Allelopathic effects of two important exotic weeds, *Ageratum houstonianum* Mill. and *Chromolaena odorata* (L.) R.M. King & H. Rob. on some crop plants

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Abstract

Weeds are undesirable plants growing in an area where they are not wanted. These are generally highly competitive and adaptable to very wide environmental conditions. While competing with crop plants for light, nutrient and moisture contents of the soil, many weeds have allelopathic effects on crop plants. The present work investigated the allelopathic effects of two dominating exotic weeds *Ageratum houstonianum* Mill. and *Chromolaena odorata* (L.) R.M. King & H. Rob. on (i) Sesame [*Sesamum indicum* L. of Pedaliaceae], (ii) Mustard [*Brassica nigra* (L.) K.Koch of Brassicaceae], (iii) Lai-patta/Mustard green [*Brassica juncea* (L.) Czern. of Brassicaceae], and (iv) Radish [*Raphanus raphanistrum* subsp. *sativus* (L.) Domin. of Brassicaceae], which showed the strong derogative effects on crop plants.

Key words: *Ageratum houstonianum*, *Chromolaena odorata*, Allelopathy, Local crops

INTRODUCTION

In agricultural science weed is generally defined as the unwanted plants which are growing in crop fields and competing with the crop plants with their short vegetative phase but with high reproductive capacity. The term Allelopathy was defined by Rice (1984) as direct or indirect inhibitory or beneficial effect by one organism on another through the production of chemical compounds (Cheng & Cheng 2015). A large number of weed species shows allelopathic effects on different plants including crop plants in cultivated lands has been reported. Allelopathy is caused by the chemical compounds releasing into the surrounding environment by means of decomposition, volatilization and root exudation (Figure 1; Anonymous 1).

Several works related to Allelopathy has been worked out in different parts of the world, including India. Allelopathic effects of *Cyperus rotundus* L., *Commelina benghalensis* L., *Parthenium hysterophorus* L. and *Prosopis juliflora* (Sw.) DC., on sorghum, wheat, green gram, soybean, sunflower and groundnut was evaluated by Channappagoudar (2005). Allelopathic effect of *Ageratum conyzoides* (L.) L., was examined by Verma and Rao (2006) on seed germination, seedling growth, total protein content and protein profile of soybean. In their study they have also examined such effects of other weeds e.g. *Cynodon dactylon* (L.) Pers., *Parthenium hysterophorus* L., and *Solanum nigrum* L. [= *Solanum americanum* Mill.].

Figure 1. The possible ways of allelochemical release into the local environment

Exotic weeds:

The presence of exotic naturalized plants in different floras is well known (Khuroo *et al.* 2012; Maiti & Guha Bakshi 1981). Occurrence of such exotics in parts of the Eastern Himalaya has been earlier recorded by many workers including Das & Chanda (1986) and Das (2002).

Two common exotic dominating species, *Ageratum houstonianum* Mill. is native to Central America and some parts of Mexico, but it becomes an invasive weed in different countries (Anonymous 2) including India; and *Chromolaena odorata* (L.) R.M. King & H. Rob. is native to the Americas and has been introduced to tropical Asia and different parts of Africa and Australia (Anonymous 3) where they are widely naturalised. It is now important to see whether these two common

weeds has some effects on the local crop plants or not.

To test this hypothesis, four common crop plants of Arunachal Pradesh were selected: (i) Sesame [*Sesamum indicum* L. of Pedaliaceae], (ii) Mustard [*Brassica nigra* (L.) K. Koch of Brassicaceae], (iii) Lai-patta/Mustard green [*Brassica juncea* (L.) Czern. of Brassicaceae], and (iv) Radish [*Raphanus raphanistrum* subsp. *sativus* (L.) Domin of Brassicaceae]. Objective of the present study was manifold, (a) to understand the interaction between crops & weeds, (b) evaluation of the effects of weeds on the test crop plants in terms of germination rate and average length of root and stem at the initial growth stage, (c) development of the data sources which reflect quantitative measure of the growth and the management of that particular weed population.

MATERIALS AND METHODS

For the experimental procedures Putman & Duke (1978), Datta & Ghosh (1987), Acharya (1998), Kadir (2001), and Ghosh (2006) were followed.

