



Evaluation of Allelopathic Potential of Eight Medicinal Species on Seeds of Wheat and Pea

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Abstract

The experiment was conducted to evaluate the allelopathic potential of eight selected medicinal species from different plant families. Aqueous leaf extract of different concentrations (1%, 3% & 5%) were used for this screening against Wheat and Pea (test plants). Filter paper method was used in this evaluation. All species showed a variable allelopathic potential against both test plants. *Pongamia glabra* and *Albizia lebbbeck* showed more negative effect against the growth of wheat plant while in case of pea plant, the growth was more reduced by the effect of *Lantana camara* and *Tagetes erecta*. All plants showed significant effect against both test plants except *Tagetes erecta*, which showed non-significant effect against wheat plant.

Key words: Allelopathic potential, *Albizia lebbbeck*, *Lantana camara*, *Pongamia glabra*, *Tagetes erecta*.

Introduction

In plant communities, species exhibit different types of relations. Among these, chemical based relationship is known as Allelopathy. The science of allelopathy, introduced by Molish, is mainly concerned with the inhibitory as well as the stimulatory biochemical interactions between plant species¹. Generally, these interactions are deleterious to the receiver plants but sometimes these can also give a selective advantage to the donor plant².

Role of allelopathy in agriculture is an important aspect of allelopathic field. So biochemical evaluation of plants plays an important role in the sustainability and improvement of agro-ecosystems. Allelopathy is one of the promising strategies for the establishment of weed resistant crops³.

Most of the plant parts like leaves, roots, stem, flowers etc. release some chemicals which may inhibit or enhance the growth of other plants coming under influence of these plants. Such chemicals are termed as allelochemicals. Among different plant parts leaves are considered to be major producers of these allelochemicals⁴.

Several workers have reported the presence of allelopathic potential in a number of plant species. Zollinger and Kells experimented allelopathic effect of *Sonchus arvensis* on Soybean and dry edible bean⁵. Kamal and Bano studied allelopathic effects of sunflower⁶. Achhireddy and Singh worked on allelopathic potential of *Lantana camara* on *Morrenia odorata* (Milkweedvine)⁷. In the same way, Belal-Uddinet *al.* evaluated the inhibitory effects of *Albizia lebbbeck* on growth of different agricultural crops⁸.

Current research has been focused on the effects of different plant species on two crops with respect to germination and growth of the test plants. In present piece of work, eight different plant species (*Helianthus annuus*, *Sonchus arvensis*, *Tagetes erecta*, *Lantana camara*, *Murrayap aniculata*, *Albizia lebbbeck*, *Bauhinia variegata* and *Pongamia glabra*) are used to evaluate their allelopathic potential against two crops (*Triticum aestivum* & *Pisum sativum*). Hence an attempt has been made to evaluate the allelopathic effects of some selected plant species on two important crops i.e., Wheat and Pea.

Methodology

The experiment was designed to study allelopathic potential of selected medicinal species (i.e., *Helianthus annuus* L., *Sonchus arvensis* L., *Tagetes erecta* L., *Lantana camara* L., *Murrayap aniculata* L., *Albizia lebbek* L., *Bauhinia variegata* L. and *Pongamia glabra* Vent.) on seed germination of *Triticum aestivum*L.(Wheat) and *Pisums ativum*L.(Pea).

To study the allelopathic effects of these plants, the leaves were collected from respective plants, thoroughly washed and kept on filter paper for absorbance of excessive water. Leaves were dried in an oven at 40° C, crushed and divided into three parts to prepare three different concentrations i.e. 1%, 3% and 5% by soaking them in distilled water for 24 hours. The extract was filtered and covered with aluminium foil. Wheat and Pea seeds were used as test plants, as they can easily germinate within one week, easy to handle and germinate with high fecundity rate and also show pronounced effects after application of aqueous extracts. Filter paper is a good medium for germination of seeds⁹. The filter paper method is effective, free from contamination and easy to handle. The extracts were applied on test plants by soaking double layer of filter papers. 10 seeds of test plants were placed between two folds of filter papers and the experiment with each concentration was replicated thrice. The radicals and hypocotyls of seeds were measured with millimeter (mm) scale. The data was analyzed by software of SPSS v 11 (Statistical analysis of Social Procedure) and Microsoft Excel and the experimental design was Randomized Complete Split Block Design. Single factor ANOVA was calculated to investigate the significance of activity. The level of significance was 0.05. Percentage growth of radicle and hypocotyl of test plants was represented by line graphs.

Results

During the present work selected medicinal species i.e., *Helianthus annuus* L., *Sonchus arvensis* L., *Tagetes erecta* L., *Lantana camara*L., *Murrayap aniculata* L., *Albizia lebbek* L., *Bauhinia variegata* L. and *Pongamia glabra* Vent., from different plant families were evaluated for allelopathic potential by using two different test plants. For screening of allelopathic potential, three different concentrations (1%, 3% and 5%) of aqueous leaf extract were used. Wheat (monocot) and pea (dicot) seeds were selected as test plants.

Varied effects were observed under the influence of different plant species. *Pongamia glabra* and *Albizia lebbek* showed highest negative effect against the growth of wheat seeds (Table 1). On the other hand, growth of pea seeds was more inhibited under the influence of *Tagetes erecta* and *Lantana camara* (Table 2). Different concentrations of leaf extract also showed diverse effects against the growth of test species. In most of the cases it was observed that highest concentrations (i.e., 5%) of plant leaf extract showed more negative effects against the growth of test species (Table 1 & 2).

