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Assessment of allelopathic potential of *Lantana species* on some selected agricultural crops

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Abstract
Lantana species is regarded both a notorious weed and a popular ornamental garden plant. Allelopathy involves both inhibitory and stimulatory biochemical interactions between plants. Lantana allelopathic effect studies have been done on several crops such as Musturds, (*Brassica juncea*,) *Coriander* (*Coriandrum sativum*) Baby corn (*Zea mays*), F_1 hybrid beet (*Beta vulgaris*), Japanese white radish (*Raphanus sativus*), Fenugreek (*Trigonella foenum graecum*) and Kasturi- methiunder both laboratory and field conditions to determine their allelopathic potential and its use. We observed that allelochemicals present in various solvents extracts of a leaf and flower such as alkaloid, flavonoids, terpenoids, triterpenoids of Lantana inhibited the germination, growth, and metabolism of several crops and vegetables such as Musturds, (*Brassica juncea*,) *Coriander* (*Coriandrum sativum*) Baby corn (*Zea mays*), F_1 hybrid beet (*Beta vulgaris*), Japanese white radish (*Raphanus sativus*), Fenugreek (*Trigonella foenum graecum*) and Kasturi- methi.

Keywords: Allelopathy, crops, germination, Phytochemicals, *Lantana species*, seeds

1. Introduction
The term, Allelopathy is derived from two Greek words Allelon (means to each other) and pathos (means to suffer). According to Molisch (1937) [11] allelopathy is defined as the harmful effect of one plant upon other. A more complete definition includes the positive and negative effects of chemical compounds produced mainly from the secondary metabolism of plants and microorganism, viruses and fungi that have an influence upon the growth and development of agriculture and biological ecosystem (Kruse *et al*., 2000; Olofsdotter *et al*., 2002; Rice, 1984; Seigler 1996; Bertin *et al*., 2003) [13, 16, 21, 23].

It is notorious that majority of allelochemicals are product of secondary metabolism.. Based on these precursors, secondary metabolites can be grouped into three main chemical classes- Terpenoids, nitrogen containing compounds and phenolic compounds, Alkaloids, Glycosides, tri-terpenoids etc. *Lantana species* is one of the plants which possess strong allelopathic effects on other plants by secreting the secondary metabolites. The secondary metabolites also includes the allelochemicals such as phenolic acids, alkaloids, Glycosides, Flavanoides and Terpenoides, Report on allelochemicals and their biological activity such as allelopathy, Phytotoxicity, herbicidal activity, inhibition and regulation of growth regulation are documented earlier. Phytochemical screening revealed that leaf, stem and root of *Lantana* contain tannin, catachin, saponin, steroids, alkaloids, phenol, anthroquinone, protein, several tri-terpenoids, flavonoids, alkaloids, glycosides.

2. Materials and methods
2.1 Collection of Plant Material
The leaves and flowers of the *Lantana species* were collected from the area surrounding the Department Of Environmental Sciences and Pashan Lake Pune. The leaves and flowers were collected randomly from 5-6 plants and were pooled together for further experimental study.

2.2 Preparation of Leaf and Flower Aqueous Extract
The 60 gm leaves of *Lantana species L.* was grinded in a Mixer by adding 600 ml sterilized distilled water and then 10% aqueous extract was prepared. The extracts were filtered through funnel with Whatmann filter paper no.1 and were stored at room temperature under dark condition for 24 hours until further use. After 24 hours different concentration (2%, 6%, and 10%) of the leaf extract were prepared by adding sterilized distilled water.

2.2.1. Processing of Plant Materials for Phytochemical Analysis
The stem bark and roots were washed in running water and cut into small pieces to facilitate drying. The pieces of plant material were dried for 12hrs in a hot air oven at 60°C. The dried plant material (Leaf and flower) were taken separately and grinded using an electric blender to obtain a fine powder. The powder was further passed through a 2mm sieve to obtain finer particles. The powdered samples were stored in a clean glassware container until further analysis.

