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Influence of different botanicals extract on the management of *Parthenium hysterophorus* (L.) for eco-friendly approach

Ramachandran A and NS Venkataraman

Abstract
The present study was carried out to find out the "Influence of different botanical extracts on the management of Parthenium through laboratory experiments. These experiments were carried out at Department of Agronomy, Agricultural College and Research Institute, Madurai during 2013-15. Influence of twenty botanicals *viz.*, *Abutilon indicum, Amaranthus spinosus, Amaranthus viridis, Azadirachta indica, Calotropis gigantea, Croton bonplandianum, Cynodon dactylon, Cyperus rotundus, Datura metel, Echinochloa crusgalli, Helianthus annuus, Lawsonia inermis, Mangifera indica, Prosopis juliflora, Solanum nigrum, Sorghum bicolor, Sorghum halepense, Tagetes erectus, Tamarindus indica, Tephrosia purpurea* were tried at different concentration under laboratory bioassay. The study reveal that the per cent germination, seedling length, seedling vigor index and seedling biomass of Parthenium was reduced significantly due to application of all botanicals, however the effect was more pronounced with botanicals extract in the order of *Datura metel, Mangifera indica, Azadirachta indica, Tagetes erectus, Helianthus annuus* and *Sorghum bicolor* both at 50 and 75% conc. Increased concentration (50 and 75%) was pronounced maximum detrimental effects on per cent germination and seedling growth parameters of *P.hysterophorus*.

Keywords: *Parthenium hysterophorus*, per cent germination, seedling length, seedling vigor index and seedling biomass.

Introduction

Allelopathy plays an important role in agricultural ecosystems and in a large scale, in the plant covers among the crop-crop, crop-weed and tree-crop covers. These interactions are detrimental and occasionally are useful and give attention to allelopathy in natural and agricultural ecosystems.

Invasion of exotic species is among the most important global scale problems experienced by natural ecosystem (Sharma *et al*., 2005) [19]. Invasive alien species are such species whose introduction or spread threatens the environment, economy or society including human health. *Parthenium hysterophorus* L. is an annual herb of neo tropical region, now fairly distributed throughout the globe. *P.hysterophorus* L. an abnoxious weed has been reported as a main source of nuisance and health hazard to mankind and animals, threat to bio-diversity and danger to environment (Knox *et al*., 2011) [14]. Today parthenium has got a position among the list of top ten worst weeds of the world and has been listed in the global invasive species data base and it has invaded almost all the states of India encroaching about 35 million hectares of land.

During the 1980's, parthenium weed used to be considered a weed of rainfed fallow and a waste land, but now it has become a weed of every crop and also into the forested land. It reported to cause yield loss upto 40% in several crops. (Khosla and Sobti, 1979) [13] and reduction in forage production upto 90% (Nath, 1988) [17].

Infestation by parthenium degrade natural eco systems. Its pollen is known to inhibit from fruit set in many crops. The germination and growth of indigenous plants are inhibited by its allelopathic effect. In human beings, the pollen grain, air borne pieces of dried plant material and roots of parthenium can cause allergy type responses like hay fever, asthma, eczema *etc*.,

Besides in animals, the plant can cause with external symptoms of pruritis, alopecia, loss of skin pigmentation, facial and body dermatitis, erythematous eruptions and anorexia. The milk of cattle, buffalo and sheep may also be tainted by parthenin (Towers and Subba Rao, 1992) [23], which can also affect sheep meat. Parthenium offers a big challenge to all attempts of control because of its high regeneration capacity, production of huge amount of seeds, high seed germination and extreme adaptability to a wide range of ecosystems.

Preventing the spread of parthenium is the most cost effective management strategy. There is a high risk of spreading parthenium by the movement of vehicle, livestock and crop produces. Eradication of *P.hysterophorus* by manual, chemical and biological control methods such as leaf feeding beetle and fungi have been carried out with variable degree of success.

