

Allelopathic Interaction among *Parthenium hysterophorus* Linn., *Cassia tora* Linn. and *Croton bonplandianum* Bail

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(Received: February 03, 2011; Accepted: March 14, 2011)

ABSTRACT

Allelopathic effects of roots, stems and leaves extract of *Parthenium hysterophorus* on the seed germination of *Cassia tora* and *Croton bonplandianum* and vice-versa have been worked out. The extracts of *Cassia* and *Croton* significantly suppressed the germination of *P. hysterophorus*. Increase in extract concentration promoted the inhibitory potential.

Key words: Allelopathy, Interaction, *Parthenium hysterophorus*, *Cassia tora*, *Croton bonplandianum*.

INTRODUCTION

Weeds have general purpose genotypes. They decrease crop yields primarily by competing for light, water and nutrients. They influence the growth of associated plants through root exudates, leachates and competition for growth resources (Sundaramoorthy and Sen, 1990). There are different control mechanisms of weeds. The chemical herbicides are effective in controlling weeds, yet risks are involved in their usage. Due to increased awareness about the risks, nowadays there is much emphasis to search for alternative methods of weed control. In this connection, allelopathy has been recognized as a natural weed control approach (Rice, 1984; Narwal, 1994; Akhtar *et al.*, 2001; Khan *et al.*, 2006).

Within last decade *Parthenium hysterophorus* Linn. has become one of the most dreaded weeds of the world (Trivedi *et al.*, 1991). This weed of Asteraceae family is a native of West Indies and Middle and North America. This has been spreading very rapidly in our whole India. The reason

of its rapid growth all around is its achenial fruit which disperses along with air very far off because of its special structure. It is now invader in crop fields also. The day is not far when it will occupy our fertile lands and will compete with our native crops. *Cassia tora* is a dominant weed of family Caesalpiniaceae during rainy season and loves shade. It was introduced originally from Tropical America and is a very common all over the study area (Patna and Vaishali) along roadsides and in wastelands. *Croton bonplandianum* belongs to family Euphorbiaceae and is found as ruderals on roadsides and canals.

In India, 4-7% of human population suffers from clinical symptoms associated with *Parthenium hysterophorus* (Shelke, 1984; Towers and Subba Rao, 1992). Reports are there for replacement of *Parthenium* through the use of other plants like *Cassia* species, *Croton bonplandianum* and others (Joshi, 1991). In this context, this study was undertaken to unravel the competitive aggressiveness of *Parthenium hysterophorus* vis-à-vis *Cassia tora* and *Croton bonplandianum* in terms of germination and radicle length.

MATERIAL AND METHODS

The materials for present investigation are *Parthenium hysterophorus*, *Cassia tora* and *Croton bonplandianum* and were locally collected from Patna. Leaves, stems and roots of all three species were used for judging allelopathic potential among themselves. They were chopped into small pieces and crushed in distilled water to get mother solution. From mother solution, desired aqueous concentrations 0.5%, 1%, 2%, 3% and 4% were prepared by dilution with distilled water. The pH of different concentrations of leaf extract of *Parthenium hysterophorus* ranged from 6 – 7.0, stem extract from 5 – 6.0 and root extract from 5 – 5.5. In *Croton bonplandianum* the pH of leaf and stem extract ranged from 6 – 7.0 and root extract from 5 – 5.5. The pH of different concentrations of leaf and stem extract of *Cassia tora* ranged from 5 – 5.5 while root extract 5.0. Now for germination and radicle growth, 25 seeds (mechanically scarified in *Cassia tora* and *Croton bonplandianum*) of species concerned were taken and surface sterilized by 0.2% HgCl₂. Seeds were finally put in petridishes

on filter paper backed with cotton wool and were moistened with extracts of desired concentrations. The treatment was replicated thrice. A separate control was also maintained. The petridishes were kept in diffuse light and at temperature 26 ± 3°C. At the end of the experiment, percentage germination and radicle length were recorded and analysed statistically.

