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Studies on Allelopathic Effects of *Ageratina adenophora* Sprengel (King and Robinson) on Some Weed Plants Growing in Forest Ecosystem

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ABSTRACT: Invasion of an eco-system by the alien species has now taken serious dimensions all across the world and ever growing menace of it is posing serious threats even to the conservation and sustainable utilization of biodiversity along-with significant impacts on the services provided by the dynamic forest ecosystem. Present study hence, was conducted to assess and evaluate the allelopathic potential of *Ageratina adenophora* -one of the fast spreading invasive species- on the seedling growth and dry weight of test weed plants like *Biden's pilosa* L. and *Cassia occidentalis* L. growing in its association in a forest eco-system. Aqueous extracts of leaf, shoot and root of *A. adenophora* having concentrations 0.5, 1.0, 2.0 and 4.0 per cent were used for determining their cumulative effect on these test plants under laboratory conditions. All the concentrations of these extracts used during the study showed inhibitory effects both on the seedling growth and dry weight of the test species which further increased with the increasing level of concentrations. Aqueous extract of the leaves showed maximum inhibition whereas, the least effect was recorded in case of root extracts.

Key words: Allelopathy, Aqueous extract, *Ageratina adenophora*, *Bidens pilosa*, *Cassia occidentalis.*

I. INTRODUCTION

Invasion by the alien species in any of the ecosystem is not only unfriendly to its functioning but also poses a myriad of problems further compounding the issues of ecological significance. These alien species also act as a continuous source of allelo-chemicals in the area they invade and because of this, some abnormalities in the normal behavior are bound to come finally leading to the undesired changes in the response of a particular eco-systems. In the process, plants native to that habitat those do not possess co-evolved defence strategies against these exotic novel chemicals may become susceptible to their inhibitory effects. This phenomenon then gives the exotic species a competitive advantage over for their successful establishment on the native flora in the invaded area [1-5]. *Ageratina adenophora* is one such exotic species belonging to family Asteraceae which is now successfully invading a large portions of the forest eco-system in North-western Himalaya region in India including the hills of Himachal Pradesh [6].

Ageratina adenophora- a species native to tropical America is considered to be a serious weed especially in the rangelands where it often replaces either the more-desirable vegetation or the native species growing around [7] and also in forests [8].

This species has recently drawn worldwide attention for its ever increasing potential to grow in the diverse habitats. Its invasion reduces growth of nearby vegetation by releasing allelopathic compounds [9] as also indicated in the earlier paras. Accordingly, the study was undertaken with a view to assess the allelopathic influence of *A. adenophora* on the seedling growth of some weed plants growing in the forest eco-system.

II. MATERIAL AND METHOD

A. Collection of plant material: Few fresh plants of *A. adenophora* were collected as such from Kansar area (30° $33'$ N and 77° $29'$ E) falling in Girinagar forest range of Paonta Sahib Forest division, Himachal Pradesh, India and were brought to the laboratory for further processing. Each part of these plants (leaves, shoot and root) were cut separately into small pieces, shade dried, grounded with the help of electronic grinder and made to fine powder. The material thereafter was further sieved through 2mm pore size mesh for subsequent analyses.

Seeds of test plants viz., *B. pilosa* and *C. occidentalis* were also collected from the same/adjoining infested area and were surface sterilized in the laboratory conditions.

B. Preparation of aqueous extract: For preparation of aqueous extract from the experimental material thus collected and processed, 4 gm samples of this powdered material obtained after crushing the leaves, shoots and roots, of the species were soaked separately in 100 ml of distilled water and the glass beakers were then kept as such at room temperature for 24 hours. Thereafter, the aqueous extracts were filtered through a muslin cloth followed by the filtration through Whatmann Filter paper number 1 and were further diluted to make concentration of 0.5,1,2 and 4 per cent [10].

C. Laboratory bioassay: Seeds of *B. pilosa* and *C. occidentalis*- being used as test plants for carrying out the laboratory studies- were soaked in distilled water for 24 hrs for imbibitions before starting the germination trial.