2.3 Seeds
Seeds of the 6 different plants such as Mustard, (*Brassica juncea*), *Coriander* (*Coriandrum sativum*), Baby corn (*Zea mays*), F1 hybrid beet (*Beta vulgaris*), Japanese white radish (*Raphanus sativus*) and Fenugreek (*Trigonella foenum graecum*), Kasturi- methi and were purchased from Damani Seed Developers, Shivajinagar, Pune.

2.4 Assessment of Allelopathic effect of the *Lantana species* leaf and flower extracts
The following parameters were used to assess the allelopathic effect of the Leaves and Flowers of *Lantana species* on the seeds of six different plants:

2.4.1. a. Effect of the leaf and flower extract of *Lantana species* on seed germination of the selected plant seeds (*in vitro)*.

2.4. b. Germination Assay

2.4c.Surface sterilization of seeds: Ten seeds of each plant in triplicate were sterilized with 0.1 % HgCl2 solution (0.5g $HgCl_2$ powder was dissolved in 500 ml distilled water) for 5 sec. The surface sterilized seeds were washed with sterilized distilled water in laminar air flow cabinet for 4-5 times before using for the germination assay.

2.4. d. Solvent Extraction

Powdered plant materials (5g) were separately dispersed in 50ml of water, 70% ethanol, acetone, methanol, and hexane. The solution was left to stand at room temperature for 24hrs and was filtered with Whatman No. 1 filter paper. The filtrate was used for the Phytochemical screening using the following tests.

2.5. Statistical analysis: All the experiments were performed in triplicates. The mean and Average calculated using MS Excel 2007.

3. Results and Discussion

3.1 Assessment of Allelopathic effect of the Leaf and flower extracts of *Lantana species:*

After eight days of incubation at room temperature the percent germination was calculated. The details of the percent seed germination plant wise is as below:

1. F1 hybrid Beet Root (*Beta vulgaris*)

The seeds of beet root plant showed low percent germination at 6% and 10% concentration of *Lantana* Leaf extract as compared to control.

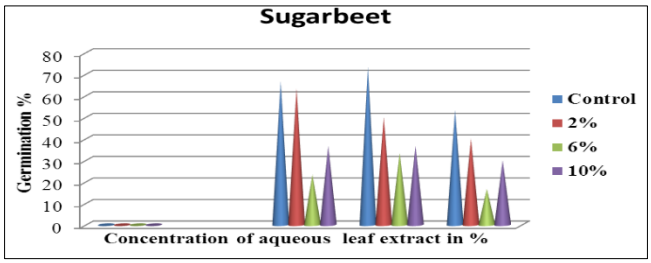

Fig 1: Allelopathic effect Leaf extract of Lantana species on the seeds of I: F1 Beet Root, at different concentrations of the Leaf extract (A: Control, B: 2%, C: 6% and D: 10%).

2. Japanese White Radish (*Raphanus sativus*)

The seeds of radish plant showed low percent germination at 6% and 10% concentration of *Lantana* Leaf extract as compared to control.

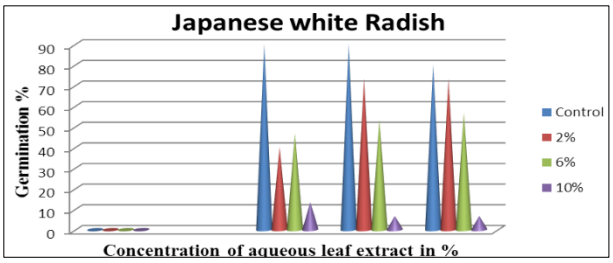

Fig 2: Allelopathic effect Leaf extract of Lantana species on the seeds of II: Japanese white Radish, at different concentrations of the Leaf extract (A: Control, B: 2%, C: 6% and D: 10%).

3. Coriander local variety

In 2%, 6% & 10% concentration seeds showed the complete inhibition of germination hence strong allelopathic effect was documented.

