Research Article

Allelopathic Effect of Some Liverworts on Seed Germination of the Weed *Bidens pilosa* L.

Shivani Thakur, Sunita Kapila*
Department of Botany, Panjab University, Chandigarh, India.
***Corresponding author's E-mail:** s_kapila0802@yahoo.co.in

Accepted on: 05-03-2015; **Finalized on:** 30-04-2015.

ABSTRACT

A study was conducted to elucidate the allelopathic effects of liverworts on seed germination and seedling growth of a weed, *Bidens pilosa*. The liverwort species selected for the study were *Plagiochasma appendiculatum, Targionia indica, Conocephalum conicum* and *Dumortiera hirsuta*. Besides the aqueous extract of these liverworts the lipophilic extract was also prepared in methanol to dissolve those bioactive compounds of thalli which are not soluble in water. In control experiments seed germination was 100 percent, whereas the liverwort extracts in both the solvents exhibited different degrees of inhibitory effect on seed germination of the weed under study. The pure lipophilic extract as well as its 70% and 50% concentrations of *P. appendiculatum* and *T. indica* were found to be 100% effective to completely check seed germination. Only 5% germination was observed in 50% lipophilic extract of *C. conicum* and *D. hirsuta*. The 20% lipophilic extracts of *T. indica*, *C. conicum* and *D. hirsuta* restricted the seed germination to 5%, 10% and 20% respectively. The aqueous extract, however, was found to be less effective, even the 100% aqueous extracts of *P. appendiculatum* and *T. indica* resulted in 80% seed germination, while those of *C. conicum* and *D. hirsuta* allowed 85% and 90% seed germination respectively on fifth day. The seedling size recorded on fifth day ranged between 0.4cm - 0.7cm in the lipophilic extract and between 1.6cm - 2.6cm in the aqueous extract.

Keywords: Allelopathic effect, liverworts, inhibitory, *Bidens pilosa*.

INTRODUCTION

Weeds are the most complex serious problem in natural resource management. *Bidens pilosa* is a troublesome, obnoxious weed, occurring mostly in agricultural areas, wetlands, grasslands, forests and wasteland.

It decreases the yield of crops by competing for water, nutrients, space, CO_2 and sunlight. It reduces human efficiencies by causing allergies, injuries, dermatitis and other health hazards. It forms dense, monoculture stands**.**

Liverworts also known as hepatics come under the Division Bryophyta. There are 6000 species of liverworts in the world. The gametophytic plant body of liverworts may be thalloid or leafy.

The liverworts contain cellular membrane bound oil bodies which contain a number of lipophilic terpenoids with a variety of aromatic compounds, several of which show biological activities such as plant growth regulatory, insect antifeedant, cytotoxic, piscicidal, muscle relaxing, allergenic contact dermatitis, insecticidal, anti-HIV, antimicrobial and antifungal activities.[1-3]

The term 'Allelopathy' was coined by Molisch, a German Plant Physiologist in 1937. Allelopathy can be defined as "any direct or indirect harmful effect of one plant on another plant or microorganism through release of chemicals in the environment".[4]

Some bryophytes show allelopathy due to the presence of some chemicals known as allelochemicals or allelomones.[5] The biochemical compounds of hepatics usually have a growth inhibiting effect, but at low concentrations they show opposite effect.

Most of the crude extracts of liverworts which contain bitter or pungent substances exhibit an inhibitory activity against seed germination and growth of seedling in some higher plants.[6,7]

The allelopathic potential of three liverworts and seven mosses has been reported on seed germination and seedling growth of *Bidens biternata* - a common weed of the Kumaun Himalayan region.[8]

On the other hand, extracts from root, stem and leaf of *Lantana camara* proved inhibitory for the germination of the spores of *Asterella angusta*.[9]

The present study was carried out to find the allelopathic effect of different liverworts on the seed germination and early seedling growth behaviour in *Bidens pilosa* - an obnoxious weed occurring mostly in agricultural areas causing tremendous loss to the crops.

MATERIALS AND METHODS

Collection of Plant Materials

Four liverworts viz., *Plagiochasma appendiculatum, Targionia indica, Conocephalum conicum* and *Dumortiera hirsuta* were selected to study their effect on germination behaviour of *B. pilosa* seeds. All these bryophytes form monocultures on the forest floors. The plants were collected in fertile condition (to aid in identification) and brought to the laboratory during the months of September-October, 2013 from Shimla.

