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Allelopathic effects of three weed plants on mycorrhizal association of *Zea mays* root

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Plants with mycorrhizal association, are often more competitive and are capable of tolerating environmental stresses better than the non-mycorrhizal ones. The mycorrhizal fungus transfers many nutrients through their hyphal network and thus play a significant role in the soil ecology. Plants considered as weeds are involved in interaction with other plant species at different trophic levels through the production and release of allelochemicals in the soil. This work presents the data on the allelopathic effects of three common weeds on mycorrhizal association in *Zea mays* root system and spore population in soil. The alkaline phosphatase and succinate dehydrogenase activities of the active mycelium of AM fungi was also studied with respect to the most effective concentrations of the alleochemicals.

Key words: Allelopathy, *Croton bonplandianum, Glomus mosseae, Lantana camara, Parthenium hysterophorus*

INTRODUCTION

Certain plants exhibit allelopathy and influence other plants and microorganisms by releasing different chemicals such as phenol, glycosides, amino acid, alkaloids, terpenes and sugars. Since almost all higher plants in terrestrial ecosystem, are associated with mycorrhiza, there is bound to have some allelopathic effect on this group of microorganisms also. Report of mycorrhizal colonization being adversely affected in response to allelopathic effect of *Eucalyptus citriodora* is available (Rukhsana and Naz, 2005). Phenolic compound released by *Croton bonplandianum* has been reported to adversely affect microorganisms and other plants grown in the rhizosphere soil. The present study has therfore, been designed to investigate the allelopathic affect of the root and leaf extracts of the three common weeds - *Lantana camara, Parthenium hysterophorus,* and *Croton bonplandianum* on mycorrhizal association in *Zea mays* root. The effect on the activity of two important enzyme namely succinate dehydrogenase (SDH) and alkaline phosphatase (ALP) of the mycorrhizal fungi has, also been studied. SDH, a mitochondrial enzyme, is considered as an indicator of viability of mycorrhiza (Vierheilig and Ocampo 1989), while ALP activity, located within the phosphate accumulating vacuoles of AM hyphae, have been proposed as physiological marker for analyzing the efficiency of mycorrhiza (Gianinazzi *et. al.,* 1972; Tisserant *et al.,* 1993) Allelopathic effect of the selected plant on the mycorrhizal spore population in the soil has also been studied.

MATERIALS AND METHODS

Experiment was conducted in plastic pots (6"diam.), each containing 500 g of sterilized field soil, inoculated with *Glomus mosseae*- infected root pieces, external mycelium and spores (25 g soil / pot). The pot soil was rendered allelopathic by applying 10 % and 25% (w/v) aqueous extract of *Lantana camara, Parthenium hysterophorus,* and *Croton bonplandianum* leaves and roots separately @ 500 ml/pot, three and seven days after transplanting 20-day-old *Zea mays* seedlings. Two seedlings were transplanted / pot and three replications were maintained for each treatment. Plants were harvested 21 and 30 days after transplanting and the feeder roots were collected from each treatment. A control without allelochemical treatment was also maintained.

Roots were stained with trypan blue (TB) (Phillips and Hayman, 1970) and the degree of mycorrhizal infection of such roots were determined by the intersect method (Giovannetti and Mosse, 1980).

Succinate dehydrogenase (SDH) and Alkaline phosphatase (ALP) activity were determined following histochemicall techniques (Gianinaggi *et al.*, 1979; Tisserant *et al.*, 1993; Vierheilig and Ocampa 1989). Spore population of *G. mossae* in the differently treated soil was determined by conventional wet-sieving process.

Statistical analysis

Data obtained was subjected to one way analysis of variance (ANOVA) and treatment means were separated by a Student-Newman-Keul's test. Percentage data were arcsine-transformed before analysis.

RESULTS

The root system of young maize plants in the control showed 35.6% degree of active and viable mycorrhizal infestation, with ALP (35.6) and SDH (34.4) activity. Arbuscular percentage was 5.4 of which 75 % showed ALP and SDH activity. However, treatment with root and leaf extracts, irrespective of the concentration (10 and 25%) resulted in reducing mycorrhizal colonization and activity of ALP and SDH indicating negative allelopathic affect. The results (Table 1) indicated that The negative allelopathic effect of leaf extract of *P.hysterophorus* was higher in both concentrations than the leaf extract of *C. bonplandianum* and *L.camara.* Degree of mycorrhizal infestation was least in 25% (w/v) of *P. hysterophorus* leaf extract. negative allelopathic affect of *P.hysterophorus* and *C.. bonplandianum* leaf extracts at both concentrations was also reflected in the total absence of arbuscules in the treated roots.

The allelopathic affect of *C. bonplandianum* root extract was found to be more negative than its leaf extract at both concentrations on the total mycorrhizal infestation in the root system (Table2). The root extract of *L. camara* and *P. hysterophorus* was, however, found to be more positive than their respective leaf extracts in respect to the total mycorrhizal infestation, percentage of viable and active hyphae showing ALP and SDH activity. With increase in the age of the *Zea mays* plants (30 days of treatment), it was found there was an increase in the degree of the mycorrhizal infestation

Table 1 : Allelopathic effect of leaf extracts of three weed plants on AME enzyme activity

Treatment Leaf Extract	Concen-tration	M%			A%		
		TB	ALP	SDH	TB	ALP	SDH
Control	--	35.56*a	35.56a	34.44a	5.35a	4.05a	4.05a
Lantana camara	10%	25.52b	23.35b	22.4b	2.68c	0.5c	0.4c
	25%	14.48b	13.44b	12.34b	1.30c	0.02c	0.02c
Parthenium hysterophorus	10%	10.00b	6.83b	6.44c	0	0	0
	25%	7.30c	6c	5.88c	0	0	0
Croton bonplandianum	10%	10.24b	7.44c	6.92c	0	0	0
	25%	8.56c	7.14c	6.50c	0	0	0

*Each value is the mean of three replications. Data followed by the same letters within each column were not significantly different ($P<0.05$, student-Newman-Keuls' test). All percentage values were are sin transformed before statistical analysis.