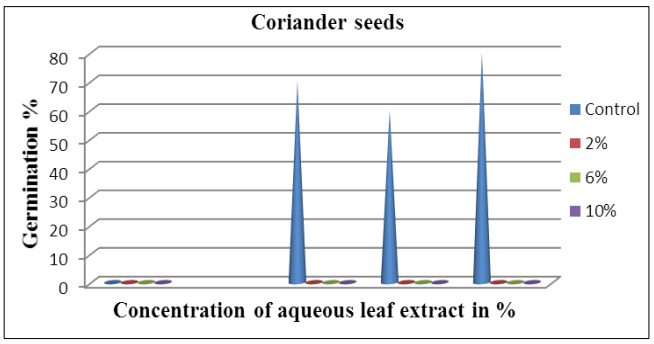

Fig 3: Allelopathic effect Leaf extract of Lantana species on the seeds of III: Coriander, at different concentrations of the Leaf extract (A: Control, B: 2%, C: 6% and D: 10%).

4. Fenugreek (methi) Nisha variety

The Fenugreek plant showed low percent germination at 6% and 10% concentration of *Lantana* Leaf extract as compared to control.

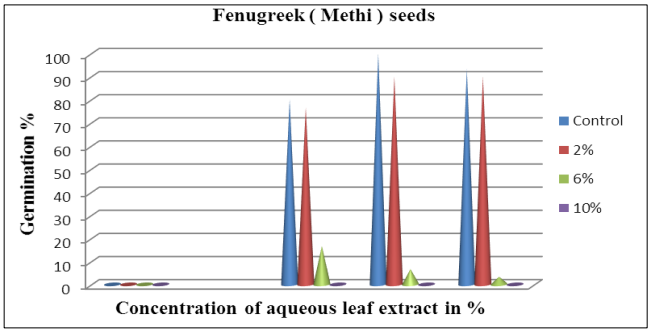

Fig 4: Allelopathic effect Leaf extract of Lantana species on the seeds of IV: Fenugreek, at different concentrations of the Leaf extract (A: Control, B: 2%, C: 6% and D: 10%).

5. Mustard Local Variety

The seeds of this plant showed less percent germination with 6% and 10% concentration of *Lantana* Leaf extract as compared to control.

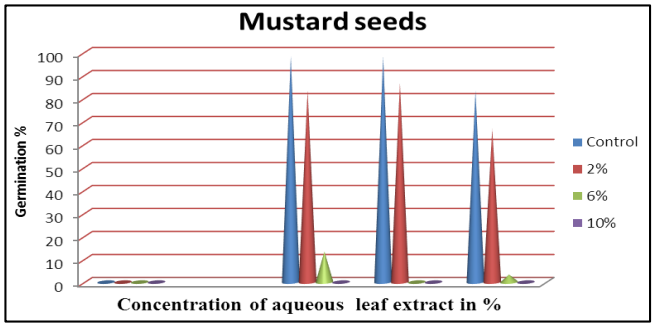

Fig 5: Allelopathic effect Leaf extract of Lantana species on the seeds of V: Mustard, at different concentrations of the Leaf extract (A: Control, B: 2%, C: 6% and D: 10%).

6. F1 Baby Corn Seed:

In 2%, 6% and 10% concentration seeds showed the complete inhibition of germination hence strong allelopathic effect was documented**.**

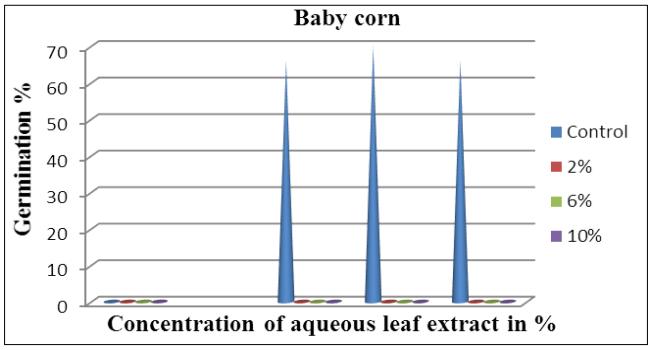

Fig 6: Allelopathic effect Leaf extract of Lantana species on the seeds of VI: Baby corn, at different concentrations of the Leaf extract (A: Control, B: 2%, C: 6% and D: 10%)

Table 1: Percent seed germination of six plant varieties at 2, 6, and 10% compared with Control sample.

