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RESEARCH ARTICLE

ALLELOPATHIC POTENTIALITIES OF TWO ORNAMENTAL PLANTS *MURRAYA PANICULATA* (L.) JACK AND *ALAMANDA CATHARTICA* L. ON GERMINATION AND GROWTH BEHAVIOUR OF FOUR SELECTED CROPS

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ABSTRACT

An experiment was conducted to understand the growth inhibitory effects of aqueous extracts obtain from *Murraya paniculata* (L.) Jack and *Alamanda cathartica* L. (Ornamental plants) on four agricultural crops of Tripura, India. The test was conducted in sterilized Petri dishes with a photoperiod of 24 hours and an average temperature of 22±2°C. The effect of different concentrations of both the leaf extracts were recorded and compared with control (i.e., distil water). Result showed different concentrations of aqueous leaf extracts caused inhibitory effect on germination, root &shoot elongation and dry biomass of receptor crops. Bioassays also indicated that the inhibitory effect was proportional to the concentrations of the extracts and higher concentration had the stronger inhibitory effect in both the species. These kinds of concentrations dependent response of the receptor plants suggested that the leaf extracts of the both species might contain allelochemical(s).

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INTRODUCTION

The term allelopathy originated from the Greek word 'allelon' meaning each other and 'pathons' means suppressing (Gross, 1999). Allelochemicals are water-soluble non-nutritional secondary metabolites like terpenoids and phenolics have specific action, produced by living organisms (i.e., plants) which have stimulatory or inhibitory effects upon the growth, reproduction, health, behavior, or population biology of neighboring organisms (Abhilasha *et al.,* 2008; Ghafar *et al.,* 2000 & Khanh *et al.,* 2007) and yield of the agro ecosystem (Debnath *et al.,* 2016a).These chemicals are release from roots, stems and leaves of plant in to the environment (Rizvi and Rizbi, 1992; Inderjit, 1996) and mainly affects plant at seed emergence/germination and on seedling growth (Alam and Islam, 2002). Allelopathic plants interfere with nearby plants by directly to the neighboring seedlings or dispersing chemical compounds in to the soil that may inhibit germination, seedlings emergences, its growth and yielding capacity (Debnath *et al.,* 2016b; Ghafar *et al.,* 2000). But allelopathic effects may be species specific (McEwan *et al.,* 2010) conditions such as life stage (Barto *et al.,* 2010), nutrients (Cipollini *et al.,* 2008) and all the chemicals present may not always be harmful, as beneficial interactions have also been reported (Foy and Inderjit, 2001). *Murraya paniculata* (L.) Jack (orange jasmine) a native species belongs to family Rutaceae and, being used as a medicinal and ornamental shrub and landscaping in the tropical and subtropical parts of the world (Olawore *et al.,* 2005). The extracts from leaf and bark had shown anti-nociceptive, anti-inflammatory, anti-diarrhoeal, anti-diabetic, anti-malarial, anti-bacterial, anti-fungal and anti-oxidant activities (Narkhede *et al.,* 2012, Goutam *et al.,* 2012, Rahman *et al.,* 2010 and Dosoky, 2016). Recently a study showed that the plant have allelopathic effects on some weed species like, *Bidens pilosa* L., *Amarathus spinosus* L., *Echinochloa crusgalli* (L.) Beauv. and *Chloris barbata* Sw. (Pangnakorn and Poonpaiboonpipattana, 2013). According to (Rohman and Riyanto, 2005), *Alamanda cathartica* L. is commonly planted as an ornamental in gardens and yard. It is also planted as ground cover and as a hedge plant (Francis, 2000). *A. cathartica* is also used in traditional medicine in the West Indies, where teas prepared from the leaves and roots are used as a strong purgative (Liogier, 1990). It is native to South America including Brazil, French Guyana, Guyana, Suriname, and Venezuela (USDA-ARS, 2013) belongs to the family Apocynaceae. It is a fast-growing vine-like woody shrub and within just one or two growing seasons,

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it can form compact colonies and completely out-compete native vegetation (Pier, 2013). Plant parts are also bitter and toxic if ingested. All parts contain the toxic iridoid lactone, allamandin, which is toxic to livestock and humans, and the sticky milky sap can cause skin irritation (Francis, 2000). The GC-MS analyses determined the presence of 28 different phytochemical compounds in the ethanolic leaf extract of A. cathartica (Johnson *et al.,* 2012).

