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Research Article

Allelopathic Effects of *Lantana camara (Linn)* on Regeneration in *Funaria hygrometrica*

Rajaram Choyal[1] and *Sanjay Kumar Sharma[2]
[1]*Department of Environmental Science, M.G.S University, Bikaner (Rajasthan), India*
[2]*Department of Botany, Govt. Degree College Nurpur, Distt. Kangra (H.P), India*
**Author for Correspondence*

ABSTRACT

Explants obtained from the apical, middle and basal parts of *Funaria hygrometrica* were allowed to regenerate with half knop's liquid culture medium supplemented with *Lantana camara(L)* leaf,stem and root extract at various concentration(i.e.5,10,15,20,30,40,50%). Maximum regeneration was observed in control. The regeneration percentage decreased with increase in extract concentration of Lantana camara (L). The leaf extract was maximum inhibitory effect followed by the stem and root extracts. The apical explants showed the highest potential for regeneration followed by the middle and basal explants.

Key Words: Allelopathic effect, *Funaria hygrometrica* and *Lantna camara.*

INTRODUCTION

Allelopathy is the ability of one plant to use chemicals to repel other plants in order to gain nutrients and light. Allelopathy of *Lantana camara* may be the cause of its toxicity to living being and its ability to cause shifts in species distribution and composition when it invades other ecosystems. *Lantana* contains about 50 species. Among them *Lantana camara* Linn, ranks as one of the top ten worst weeds in the world (Chopra and Kumar, 1961). Lantana camara Linn (family Verbenaceae) is a wild luxuriantly growing weed plant which has enchroached upon large parts of pastures and forest area in tropical and subtropical part of the world (Choudhary & Bapna1995). Lantana *camara* is an aggressive invader of natural ecosystem. Its leaf, stem and root contain some harmful allelochemicals which inhibits the germination and growth of Mosses (Mersie and Sing, 1987). *Lantana camara* has allelopathic effect against agronomic crops and it is one of the most toxic weeds in the world (Giles, K.L.1971). Keeping this problem in mind an attempt has been made together with information on various constituents of *Lantana camara* and the effect of allelochemicals present in different plant parts which affect regeneration in Bryophytes. Very little work has been done on allelopathic effect of *Lantana camara* on Bryophytes. The objective of the present study is to study the Allelopathic effects of Lantana camara (Linn) on *Funaria hygrometrica*.

MATERIALS AND METHODS

The material was collected from various localities of Dharmshala tehsil of Kangra District,H.P(India). The collected moss was carefully determined. Its identification was confirmed by matching the herbarium sheets at M.D.P.G. college, Sriganganager, Rajasthan.

Experimental Design

Explant obtained from the apical , middle and basal parts of *Funaria hygrometrica* were allowed to regenerate in Petri dishes containing filter paper moistened with half-strength knop's liquid culture supplemented with *Lantana camra* root , stem,and leaf extracts at various concentration (*i.e.,* 5, 10, 15, 20, 30, 40and 50 %). The regeneration percentage was recorded on 10th 20th and 30th day .

Sterilization of Glassware And Culture Media

Corning flask, plastic petri dishes, Whatman's filter paper No. 1 and test tubes were used for the experimental work. The glassware was wrapped in an aluminum foil and sterilized dry in an oven at 120°C for 48 hours. Plastic petri dishes and Whatman's filter paper No. 1 were wrapped in aluminium foil and sterilized in an autoclave. Half Knop's culture medium contained in conical glass flask was also sterilized by autoclaving.

Sterilizatoin of Explants

Before setting the experiments the gametophyte of *Funaria hygrometrica* was washed repeatedly under slow running tap water to remove soil particles. Then apical, middle and basal explants were surface sterilized for 2-3 minutes in 2% solution of calcium hypochlorite and again washed with double distilled water.

RESULTS

Regeneration from Apical Explants

Regeneration from Apical Explants of *Funaria hygrometrica* with Leaf, Stem and Root Extracts *of L. camara* in Half Knop's Liquid Culture Medium was recorded on 10^{th}, 20^{th} and 30^{th} day.

On 10th day, (Table 1.1a &1.1b) shows that the highest regeneration was recorded in control i.e. 66.67 %. The percentage of regeneration was recorded only up to 30 % (6.66) concentration of leaf and stem extracts, and 40 % (6.67) of root extract. The mean value for regeneration percentage was maximum for root extract (32.50) followed by stem extract (26.67) and leaf extract (23.33). It is evident from the mean values that there was complete inhibition of regeneration at 50 % and beyond with respects to all the plant parts.