Highest aqueous concentration (5%) of *Sonchus arvensis* L. inhibited 37% growth of radical and 45% growth of hypocotyl of Wheat (Fig. 1). While same concentration of *S. arvensis* L. inhibited 21% radical growth and 6% hypocotyl growth of Pea plant (Fig. 2). In case of 3% concentration, *S. arvensis* L. reduced 15% and 10% growth of radical and hypocotyl of wheat plant respectively (Fig. 1). Similarly it also reduced 14% and 5% growth of radical and hypocotyl of pea respectively (Fig. 2). While 1% leaf extract concentration showed least effect on growth of radical and hypocotyl of both test plants (Wheat and Pea). Under the influence of this concentration reduction up to 13% radical growth and 7% hypocotyl growth of wheat and 9% radical growth and 3% hypocotyl growth of pea plant was observed (Fig. 1 &2). The observations of the present study showed that aqueous extract of *S. arvensis*L.exhibited significant inhibitory effect on the growth of wheat 0.44 (Table 1) and pea 0.51 (Table 2).

All concentrations of *Helianthus annuus* L. also showed growth inhibitory effect on both test plants except 1% extract, which showed slightly stimulatory effect (3%) on hypocotyl growth of wheat in the present piece of work. The growth inhibition, observed, was more in radical growth as compared to that of

hypocotyl growth. As with 5% concentration, 56% radical growth and 5% hypocotyl growth of wheat was reduced (Fig. 3) while 14% growth of radical and 6% growth of hypocotyl of pea were reduced (Fig. 4). Similarly with 3% concentration, 15% and 11% growth of radical and hypocotyl of wheat was reduced respectively (Fig. 3). The same concentration also inhibited the growth of pea with almost same percentages i.e., 11% radical and 9% hypocotyl growth (Fig. 4). 1% concentration reduced hypocotyl and radical growth of pea (i.e., 8%) as well as radical growth of wheat (i.e., 3%). Present results indicated that aqueous extract of *Helianthus annuus* L. exhibited significant inhibitory effect on wheat 0.39 (Table 1) and pea 0.57 (Table 2) but less than that of *Sonchus arvensis* L.

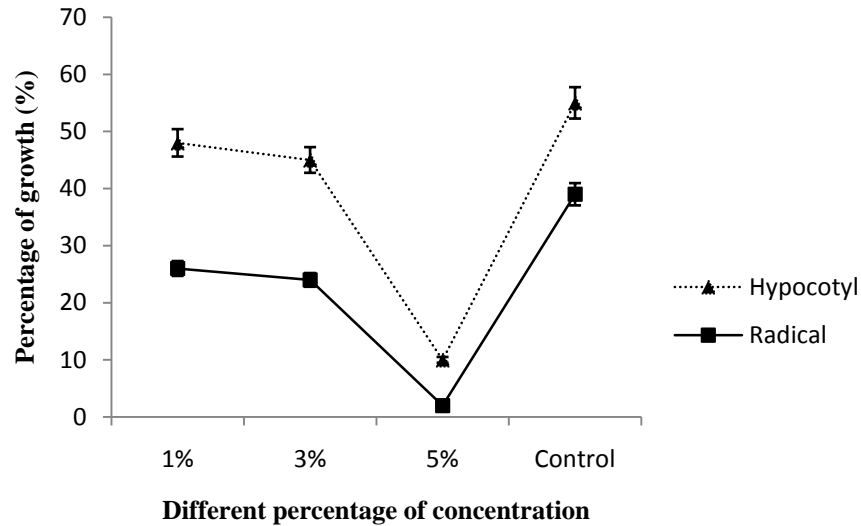


Fig. 1: Allelopathic Effect of Various Aqueous Leaf Extracts of *Sonchus arvensis* L. on Wheat

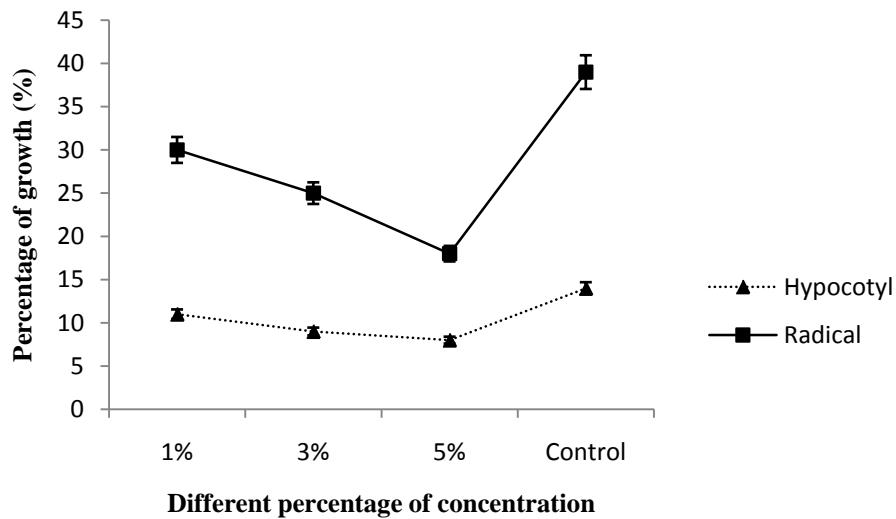


Fig. 2: Allelopathic Effect of Various Aqueous Leaf Extracts of *Sonchus arvensis* L. on Pea