However, recently the herbicidal activities have been investigated in *Murraya paniculata*, but there is no comprehensive research on allelopathic effects of these two species on agricultural crops. Therefore the objective of the present study was to determine, the allelopathic effects of aqueous leaf of the species *Murraya paniculata* and *Alamanda cathartica* on germination and seedling growth of four widely cultivated agricultural crops.

MATERIALS AND METHODS

The experiment was conducted in complete randomized design (CRD) in the lab of Plant Diversity and Forest Biotechnology TU, Tripura, India in 2015, with different concentrations of leaf extracts (Control, 1.25%, 2.5%, 5%, 10% and 20%) labeled as T_0, T_1, T_2, T_3, T_4 and T_5 respectively and replicated 3 times.

The receptor plants

The receptor agricultural crops were *Cicer arietinum* L. (Chick pea), *Vigna radiata* L. (Mung bean), *Vigna mungo* (L.) Hepper (Black gram) and *Trigonella foenum-graecum* L. (Fenugreek seed).

Donor plant and sample collection

Donor plant and preparation of leaf extracts for the present experiment we collected the mature leaves of *Murraya paniculata* and *Alamanda cathartica* in the month of February (2015) from the areas surrounding vegetable fields west Tripura district. After collection the leaves were thoroughly washed and placed in the shade for drying within the laboratory at room temperature for 144 hours. After that the leaves were pieces into small sizes up to 1cm long and further dried up. Fully dried leaves were grinded into a powder using kitchen grinder.

Preparation of Aqueous extracts

Hundred grams of leaf powdered sample were soaked in 500 ml of distilled water within 1 liter conical flask for both the species separately. After that the conical flasks were kept on a mechanical shaker for 24 hours and filtered through cotton cloth. The supernatant were centrifuged at 10,000 rpm for 10 minutes for separating the extra debris from the solutions, which served as a stock solution (20%) for aqueous extract. From that solution various concentrations of extract were prepared by the way of dilution for both the donor species.

Experiment design

Healthy seeds of all four selected pulses were surface sterilized with 0.1% sodium hypochlorite solution for 2 min and washed thoroughly with distilled water in such a way that the excess of sodium hypochlorite should not contaminate the inner cotyledons of the seeds. Then sufficient numbers of autoclaved Petri dished were prepared; each containing a single layered of No.3 What man filter paper. Each Petri dish was wetted with 5 ml of test solutions of different concentrations of leaf extracts obtain from both the species separately. The Petri dish wetted with distilled water were taken as control and considered to be set 0. In each Petri dish, 25 surface sterilized seeds were placed separately for each tested species. A total of 3 replications of all the sets of various concentrations were kept undisturbed at room temperature (22 ± 2°C) in the laboratory for 5 days. The numbers of germinated seeds, length of radical and plumule of each set were recorded for the different experimental set used for both the leaf extracts at 5th days. The emergence of a radical approximately 1 mm in length was taken into considered as germination. For radical and plumule length measurement 10 seedlings were selected randomly from every Petri plate and measured by using proper cm scale. To observe the effects of allelochemicals on seedling biomass in aqueous leaf solution of *Murraya paniculata* and *Alamanda cathartica*, 10 seedlings of each Petri plate were taken and cut separated all of them into radical and plumule. Fresh biomass of that separated parts of the seedlings were taken separately into trussing papers and weighted by using electronic balance and for estimating the dry weight biomass all the fresh seedling parts were kept in to hot air oven (45°C) for 3 days and further weighted in to same electronic balance.

Treatments

The following treatments were followed during the experiment:
T_0 Seeds of receptor plants grown in distill water only (Control);
T_1 Seeds of receptor plants grown in extracts of 1.25% concentration;
T_2 Seeds of receptor plants grown in extracts of 2.5% concentration;
T_3 Seeds of receptor plants grown in extracts of 5% concentration;
T_4 Seeds of receptor plants grown in extracts of 10% concentration;
T_5 Seeds of receptor plants grown in extracts of 20% concentration.