Twelve seeds of *B. pilosa* and *C. occidentalis* each were separately placed on whatmann filter paper number 1 in sterile Petri dishes (9cm dia) and were covered with glass coverings. 10ml aqueous extract of a particular concentration was added to each of the Petri - dishes as per the treatment and distilled water was used as a control. There were 15 treatments having four concentration levels (0, 0.5, 1, 2 and 4 per cent) of each leaf, shoot and root extracts.

The experiment was conducted in the laboratory at room temperature for eight days with 12 hrs supply of fluorescent light during the night. Required moisturizing of the filter papers with the appropriate extracts was ensured during experimentation and all the experiment were repeated twice.

D. Physical parameters: At the end of each of the experiment *i.e.* after eight days, the seedling growth of the test plants was measured by using a centimeter scale and dry weight of seedling was determined with the help of 4 digit digital balance.

E. Statistical Analysis: Three replications were maintained and Completely Randomized Design (CRD) was followed for statistical analysis (11). The data were subjected to analysis of variance (ANOVA) at $p<0.05$ was statistically analyzed using SPSS version 16. Response Index (RI) was calculated using the formula [12] to observe the magnitude *of* inhibition versus stimulation by various leachates on, seedling growth and dry weight.

III. RESULTS

A. Plumule length: Response index (RI) of plumule growth in all the leachate concentrations prepared by using all the plant parts has been presented in Table 1, Fig. 1. Significant decline in the plumule lengths of *B. pilosa* and *C. occidentalis* was recorded in all the concentrations of aqueous extracts when compared with the control. Treatments used with reference to all the plant parts also showed the similar pattern. Leaf extract with 4 per cent concentration registered the maximum reduction (59.87%) of plumule length in *B. pilosa* followed by 56.34% in case of shoot extract of this test species with the same concentration. Minimum values of per cent reduction over the control were however, recorded 9.03 and 11.44 in *B. pilosa* and *C. occidentalis* respectively when treated with the 5 per cent root extract of *A. adenophora*.

Table 1. Effect of different per cent concentration of leachates obtained from different plant parts of *A. adenophora* on the plumule length (cms) of *Bidens pilosa* and *Cassia occidentalis.*

Leachate	Leaf Extract		Shoot Extract		Root Extract	
Concentrations (per cent)	***B. pilosa***	***C. occidentalis***	***B. pilosa***	***C. occidentalis***	***B. pilosa***	***C. occidentalis***
Plumule length (cm)						
Control	3.24 ± 0.15	3.58 ± 0.16	4.10 ± 0.10	6.98±0.09	4.87 ± 0.26	5.94 ± 0.26
0.5	2.63 ± 0.15 (18.82)	2.79 ± 0.09 (22.06)	3.40 ± 0.12 (17.07)	5.80±0.13 (16.90)	4.43 ± 0.20 (9.03)	5.26 ± 0.33 (11.44)
1	2.21 ± 0.10 (31.79)	2.41 ± 0.08 (32.68)	2.92 ± 0.13 (28.78)	4.70±0.14 (32.66)	4.22 ± 0.19 (13.34)	4.85 ± 0.21 (18.35)
2	1.79 ± 0.10 (44.75)	2.13 ± 0.10 (40.50)	2.58 ± 0.11 (37.07)	4.26±0.12 (38.96)	3.83 ± 0.21 (21.35)	4.65 ± 0.16 (21.71)
4	1.30 ± 0.10 (59.87)	1.63 ± 0.08 (54.46)	1.79 ± 0.10 (56.34)	3.38±0.10 (51.57)	3.01 ± 0.16 (38.19)	3.75 ± 0.13 (36.86)