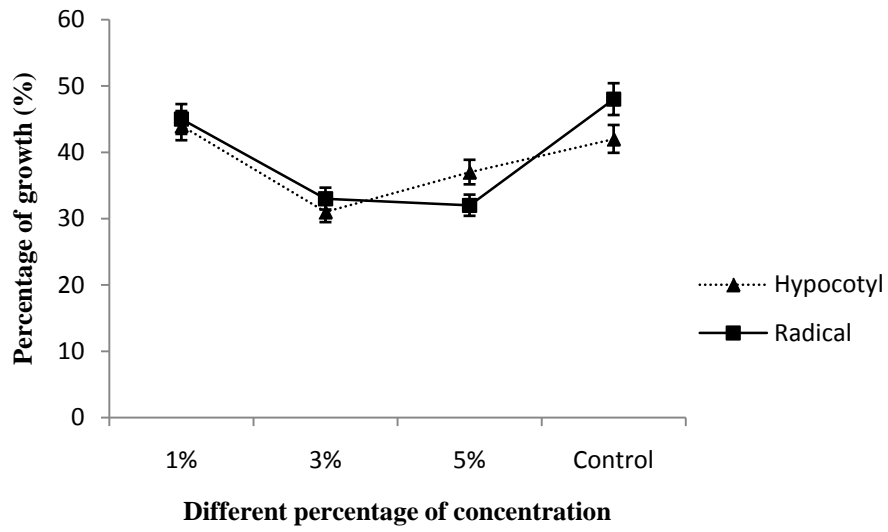


Fig. 3: Allelopathic Effect of Various Aqueous Leaf Extracts of *Helianthus annuus* L. on Wheat

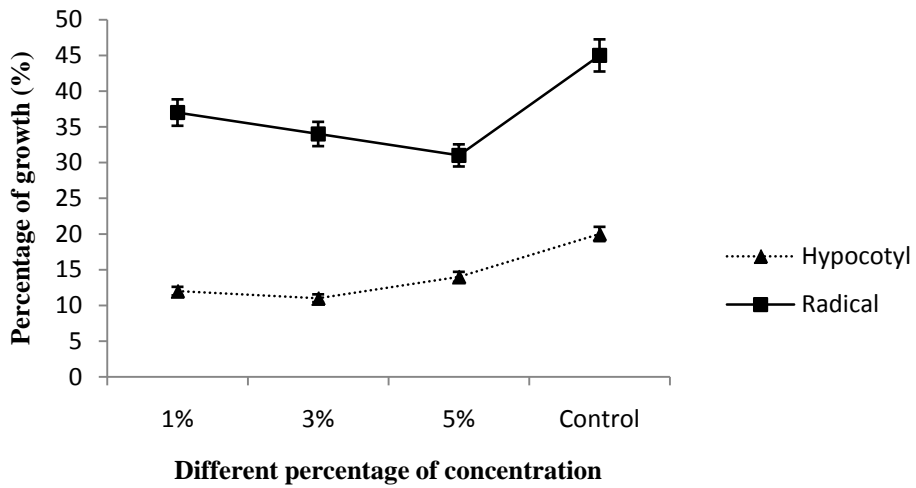


Fig. 4: Allelopathic Effect of Various Aqueous Leaf Extracts of *Helianthus annuus* L. on Pea

Table 1: Analysis of Variance for Allelopathic Activity of Selected Species of Family Asteraceae on *Triticumaestivum* L.(Test Plant)

Species Name	Control (mm)		Length of Hypocotyl and Radical in Different Concentrations (mm)						F Value	P Value
			1%		3%		5%			
	H	R	H	R	H	R	H	R		
<i>Helianthus annuus</i> L.	42	48	44	45	31	33	37	32	0.94	0.39*
<i>Sonchus arvensis</i> L.	55	39	48	26	45	24	10	2	0.82	0.44*
<i>Tagetes erecta</i> L.	66	43	63	45	62	48	55	46	4.16	0.02**
<i>Lantana camara</i> L.	42	43	38	26	39	23	36	20	0.3	0.6*
<i>Murraya paniculata</i> L.	56	49	41	23	33	15	19	9	0.49	0.61*
<i>Albizia lebbek</i> L.	94	89	84	54	85	98	81	53	0.05	0.94*
<i>Bauhinia variegata</i> L.	88	50	85	97	89	71	109	93	0.1	0.9*
<i>Pongamia glabra</i> Vent.	5	5	5	4	5	2	4	1	0.01	0.99*

Key: H = Hypocotyl, R = Radical, * = Significant effect, ** = Non-Significant effect, Alpha Value = 0.05

Table 2: Analysis of Variance for Allelopathic Activity of Selected Species of Family Asteraceae on *Pisum sativum* L. (Test Plant)

Species Name	Control (mm)		Length of Hypocotyl and Radical in Different Concentrations (mm)						F Value	P Value
			1%		3%		5%			
	H	R	H	R	H	R	H	R		
<i>Helianthus annuus</i> L.	20	45	12	37	11	34	14	31	0.57	0.57*
<i>Sonchus arvensis</i> L.	14	39	11	30	9	25	8	18	0.67	0.51*
<i>Tagetes erecta</i> L.	10	30	11	33	14	36	10	32	0.04	0.96*
<i>Lantana camara</i> L.	19	64	14	34	12	33	12	32	0.05	0.95*
<i>Murraya paniculata</i> L.	38	78	30	70	32	72	36	75	0.3	0.73*
<i>Albizia lebbek</i> L.	26	67	33	40	19	56	29	45	0.87	0.43*
<i>Bauhinia variegata</i> L.	48	76	35	60	43	79	46	74	0.58	0.56*
<i>Pongamia labra</i> Vent.	20	66	34	50	33	45	34	65	0.13	0.87*

Key: H = Hypocotyl, R = Radical, * = Significant effect, ** = Non-Significant effect, Alpha Value = 0.05

In contrast to *Sonchus arvensis* L. and *Helianthus annuus* L., *Tagetes erecta* L. slightly stimulated the growth of pea plant with all concentrations, as in lowest aqueous concentration (1%), slight stimulation up to 3% in radical and 1% in hypocotyl growth was observed (Fig. 6). Similarly with 3% concentration, 4% and 6% growth of hypocotyl and radical was stimulated respectively (Fig. 6). While 5% concentration showed almost negligible effect on pea growth. The effect of these concentrations of leaf extract on wheat was slightly different from that of pea plant. It was observed that with 5% concentration, 11% hypocotyl inhibition and 3% radical stimulation was observed (Fig. 5). Similarly with 3% concentration hypocotyl showed inhibitory growth effect and radical showed stimulatory growth effect (Fig. 5). But in case of 1% concentration, the effect was almost negligible. The observations revealed that the effect of aqueous extract of *T. erecta* L. on growth of wheat was non-significant 0.02 (Table 1) while the same plant species showed significant effect on pea 0.96 (Table 2).

