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Allelopathic Effect of Selected Weeds on Biochemical Activity of *Parthenium hysterophorus*

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Abstract: In order to assess the magnitude of suppressing capabilities of *Cassia occidentalis, Rumex dentatus, Calotropis procera and Withania somnifera* on *Parthenium hysterophorus* a laboratory study was conducted to evaluate the synergistic effect of 3rd and 9th d aqueous shoot leachates of above mentioned weeds on biochemical activities (chlorophyll, nitrogen percentage, protein percentage) and mortality percentage of *Parthenium hysterophorus*. It is evident from the present results that treatment having 100%, 9th d aqueous shoot leachates of *Cassia* has the potential to reduce the level of biochemical activities and increase the mortality to a great extent, which was followed by *Rumex dentatus*. Their toxicity exhibited period and dose dependent pattern. The demonstrated bioactivity may be attributed to phenolic compounds present in *Cassia*. *Cassia* may offer an alternative tool for the control of *Parthenium* in India.

Key words: Allelopathy, botanic agents, carrot weed, chlorophyll, mortality

INTRODUCTION

In the recent years, creating competition between native and alien species has gained momentum. Numerous plants are reported to possess allelopathic potential and effort has been made to use them in weed control. *Parthenium hysterophorus* L. or carrot weed, is an annual member of the tribe Heliantheae of the family Asteraceae is commonly known as *Parthenium* weed in Australia and Congress grass in India, where the flower shape has been fancifully compared to the Congress building in New Delhi. It is a poisonous, pernicious and aggressive weed, posing a serious threat to human beings and livestock. There has been an epidemic of hundreds of cases of *Parthenium* weed dermatitis in India. Several cases have been reported from USA by Subba *et al*. (1977) and Towers (1981). Several methods have been recommended to suppress its growth but none appears to have worked satisfactorily as each suffers from one or more limitations such as inefficacy, prohibitive cost, impractibility, pollution of environment and only limited relief. Therefore, an allelopathic (biochemical interaction) approach has been tried under this investigation for management of *Parthenium* weed.

Studies were undertaken to evaluate the allelopathic potential of all the selected botanic agents on *Parthenium hysterophorus in vitro*, and also to find out if any allelopathic component is involved to substantiate the visual observation and if so, are the selected botanic agents sufficient enough to replace *Parthenium* in the nature in the long run or it needs further human effort to help from spreading this weed in nature with minimum effort to replace it.

MATERIALS AND METHODS

This study was conducted during 2008-2009 in Botany Department, St. John's College, Agra.

Tested material: Plant species, *Cassia occidentalis*, *Rumex dentatus*, *Calotropis procera* and *Withania somnifera* were collected from Namner region, UP West India and *Parthenium hysterophorus* from Dayalbagh region of Agra district. These plant materials were carefully examined for identification by the Herbarium at the Botany Department, St. John's College, Agra, India.

Preparation of aqueous leachates: The upper parts of shoots of *Cassia occidentalis, Rumex dentatus, Calotropis procera* and *Withania somnifera* were collected from the field. 100 g of shoots were soaked in 500 mL of double distilled water, each under aseptic conditions for 3 and 9 d and placed in conical flasks and kept under refrigeration at 8±1ºC. The aqueous leachates were filtered through three layers of muslin cloth/cheese cloth to remove debris. The filtrate was then refiltered through one layer of Whattman No. 1 filter paper. Leachates of 50 and 100% concentration were prepared with sterilized distilled water and used for bioassay.

Chlorophyll estimation: Chlorophyll content of *Parthenium hysterophorus* was estimated according to Arnon (1949). 40 mg (0.04 g) of *Parthenium* leaves were treated with 50 and 100% of shoot leachates of botanic agents for 72 h. After 72 h the treated *Parthenium* leaves were placed in black plastic bottles containing 10 ml of 80% acetone and then it was sealed with adhesive tape at

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its mouth so that acetone may not get evaporated and kept undisturbed in a refrigerator for 5-6 d at 8±1°C temperature. After 6 d optical density was recorded by spectrophotometer at different wavelength i.e. 480, 510, 630, 645, 652, and 665 nm.

