SURVIVAL INSTINCT OF WEEDS IN AGROECOSYSTEM

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Abstract

Green plants produce hundreds of compounds that are not involved in primary metabolism of the plants and hence are called the secondary products. The compounds (alleloehemicals) involved in interspecific chemical interactions (allelopathy) with higher plants are often phytotoxic, a herbicidal to other species or even to the species producing them (autotoxicity). The purpose of this investigation was to screen out the phytotoxicity of the leaf extracts and leaf leachates of *Parthenium hysterophorus* L. on the serious two weed species *Crotolaria saltiana* L. and *Mimosa pudica* L.,measured in terms of seed germination, T_{50} (time required for 50% germination), TTC stainability, speed of germination and metabolism were analysed by some reliable biochemical indices. The present study shows that on seed pre-treatment of *Crotolaria* and *Mimosa* with various concentrations [1:1 and 1:2 (w/v)] of *Parthenium* fresh leaf extracts and fresh leaf leachates, for 6 hrs, reduces percentage germination, TTC-stainability, speed of seed germination, along with increase of the T_{50} values and activities of catalase and dehydrogenase enzymes. It further reemphasizes the fact that a fast growing exotic invasive weed like *Parthenium* having inhibiting property should be treated as a potential threat to plant diversity in a natural ecosystem. Therefore, this study calls for the proper management of *Parthenium* and other invasive weeds showing similar behaviour.

Introduction

The interference in the growth of one plant by another can result either from competition which involves the removal of some factors (nutrient, water and light) from the environment, habitat or through chemical(s) released from one plant (donor) that affects other (receiver) in sharing the habitat. The phenomenon known as "allelopathy" is now considered as important as competition for influencing plant growth both in natural and agricultural ecosystem. In natural or man managed agro-ecosystems, neighbouring plants may interact with the growth and development of other species. The term allelopathy signifies that

interaction or inhibition of growth (Molish, 1937) by the release of chemicals from plant parts by leaching, root exudation, volatilisation residue decomposition and other processes, both crop and weed species. These interactions are widely known in different groups of plants such as algae, lichens, crops, as well as annual and perennial weeds (Rice, 1984; Putnam, 1985; Horseley, 1991; Lawrey, 1993; Inderjit and Dakshini, 1994; Inderjit, 2005). Allelopathy is also an expression for the ecological phenomena which are normal constituents of the environment of terrestrial plants (Datta and Sinha Roy, 1974; Rice, 1984). There are some common indices for assessing allelopathic action of plants or plant parts. These include, among others, germination behaviour and other physio-biochemical responses of test species (Bhattacharjee et al, 2001 and 2003; Bhakat et al, 2002, 2005, 2006). Recently it is focused on establishing research procedures which may improve the credibility of evaluations of the allelopathic potential of an exotic weed *Parthenium* which has become invasive and forms monospecific stands in different ecosystems in West Bengal (Nayak et al., 2001). *Parthenium* is serious owing to its wide adaptability to different environmental conditions and habitats. Many researches have been done on the allelopathic effect or phytotoxicity of *Parthenium* to other plants. The allelopathic effects of *Parthenium* on *Crotolaria* and *Mimosa* seeds may be responsible for the inhibitory effect on seed germination behaviour and seed metabolism.

Materials and Methods

Fresh, mature and healthy leaves (100 g) of *Parthenium* hysterophorus L. (Fam. Asteraceae), collected from Vidyasagar University campus, Paschim Medinipur were thoroughly homogenized using 75 ml distilled water. The homogenate was sieved through a fine cloth and then centrifuged at 5000 g thrice for 15 minutes each. The supernatant was then made up to 100 ml using distilled water and this was considered as 1:1 (w/v) proportion stock solution of leaf extract. From this stock solution another concentration of 1:2 (w/v) was prepared using distilled water. And this was taken as the two gradation leaf extract solutions. Another lot of fresh 100 g leaf samples of the *Parthenium* was immersed in 75 ml distilled water for 48 hrs and the leachate was decanted in a separate beaker. The total volume of the leachate was then made up to 100 ml using distilled water and this was taken as the 1:1 (w/v) proportion of leaf leachate. From this stock solution another concentration of 1:2 (w/v) was prepared using distilled water. And this was taken as the two gradation leaf leachate solutions.

Five lots of 10 g each of fully viable *Crotolaria* and *Mimosa* seeds were surface sterilized with 0.1% $HgCl_2$ solution for 90 seconds. The seed lots were then separately presoaked in the two concentrations of leaf extracts or leaf leachates for 24 h. Then these seeds were used for various biochemical tests. Data on seed germination (%), TTC—stainability, T_{50} values, speed of germination, activities of catalase and dehydrogenase enzymes in seeds were recorded.