Sr. no	Treatment Crop	Treatment	% Germination (in Triplicates)			Average
			1	2	3	
1	F1Baby Corn	Control	66	70	66	67.33
		2%	0	0	0	
		6%	0	0	0	
		10%	0	0	0	
			0	0	0	
2	Mustard Local variety	control	98.33	98.33	83.33	93.33
		2%	83.33	86.66	66.66	78.88
		6%	13.33	0	3.33	5.55
		10%	0	0	0	0
3	F1hbr	Control	66.66	73.33	53.33	64.44
		2%	63.33	50	40	51.11
		6%	23.33	33.33	16.66	24.44
		10%	36.66	36.66	30	34.44
4	Japanese White Radish	Control	90	90	80	86.66
		2%	40	73.33	73.33	62.22
		6%	46.66	53.33	56.66	52.21
		10%	13.33	6.66	6.66	8.88
5	Fenugreek	control	80	100	93.33	91.11
		2%	76.66	90	90	85.55
		6%	16.66	6.66	3.33	8.88
		10%	0	0	0	0
6	Coriander	Control	70	60	80	70
		2%	0	0	0	0
		6%	0	0	0	0
		10%	0	0	0	0

Assessment of Allelopathic effect of the Flower extracts of *Lantana species*

After eight days of incubation at room temperature the percent germination was calculated. The details of the percent seed germination (plant wise) is described below:

1. F1 hybrid Baby corn (*Zea mays*)

The seeds of baby corn plant showed low percent germination at 2%, 6%, and 10% concentration of *Lantana species* Flower extract as compared to control.

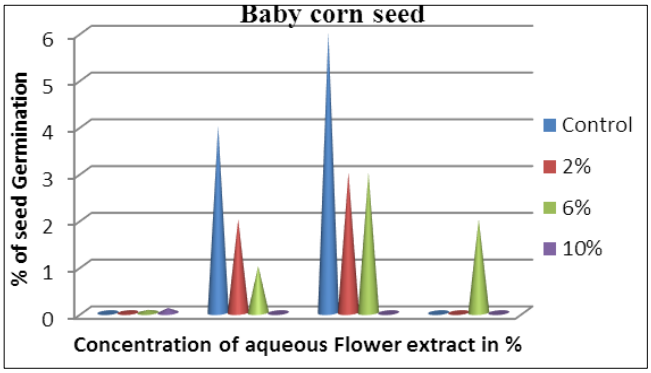

Fig 7: Allelopathic effect Flower extract of *Lantana species* on the seeds of I: Baby corn, at different concentrations of the Flower extract (A: Control, B: 2%, C: 6% and D: 10%).

2. Japanese white Radish (*Raphanus sativus*):

The seeds of radish plant showed zero percent germination at 2%, 6% and 10% concentration of *Lantana* Flower extract as compared to control.

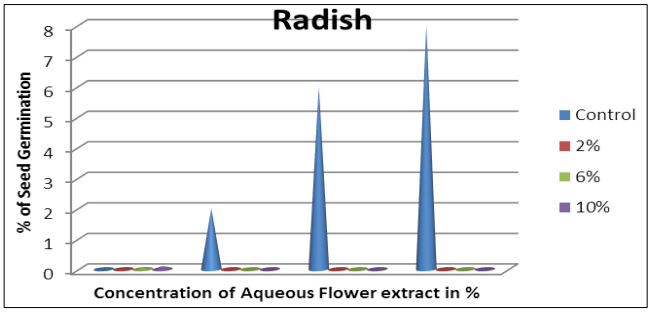

Fig 8: Allelopathic effect Flower extract of *Lantana species* on the seeds of II: Radish, at different concentrations of the Flower extract (A: Control, B: 2%, C: 6% and D: 10%).

3. Fenugreek (methi) Nisha variety

The seeds of methi plant showed low percent germination at 2%, 6%, and 10% concentration of *Lantana* Flower extract as compared to control.

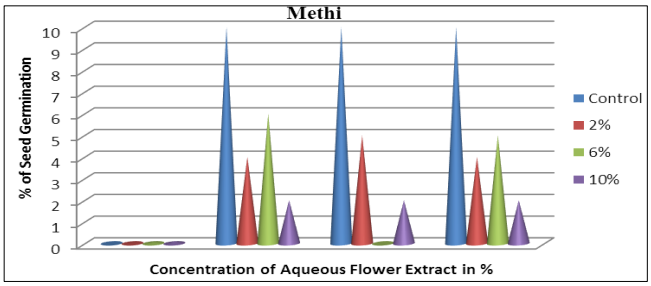

Fig 9: Allelopathic effect Flower extract of *Lantana species* on the seeds of III: Methi, at different concentrations of the Flower extract (A: Control, B: 2%, C: 6% and D: 10%).