Manual uprooting of parthenium before flowering and seed setting is the most effective method by adopting proper precaution measures. Uprooting the weeds after seed setting will increase the area of infestation. Parthenium is reported to be controlled by foliar spray of some herbicides (Javaid *et al*., 2006) [11]. Although herbicides are the most effective immediate solution to most weed problems but increased and indiscriminate use of these herbicide resulted in resistance and resurgence in pests. Resistance to specific synthetic herbicides is increasing dramatically in the last two decades leading to lowering the land values resulting farmers to run out of weed controlling chemicals. Now, it is imperative to concentrate on research to find out some natural extract to control this menace, thereby minimizing or avoiding the frequent use of herbicides in future. Furthermore, increasing public concern on environmental issues requires alternative weed management systems, which are less pesticide dependent or based on naturally occurring compounds (Singh *et al*., 2003) [21]. With increasing societal concern regarding the harmful effects of chemical or synthetic pesticides on humans as well as on environment have aroused substantial interest to evolve alternate eco-friendly approaches for the control of parthenium.

In this regard, allelopathic effect of different plants is drawing attention on many researchers in the recent past. Therefore, keeping this view, studies on exploring the efficacy evaluation of certain botanicals extract on the growth of parthenium was under taken with the following objectives.

1. To influence of allelopathic potential of different botanicals leaf extract on *Parthenium hysterophorus* L.
2. To effect of identified botanicals with different concentrates on morpho physical and biochemical properties of *Parthenium.*

Materials and methods

The experiment was conducted in Agricultural College and Research Institute, Madurai, which is situated at 9º54' N latitude and 78º 54' 'E' longitude with an altitude of 147 m above mean sea level. Laboratory bioassay study was conducted to find out the effect of aqueous leaf extracts of botanicals (Plate 1) on the control of *P. hysterophorus* L. The details of the experiments are furnished below. The experiment was carried out during December 2013 by following complete randomized block design (CRBD). The experiment consists of twenty botanicals with three concentrations and the botanicals and concentrations are presented as below.

Botanicals

B_1	*Abutilon indicum*	**B_{11}**	*Helianthus annuus*
B_2	*Amaranthus spinosus*	**B_{12}**	*Lawsonia inermis*
B_3	*Amaranthus viridis*	**B_{13}**	*Mangifera indica*
B_4	*Azadirachta indica*	**B_{14}**	*Prosopis juliflora*
B_5	*Calotropis gigantea*	**B_{15}**	*Solanum nigrum*
B_6	*Croton bonplandianum*	**B_{16}**	*Sorghum bicolor*
B_7	*Cynodon dactylon*	**B_{17}**	*Sorghum halepense*
B_8	*Cyperus rotundus*	**B_{18}**	*Tagetes erectus*
B_9	*Datura metel*	**B_{19}**	*Tamarindus indica*
B_{10}	*Echinochloa crusgalli*	**B_{20}**	*Tephrosia purpurea*

Concentrations

C_1 25% plant extract
C_2 50% plant extract
C_3 75% plant extract
Control: Spray with distilled water

Collection of *Parthenium* seeds

Seeds of *Parthenium* were collected from Agricultural College and Research Institute, experimental farm during December 2013 and dried in shade for about a week. Air dried seeds with moisture content below 12% managed through repeated weighing and drying was used for this experiment (Jawahar *et al*., 2013) [12].

Collection of botanicals

Botanicals of twenty different plants leaves at before flowering were collected and the leaves were washed gently with tap water only a few seconds for removing contaminants like dust etc.

Preparation of aqueous leaf extracts

The collected fresh leaves of each botanicals were cut into small pieces, soaked in alcohol and water at 1:1 proportion, and kept for overnight. After 12 hrs, soaked leaves were ground with the help of mixer grinder. From the paste, the leaf extract of each botanical species was prepared by filtration which represented 100 per cent stock solution (Sripunitha, 2009) [22]. Further dilution of 25, 50 and 75 per cent (w/v) concentrations were prepared by adding appropriate quantity of distilled water to the 100 per cent stock solution and used as per the treatment schedule.

Sowing

In a laboratory bioassay, the effect of different concentrations of leaf extracts on germination and early seedling growth of Parthenium was studied. For this,

10 seeds of Parthenium were placed in a 9-cm diameter petri plate lined with a filter paper and moistened with 3 ml of different concentrations of leaf extracts. Treatment with distilled water served as control. Each treatment was replicated thrice. The petri plates were incubated at 25 °C and 12 hrs light period daily for 10 days. This laboratory bioassay study was conducted twice and means values were taken for the study.