Nitrogen estimation: Nitrogen was estimated by following the method of Snell and Snell (1955). 100 mg (0.1 g) of *Parthenium* leaves were treated with 50% and 100% of shoot leachates of botanic agents for 72 h. Then the treated *Parthenium* leaves were placed in 50 ml conical flask and mixed with 2 mL of conc. H_2SO_4 and then it was heated on hot plate at 40°C. When volume reduces to half of the original volume, 1.5 mL of 30% H_2O_2 was added. Then the solution was heated gently at 10-20°C till the clear extract was obtained. The content was then transferred in 100 mL volumetric flask and the volume was made up to the mark with distilled water. After preparation of acid extract of plant material, the nitrogen was estimated as follows - 1.0 mL of prepared acid extract from plant material was taken in 50 mL volumetric flask. To this 10 drops of 10% NaOH and 10 drops of 10% sodium silicate was added and the solution was diluted up to the mark. 1.0 ml of freshly prepared nesseler's reagent was added to the flask, the color intensity was measured by colorimeter after 15 min at transmittance of 420 nm using a reagent blank as reference. With the help of standard curve prepared with 100 ppm NH_4Cl solution the amount of N_2 in the sample was found out.

Protein estimation: The protein content in plant sample was calculated by multiplying percentage nitrogen content of plant sample by the factor of 6.25.

$$\text{Percentage of Protein} = \% \text{ of Nitrogen} \times 6.25$$

Mortality was determined according to Abbot Formula (El-Kamali, 2001):

$$\frac{\text{Treatment mortality \% - control mortality}}{\text{100- mortality \% control}}$$

Statistical analysis of the two-way factorial design used Analysis of variance, with the 5% level of significance.

RESULTS AND DISCUSSION

The chemical exudates from allelopathic plants are proposed to play a major role in the allelopathy mode of action. Evidence showed that a higher plant releases a diversity of allelochemicals into the environment, which includes phenolics, alkaloids, long-chain fatty acids terpenoids and flavanoids Rice (1984) and Chou (1995). Allelopathic effects of these compounds are often observed to occur early in the life cycle, causing inhibition of seed germination and/or seedling growth. The compounds exhibit a wide range of mechanisms of action, affect on DNA (alkaloids), photosynthetic and mitochondrial function (quinones), phytohormone activity, ion uptake and water balance (phenolics). Interpretations of mechanisms of action are complicated by the fact that individual compounds can have multiple phytotoxic effects (Einhellig, 2002). In the course of extensive survey carried out to assess the distribution of *Parthenium* in India in the years, 1987-1990 (Aneja *et al.*, 1991), it was observed that *Parthenium* does not grow in proximity of some plant species. This was suggestive of natural antagonism of these species to *Parthenium*. *Parthenium hysterophorus* has been chosen for this study. The criteria for studied *Parthenium* is (a).

It excludes all beneficial forage plants resulting in a monoculture of non-nutritious vegetable matter in which it is impossible to sustain cattle (b). The contact allergy can be developed from repeated contact with *Parthenium* weed or its disseminated parts and can be perpetuated in sensitized, such as trichomes.

Parthenium were found near crop plants of Dayalbagh region in Agra. *C. occidentalis*, *R. dentatus, C. procera* and *W. somnifera* which were growing in its vicinity were selected to investigate their leachates effect against *Parthenium*. Biochemical activities and mortality results of 3rd and 9th day aqueous shoot leachates of 50 and 100% concentration of selected weeds on *Parthenium* was expressed on Two-way ANOVA at 5% level of significance. The results of the toxicity of the investigated selected weeds on *Parthenium* are presented in Table 1 and 2.

The 100%, 9th day aqueous shoot leachates obtained from *Cassia* exhibited high toxic effects on biochemical activity against the target weed. Chlorophyll, nitrogen percentage and protein content was found to be 4.09, 0.28 and 3.75%, respectively whereas, in 100% 3rd day aqueous shoot leachates obtained from *Cassia* chlorophyll, nitrogen percentage and protein content was found to be 5.15, 0.60 and 6.87%, respectively (Table 1). The order of severity is *C. occidentalis*> *R. dentatus*> *C. procera*>*W. somnifera*. Similar results were obtained in mortality percentage (Table 2).