Statistical analysis

Calculations of inhibition and germination percentage were determined by the formulae given below. Radical/plumule growth and biomass (dry weight) were estimated by using Microsoft excel, 2008 and IC_{50} values were calculated by using an online linear regression calculator. In case preparation of graph with standard deviation using standard bar, we used MS-Excel (2008 Version)

Inhibition percentage I= [1- (Et/Ec) x 100]

Where, Et = Mean of the treated sample

Ec= Mean of the controlled sample
Germination percentage = 100 – inhibition percentage

RESULTS AND DISCUSSION

Germination: The germination percent of the 4- receptor plants *Cicer arietinum* L., *Vigna radiata* L., *Vigna mungo* (L.) Hepper and *Trigonella foenum-graecum* L. is shown in (Table 1&2; Figure 1&2).

Table 1. Percentage of inhibition on germination, growth and seedling biomass of four crops treated with aqueous leaf extracts of *Murraya paniculata*

Parameters	*Cicer arietinum*				*Vigna radiata*				*Vigna mungo*				*Trigonella foenum-graecum*			
	G	R	P	B	G	R	P	B	G	R	P	B	G	R	P	B
T_0(control)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T_1 (1.25%)	6.67	36.56	51.80	42.59	2.71	18.34	28.95	36	6.79	15.61	38.75	44.69	17.45	2.84	27.79	25
T_2 (2.5%)	70.78	37.42	54.68	59.26	9.45	19.24	29.43	48	10.78	17.1	39.64	53.2	25.45	4.74	29	58.33
T_3 (5%)	77.45	92.26	92.26	81.48	17.45	37.36	60.80	52	13.79	17.84	56.35	68.09	29.45	35.54	89.12	70.83
T_4 (10%)	100	100	100	100	46.11	70.92	72.65	72.8	40.11	57.99	78.4	77.87	86.78	67.30	97.88	86.67
T_5 (20%)	100	100	100	100	91.5	100	100	100	91.5	100	100	100	100	100	100	100
$IC_{50\%}$	4.44	3.93	2.18	2.99	11.18	8.30	6.76	6.1	11.49	9.57	5.95	4.56	9.79	9.25	4.89	4.85

G, Germination; R, Radical; P, Plumule; B, Biomass (Dry)

Table 2. Percentage of inhibition on germination, growth and seedling biomass of four crops treated with aqueous leaf extracts of *Alamanda cathartica*

Parameters	*Cicer arietinum*				*Vigna radiata*				*Vigna mungo*				*Trigonella foenum-graecum*			
	G	R	P	B	G	R	P	B	G	R	P	B	G	R	P	B
T_0 (control)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T_1 (1.25%)	37.82	3.56	14.44	42.43	8	11.81	26.02	25	2.56	21.68	59.35	15.79	30.93	15.81	16.62	41.18
T_2 (2.5%)	84	44.86	26.67	54.55	18.19	37.90	64.34	41.67	5.78	49.59	73.66	36.82	37.98	49.88	31.72	82.35
T_3 (5%)	89.44	81.14	82.22	65.16	30.89	61.86	89.76	62.5	9.88	56.1	84.15	47.37	43.93	62.29	57.70	91.18
T_4 (10%)	100	100	100	100	75.23	78.16	94.58	100	57.68	63.96	89.95	63.16	70.89	100	100	100
T_5 (20%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
$IC_{50\%}$	1.46	5.46	5.68	3.97	8.63	6.82	3.45	5.42	10.33	6.80	1.14	7.81	7.08	5.47	6.26	1.24

G, Germination; R, Radical; P, Plumule; B, Biomass (Dry)