On 20th day, control resulted in the highest per cent of regeneration i.e. (73.33 %). In leaf and stem extracts the percentage of regeneration occurred only up to 30 % (13.33) concentration, and 50 % (6.67) of root extract. The mean value for regeneration per cent was maximum for root extract (40.00), followed by stem (31.67) and leaf extract (28.33).

On 30th day, the maximum regeneration per cent was recorded in control *i.e.* , (86.66 %). The maximum mean value for regeneration percentage was observed in root extract (46.66) followed by stem (40.83) and leaf extract (35.83) mean value shows that regeneration observed from 5 % to 50 % concentrations. It was seen that addition of different extracts resulted in decrease in regeneration per cent as compared to control.

It is revealed from statistical analysis that difference between the different extracts was significant on 30th day. Difference between different concentrations was always significent but interaction between explants and concentrations were not significant.

Regeneration from Middle Explants

Regeneration from Middle Explants of *Funaria hygrometrica* with Leaf, Stem and Root Extracts of *L. camara* in Half Knop's Liquid Culture Medium on 10th , 20th and 30th day

On 10th day, (Table1.2b & 1.2b) Shows that 53.33 per cent regeneration was recorded in control which was highest. In leaf extract the percentage of regeneration was recorded up to 15 % (6.67) concentration, up to 20 % (13.33) concentration of stem extract whereas it took place up to 30 % (6.67) concentration of leaf extract. The Maximum percentage of regeneration occurred from root extract (25.83), followed by stem (20.83) and leaf extract (13.33). There was complete inhibition of regeneration at 40 % of concentration and above of all parts *of Lantana* extracts.

On 20th day, control shows 60.00 % regeneration. In leaf extract the percentage of regeneration was recorded up to 20 % (13.33), whereas up to 30 % (6.67) of stem extract and 40 % (6.67) of root extract. Mean value shows that root extract had the maximum regeneration per cent (30.83), followed by stem (25.00) and leaf extract (20.00).

On 30th day control resulted in the highest per cent of ultimate regeneration i.e. 73.33 %. Leaf extracts shows regeneration up to 30 % (13.33). The regeneration was observed up to 30 % (20.00) concentration of stem extract and 40 % (13.33) concentration of root extract. Regeneration did not take place at 50 % and beyond this concentrations of each *Lantana* extract. The mean value for regeneration per cent was the maximum for root extract (41.67), followed by stem extract (35.00) and leaf extract (28.33). It was found that increase in concentration resulted in respective decrease of regeneration per cent. Root extract shows the maximum regeneration while leaf extract shows the minimum regeneration per cent. It was observed from statistical analysis that difference between the different extracts was significant on 10th day only. Difference between different concentrations was significant but their interaction was not significant.

Regeneration from Basal Explants

Regeneration from Basal Explants of *Funaria hygrometrica* with Leaf, Stem and Root Extracts of *L. camara* in Half Knop's Liquid Culture Medium on 10th, 20th and 30th day

On 10th day, (Table 1.3a& 1.3b) shows that addition of different extracts resulted in decrease in regeneration per cent as compared to control. The maximum regeneration was observed in control which was 60.00 per cent. The minimum regeneration was observed at 20 % (6.67) concentration of leaf extract, at 30 % (6.66) concentration of stem extract and same value 30 % (6.66) concentration of root extract. The mean value for regeneration per cent was maximum for root extract (27.50), followed by stem (21.67) and leaf extract (16.67) respectively. A complete inhibition of regeneration was observed at the concentration of 40 % in all the extracts. On 20th day, control resulted in the highest per cent of regeneration i.e. 66.67. In leaf extract regeneration was observed only up to 30 % (6.67) concentration, up to 30 % (13.33) concentration of stem extract and 40 % (6.67) of root extract. Root extract shows the maximum regeneration i.e. 35.83 followed by stem (30.00) and leaf extract (25.00) which was the minimum mean value. Only 50 % concentration shows complete inhibition of regeneration.

On 30th day, 80.00 per cent regeneration occurred in control, whereas the minimum regeneration was observed up to 30 % (13.33) concentration of leaf extract, up to 50 % (6.67) concentration of stem and 50 % (13.33) concentration of root extract.

Table 1.1a: Effect of different concentration of leaf, stem and root extract of *Lantana camara* on apical explants of *Funaria hygrometrica* on 10th, 20th and 30th day in Half Knop's Liquid culture medium.