4. F1 hybrid beet root (*Beta vulgaris*)

The seeds of beet plant showed Zero percent germination at 2%, 6%, and 10% concentration of *Lantana* Flower extract as compared to control.

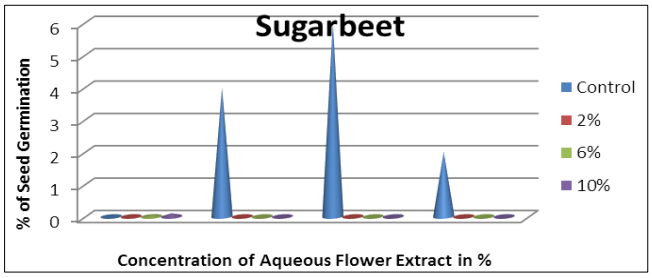

Fig 10: Allelopathic effect Flower extract of *Lantana species* on the seeds of III: Coriander, at different concentrations of the Flower extract (A: Control, B: 2%, C: 6% and D: 10%).

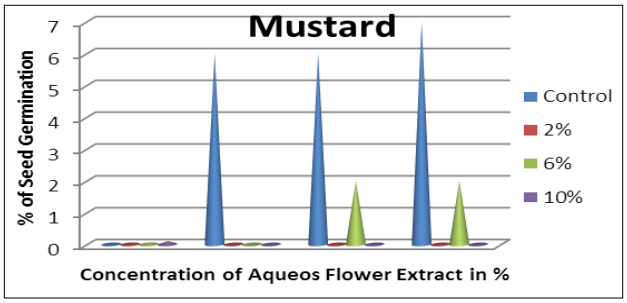

Fig 11: Allelopathic effect Flower extract of *Lantana species* on the seeds of V: Mustard, at different concentrations of the Flower extract (A: Control, B: 2%, C: 6% and D: 10%).

5. Mustard Local Variety

The seeds of Mustard plant showed Zero percent germination at 2%, 6%, and 10% concentration of *Lantana* Flower extract as compared to control**.**

6. Kasturi methi

The seeds of Kasturi methi plant not showed Zero percent germination at 2%, 6%, and 10% concentration of *Lantana* Flower extract as compared to control

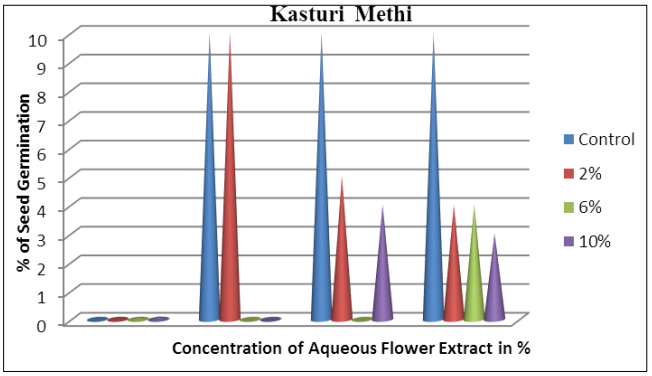

Fig 12: Allelopathic effect Flower extract of *Lantana species* on the seeds of VI: Kasturi methi, at different concentrations of the Leaf extract (A: Control, B: 2%, C: 6% and D: 10%).