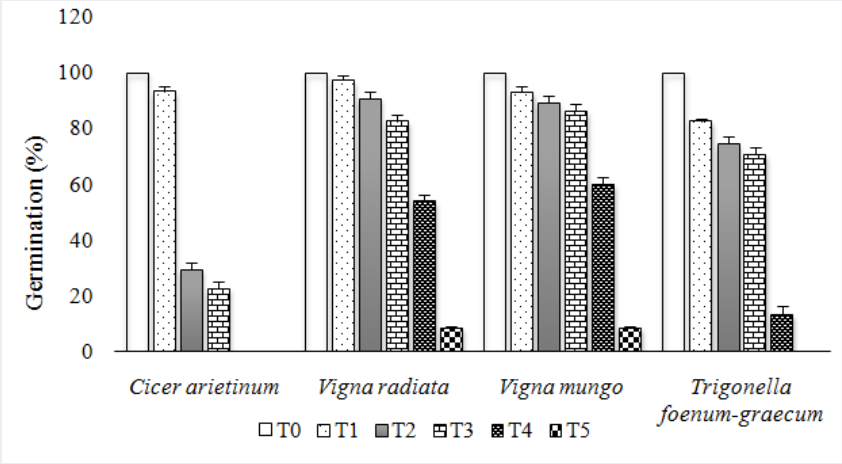

Figure 1. Effects of *M. paniculata* leaf extracts on seed germination % of four selected crops at 5th day. The vertical bars indicate SD of mean

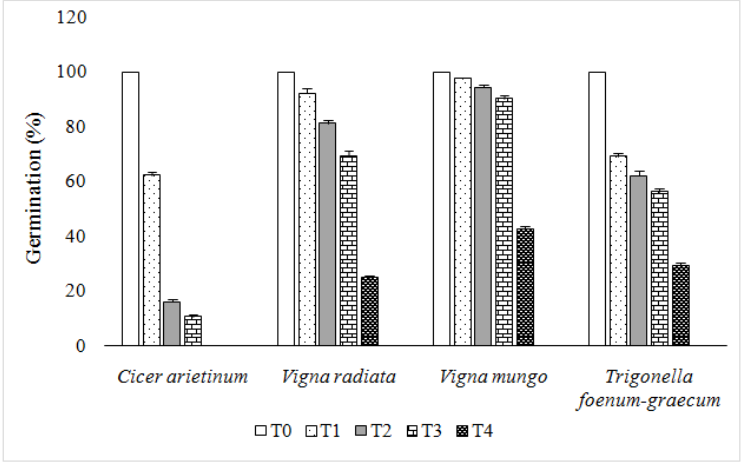

Figure 2. Effects of *A. cathartica* leaf extracts of on seed germination % of four selected crops at 5th day. The vertical bars indicate SD of mean

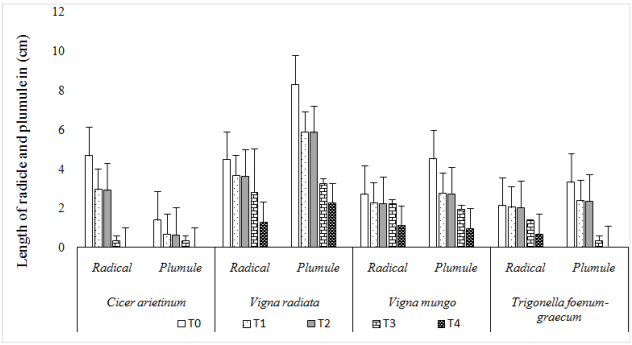

Figure 3. Effects *M. paniculata* on radical-plumule growth (cm) of four selected crops. The vertical bars indicate SD of mean

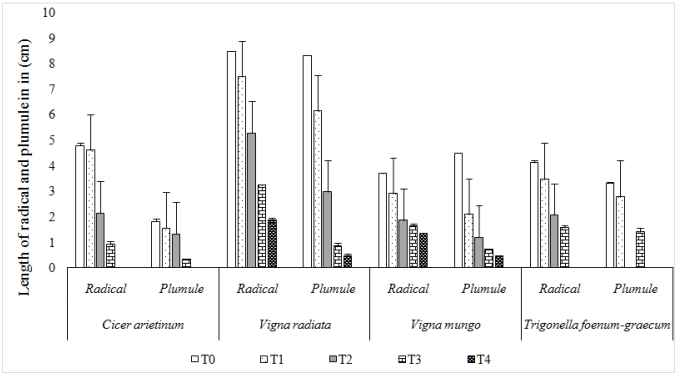

Figure 4. Effects of *A. cathartica* on radical- plumule growth (cm) of four selected crops. The vertical bars indicate SD of mean