Preparation of extract and leachate solutions:

Mature and healthy crop plant seeds of locally cultivated varieties were collected from the farmers and stored at 4° C in brown paper envelopes. Freshly collected aerial plant part of weeds were used to make aqueous extract (100 g in 250 ml of distilled water). Similarly, for leachate solution, 100 g of fresh plant material was soaked in distilled water for 72 hours. In both the cases filtrate (1:2.5 w/v) was treated as stock solution (strained through filter paper) and by subsequent dilution of the stock with distilled water different concentration gradients (1:5, 1:10, 1:20 w/v) were prepared. There was a control set using distilled water in each set of experiment. Two replicas were maintained for each set to nullify the experimental error.

Germination test: The tests using *A. houstonianum* were conducted in the month of March 2018 and the other tests with *C. odorata* was done in November 2017. Healthy and mature crop seeds (Sesame, Mustard, Lai-patta & Radish) were allowed to germinate in control (distilled water) and in different concentration of test solutions (1:2.5, 1:5, 1:10 and 1:20 w/v) of *Ageratum houstonianum* and *Chromolaena odorata* separately for extract

and leachate. The experiments were conducted at room temperature under normal light during the day and dark at night. The germinated seeds were counted regularly and the linear length of roots, stem and total seedling length were recorded.

Germination Percentage: The germination percentage was calculated with the formula

$$\text{Germination Percentage} = \frac{\text{Total number of germinated seeds}}{\text{Total number of seeds sown}} \times 100$$

RESULTS AND DISCUSSIONS

For the present set of experiments extract and leachate solutions of two weeds were used for four different crop plants (Sesame, Mustard, Lai-patta & Radish) were used separately. For each set, total germinated seeds were counted and linear length of root, stem and the whole seedling were also measured.

Germination %: The germination percentage decreases along with the increasing concentration of extract and leachate solutions of *A. houstonianum* and *C. odorata* in compared to control set. The effects of both the weeds are almost same in all the crop seed germination. In case of *A. houstonianum* the highest rate of germination (93%) was found in mustard, in the lowest con. i.e. 1:20 w/v extract solution; followed by radish (86%) in 1:20 w/v leachate soln. The lowest germination rate (26%) showed by Lai-patta (mustard green) in 1:2.5 w/v extract soln. which was followed by 30% (1:2.5 w/v leachate soln.) in mustard and 33% (1:2.5 w/v extract soln.) in sesame (**Table 1**). That means *A. houstonianum* has

Table 1. Effects of *Ageratum houstonianum* extract and leachate at different concentrations on germination and seedling growth of test crop plants.

Parameters	Con. (w/v)	Sesame		Mustard		Lai-patta		Radish	
		Extr.	Leach.	Extr.	Leach.	Extr.	Leach.	Extr.	Leach.
Germination %	Control	70	86	96	100	66.6	90	90	93
	1:2.5	33	46	40	30	26	43	36	40
	1:5	50	66.6	50	36	40	50	53	80
	1:10	63	73.3	80	80	53	63	80	83
	1:20	66	83.3	93	86.6	60	76.6	83	86
Mean root length (cm) per seedling	Control	17.5	10.5	43.4	47.5	28.6	37.4	38.4	26.2
	1:2.5	5.3	2.8	13.3	8.4	15.7	8.5	14.1	4.1
	1:5	16.3	13.4	26.8	12.7	38.6	12.3	38.1	18.1
	1:10	22.1	19.3	37.8	30.7	33.1	23.2	49.6	45.3
	1:20	25.2	22.8	49.2	49.3	34	24.9	45.3	42.4
Mean stem length (cm) per seedling	Control	10.4	4.3	21.1	20.7	17.6	11.5	24.4	18.9
	1:2.5	8.4	6.5	18.7	15.4	21.3	15.7	19.8	10.2
	1:5	12.1	12.8	23.3	16	24.6	14	22.9	17.6
	1:10	13.3	13.2	22.6	16.8	21.6	14.8	27.9	24.9
	1:20	10.1	9.5	27.3	17.7	22.2	15	24.3	24.9
Average length(cm) of seedling	Control	27.9	14.8	64.5	68.2	46.2	48.9	62.8	45.5
	1:2.5	13.7	9.3	32	23.8	37	24.2	33.9	14.3
	1:5	28.4	26.2	50.1	28.7	63.2	26.2	61	35.7
	1:10	35.4	32.5	60.4	47.5	54.7	38	77.5	70.2
	1:20	35.3	32.3	76.5	67	56.2	39.9	69.6	67.3

Table 2. Effects of *Chromolaena odorata* extract and leachate at different concentrations on germination and seedling growth of test crop plants.