Figures in parenthesis indicate per cent reduction over control

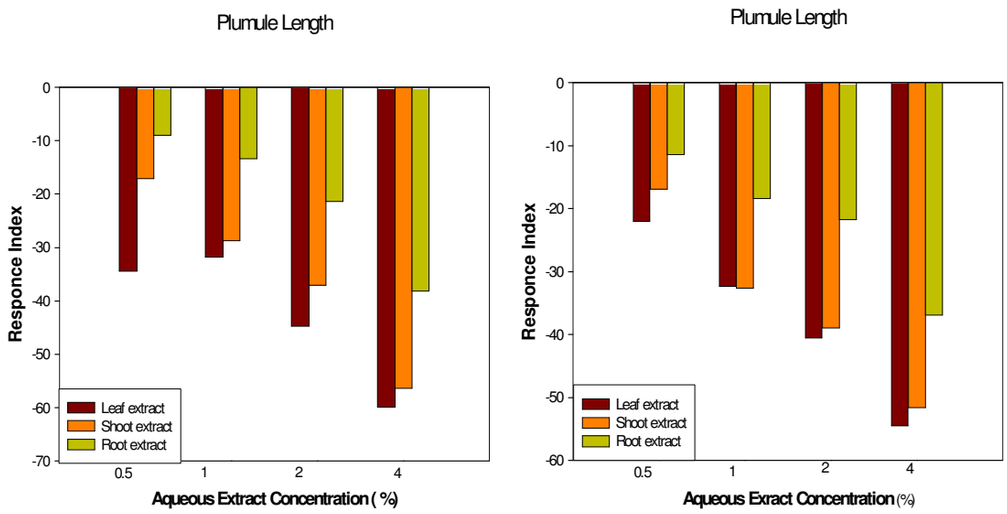

Fig. 1. Effect of different per cent concentration of leachates obtained from different plant parts of *A. adenophora* on Plumule length of *Bidens pilosa* and *Cassia.*

B. Radicle length

On the similar lines, a significant effect on the growth of radicle length of *B. pilosa* and *C. occidentalis* was observed when seeds were treated with aqueous extracts of *A. adenophora* when compared to the respective controls (Table 2, Fig. 2). The inhibitory effect of leachate concentrations of all the category of plant component used increased with the increase in concentrations thereby, hinting at the toxic effects of leachates even on the radicle growth. Maximum reduction in the radicle length over control was recorded in *B. pilosa* 91.25% in 4 per cent leaf aqueous extract treatments followed by reduction per cent value of (76.73%) in case of shoot extract in the same species and having the same concentration. All the concentrations as obtained from the root extracts of *A. adenophora* showed their least effect thereby having the least values.

Table 2. Effect of different per cent concentration of leachates obtained from different plant parts of *A.adenophora* on the radicle length (cms) of *Bidens pilosa* and *Cassia occidentalis.*

Leachate	**Leaf Extract**		**Shoot Extract**		**Root Extract**	
Concentration (per cent)	***B. pilosa***	***C. occidentalis***	***B. pilosa***	***C.occidentalis***	***B.pilosa***	***C. occidentalis***
Radicle length (cm)						
Control	3.43 ± 0.25	2.54 ± 0.05	3.31 ± 0.18	3.12±0.09	2.98 ± 0.19	2.97± 0.18
0.5	2.25 ± 0.20 (34.40)	2.01 ± 0.10 (20.86)	2.50 ± 0.12 (24.47)	2.69±0.13 (13.78)	2.62 ± 0.18 (12.08)	2.52 ± .16 (15.15)
1	1.67 ± 0.18 (51.31)	1.61 ± 0.06 (36.61)	2.30 ± 0.12 (30.51)	2.19±0.14 (29.80)	2.14 ± 0.15 (28.18)	2.24 ± 0.18 (24.57)
2	1.19 ± 0.08 (65.30)	1.24 ± 0.11 (51.18)	1.62 ± 0.11 (51.05)	2.18±0.12 (30.12)	2.03 ± 0.15 (31.87)	2.19 ± 0.09 (26.26)
4	0.30 ± 0.10 (91.25)	0.71 ± 0.05 (72.04)	0.77 ± 0.10 (76.73)	1.64±0.10 (47.43)	1.52 ± 0.12 (48.99)	2.02 ±0.08 (31.98)

