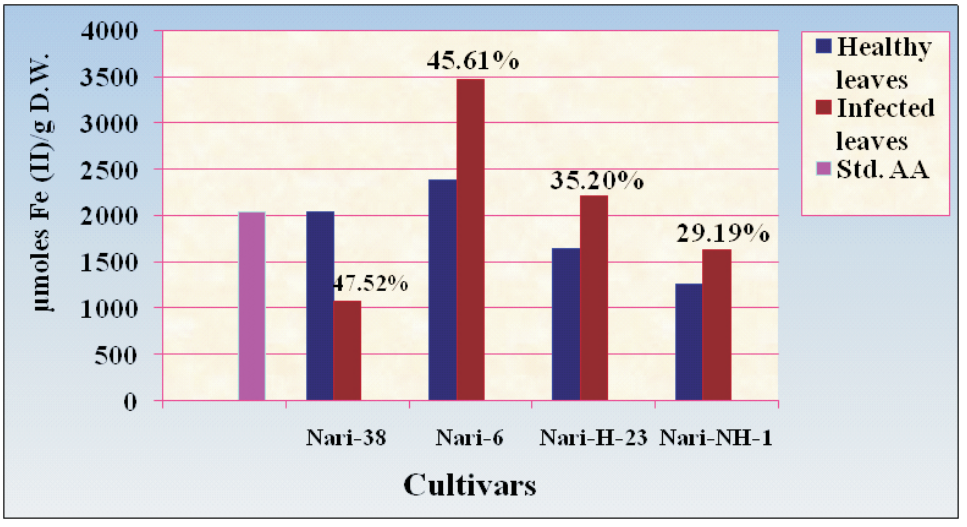

Fig. II. Effect of foliar fungal disease complex on FRAP in cultivars of safflower. (%- indicates percent increase or decrease over healthy leaves).

their concentration. They further speculated that presence of the flavonoids and phenols in all the tested extracts of *A. squamosa* leaves might have contributed to the antioxidant activity. Similarly, Ravindran *et al*., (2012) found that a significant linear correlation ($r^2 = p < 0.05$) was established between total phenolics and reducing ability of extracts of mangrove plant parts like leaf and root and their fungal endophytes and concluded that the high correlation values of mangrove leaf endophytes than that of the mangrove leaves infers that the endophytic fungal association may favor the plant under adverse conditions.

The FRAP activity increased in infected leaves extract of all safflower cultivars except Nari-38 over healthy leaves extract under the pathogenesis of foliar fungal disease complex. This findings is in agreement with Thite *et al*., (2013) who observed that FRAP was increased gradually in infected leaves with increased concentration of leaf extract of *X. strumarium* and *D. sissoo* over healthy leaves under the pathogenesis of powdery mildew infection caused by *Oidium xanthami* and *Ovulariopsis sisso* sp. respectively. Kim et al., (2010) observed that Glyceollins, a major bioactive compounds present in soybean when elicited by biotic elicitors such as food-grade fungus *Aspergillus sojae* showed a antifungal activity by inducing strong ferric redcing antioxidant power with significant scavenging activities of radicals including singlet oxygen, superoxide anion, ABTS, and DPPH.

CONCLUSION:-

In the present investigation, increase of reducing power and FRAP in infected leaves of all safflower cultivars except Nari-38 over healthy leaves under the pathogenesis of foliar fungal disease complex indicates that reductive ability of antioxidants play an important role to protect cultivars from oxidative damage and to mitigate the additive effect of foliar fungal disease complex. The significant increase in reducing power and FRAP in infected leaves of Nari-6, Nari-H-23 and Nari-NH-1 over healthy leaves suggest that they have antioxidant potential to increase the resistance capacity against foliar fungal disease complex while Nari-38 showing reverse trend and being susceptible to foliar fungal disease complex.

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