Table 2: Percent seed germination of six plant varieties at 2, 6 and 10% compared with control sample

S.r.no	Treatment crop		% of Germination (in triplicates)			Average
			1	2	3	
1	Methi Nisha Var.	control	10	10	10	10
		2%	4	5	4	4.33
		6%	6	0	5	3.66
		10%	2	2	2	2
2	Mustard	Control	6	6	7	6.33
		2%	0	0	0	0
		6%	0	2	2	1.33
		10%	0	0	0	0
3	Beet	Control	4	6	2	4
		2%	0	0	0	
		6%	0	0	0	
		10%	0	0	0	
			0	0	0	
4	Radish	Control	2	6	8	5.33
		2%	0	0	0	
		6%	0	0	0	
		10%	0	0	0	
5	Baby corn	control	4	6	0	3.33
		2%	2	3	0	1.66
		6%	1	3	2	2
		10%	0	0	0	0
6	Methi	Control	10	10	10	10
		2%	10	5	4	6.33
		6%	0	0	4	1.33
		10%	0	4	3	2.33

3.2 Phytochemical Analysis of Leaf and Flower Extract of *Lantana species*.

Table 2

Phytochemicals	Acetone	Methanol	70%Ethanol	Water Extract	Hexane Extract
Alkaloid	+	+	+	+	+
Flvonoid	-	-	-	+	-
Triterpenoides	-	+	-	+	-
Terpenoides	+	+	+	+	+
Phytochemicals	Acetone	Methanol	70%Ethanol	Water Extract	Hexane Extract
Alkaloid	-	+	+	+	-
Flvonoid	-	+	+	+	-
Triterpenoides	+	+	+	+	+
Terpenoides	+	-	+	+	-

(+= Present, - =Absent)

(+= Present, - =Absent)

Table 1-2. The alkaloid, glycoside, terpenoid, and triterpenoid present in a various solvent extract of leaf and flower of *Lantana species* which were responsible for allelopathic effect.

4. Discussion

The allelopathic effects of different concentrations of aqueous leaf extracts and leaf leachates from leaves of *L. camara* were inhibitory to all parameters viz., seed germination to metabolism of mung bean (*Vigna radiata*) seeds (Maiti et al., 2010). Leaf extract of *Lantana camara L*. showed a wide variation in the reduction of the germination rate of seeds of both the vegetable species, radish (*Raphanus sativus L*.) and spinach (*Spinacia oleracea L*.) over the control. The 100% concentration of leaf extract showed maximum inhibition followed by 50% leaf extract (Mishra et al., 2015) there are similar inhibition of aqueous extract *of Lantana species* observed in this research work. According to (Solomon Charles Ugochukwu et al., 2013) results obtained for qualitative screening of phytochemicals in stem bark and roots of *D. tripetala* are presented four phytochemicals screened for, nine were found present in various solvent extracts. They are alkaloid, cardiac glycosides, flavonoids, phenols, carbohydrates, saponins, sterols, tannins and terpenoids. In all, more phytochemicals were found present in the stem bark than in the roots. Remarkably, flavonoids and saponins were not present in roots but present in stem bark. This suggests that the stem bark offers a wider array of phytochemicals than the root, From the stem bark, water extract showed the presence of alkaloid, cardiac glycosides, carbohydrate, flavonoids, phenol, saponins and tannin. However, 70% ethanol and acetone had alkaloid, cardiac glycosides, carbohydrates, flavonoids, phenol, saponins, tannins and terpenoids. The stem bark methanol extract had the presence of alkaloid, cardiac glycosides, carbohydrate, flavonoids, phenol, sterols, tannins and terpenoids, In this research work the Phytochemicals were observed similar with *D. tripetala*. Therefore leaf and flower solvent extract of *lantana species* showed presence of alkaloid, flavonoids, triterpenoid and terpenoid which affects the germination of Agricultural crops. (Solomon Charles Ugochukwu et al., 2013).

5. Conclusion

Based on the present study following conclusions can be drawn: (1) the leaf and flower extract of the *Lantana species* do possess allelopathic effect, (2) *Lantana* leaf and flower produces allelochemical such as alkaloid, Flavonoid, triterpenoids, terpenoids and leads to effect on the germination of selected various crops seeds such asMusturds, (*Brassica juncea*,)*Coriander* (*Coriandrum sativum*) Baby corn (*Zea mays*), F_1 hybrid beet (*Beta vulgaris*), Japanese white radish (*Raphanus sativus*), Fenugreek (*Trigonella foenum graecum*) and Kasturi- methi.(3) due to its strong allelopathic potential *Lantana species* may lead to huge loss of agricultural production per annum if not handled properly.

6. Acknowledgement

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