Extract of *Lantana camara* (Verbinaceae) strongly inhibited growth of both test plants. Highest concentration (5%) had left greatest effect against the growth of test plants. In case of Wheat as test plant,

5% concentration inhibited 23% radical growth and 7% hypocotyl growth. 3% concentration reduced 4% and 20% growth of hypocotyl and radical respectively. While 1% concentration less inhibited the growth of Wheat seeds i.e., 5% hypocotyl and 17% radical (Fig. 7). On the other hand, extract of *Lantana camara* also affected verily growth of Pea seeds. 5% concentration reduces 32% radical and 7% hypocotyl growth. Lower concentrations of plant extract (i.e., 3% & 1%) showed approximately similar effects like that of higher concentration, against growth of Pea seeds (Fig. 8). Results indicated that *Lantana camara* shows significant effects on Wheat (0.6) as well as Pea plant (0.95) (Table 1 & 2).

Another plants species, *Murrayap aniculata* (Rutaceae), also showed inhibitory effects against the growth of both test plants but the effect on Wheat plant was greater as compared to that on Pea plant. On Wheat plant, highest concentration (5%) greatly reduced the radical growth (40%) as well as hypocotyl growth (37%). Extract of 3% concentration reduced 34% and 23% growth of radical and hypocotyl respectively. While the effect of lowest concentration (i.e., 1%) was lowest on the growth of Wheat seeds. At this concentration, 26% radical and 15% hypocotyl growth was reduced (Fig. 9). In case of Pea plant, the inhibitory effect was slight. 5% concentration inhibited 3% radical growth and 2% hypocotyl growth. Other concentrations (i.e., 3% & 1%) showed approximately similar effects as that of 5% concentration (Fig. 10). By the analysis of observations, it is cleared that *Murrayap aniculata* has significant effect on Wheat (0.61) and Pea plants (0.73) (Table 1 & 2).

Albizia lebbeck (Fabaceae) showed dramatic effect on the growth of both test plants. 5% concentration of plant extract reduced 36% and 13% radical and hypocotyl growth of Wheat seeds respectively. At 3% concentration, the effect on radicle growth was negligible while on hypocotyl growth, it was 9%. At lowest concentration (1%), 35% radical and 10% hypocotyl growth was reduced (Fig. 11). On Pea plant, the effects were different as compared to that of Wheat plant. 22% radical growth was reduced and 3% hypocotyl growth was stimulated in 5% concentration of plant extract. 3% concentration influenced 11% radical growth and 7% hypocotyl growth. While 1% concentration showed 27% inhibitory effect on radical growth and slightly stimulatory effect on hypocotyl growth (7%) (Fig. 12). According to present results, it is shown that *Albizia lebbeck* has significant effect on Wheat (0.94) and Pea (0.43) plants (Table 1 & 2).

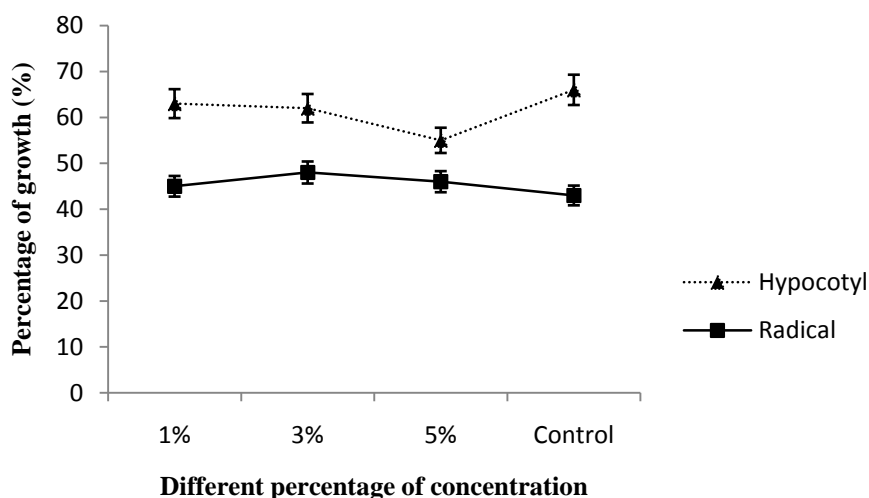


Fig. 5: Allelopathic Effect of Various Aqueous Leaf Extracts of *Tagetes erecta* L. on Wheat

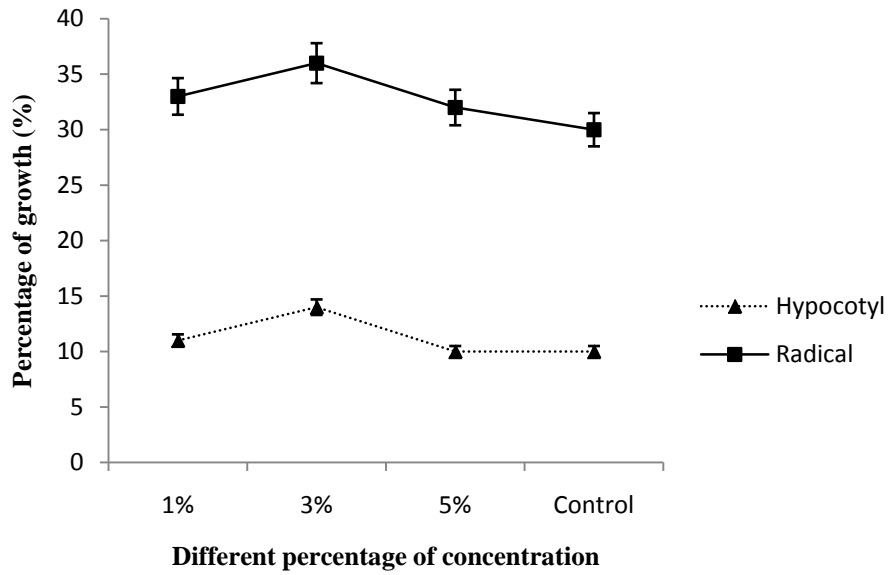


Fig. 6: Allelopathic Effect of Various Aqueous Leaf Extracts of *Tagetes erecta* L. on Pea