The experiments were done in the Departmental laboratory of Botany, Patna University.

RESULTS AND DISCUSSION

The mean weight of the fresh 100 seeds was 0.11 gm in *Parthenium hysterophorus*, 0.73 gm in *Croton bonplandianum* and 1.55 gm in *Cassia tora*.

The initiation period for germination was 2 days in *Parthenium*, 3 days in *Cassia tora* and 11 days in *Croton bonplandianum*. The percentage germination was highest in *Parthenium hysterophorus* (Table 1).

Table 1 : Germination percentage of freshly harvested seeds

Species	Initiation Period (days)	Rate of Germination % per 24 h	Percentage Germination ± S.E.
<i>Cassia tora</i> Linn.	3	3.75	84±2.31
<i>Croton bonplandianum</i> Baill.	11	4.95	88±2.31
<i>Parthenium hysterophorus</i> Linn.	2	10.55	97.33±3.08

Table 2: Effect of aqueous leaf, stem and root extract of *Parthenium hysterophorus* on *Cassia tora*

Concentration	Aqueous leaf extract of <i>Parthenium</i> on <i>Cassia</i>		Aqueous stem extract of <i>Parthenium</i> on <i>Cassia</i>		Aqueous root extract of <i>Parthenium</i> on <i>Cassia</i>	
	% germination	Mean length of radicle in cm.	% germination	Mean length of radicle in cm.	% germination	Mean length of radicle in cm.
Control	84±2.31	4.49±0.22	84±2.31	4.49±0.22	84±2.31	4.49±0.22
0.5%	76±2.31	3.92±0.22	78.67±2.67	4.2±0.15	78.67±3.53	4.18±0.20
1%	78.67±1.33	3.77±0.38	82.67±3.53	3.77±0.15	74.67±3.53	3.85±0.22
2%	74.67±1.33	3.5±0.17	81.33±1.33	4±0.43	76±2.31	3.42±0.60
3%	82.67±1.33	3.58±0.55	74.67±3.53	3.75±0.30	81.33±1.33	4.02±0.64
4%	73.33±1.34	3.5±0.58	78.67±1.33	4.29±0.41	74.67±3.53	3.83±0.22

Table 3: Effect of aqueous leaf, stem and root extract of *Parthenium hysterophorus* on *Croton bonplandianum*

Concentration	Aqueous leaf extract of <i>Parthenium</i> on <i>Croton</i>		Aqueous stem extract of <i>Parthenium</i> on <i>Croton</i>		Aqueous root extract of <i>Parthenium</i> on <i>Croton</i>	
	% germination	Mean length of radicle in cm.	% germination	Mean length of radicle in cm.	% germination	Mean length of radicle in cm.
Control	88±2.31	2.75±0.29	88±2.31	2.75±0.29	88±2.31	2.75±0.29
0.5%	73.33±7.06	2.75±0.25	86.67±1.33	2.77±0.42	81.33±4.81	2.5±0.29
1%	84±2.31	2.42±0.16	78.67±3.53	2.82±0.20	76±1.2.31	2.75±0.14
2%	73.33±4.81	2.75±0.43	77.33±2.67	2.35±0.18	73.33±3.53	2.42±0.16
3%	82.67±1.33	2.77±0.42	82.67±1.33	2.77±0.17	74.67±4.81	2±0.43
4%	72±2.31	2.42±0.46	74.67±2.67	2.75±0.14	70.67±1.33	2.42±0.36

Table 4: Effect of aqueous leaf, stem and root extract of *Cassia tora* on *Parthenium hysterophorus*