Table 1: Nature of substratum and herbarium reference numbers

Name of Taxon	Locality and altitude	Substratum	Herbarium reference No.
Plagiochasma appendiculatum Lehm. et Lindenb.	Shimla 2200 m	soil gathered on rocks	PAN 6114
Targionia indica Udar et Gupta	Shimla 2200 m	On soil	PAN 6115
Conocephalum conicum (L.) Necker	Shimla 2200 m	On wet soil	PAN 6116
Dumortiera hirsute (Sw.) Nees	Shimla 2200 m	On wet soil	PAN 6117

Table 2: Percent seed germination in *Bidens pilosa*

Plant samples	Days	Aqueous extract				Methanolic extract			
		20%	50%	70%	100%	20%	50%	70%	100%
Plagiochasma appendiculatum	1	30	20	15	5	-	-	-	-
	2	45	30	25	20	-	-	-	-
	3	55	40	45	40	-	-	-	-
	4	65	50	60	65	-	-	-	-
	5	90	90	85	80	-	-	-	-
Targionia indica	1	40	20	10	15	-	-	-	-
	2	50	30	40	25	-	-	-	-
	3	65	40	60	50	-	-	-	-
	4	70	65	75	65	-	-	-	-
	5	95	80	85	80	5	-	-	-
Conocephalum conicum	1	40	35	20	25	-	-	-	-
	2	65	40	45	40	-	-	-	-
	3	70	55	55	60	-	-	-	-
	4	80	75	60	70	5	-	-	-
	5	95	90	80	85	10	5	-	-
Dumortiera hirsuta	1	55	50	35	20	-	-	-	-
	2	75	65	45	35	-	-	-	-
	3	80	80	60	70	-	-	-	-
	4	95	90	85	85	10	-	-	-
	5	100	100	95	90	20	5	-	-

Table 3: Seedling size (in cm) of *Bidens pilosa* on fifth day of experiment

Plant Samples	Aqueous extract				Methanolic extract			
	20%	50%	70%	100%	20%	50%	70%	100%
Plagiochasma appendiculatum	3.4cm	3.2cm	2.0cm	1.6cm	-	-	-	-
Targionia indica	3.0cm	3.2cm	2.1cm	1.8cm	0.4cm	-	-	-
Conocephalum conicum	3.2cm	2.9cm	2.4cm	2.1cm	0.7cm	0.5cm	-	-
Dumortiera hirsuta	3.2cm	3.4cm	2.9cm	2.6cm	0.9cm	0.7cm	-	-

Collection of *Bidens pilosa* seeds

The seeds of *B. pilosa* were collected from monoculture stand. In the experiment, air dried, fully developed, healthy and disease free seeds were used.

Preparations of Plant Extract

Plants were washed with distilled water to remove soil particles, contaminant parts of other plants and blotted to dry. Extracts were prepared from entire green thalli. For extraction, water and methanol were used as two extracting solvents. For preparing the extracts, 5 g fresh thalli of each liverwort were crushed in 50ml of distilled water or methanol in pestle and mortar.

The extracts were filtered through Whatman No. 1 filter paper and final volume of extract was made to 100ml by adding respective solvent. This was considered as stock

solution and it was further diluted to different concentrations.

Procedure

During each experiment, three replicates were prepared for each sample. The petriplates (9 cm. diameter) were lined with filter paper and sterilized. In each petriplate, twenty seeds of *B. pilosa* were placed and eight ml of extract was poured. For control also, the plates were prepared in the same manner but without liverwort extract. The experiments were carried out at room temperature (20°–22°C) in dark for five days. Emergence of radical was considered as the criterion for seed germination.

RESULTS AND DISCUSSION

Table 2 shows the allelopathic effect of four liverworts (*Plagiochasma appendiculatum, Targionia indica, Conocephalum conicum, Dumortiera hirsuta*) on seed germination of the weed *Bidens pilosa.* In control experiments, seed germination was 100 percent, whereas the liverwort extracts in both the solvents exhibited different degrees of inhibitory effect on seed germination of the weed under study. The pure lipophilic extract as well as its 70% and 50% concentrations of *P. appendiculatum* and *T. Indica* were found to be 100% effective to completely check seed germination. Only 5% germination was observed in 50% lipophilic extract of *C. conicum* and *D. hirsuta*. The 20% lipophilic extracts of *T. indica*, *C. conicum* and *D. hirsuta* restricted the seed germination to 5%, 10% and 20% respectively. In an earlier investigation, *T. hypophylla* proved most effective as its lipophilic extract completely inhibited the seed germination in *B. biternata*.[8] But in the present study, all the methanolic concentrations of *Plagiochasma appendiculatum* proved to be effective to completely check the seed germination in the weed *B. pilosa* followed by *T. indica* showing merely 5% seed germination in only 20% lipophilic extract. The least effective to inhibit the germination is *Dumortiera hirsuta*. The aqueous extract of all the species, however, was found to be less effective, even the 100% aqueous extracts of *P. appendiculatum* and *T. indica* resulted in 80% seed germination, while those of *C. conicum* and *D. hirsuta* allowed 85% and 90% seed germination respectively on fifth day. Frahm found that some bryophytes have inhibitory effect on the germination of the seed plants in their vicinity while others showed stimulatory effect. They also reported that the higher concentrations of aqueous as well as alcoholic extracts have inhibitory effect on growth of these seed plants.[10] On the other hand, the germination of the spores of *Asterella angusta* was reported to be inhibited by the allelopathic effect of *Lantana camara* resulting in absence of liverworts in the immediate vicinity of the shrub.[9]