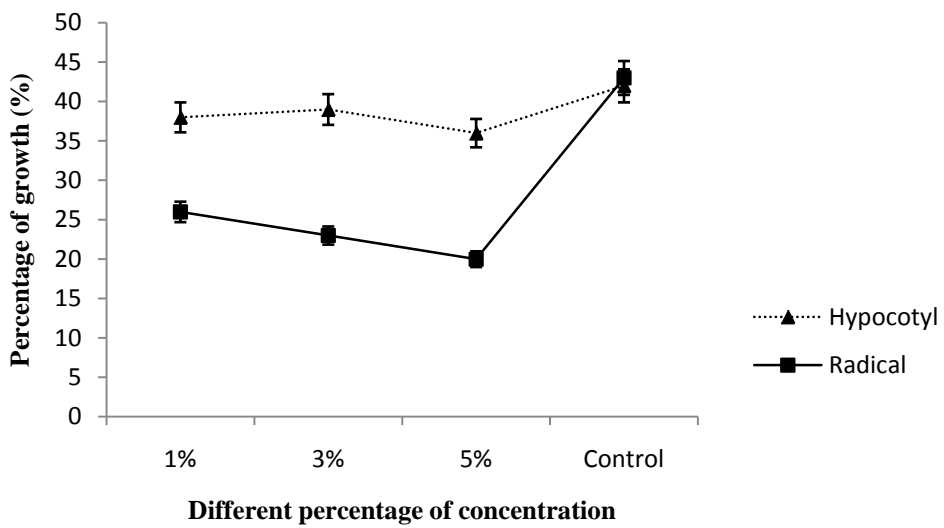


Fig. 7: Allelopathic Effect of Various Aqueous Leaf Extracts of *Lantana camara* L. on Wheat

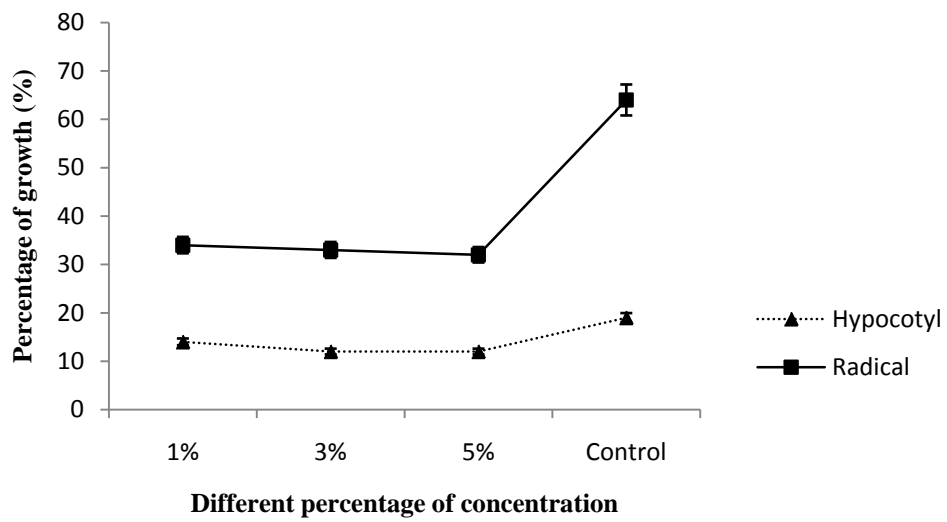


Fig. 8: Allelopathic Effect of Various Aqueous Leaf Extracts of *Lantana camara* L. on Pea

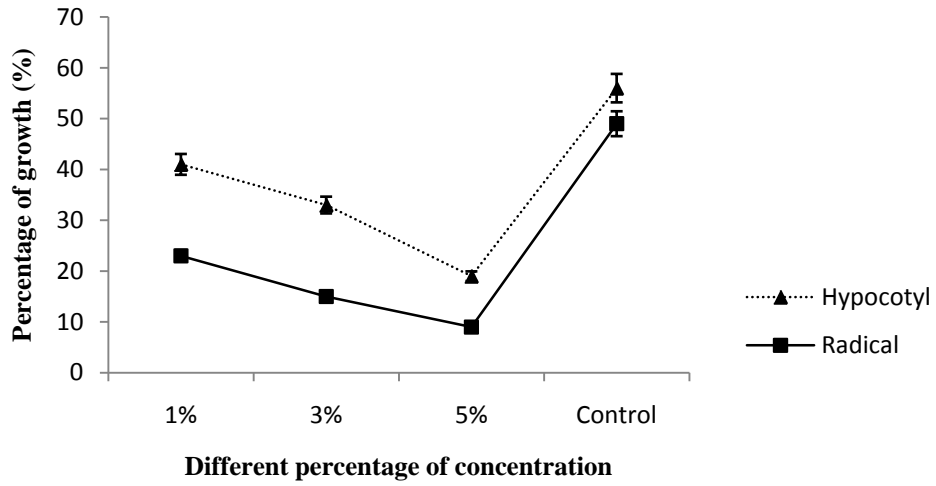


Fig. 9: Allelopathic Effect of Various Aqueous Leaf Extracts of *Murraya paniculata* L. on Wheat