Concentration	Aqueous leaf extract of <i>Cassia</i> on <i>Parthenium</i>		Aqueous stem extract of <i>Cassia</i> on <i>Parthenium</i>		Aqueous root extract of <i>Cassia</i> on <i>Parthenium</i>	
	% germination	Mean length of radicle in cm.	% germination	Mean length of radicle in cm.	% germination	Mean length of radicle in cm.
Control	97.33±3.08	2.63±0.09	97.33± 3.08	2.63± 0.09	97.33±3.08	2.63±0.09
0.5%	56±2.31	1.73±0.15	57.33±1.33	1.83 ±0.09	53.33±1.33	1.77±0.15
1%	54.67±3.53	1.37±0.09	54.67 ±1.89	1.53 ±0.04	56±2.31	1.5±0.17
2%	49.33±1.33	0.97±0.12	48± 2.31	1.03 ±0.09	49.33±2.67	1.2±0.15
3%	42.67±3.53	0.8±0.06	45.33± 1.33	0.93 ±0.04	48±2.31	1.13±0.15
4%	36±2.31	0.53±0.09	40± 2.31	0.8 ±0.06	37.33±3.53	0.73±0.20

Table 5: Effect of aqueous leaf, stem and root extract of *Croton bonplandianum* on *Parthenium hysterophorus*

Concentration	Aqueous leaf extract of <i>Croton</i> on <i>Parthenium</i>		Aqueous stem extract of <i>Croton</i> on <i>Parthenium</i>		Aqueous root extract of <i>Croton</i> on <i>Parthenium</i>	
	% germination	Mean length of radicle in cm.	% germination	Mean length of radicle in cm.	% germination	Mean length of radicle in cm.
Control	97.33±3.08	2.63±0.09	97.33±3.08	2.63±0.09	97.33±3.08	2.63±0.09
0.5%	58.67±1.33	1.63±0.09	60±2.31	1.83±0.07	57.33±1.33	1.97±0.09
1%	53.33±1.34	1.4±0.26	54.67±1.33	1.67±0.09	52±2.31	1.6±0.10
2%	42.67±3.53	1.33±0.09	44±2.31	1.46±0.04	37.33±1.33	1.03±0.09
3%	40±4.01	0.77±0.09	41.33±2.67	1.13±0.12	36±2.31	0.77±0.09
4%	33.33±1.33	0.6±0.12	36±2.31	0.93±0.09	29.33±1.33	0.7±0.06

The rate of germination per day was 3.75% in *Cassia tora*, 4.95% in *Croton bonplandianum* and 10.55% in *Parthenium hysterophorus*. The root, stem and leaf extract of *Parthenium* had no remarkable effect on germination and radicle length of other two species (Tables 2 and 3).

But aqueous extracts obtained from roots, stems and leaves of *Cassia tora* and *Croton bonplandianum*, significantly suppressed the germination of *P. hysterophorus*. Generally increase in the extract concentration increased the inhibitory potential.

Aqueous leaf, stem and root extracts of *Cassia* in every concentration (i.e. 0.5 – 4%) were inhibitory for seed germination of *Parthenium*. At 0.5%, the germination percentage was 53.33 to 57.33% but at 4%, it declined to 37-40% (Table 4). The trend of inhibition was similar.

The effect of aqueous leaf extract of *Croton* on *Parthenium* is similar to *Cassia*. The root extract was more potent and it declined the germination

upto 29.33% at 4% (Table 5). The stem extract was intermediate in effect.

Aqueous extracts of *Cassia tora* and *Croton bonplandianum* also suppressed the radicle length of the *Parthenium* seedlings. Progressive inhibition was observed in the linear growth of radicle with proportionate increase in the concentration of the extract. Radicle length was maximum at earlier and then there was a continuous decrease i.e. 1.73 cm and 0.53 cm (in 0.5% and 4% aqueous leaf extract of *Cassia tora*), 1.83 cm and 0.8 cm (in 0.5% and 4% aqueous stem extract of *Cassia tora*), 1.77 cm and 0.73 cm (in 0.5% and 4% aqueous root extract of *Cassia tora*) whereas 1.63 cm and 0.6 cm (in 0.5% and 4% aqueous leaf extract of *Croton bonplandianum*), 1.83 cm and 0.93 cm (in 0.5% and 4% aqueous stem extract of *Croton bonplandianum*) and 1.97 cm and 0.42 cm (in 0.5% and 4% aqueous root extract of *Croton bonplandianum*).