Mamatha and Mahadevappa (1988, 1992) based on their preliminary surveys have reported that *Cassia sericea, C. tora, Tephrosia purpurea* and *Croton bonplandianum* restricted *Parthenium* invasion in many states in India. Joshi and Mahadevappa (1986) reported that *Cassia occidentalis* has successfully displaced this weed in Dharwad and surrounding areas under natural course. Weeds like *Achyranthes aspera*, *Datura stramonium, Calotropis procera, Cassia occidentalis* etc., were commonly found in close vicinity at different sites, *C. occidentalis* was dominant cohabiting *Parthenium* successfully (Knox *et al.*, 2006).

Table 1: Effect of 3rd and 9th day aqueous shoot leachates of selected botanic agents on biochemical activity of *Parthenium hysterophorus* at 50 and 100% dose. The negative control group had distilled water. CD = critical difference at the 5% level of significance

		3rd day shoot leachates			9th day shoot leachates		
Botanic agents	Concentration (%)	Chlorophyll	Nitrogen (%)	Protein (%)	Chlorophyll	Nitrogen (%)	Protein (%)
Cassia	50	5.15±(0.1)	0.60±(0.0)	6.87±(0.4)	4.09±(0.0)	0.28±(0.0)	3.75±(0.1)
occidentalis	100	4.12±(0.0)	0.30±(0.0)	3.75±(0.3)	2.44±(0.1)	0.18±(0.0)	3.00±(0.1)
Rumex	50	11.95±(0.4)	1.97±(0.2)	15.47±(1.5)	10.67±(0.3)	1.05±(0.0)	14.00±(0.2)
dentatus	100	10.00±(0.0)	1.15±(0.0)	14.01±(0.4)	10.06±(0.0)	1.00±(0.0)	13.90±(0.3)
Calotropis	50	17.47±(0.2)	2.36±(0.1)	20.97±(0.8)	16.88±(0.2)	1.97±(0.0)	18.97±(0.2)
procera	100	16.77±(0.1)	2.00±(0.1)	19.05±(0.3)	15.22±(0.1)	1.08±(0.0)	17.95±(0.2)
Withania	50	23.46±(0.2)	5.30±(0.1)	30.18±(0.9)	21.12±(0.0)	4.00±(0.0)	20.62±(0.1)
somnifera	100	22.92±(0.4)	4.97±(0.4)	28.49±(3.0)	19.39±(0.0)	3.15±(0.0)	19.87±(0.4)
Control	-	29.52±(0.0)	6.51±(0.0)	43.12±(0.4)	29.42±(0.0)	6.40±(0.0)	43.00±(0.1)
CD (P = 0.05)	-	0.11	0.55	3.44	0.10	0.45	2.85

All the values are mean of six replications; Values in parenthesis are ± se (m)

Table 2: Effect of 3rd and 9th day aqueous shoot leachates of selected botanic agents on mortality of *Parthenium hysterophorus* at 50 and 100% dose. The negative control group had distilled water. CD = critical difference at the 5% level of significance

		3rd day shoot leachates	9th day shoot leachates
Botanic agents	Concentration (%)	Mortality (%)	Mortality (%)
Cassia occidentalis	50	14.80±(0.3)	25.02±(0.3)
	100	15.82±(0.1)	26.08±(0.0)
Rumex	50	13.97±(0.2)	24.36±(0.0)
dentatus	100	14.27±(0.0)	24.98±(0.0)
Calotropis	50	14.00±(0.5)	20.56±(0.0)
procera	100	14.20±(0.0)	21.22±(0.0)
Withania	50	13.00±(0.0)	17.86±(0.0)
somnifera	100	13.50±(0.2)	16.97±(0.0)
Control	-	5.00±(0.0)	5.00±(0.0)
CD (p = 0.05)	-	0.15	0.23

All the values are mean of six replications; Values in parenthesis are ± se (m)

It is evident from the present results that *C. occidentalis* has the potential to curb the population of *Parthenium*. Their toxic effect is period and dose dependent. These laboratory observations are found to be in conformity with the population pattern observed in fields, thus proving the concept of allelopathic or biomolecular interactions amongst the plant species as a natural replacement method.

CONCLUSION

This study concluded that the 100%, 9th day aqueous shoot leachates of *Cassia occidentalis* have significant activity against *Parthenium hysterophorus* and offers an alternative tool for the control of this obnoxious weed thus proving the concept of allelopathic or biomolecular interactions amongst the plant species as a natural replacement method.

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