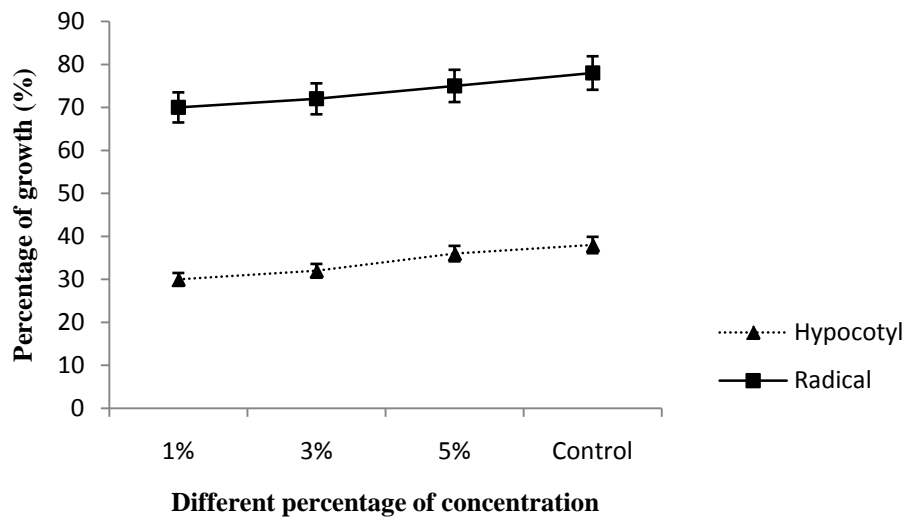


Fig. 10: Allelopathic Effect of Various Aqueous Leaf Extracts of *Murraya paniculata* L. on Pea

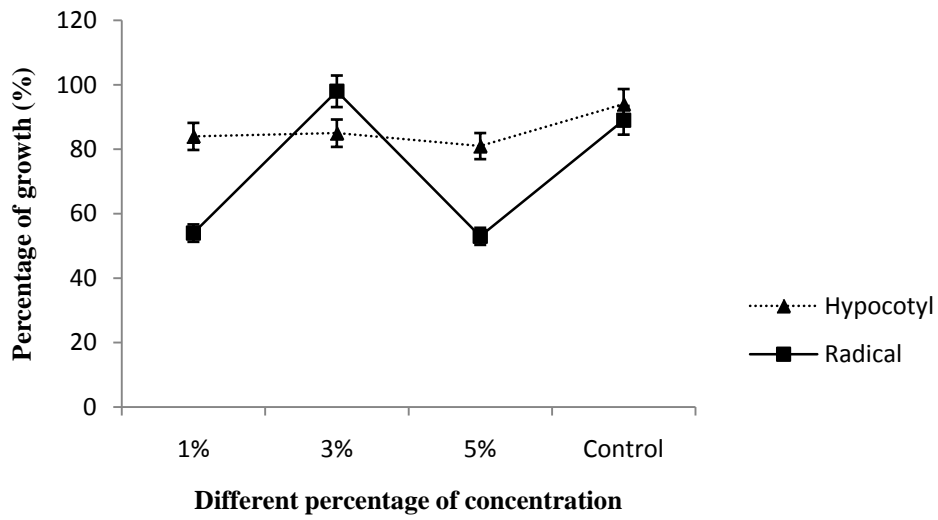


Fig. 11: Allelopathic Effect of Various Aqueous Leaf Extracts of *Albizia lebeck* L. on Wheat

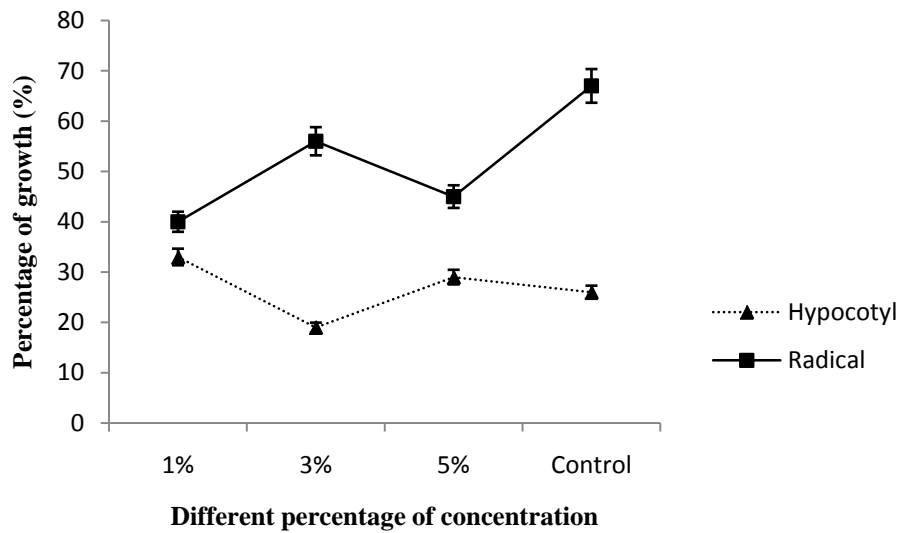


Fig. 12: Allelopathic Effect of Various Aqueous Leaf Extracts of *Albizia lebeck* L. on Pea

Another species, *Bauhinia variegata* (Fabaceae), also influenced slightly the growth of both test plants. In case of Wheat as test plant, stimulatory effect was observed. At 5% concentration, 43% radical growth and 11% hypocotyl growth was increased. At 3% concentration, 21% increase in radical growth and negligible effect on hypocotyl growth was observed. While at 1% concentration, radical growth was increased with 47% and hypocotyl growth was decreased with 3% (Fig. 13). On the other hand, growth of Pea plant was inhibited to some extent. At 5% concentration, 2% radical and hypocotyl growth was reduced. At 3% concentration, 3% radical growth was increased and 5% hypocotyl growth was decreased. While at lowest concentration (1%), 17% and 13% radical and hypocotyl growth was reduced (Fig. 14). *Bauhinia variegata* has shown significant effect on both Wheat (0.9) and Pea (0.56) plants (Table 1 & 2).