Figures in parenthesis indicate per cent reduction over control

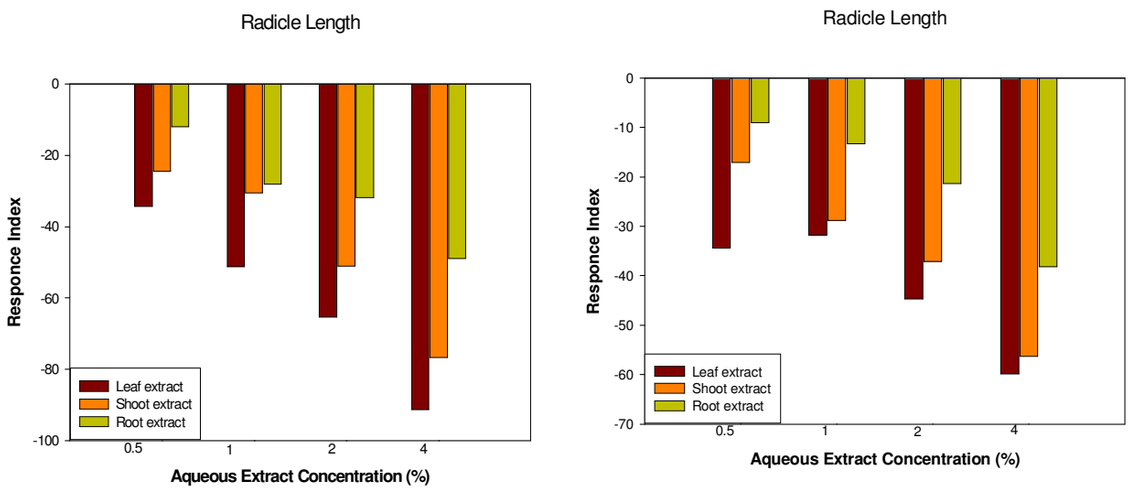

Fig. 2. Effect of different per cent concentration of leachates obtained from different plant parts of *A. adenophora* on radicle length of *Bidens pilosa* and *Cassia occidentalis*

C. Seedling Dry weight

The dry weight of seedlings of test species also recorded in the same fashion with increasing concentration of leachates. The RI of dry weight of seedlings in all the leachate concentrations is presented in Table 3. In case of dry weight of the seedlings *B. pilosa* (53.57%) showed maximum reduction in case of leaf aqueous extract of 4 per cent concentration followed by shoot (48.24%) and root (28.57%) aqueous extracts of the same concentration when compared with the control (Table 3, Fig. 3). It was seen that, *C. occidentalis* showed less reduction as compared to *B. pilosa* in all the treatments.

In majority of these treatments, maximum reduction was observed in case of *B. pilosa* as compared to *C. occidentalis*. The inhibitory effect was found to be concentration dependent and amongst the different plant parts of *A. adenophora*, Leaves showed the most allelopathic influence followed by shoot and root parts.

Table 3. Effect of different per cent concentration of leachates obtained from different plant parts of *A. adenophora* on the seedling dry weight of *Bidens pilosa* and *Cassia occidentalis*.

	Leaf Extract		**Shoot Extract**		**Root Extract**	
Concentration (per cent)	***B. pilosa***	***C. occidentalis***	***B. pilosa***	***C. occidentalis***	***B. pilosa***	***C. occidentalis***
Dry Weight (mg)						
Control	0.84 ± 0.12	6.36±0.09	1.14 ± 0.04	10.91 ± 0.40	0.84 ± 0.01	7.76 ± 0.11
0.5%	0.59 ± 0.008 (29.76)	5.44±0.15 (14.46)	0.96 ± 0.01 (15.78)	9.86 ± 0.48 (9.62)	0.84 ± 0.01 (0)	7.46 ± 0.09 (3.86)
1%	0.53 ± 0.003 (36.90)	5.10±0.12 (19.81)	0.92 ± 0.01 (19.29)	8..98 ± 0.51 (17.69)	0.72 ± 0.005 (14.28)	7.40 ± 0.06 (4.63)
2%	0.51 ± 0.003 (39.28)	4.05±0.10 (36.32)	0.86 ± 0.01 (24.56)	7.35 ± 0.89 (32.63)	0.72 ± 0.005 (14.28)	7.06 ± 0.05 (9.02)
4%	0.39 ± 0.006 (53.57)	3.80±0.12 (40.25)	0.59 ± 0.02 (48.24)	6.73 ± 0.58 (38.31)	0.60 ± 0.002 (28.57)	6.98 ± 0.14 (10.05)