To analyse percentage germination and T_{50} value from treatment sets, three groups of 100 fresh seeds (i.e. 300 fresh seeds) were transferred to separate Petri dish (10 cm diameter) containing filter paper moistened with 10 ml each of leaf extracts or leachates and distilled water for control. Germination (%) was recorded after 24 h of seed soaking following the International Rules of Seed Testing (ISTA, 1976). Speed of germination according to Halder (1981) was analysed at 24 hour intervals.

For analysing TTC-stainability, three hundred seed samples of de-husked *Crotolaria* and *Mimosa* seeds were allowed to imbibe in 8 ml 0.5% TTC (2,3,5- triphenyl tetrazolium chloride) solution (w/v) in Petri dishes for 24 h in dark condition. Percentage TTC-staining was recorded taking samples from the embryonal axes of *Crotolaria* and *Mimosa* seeds.

Extraction estimation of the enzyme catalase was done as per the method described by Snell and Snell (1971) modified by Biswas md Choudhuri (1978). For the assay of these enzymes the blank was taken as zero time control. Statistical analysis of the data was done in terms of least significant difference (LSD) which was calculated at 95% confidence limits (Panse and Sukhatme, 1967).

Results

Effect on germination percentage, T_{50} values and TTC-stainability (Table-I): Data clearly revealed that percentage germination of *Crotolaria Mimosa* seeds were strongly inhibited by continuous treatment with two concentrations of leaf extracts and leaf leachates of *Parthenium.* The effect of *Parthenium* leaf extracts was found more inhibitory than that of leaf leachates, and the data shows that the more concentrated extracts were more injurious. On the other hand in treated seeds, time (hrs) required for 50% germination was noted significantly high than control. The leaf extract and leaf leachate treated seed couldnot attain 50% germination. Treatments of the *Crotolaria* and *Mimosa* seeds with leaf extracts and leaf leachates of all types could alter gross TTC-stainability of the seeds. Here, both leaf extracts

and leachates of *Parthenium* significantly decreased the percentage of seed staining, which also clearly established the allelopathic potentiality of *Parthenium*.

Effect on speed of germination (Table-2): Data showed that in control samples, percentage germination of *Crotolaria* and *Mimosa* seeds increase in the advancement of the germination period as recorded from 24 to 168 hrs. However, both leaf extracts and leaf leachates of all concentrations of *Parthenium* rendered inhibition of speed of germination during the observation period recorded at 24 hours intervals.

Effect on changes of catalase and dehydrogenase (Table-3): Activities of both the enzymes were seriously impaired in seed samples irrespective of treatments with two concentration of leaf extracts and leaf leachates of *Parthenium*.

Table - 1. Effect of seed pretreatment with fresh leaf extracts (LE) and fresh leaf leachates (LL) of *Parthenium* on percentage germination, time (hrs) to 50% germination (T_{50}) and TTC stainability of *Crotolaria* and *Mimosa* seeds.

Treatments	**Germination %**		**T_{50} germination**		**TTC stainability**	
	Crotolaria	***Mimosa***	***Crotolaria***	***Mimosa***	***Crotolaria***	***Mimosa***
LE (1:1)	0	10.53	NA	NA	66.2	72.1
LE (1:2)	11.31	18.21	NA	NA	73.6	80.2
LL (1:1)	21.43	31.55	NA	NA	80.3	87.7
LL (1:2)	28.57	42	NA	NA	89.5	93.8
Control	100	100	35.37	16.29	100	100
LSD (P=0.05)	1.25	1.1	NC	NC	5.32	6.01

NC: Not calculated

Table - 2. Effect of seed pretreatment with fresh leaf extracts (LE) and fresh leaf leachates (LL) of *Parthenium* on speed of germination of *Crotolaria* and *Mimosa*

Treatments	**Speed of germination after (in hrs)**	
	Crotolaria	***Mimosa***

	24	**48**	**72**	**96**	**120**	**144**	**168**	**24**	**48**	**72**	**96**	**120**	**144**	**168**
LE (1:1)	0	0	0	0	0	0	0	0	0	2.1	6.3	8.2	10.5	10.5
LE (1:2)	0	1.3	5.6	8.9	10.2	11.3	11.3	0	1.7	4.2	7.4	13.5	18.2	18.2
LL (1:1)	1.2	7.1	12.1	16.5	18.2	21.4	21.4	0	9.2	11.8	18	25.6	31.5	31.5
LL (1:2)	3.5	14.2	21.4	23.5	25.5	28.5	28.5	6.5	15.7	15.7	21	42	42	42
Control	28.5	67.8	89.2	100	100	100	100	73.6	78.9	84.2	88	100	100	100
LSD (P=0.05)	0.13	0.15	0.67	0.91	1.03	1.14	1.14	0.71	0.18	0.22	0.65	0.87	1.1	1.1

Table - 3. Effect of seed pretreatment with fresh leaf extracts (LE) and fresh leaf leachates (LL) of *Parthenium* on catalase and dehydrogenase activities in kernels of *Crotolaria* and *Mimosa* seeds.