Parameters	Con. (w/v)	Sesame		Mustard		Lai-patta		Radish	
		Extr.	Leach.	Extr.	Leach.	Extr.	Leach.	Extr.	Leach.
Germination %	Control	100	96	93	100	93	93	96	96
	1:2.5	50	53	66	33	50	66	80	50
	1:5	73	66	86	56	66	73	83	83
	1:10	80	76	90	66	83	80	83	90
	1:20	93	86	93	90	86	86	90	93
Mean root length (cm) per seedling	Control	34.8	43.9	24.5	63.7	37.1	38.6	29	55.3
	1:2.5	5.3	10.6	6.2	2.6	4	4.8	22.2	1.7
	1:5	14.2	22.6	24.2	33.3	32.8	27.3	22.8	19.8
	1:10	31.7	25	26.4	45.4	26.4	37.8	26.3	27.1
	1:20	27.9	31.7	25.2	58.2	29.6	46.8	29.2	21.5
Mean stem length (cm) per seedling	Control	16.6	14.4	15.1	17.2	16.5	17.4	21.3	21
	1:2.5	10.2	13.8	13.2	10.7	11.1	15.8	16.1	4.8
	1:5	17.6	10.9	18.7	23.4	24	19.6	6.6	10.5
	1:10	20.2	14.6	21.5	26	24.4	29.8	14.9	19.4
	1:20	18.4	14.2	20.1	26.6	22.3	30.7	19.3	12.3
Average length(cm) of seedling	Control	51.4	58.3	39.6	80.9	53.6	55.7	50.3	76.3
	1:2.5	15.5	24.4	19.4	13.3	15.1	20.6	38.3	6.5
	1:5	31.8	33.5	42.7	56.7	56.8	46.9	29.4	30.3
	1:10	51.9	39.6	47.9	71.4	50.8	67.6	41.2	46.5
	1:20	46.3	45.9	45.3	84.8	51.9	77.5	48.5	33.8

Figure 1. Effect of *Ageratum houstonianum* extract and leachate on Germination % of (a) Sesame (b) Mustard (c) Lai-patta & (d) Radish.

strong inhibitory effect on germination of Lai-patta, mustard and sesame than radish. Whereas in *C. odorata* lowest value for germination rate (33%) was found to occur in mustard, in 1:2.5 w/v leachate soln. Followed by 50% (in mustard 1:2.5 w/v extract & 1:2.5 w/v leachate

solution) (Table 2). From the results we can conclude that *C. odorata* more adversely affect the germination of Mustard seeds than the other crop plants.

Figure 3. Effect of *Chromolaena odorata* extract and leachate on Germination % of (a) Sesame, (b) Mustard, (c) Lai-patta, and (d) Radish.

Table 3. Mean root length of crop seedlings in presence of highly concentrated extract and leachate solution (1:2.5 w/v) of (A) *Ageratum haoustonianum*, and (B) *Chromolaena odorata*

A <i>Ageratum haoustonianum</i>								
Mean root length (cm) in 1:2.5 w/v con. and Control set								
	Sesame		Mustard		Lai patta		Radish	
	1:2.5	Ctrl.	1:2.5	Ctrl.	1:2.5	Ctrl.	1:2.5	Ctrl.
Extract	5.3	17.5	13.3	43.4	15.7	28.6	14.1	38.4
Leachate	2.8	10.5	8.4	47.5	8.5	37.4	4.1	26.2

B <i>Chromolaena odorata</i>								
Mean root length (cm) in 1:2.5 w/v con. and Control set								
	Sesame		Mustard		Lai patta		Radish	
	1:2.5	Ctrl.	1:2.5	Ctrl.	1:2.5	Ctrl.	1:2.5	Ctrl.
Extract	5.3	34.8	6.2	24.5	4	37.1	22.2	29
Leachate	10.6	43.9	2.6	63.7	4.8	38.6	1.7	55.3