It is clear from the Table 3 that aqueous extract was not much effective in controlling the seedling size. In lipophilic extract the seedling size recorded on fifth day ranged from 0.4cm to 0.7cm and in aqueous extract it ranged from 1.6cm to 2.6cm in the studied liverworts. The flavonoids from mosses inhibit spore germination and protonemal growth in the moss *Tortula muralis* and root development in an angiosperm *Raphanus sativus*.[11] The acetone extracts of *P. appendiculatum* and *T. hypophylla* proved the most effective in reducing the seedling growth of the weed *B. biternata*.[8] In the present study, the highest inhibition to seedling growth is shown by *Plagiochasma appendiculatum* and the least effect by *Dumortiera hirsuta.* All the bryophytes strongly suppress the regeneration of vascular plants and the bryophyte phenolics negatively affect germination and, even more strongly, the early development of seedlings.[12]

CONCLUSION

It is concluded from the results of present study that methanolic extracts of all the studied liverworts had inhibitory effect on seed germination and the growth of seedlings of the weed, *Bidens pilosa.* Because of their inhibitory effect, liverworts can be used in biological control of the weeds. By utilizing the allelopathic potentiality of liverworts in alternative weed management strategy, the use of synthetic herbicides can be minimized to a certain extent.

Acknowledgement: The first author is grateful to the University Grant Commission, New Delhi for financial assistance.

REFERENCES

1. Asakawa Y, Terpenoids and aromatic compounds with pharmacological activity from bryophytes, In: Bryophytes: Their Chemistry and Chemical Taxonomy, Zinsmeister HD, Mues R, Eds., Clarendon Press, Oxford, UK, 1990, 369-410.
2. Asakawa Y, Phytochemistry of Bryophytes: Biologically active terpenoids and aromatic compounds from liverworts, In: Phytochemicals in human health protection, nutrition, and plant defense, Romeo JT, Ed., Kluwer Academic/Plenum, New York, 1999, 319-342.
3. Asakawa Y, Chemosystematics of the Hepaticae, Phytochemistry, 65, 2004, 623-669.
4. Rice EL, Allelopathy, 1ST Ed., Academic Press, New York, 1974, 353.
5. Asakawa Y and Aratani T, Occurrence of sesquiterpene lactone in *Frullania* and *Diplophyllum,* Journal of the Hattori Botanical Laboratory, 41, 1976, 377-380.
6. Matsuo A, Nadaya K, Nalayama M, Hayashi S, Plant growth inhibitors isolated from the Liverwort *Plagiochila ovalifolia*, Nippon Kagaku Kaishi, 1981, 665-670.
7. Sawant UJ and Karadge BA, Review of bryophytes with special reference to eco-physiological studies, mineral elements, allelopathy and uses, Indian Journal of Advances in Plant Research, 1, 2014, 10-23.
8. Sharma A, Bargali K and Pande N, The allelopathic potential of bryophyte extract on seed germination and seedling growth of *Bidens biternata*, Nature and Science, 7, 2009, 30-38.

9. Kothari M and Choudhary BL, Allelopathic effects of *Lantana camara* Linn., On spore germination of *Asterella angusta* Steph. - A liverwort, Indian Journal of Experimental Biology, 39, 2001, 1194-1198.

10. Frahm JP, Risse S, Saan-Klein BV, Are bryophytes extracts inhibiting or promoting seed growth? Archive for Bryology, 2012, 127.

11. Basile A, Sorbo S, Lopez-Saez JA, Castaldo Cobianchi R, Effects of seven pure flavonoids from mosses on germination and growth of *Tortula muralis* Hedw. (Bryophyta) and *Raphanus sativus* (Magnoliophyta), Phytochemistry, 62, 2003, 1145-1151.

12. Soudzilovskaia NA, Graae BJ, Douma JC, Grau O, Milbau A, Shevtsova A, Wolters L, Cornelissen JHC, How do bryophytes govern generative recruitment of vascular plants? New Phytologist, 190, 2011, 1019-1031.

Source of Support: Nil, **Conflict of Interest:** None.