Correlation coefficient (r) between different concentrations and germination percentage was

Table 6 : Correlation coefficient (r) between concentrations and germination percentage

S. No.	Concentration and germination percentage	Value of Correlation coefficient (r)	Nature of correlation
1	Leaf extract of Ct on Ph	0.995***	-ve
2	Stem extract of Ct on Ph	0.760	-ve
3	Root extract of Ct on Ph	0.823*	-ve
4	Leaf extract of Cb on Ph	0.978***	-ve
5	Stem extract of Cb on Ph	0.972***	-ve
6	Root extract of Cb on Ph	0.959***	-ve
7	Leaf extract of Ph on Ct	0.089	-ve
8	Stem extract of Ph on Ct	0.470	-ve
9	Root extract of Ph on Ct	0.033	-ve
10	Leaf extract of Ph on Cb	0.180	-ve
11	Stem extract of Ph on Cb	0.620	-ve
12	Root extract of Ph on Cb	0.870*	-ve

* Significant at P=0.05

*** Significant at P=0.01

Ph=*Parthenium hysterophorus*, Ct= *Cassia tora*,
Cb=*Croton bonplandianum*

Table 7: Correlation coefficient (r) between concentrations and radicle length

S. No.	Concentration and radicle length	Value of Correlation coefficient (r)	Nature of correlation
1	Leaf extract of Ct on Ph	0.974***	-ve
2	Stem extract of Ct on Ph	0.944***	-ve
3	Root extract of Ct on Ph	0.978***	-ve
4	Leaf extract of Cb on Ph	0.976***	-ve
5	Stem extract of Cb on Ph	1.0***	-ve
6	Root extract of Cb on Ph	0.949***	-ve
7	Leaf extract of Ph on Ct	0.833*	-ve
8	Stem extract of Ph on Ct	0.190	+ve
9	Root extract of Ph on Ct	0.228	-ve
10	Leaf extract of Ph on Cb	0.234	-ve
11	Stem extract of Ph on Cb	0.040	-ve
12	Root extract of Ph on Cb	0.400	-ve

* Significant at P=0.05

*** Significant at P=0.01

Ph=*Parthenium hysterophorus*, Ct= *Cassia tora*,
Cb=*Croton bonplandianum*

worked out. The leaf extract of *Cassia tora* on *Parthenium hysterophorus* shows significant negative correlation at 1% level. The leaf, stem and root extract of *Croton bonplandianum* on *Parthenium hysterophorus* shows negative and significant correlation at 1% level. Only the root extract of *Parthenium hysterophorus* on *Croton bonplandianum* was significant at 5% level (Table 6).

There was negative correlation between concentrations and radicle length. It was significant in *Cassia tora* and *Croton bonplandianum* on *Parthenium hysterophorus*. The leaf extract of *Parthenium hysterophorus* on *Cassia tora* was negatively correlated and significant at 5% level (Table 7).

Any direct or indirect, inhibitory or stimulatory effect of one plant on another through the production of volatile chemical compounds has been termed as allelopathy. Chemicals that impose allelopathic influences are called allelochemicals. The harmful effect of higher extract concentration

on growth parameters might be due to excess of allelochemicals which inhibit gibberellin and IAA – induced growth. It is hoped that exploitation of these natural mechanisms may lead to novel approaches to weed management with undoubted environmental advantages.

Croton bonplandianum with well developed root and shoot systems are able to suppress the vegetative growth of *Parthenium hysterophorus*. The chemical constituents of *Croton bonplandianum* are palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid and β -linoleo-di- α -lanolenin while of *Cassia tora* are glycoside, oleic acid, emodin, stearic acid, palmitic acid, lignoceric acid and sitosterol (β -sitosterol- β -D-glucoside). Further *Cassia tora* and *Croton bonplandianum* are valued as fodder.

ACKNOWLEDGEMENTS

The authors are extremely thankful to Prof. U.K. Sinha, Head, Department of Botany, Patna University for providing laboratory facilities.

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