Concentration	10th day				20th day				30th day			
	LLE	LSE	LRE	Mean	LLE	LSE	LRE	Mean	LLE	LSE	LRE	Mean
Control	66.66	66.66	66.66	66.66	73.33	73.33	73.33	73.33	88.66	86.66	86.66	86.66
5%	46.66	53.33	60.00	53.33	53.33	60.00	66.66	60.00	66.66	60.00	66.66	60.00
10%	33.33	40.00	46.66	40.00	40.00	46.66	60.00	48.88	46.66	53.33	60.00	53.33
15%	20.00	26.66	40.00	28.88	26.66	33.33	46.66	35.55	33.33	40.00	53.33	48.88
20%	13.33	20.00	26.66	20.00	20.00	26.66	33.33	26.66	26.66	20.00	46.66	40.00
30%	6.66	6.66	13.33	8.88	13.33	13.33	20.00	15.55	20.00	13.33	33.33	22.22
40%	0.00	0.00	6.66	2.22	0.00	0.00	13.33	4.44	6.66	6.67	20.00	13.33
50%	0.00	0.00	0.00	0.00	0.00	0.00	6.66	2.22	0.00	0.00	13.33	6.66
Mean	23.33	26.66	32.50	27.50	28.33	31.66	40.000	33.33	35.83	40.33	46.66	40.55
SEm±	6.53	6.53	6.53	3.77	7.45	7.45	7.45	4.3	8.71	7.33	7.33	4.23
CD 5 %	18.56	18.56	18.56	10.71	21.19	21.19	21.19	12.24	24.78	20.84	20.84	12.03
Extract medium (A) SEm±	2.31				2.64				2.59			
CD 5 %	6.56				7.493				7.367			

Table 1.1b: Mean square of different days for regeneration in apical explants(Statistical analysis of table 1.1a)

Source	d.f	10th day	20th day	30th day
Between extracts (A)	2	516.667	886.667	938.88*
Between centrations (B)	7	5345.24**	6069.84**	5647.62**
A X B	14	40.47	40.4762	30.9524
Error	48	127.778	166.667	161.111

** Significant at 5 % level of significance, ** Significant at 1 % level of significance*

LLE= Lantana Leaf Extract LSE= Lantana Stem Extract LRE= Lantana Root Extract

Table 1.2a: The effect of different concentration of leaf, stem and root extract of Lantana camara on middle explants of Funaria hygrometrica on 10th, 20th and 30th day in Half Knop's Liquid culture medium.

Concentration	10th day				20th day				30th day			
	LLE	LSE	LRE	Mean	LLE	LSE	LRE	Mean	LLE	LSE	LRE	Mean
Control	53.33	53.33	53.33	53.33	60.00	60.00	60.00	60.00	73.33	73.33	73.33	73.33
5%	26.66	40.00	46.66	37.77	40.00	46.66	53.33	46.66	46.66	60.00	66.66	57.77
10%	20.00	33.33	40.00	31.11	26.66	40.00	46.66	37.77	40.00	53.33	60.00	51.11
15%	6.67	26.66	33.33	22.22	20.00	26.66	40.00	28.88	33.33	40.00	53.33	42.22
20%	0.00	13.33	20.00	11.11	13.33	20.00	26.66	20.00	20.00	33.33	40.00	31.11
30%	0.00	0.00	6.66	2.22	0.00	6.66	13.33	6.66	13.33	20.00	20.66	20.00
40%	0.00	0.00	0.00	0.00	0.00	0.00	6.66	2.22	0.00	0.00	13.33	4.44
50%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	13.33	20.83	25.83	19.72	20.00	25.00	30.83	25.27	28.33	35.00	41.66	35.00
SEm±	6.8	6.8	6.8	3.93	7.2	7.2	7.2	4.16	8.16	8.16	8.16	4.71
CD 5 %	19.35	19.35	19.35	11.17	20.48	20.48	20.48	11.82	23.22	23.22	23.22	13.40
Extract medium (A) SEm±	2.31				2.55				2.89			
CD 5 %	6.84				7.23				8.20			

Table 1.2b: Mean square of different days for regeneration in middle explants (Statistical analysis of table 1.2a)

Source	d.f	10th day	20th day	30th day
Between extracts (A)	2	950.00*	705.556	1066.67
Between centrations (B)	7	3733.33**	4342.06**	6041.27**
A X B	14	92.85	51.58	69.84
Error	48	138.88	155.55	200.00

**Significant at 5 % level of significance, ** Significant at 1 % level of significance*

LLE= Lantana Leaf Extract LSE= Lantana Stem Extract LRE= Lantana Root Extract

Table 1.3a: Effect of different concentration of leaf, stem and root extract of *Lantana camara* on basal explants of *Funaria hygrometrica* on 10th, 20th and 30th day in Half Knop's Liquid culture medium.