Aqueous extract of *Pongamia glabra* (Fabaceae), showed inhibitory effect on growth of Wheat plant while on Pea plant, the effect varied differently. In case of Wheat plant, 4% radical and 1% hypocotyl growth was reduced under the influence of 5% concentration. At 3% concentration, 3% radical growth was decreased while at 1% concentration, 1% radical growth was decreased. There was no effect on hypocotyl growth under the influence of these two concentrations (Fig. 15). In contrast to Wheat plant, growth of Pea seeds behaved verily. At highest concentration (5%), 14% reduction in hypocotyl growth and almost negligible effect on radical growth was observed. 21% reduction in radical growth and 13% stimulation in hypocotyl growth were observed with 3% plant extract. Similarly at 1% concentration, radical growth was reduced (16%) and hypocotyl growth was increased (14%)(Fig. 16). *Pongamia glabra* also showed significant effect on Wheat (0.99) as well as Pea (0.87) plants (Table 1 & 2).

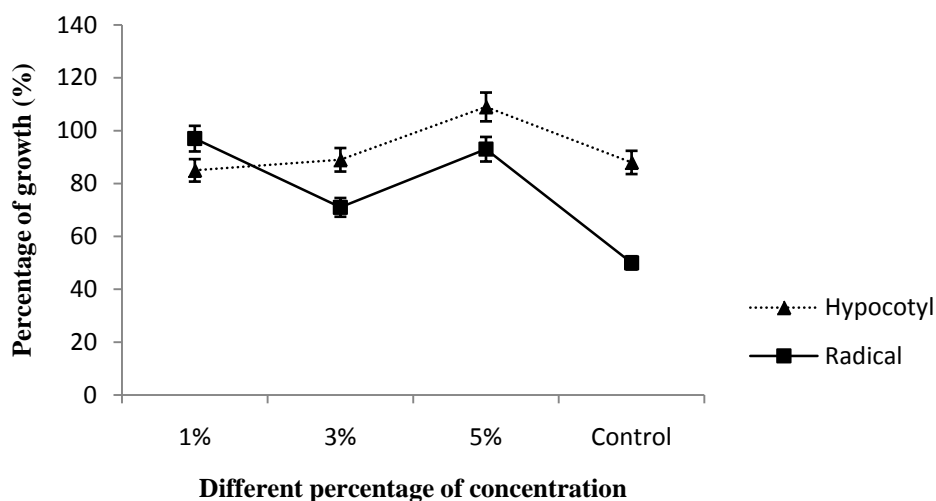


Fig. 13: Allelopathic Effect of Various Aqueous Leaf Extracts of *Bauhinia variegata* L. on Wheat

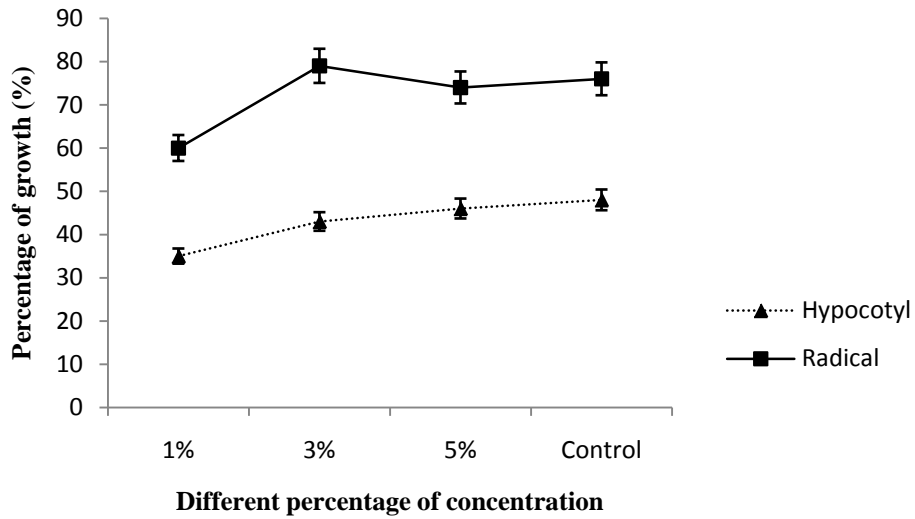


Fig. 14: Allelopathic Effect of Various Aqueous Leaf Extracts of *Bauhinia variegata* L. on Pea

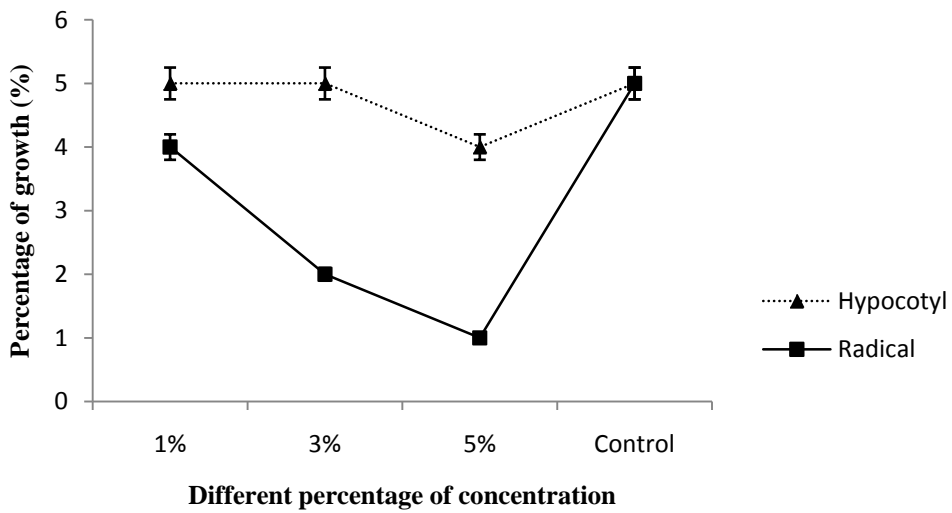


Fig. 15: Allelopathic Effect of Various Aqueous Leaf Extracts of *Pongamia glabra* Vent. on Wheat