Treatments	**Catalase (unit/hr/g wet wt)**		**Dehydrogenase (ΔOD/100 seeds/3 ml)**	
	Crotolaria	***Mimosa***	***Crotolaria***	***Mimosa***
LE (1:1)	49.05	40.5	0.23	0.12
LE (1:2)	75.21	72.65	0.29	0.17
LL (1:1)	83.94	92.24	0.34	0.24
LL (1:2)	92.45	100.37	0.4	0.32
Control	130.21	108.56	0.48	0.41
LSD (P=0.05)	5.01	4.13	0.03	0.02

Fig 1: TTC-staining pattern of *Crotolaria* seeds pretreated with fresh leaf extracts (LE) and leaf leachates (LL) of *Parthenium*

Fig 2: TTC-staining pattern of *Mimosa* seeds pretreated fresh leaf extracts (LE) and leaf leachates (LL) of *Parthenium*

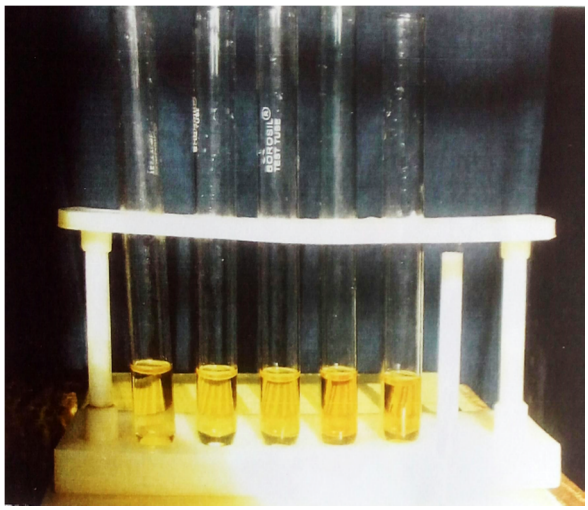

Fig 3: Photograph showing different intensity or GOLDEN YELLOW colour for CATALASE in different treatments of fresh leaf extracts and leaf leachates of *Parthenium* on *Crotolaria* seeds

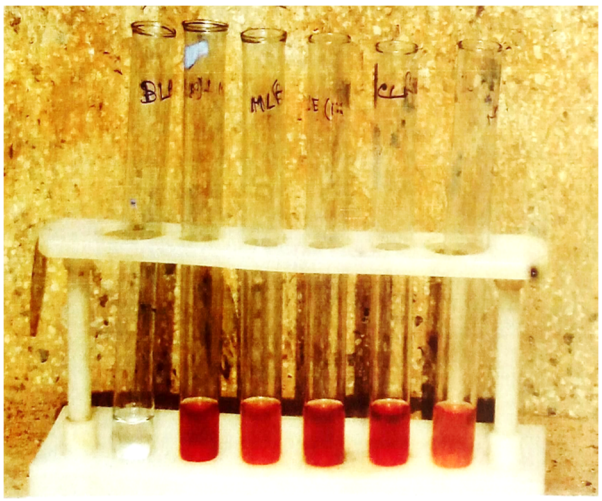

Fig 4: Photograph showing different intensity of RED colour for DEHYDROGENASE in different treatments of fresh - leaf extracts and leaf leachates of *Parthenium* on *Mimosa* seeds

Discussion

The present study shows that fresh leaf extracts and leaf leachates of Parhtenium hysterophorus strongly inhibited the germination and TTC-stainability and enhanced T_{50} hours (Table-I) of *Crotolaria* and *Mimosa* seeds. The allelochemicals of *Parthenium* extremely slowed down the speed of germination (Table-2) as well as catalase and dehydrogenase activities (Table-3).

Analysis of germination behaviour is considered to be a reliable index of evaluation of allelopathic action (Bhattacharjee et al., 2001; Datta and Chakraborty, 1982; Ghosh, 1979; Nayek et al., 2004; Bhattacharjee et al, 2003). Reduced germinability and TTC-stainability, slower rate of germination are important effects of allelopathic action of plants and such action is chiefly exerted by a number of inhibitors of chemical nature (Ghosh and Dutta, 1989).

Various inhibitors present in plants having allelopathic property reduced the overall metabolism of plants or plant parts are reported to be strongly impaired (Nayek, 2000; Datta

and Chakraborti, 1982). Results, therefore, point out that both leaf extracts and leaf leachates of *Parthenium* possesses some chemicals which efficiently rendered allelopathic action on *Crotolaria* and *Mimosa* seeds.

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