Concentration	10th day				20th day				30th day			
	LLE	LSE	LRE	Mean	LLE	LSE	LRE	Mean	LLE	LSE	LRE	Mean
Control	60.00	60.00	60.00	60.00	66.66	66.66	66.66	66.66	80.00	80.00	80.00	80.000
5%	33.33	46.66	53.33	44.44	46.66	53.33	60.00	53.33	53.33	66.66	73.33	64.44
10%	20.00	26.66	46.66	31.11	33.33	46.66	53.33	44.44	53.33	60.00	66.66	60.00
15%	13.33	20.00	33.33	22.22	26.66	33.33	46.66	35.55	33.33	46.66	60.00	46.66
20%	6.66	13.33	20.00	13.33	20.00	26.66	33.33	26.66	26.66	40.00	53.33	40.00
30%	0.00	6.66	6.66	4.44	6.66	13.33	20.00	13.33	13.33	26.66	33.33	24.44
40%	0.00	0.00	0.00	0.00	0.00	0.00	6.66	2.22	0.00	13.33	20.00	11.11
50%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.66	13.33	0.00	6.66
Mean	16.66	21.66	27.50	21.94	25.00	30.00	35.85	30.27	32.50	42.50	50.00	41.66
SEm±	5.61	5.61	5.61	3.24	7.93	7.93	7.93	4.58	9.13	9.13	9.13	5.27
CD 5 %	15.95	15.95	15.95	9.21	22.56	22.56	22.56	13.03	25.96	25.96	25.96	14.99
Extract medium (A) SEm±	1.98				2.81				3.23			
CD 5 %	5.64				7.97				9.17			

Table1.3b: Mean square of different days for regeneration in basal explants (Statistical analysis of table 1.3a)

Source	d.f	10th day	20th day	30th day
Between extracts (A)	2	705.55	705.55	1850*
Between centrations (B)	7	4348.41**	5256.35**	6180**
A X B	14	96.03	51.58	59.52
Error	48	94.44	188.88	250.00

** Significant at 5 % level of significance, ** Significant at 1 % level of significance*

LLE= Lantana Leaf Extract LSE= Lantana Stem Extract LRE= Lantana Root Extract

The mean value percentage for root extract was (50.00), while for stem extract (42.00) and (32.28) for leaf extract. Regeneration occurred at 50 % concentrations of stem and root extract also. It was observed that the percentage of regeneration increased with the passage of time and increase in concentration resulted in respective decrease of regeneration per cent.Statistical analysis revealed that difference between the different extracts was significant on 30th day. Difference between different concentrations was always significant, but their interaction was not significant.

DISCUSSION

Regeneration process affected by allelochemicals is in the decreasing order of leaf, stem and root extracts *of Lantana camara.* Process of regeneration was very little affected by *Lantana* root extract, while leaf extract affected the process more adversely. Similar result were observed by Rahbar, and Chopra (1982) who studied the allelopathic effect of *L. camara* on regeneration of a liverwort *Asterella angusta.* Bhansali and Choudhary (2002) also concluded that leaf, stem and root extract *of L. camara* proved inhibitory for the regeneration of moss *Physcomitrium japonicum.* Chaudhary and Agrawal (2003) reported that leaf, stem and root extracts *of Lantana camara* prepared in Half Knop's liquid culture medium and water extracts inhibited the spore germination of *Plagiochasma appendiculatum.* Leaf extract is the most potent inhibitor followed by stem and root extracts.

The phytotoxicity of *Lantana* leaf extracts was the maximum due to complex interactions between its 14 phenolic compounds (Gedenas. 2001). Glandular trichomes present on the leaf surface might be storing these chemicals is the second reason, and third reason was the more solubility of allelochemicals present in leaves as compared to stem and root. Absence of glandular and non glandular trichomes on the root may result in lesser solubility of these allelochemicals content as cellular constituents of the root cells. According to Schuster(1980) allelopathy partially provides protection against decay and imparts dormancy to weed seeds present in the soil and thus they remain viable for several years. The weeds affect plants through release of phytotoxins from seeds decomposing residues may exert allelopathic effect on neighbouring plants due to (a) Inhibition of biological nitrogen fixation, (b) Inhibition of seed germination, growth and yield.

The inhibition of regeneration process in different explant of *Funaria hygrometrica* was found in the decreasing order of apical, basal and middle explant. The results are in conformity with Patidar& Kaul (1993) and Choudhary & Agarwal (2003) in liverwort *Riccia billardieri* and Chohan(2002) in liverwort *Asterella angusta.* Apical explants least affected by all three extracts due to presence of higher concentration of auxin in this region. Basal explants has higher concentration of growth hormones in comparison to middle part, so basal part shows higher regeneration as compared to control and middle explants. Fulford,M (1956) found out the synthesis of auxins in the apical region of leaves. Polar transport of auxins is a well established phenomenon. The capacity of regeneration increases with passage of time which may be due to degradation of allelochemicals present in different exracts *of Lantana.*

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