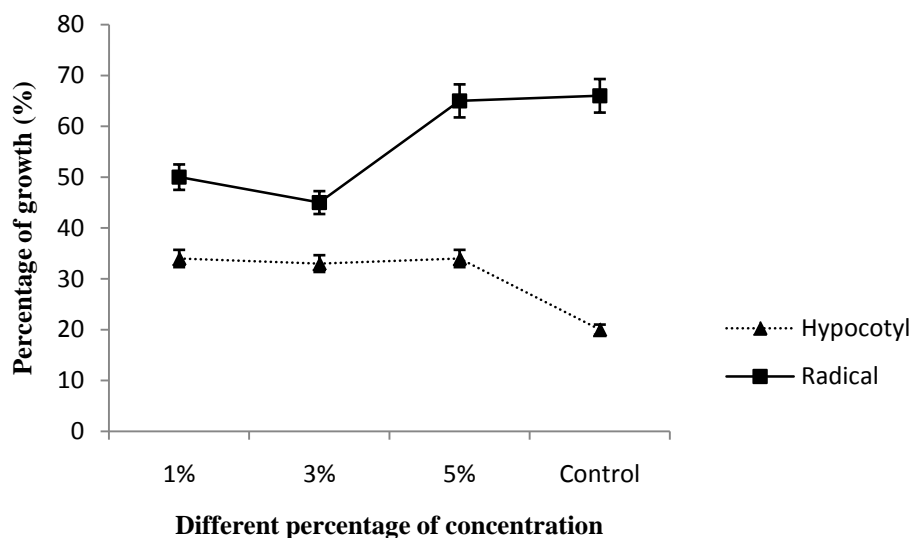


Fig. 16: Allelopathic Effect of Various Aqueous Leaf Extracts of *Pongamia glabra* Vent. on Pea

DISCUSSION

In plant communities, species exhibit different types of relations like that, based on morphology, chemicals etc. Allelopathy is a type of chemical based relationship. The science of allelopathy is mainly concerned with the inhibitory as well as the stimulatory biochemical interactions between plant species¹. The observations revealed that different concentrations of leaf extracts inhibit the germination of crop seeds to certain extent. Overall, all treatments showed reduction in seedling growth with one or two exceptions.

Many authors have reported allelopathic potential of sunflower against different test species. Aqueous extract of Sunflower root significantly inhibited the seedling growth of Wheat plant¹⁰. According to Kamal & Bano, leaf extract of Sunflower showed greatest allelopathic potential against two Wheat cultivars, followed by root and stem extracts⁶. Sunflower (*Helianthus annuus*) contains water-soluble allelochemicals that inhibits the germination and growth of different species. It is considered that these chemicals are released in the environment through leaching, decomposition or root exudation¹¹⁻¹². This specific character of plant species can be used in weed management programmes. Some phenols and terpenes have also been reported in different cultivars of Sunflower¹³⁻¹⁴.

Lantana camara L. is an invasive weed, wide spread in India¹⁵. According to different authors' findings, *Lantana* has allelopathic potential against growth of many crop plants and weeds. It contains some water soluble phytotoxins¹⁶⁻¹⁷. Nandi and Dalal experimented on leaf extract *Lantana camara* against growth of Radish and Spinach seeds. The extract significantly damaged the seeds of these plants¹⁸. Reduced germinability was due to allelopathic action of plants exerted by some inhibitory chemical substances¹⁹. These findings are in correspondence with the present results for *Lantana camara* showing this species as an exotic, fast growing and invasive weed and should be treated as potential threat to plant biodiversity in a natural ecosystem¹⁸.

Sonchus arvensis is considered to be universal in its distribution on different soils²⁰. Latha *et al.* reported the effects of *Pongamia pinnata* on two crops (wheat and rice) and two weeds (*Cassipourea* and *C. occidentalis*). No effects were observed on the growth of weeds while growth of crops was significantly

inhibited under the influence of *Pongamia pinnata*. They reported vanillic acid, syringic acid, melilotic acid and derivatives of quercetin and kaempferol as allelochemicals found in *Pongamia pinnata*²¹.

Albizia lebbek, *Pongamia glabra* and *Bauhinia variegata* are common tree species which are normally planted with many agricultural crops like wheat, rice, maize, soybean, vegetables etc. There must be some awareness related to their positive or negative effects so that the agricultural crops can be made safe from destroying²². According to Parvin *et al.* the inhibitory effects of *Albizia lebbek* on mungbean and soybean were varied according to different parts of plants. Aqueous leaf extracts showed highest allelopathic effects²³. The results obtained in present investigation are similar according to the report of Parvin *et al.* Belal-uddin *et al.* also reported significant inhibitory effects of *Albizia lebbek* on growth of some agricultural crops⁸. So observations of present experiment also coincide with that of the above mentioned work.

CONCLUSION

Study of allelopathy plays an important role in agriculture. It is one of the promising strategies for the establishment of weed resistant crops. So biochemical evaluation of plants plays an important role in the sustainability and improvement of agro-ecosystems. From the experiment it was concluded that all plant species under observation have varied allelopathic effects on different agricultural crops. Among all, *Albizia lebbek* and *Pongamia glabra* greatly inhibited the growth of wheat plant while *Tagetes erecta* and *Lantana camara* were found to be more inhibitory against growth of pea plant.

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