Mean Root length (cm): Subsequent dilution of stock solution (1:2.5 w/v) into 1:5, 1:10 and 1:20 w/v affected the initial growth of seedlings; upto 1:10 w/v solution increasing concentration of weed solution decreases the root length. But, almost in all the cases highest dilution of the stock solution (1:20 w/v) showed stimulatory effects on the root and stem growth, it may lead to the adverse effects little later. But till that period of growth it was not clear. By using the *A. houstonianum* the lowest mean root length (2.8 cm) was of sesame in 1:2.5 w/v leachate soln, it was then followed by 4.1 cm (1:2.5 w/v leachate solution) in radish and 5.3 cm (1:2.5w/v extract solution) in sesame [Table 3 (A)]. The results revealed that *A. houstonianum* have severe inhibitory effects on root growth of sesame than mustard, lai-patta and radish. Whereas in *C. odorata* minimum root growth (1.7 cm) was found in radish, maintained in 1:2.5 w/v leachate solution followed by 4 cm and 4.8 cm in lai-patta in 1:2.5 w/v extract and leachate solutions respectively [Table 3 (B)].

Mean stem length (cm): *A. houstonianum* inhibit the stem growth in it's highest concentrated test solution (1:2.5 w/v extract solution) in case of sesame, mustard, and radish.

Table 4: Mean stem length of crop seedlings in highly concentrated extract and leachate solution of (A) *Ageratum haustonianum* and (B) *Chromolaena odorata*, with respect to control (Ctrl.).

A <i>Ageratum haustonianum</i>									B <i>Chromolaena odorata</i>								
Mean stem length (cm) in 1:2.5 w/v con. and Control set									Mean stem length (cm) in 1:2.5 w/v con. and Control set								
	Sesame		Mustard		Lai patta		Radish			Sesame		Mustard		Lai patta		Radish	
	1:2.5	Ctrl.	1:2.5	Ctrl.	1:2.5	Ctrl.	1:2.5	Ctrl.		1:2.5	Ctrl.	1:2.5	Ctrl.	1:2.5	Ctrl.	1:2.5	Ctrl.
Extract	8.4	10.4	18.7	21.1	21.3	17.6	19.8	24.4	Extract	10.2	16.6	13.2	15.1	11.1	16.5	16.1	21.3
Leachate	6.5	4.3	15.4	20.7	15.7	11.5	10.2	18.9	Leachate	13.8	14.4	10.7	17.2	15.8	17.4	4.8	21

Lai-patta didn't show any significant effects in comparing with the control set [Table 4 (A)]. It has been observed that, along with the increasing concentration of *C. odorata* in test solution, the linear length of stem decreases up to 1:10 w/v concentration, in highest diluted condition i.e. in 1:20 w/v, showed increased stem growth than the control set in all the crop seedlings [Table 4 (B)].

Conclusion

In nature, every land, whether it is cultivated or not, contains specific amount of resources for the growth and development of natural vegetation. The density of this growth promoting resources varies according to the soil type and other environmental conditions. When the weed plant grows along with the crops in fields, they utilise a large amount of these resources that may lead to the reduction of quantity and quality of the agricultural products (Anonymous 2013).

The knowledge obtained from the above experiment can be applied to recognize those weedy plants having negative impacts on crops and can be removed from field in their early stage of growth. Allelopathic studies, therefore offers possibilities for a better agricultural practices.

In our country weed accounts for 37 % annual loss of agricultural produce. The weedy plants are significant pests of crops those may cause maximum loss of agronomic products (Das 2008).

In the world, around 30,000 weed species are recognized, out of these 18,000 species cause damage to crops. It has been estimated that occurrence of weed in crop fields cause 5 % loss to production even in most developed countries, 10 % loss in less developed countries and 25 % loss in the least developed countries (Leela Rani & Raju 2011).

So, the presently acquired knowledge on the allelopathic effects of two exotic weeds will be of much use in minimizing the loss of crop production in the areas affected by these species.

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