Figures in parenthesis indicate per cent reduction over control

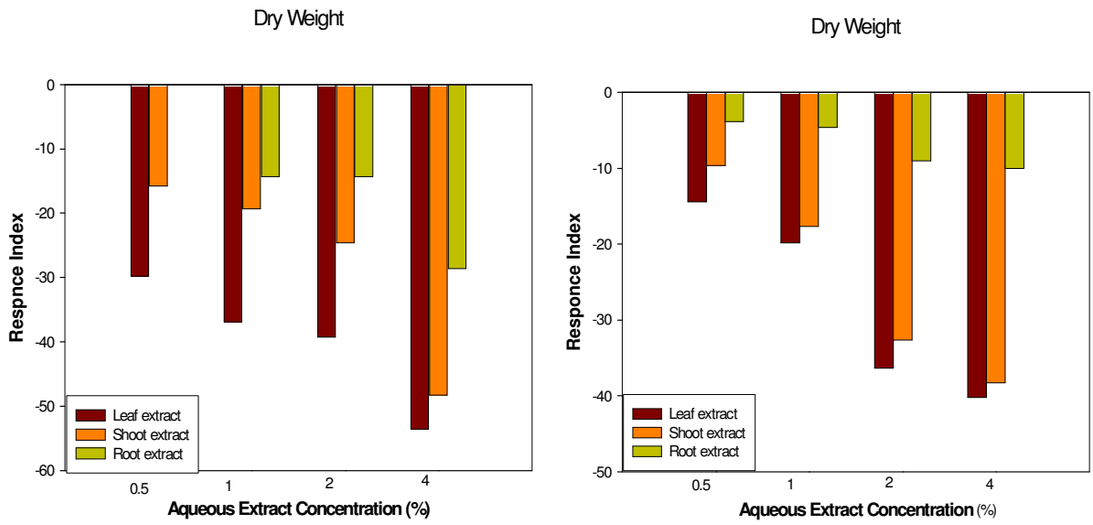

Fig. 3. Effect of different per cent concentration of leachates obtained from different plant parts of *A.adenophora* on dry weight of (a) *Bidens pilosa* and (b) *Cassia occidentalis*.

IV. DISCUSSION

The study clearly indicates that various extracts of *A. adenophora* exhibit allelopathic effects on seedling growth of *B. pilosa* and *C. occidentalis*- the test species used in the present case. The application of these extracts severely affected the growth of emerging radicle and plumule. Amongst the test crops, *C. occidentalis* with larger seeds was found to be less sensitive to the applications of *A. adenophora* when compared to the seeds of *B. pilosa*. This observation is in conformity to the earlier findings of the authors [13] who concluded that seed size is an important factor since, species with small seeds had been affected more adversely. In addition, it was also observed that the inhibition of seedling growth is concentration dependent and more inhibition was observed at higher level of concentrations in all the treatments. These results when correlated with the earlier reports further strengthens the findings that allelopathy is a concentration-dependent phenomenon and includes both stimulatory and inhibitory activities [14-16]. Maximum reduction was recorded in the radicle length in both the test plants in all the aqueous extracts of *A. adenophora,* which may be due to the direct contact of roots with the leachates. These findings are in accordance with the earlier conclusion of authors [17-19], where root growth was found more sensitive and responding more strongly to the increasing concentration of the aqueous extracts.

A significant reduction in the radicle length, plumule length and dry weight of seedlings was recorded in response to all the aqueous extracts, but maximum reduction was seen in case of leaf extract. It may be because of the fact that the foliar leachates have been regarded as the most phyto-toxic in nature probably owing to their proportionately greater biomass and with greater metabolic activity or production of more metabolites [20]. Present findings are in close conformity to the earlier observations of different groups of workers who have reported that *A. adenophora* contains a large amount of allelo-chemicals especially in the leaves, which inhibit the growth of many plants in nurseries and plantations [21-24]. Previous authors [25-26] also recorded that allelo-chemicals released into the surrounding might inhibit or retard root or radicle and shoot or coleoptile of plants.

V. CONCLUSION

The present study provides the evidence of allelopathic potential of *A. adenophora* on *B. pilosa* and *C. occidentalis* The allelopathic activity of plant extracts is mainly due to the various phyto-toxic compounds present in the extracts which may independently or jointly contribute towards the plant growth regulatory effect .Further investigations are essentially required to identify the active compounds of the extracts responsible for this activity.

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