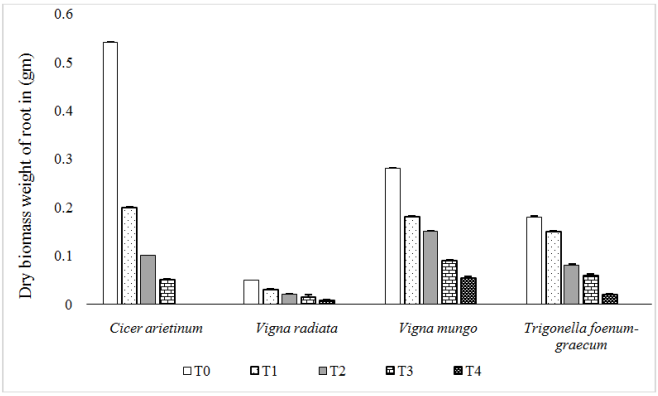

Figure 5. Effects of aqueous leaf extracts of *Murraya paniculata* on DWR of four selected crops after 5thdays. The vertical bars indicate SD of mean

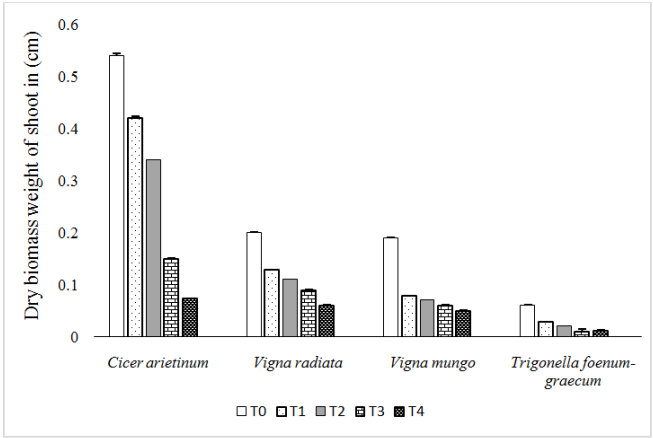

Figure 6. Effects of M.paniculataon DWS of four selected crops after 5thdays. The vertical bars indicate SD of mean

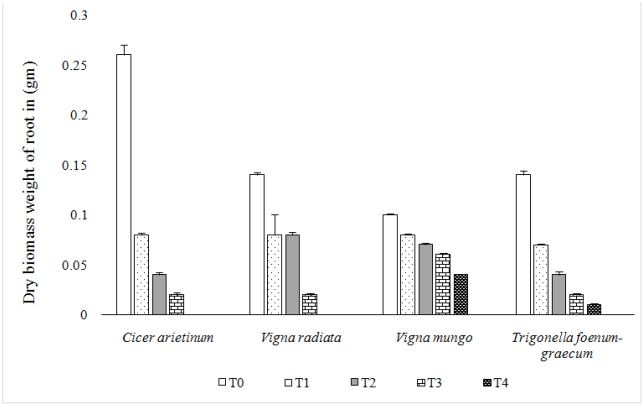

Figure 7. Effects of *A. cathartica* L. DWR of four selected crops after 5th days. The vertical bars indicate SD of mean

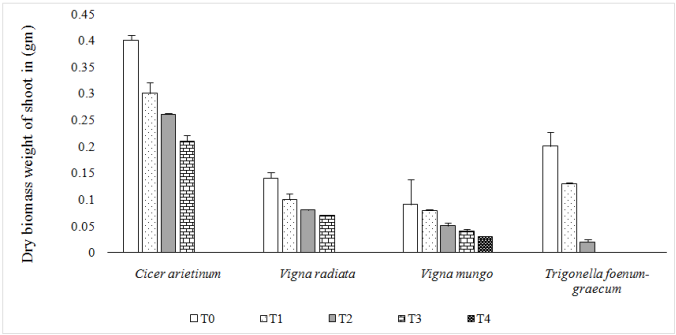

Figure 8. Effects of *A. cathartica* L. DWS of four selected crops after 5th days. The vertical bars indicate SD of mean