(73%), which was also reflected in the increase percentage of ALP and SDH- active hyphae, total arbuscules in the root system and ALP and SDH-active arbuscules (Fig.2). Further it was observed that the negative allelopathic affect became gradually neutralized and increased mycorrhizal colonization, ALP and SDH-active and viable hyphae and arbuscule production in the root system

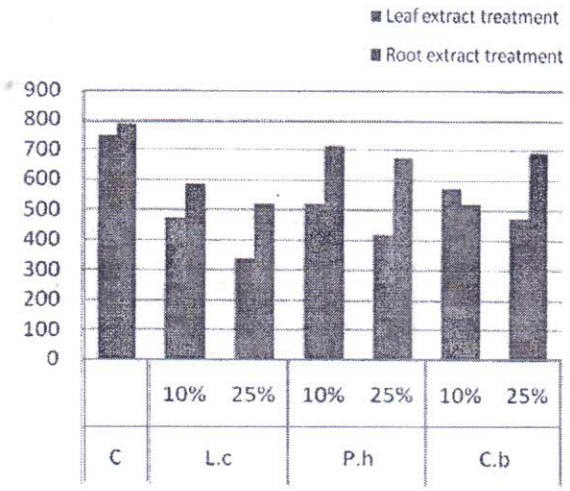

Fig. 1 : *G.mosseae* spore population/ 100 g soil after the treatment of allelochemical.

could be observed. However, no ALP and SDH activity was recorded in the arbuscules even a month after treatment.

Table 2 : Allelopathic effect of root extracts of three weed plants on AM fungi infestation.

Treatment Root Extract	Concen-tration	M%			A%		
		TB	ALP	SDH	TB	ALP	SDH
Lantana camara	10%	28.76*a	24.4a	23.56a	0.52c	0.41c	0.4c
	25%	19.40b	14.52b	13.08b	1.02c	1.02c	0.30c
Parthenium hysterophorus	10%	11.56b	7.8c	7.8c	0.10c	0.03c	0.02c
	25%	8.44c	7.03c	6.8c	0	0	0
Croton bonplandianum	10%	9.72c	7.28c	5.68c	0	0	0
	25%	5.6c	4.96c	3.8c	0	0	0

*Each value is the mean of three replications. Data followed by the same letters within each column were not significantly different (*P<0.05,* Student-Newman-keuls' test). All percentage values were arc sin transformed before statistical analysis.

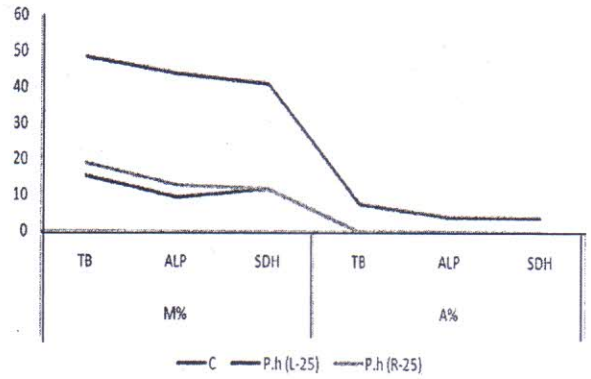

Fig. 2 : Mycorrhizal infestation percentage & SDH-ALP activity after 30th day of treatment

Negative allelopathic affect of both leaf and root extract of the three weeds plant could also be observed on the total spore count of *G. mosseae* / 100g of soil. The maximum negative affect was seen in 25% (w/v) of leaf extract of *L. camara* (Fig.1).

DISCUSSION AND CONCLUSION

Negative effect of allelochemicals on mycorrhizal fungus has been reported by several worker observed that allelopathic grasses decreased the mycorrhizal colonization of other plants including *Zea mays* L. It has also been recorded the exotic weed can interfere with nearby species by releasing allelochemicals that either directly inhibit growth and cause disturbance of associated species or affect then indirectly by disrupting their interaction with soil organisms such as arbuscular mycorrhizal fungi (Karasawa *et al.,* 2002). In the present study a similar trend has been observed and it is found that allelochemicals present in the root and leaf extract of the three plants selected for the study could not only reduce the AMF inoculum present in the soil, but considerably reduce the degree of mycorrhizal infestation in maize roots (Elmer, 2002) Further, the allochemicals present in the leaf and root extracts are found to reduce the ALP abd SDH associated active and viable hyphae in the roots to varying degrees. The negative affect is, however, found to be transient and appeared to wear off after a certain priod of time, when mycorrhizal infestation of root system gradually increased again. This study is specially relevant since there has been an increasing trend of use of botanicals for plant disease control. such botanicals while affecting the plant pathogens, may also, for a short period of time, reduce the positive roleof mycorrhiza in uptake of nutrients and enhancing plant growth.

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