In almost all cases, variation of germination percent varied evenly due to different concentrations. With the increase of concentration, the germination rates were decreased treated with both the species and the inhibitory effect was progressively increased. In all cases, the maximum inhibitory effect (100%) was found at T_5 treatment (20% conc.) except *V. radiata* (91.5%) and *V. mungo* (91.5%) when treated with the extracts of *Murraya paniculata* while, 100% inhibitions were showed by the all receptor crops, extract treated with *Alamanda cathartica.* The IC_{50} values were recorded (4.44, 11.18, 11.49 and 9.79%) in case of *Murraya paniculata* while in *Alamanda cathartica* the IC_{50} values were (1.46, 8.63, 10.33 and 7.08%) for *Cicer arietinum*, *Vigna radiata, Vigna mungo* and *Trigonella foenum-graecum* respectively, which indicate *Alamanda cathartica* is more effective than the *Murraya paniculata* to all the receptor species. Among the receptors *Vigna radiata* and *Vigna mungo* were little bit less sensitive in different concentrations of the both donor plant. It was also perceived that leaf extracts of *Murraya paniculata* and *Alamanda cathartica* delayed the germination significantly in all the receptor crops compared to the control treatments. These results are more or less similar to the findings of Bora *et al.* (1999), who found the allelopathic effect of aqueous leaf extracts of *Acacia auriculiformis* on seed germination of some agricultural crops.

The allelopathic effect of *Bambusa arundinacea* on *Arachis hypogaea* was reported (Eyini *et al.,* 1989) to conclude that, aqueous extracts of weeds inhibited the seed germination of selected crops. Debnath *et al.,* (2016) also found that the aqueous extracts of an invasive weed *Solanum sisymbriifolium* have inhibitory effects on some agricultural crops.

Growth behaviors

Radical and plumule elongation

The average mean root &shoot lengths and inhibitory effects of the germinated seedlings of agricultural crops in all the receptor are shown in (Table 1&2; Figure 3&4). The study revealed that in comparison to control and the inhibitory effect was gradually increased with the increase of concentrations for both the species. The greater inhibitory effects of radical and plumule were found as like germination inhibition where *Cicer arietinum* and *Trigonella foenum-graecum* were highly sensitive than other two receptor species. All the receptor species showed (100%) inhibitory effects at T_5while, *Cicer arietinum* showed same at T_4 in case of both the species and *Trigonella foenum-graecum* also showed(100%) inhibitory effects at T_4 when treated with *Alamanda cathartica,* which indicate *Cicer arietinum* and *Trigonella foenum-graecum* is high sensitive to the donor plant *Alamanda cathartica.* Among the survivors the highest inhibition was found (97.88) in case of *Trigonella foenum-graecum* shoot when treated with leaf extract of *Murraya paniculata* at T_4 and the lowest inhibitory effect was found on *Trigonella foenum-graecum* (2.84) in extract of *M. paniculata* at T_1. IC_{50} values of aqueous extract for radical and plumule growth of *Cicer arietinum, Vigna radiata, Vigna mungo* and *Trigonella foenum-graecum* were recorded from 1.14% to 9.25% (Table 1&2). Our observations are support by the previous workers (Kato-noguchi, 2001; Caussanel, 1979; Chung and Miller, 1995; Babu and Kandasamy, 1997) that the activity of the weeds residue is directly proportional to the concentrations used in the experiment.

Biomass (dry weight)

The dry weight of 5 days old receptor seedlings were effected upon treated with the various aqueous leaf extracts concentration of *M. paniculata* and *A. cathartica.* Although at T_1, the inhibition of dry weight of the seedlings were 15-40%, higher concentration reduced the weight and when it reach at T_5 then almost all the sets were completely inhibited. The inhibition activity of both the donor species are more or less similar and insignificantly different to all the receptor species. Among the survivor, lowest inhibition percentage was see in *V. mungo* (15.79%) at T_1 within the *A. cathartica* leaf extracts while highest was found in *Trigonella foenum-graecum* (91.18) at T_4 of the same extract. Inhibition percentage of dry biomass of *M. paniculata* and *A. cathartica* on the four receptor plants were shown in (Table 1&2) and reduction in biomass was also observed with increase in concentrations. These reductions in biomass may be due to stunted and reduced growth of the seedlings reported by (Tripathy *et al.,* 2000). In this comparative study, though both the extracts showed allelopathic potential, the degree of inhibition to all the receptor species seemed to be highest but *A. cathartica* is higher effective than the *M. paniculata.*

Conclusion

It is evident from the present investigation that both the donor species *M.* paniculata and *A. cathartica* has allelopathic potentiality to all the receptor species. Our study also reveals that aqueous extracts of both the leaves of ornamental species are the potent source of toxic metabolites as compare to the receptor seeds which might reduce the economy of the commercial vegetables. Therefore the site selection for these two ornamental plants will be maintained.

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