Observations

Germination percentage

Germination/emergence was measured on 7 DAS and was calculated following the procedure of seedling evaluation in the Handbook of Association of Official Seed Analysts (AOSA, 1990) [4] by using the formula:

$$\text{Germination \%} = \frac{\text{No. of germinated seeds}}{\text{Total No. of seeds}} \times 100$$

Root length

Root length was measured on 10 DAS and mean value was calculated and expressed in millimetre.

Shoot length

Shoot length was also measured by using the same seedlings and expressed in millimetre.

Seedling vigor index

The seedling vigor index was calculated as suggested by using Abdul –Baki and Anderson (1973) [1] formulae.

SVI= (Shoot length + Root length) X Germination percentage

Fresh weight

The seedlings measured for root and shoot length were also used for recording fresh weight and expressed in milligrams.

Statistical analysis

The experimental data collected from three replications were subjected to statistical scrutiny by the method suggested by Gomez and Gomez (1984) [6] and whenever the results were found significant critical differences were worked out at five per cent probability level.

Results

Per cent germination

Result data on aqueous leaf extract of botanicals with different concentration on germination percentage are presented in Table (1).

Among the botanicals, the highest inhibition was observed with *Datura metel* where only (4.44%) seeds were germinated followed by *Mangifera indica* (8.89). Moreover, *Azadirachta indica, Tagetes erectus, Helianthus annuus and Sorghum bicolor* were also differ significantly in lowest the germination percentage from other plant extracts as well as control. Therefore the order of inhibition was observed as *Datura metel* > *Mangifera indica* > *Azadirachta indica* > *Tagetes erectus* > *Helianthus annuus* > *Sorghum bicolor*.

Though, *Solanum nigrum* and *Amaranthus viridis* with 50 and 75% concentrations registered minimum germination percentage at lower concentration, but the inhibition was very less as compared to *Datura metel, Mangifera indica, Azadirachta indica, Tagetes erectus, Helianthus annuus* and *Sorghum bicolor*.

The adverse effect of 25 to 75% concentration was significant on the germination of *P.hysterophorus* seeds. The highest concentration of 75% extract reduced the germination percentage to the level of (24.50) that was on par with 50% concentration (26.33).Whereas control recorded maximum germination percentage of 100.

The competition interaction effects between concentrations and botanicals were found significant. Among the interactions, *Datura metel, Mangifera indica, Azadirachta indica, Tagetes erectus, Helianthus annuus, Sorghum bicolor* and *Solanum nigrum* and *Amaranthus viridis* with 50 and 75% concentration completely inhibited the germination percent and were on par with each other as compared to other plant extracts and control.

Table 1: Influence of botanicals on per cent germination of *Parthenium hysterophorus* L

Botanicals	Per cent germination			
	Concentration			Mean
	C_1 – 25%	C_2 – 50%	C_3 – 75%	
B_1	76.66 (66.05)	16.66 (23.85)	13.33 (21.14)	35.55 (37.01)
B_2	73.33 (60.00)	6.60 (12.38)	3.33 (6.33)	27.75 (26.24)
B_3	70.00 (61.91)	0.00 (0.28)	0.00 (0.28)	23.33 (20.82)
B_4	40.00 (39.14)	0.00 (0.08)	0.00 (0.28)	13.33 (13.24)
B_5	50.00 (45.00)	33.33 (35.01)	30.00 (33.00)	37.78 (37.67)
B_6	86.66 (72.19)	43.33 (41.15)	40.00 (39.14)	56.66 (50.83)
B_7	96.66 (83.66)	83.33 (69.98)	80.00 (67.97)	86.66 (73.87)
B_8	96.66 (83.66)	76.66 (61.92)	73.33 (59.21)	82.22 (68.26)
B_9	13.33 (21.14)	0.00 (0.28)	0.00 (0.28)	4.44 (7.23)
B_{10}	96.66 (83.66)	86.66 (68.85)	83.33 (69.98)	88.88 (74.16)
B_{11}	46.66 (43.07)	0.00 (0.28)	0.00 (0.28)	15.55 (14.55)
B_{12}	93.33 (80.95)	70.00 (56.99)	66.66 (55.07)	76.66 (64.34)
B_{13}	26.66 (30.78)	0.00 (0.28)	0.00 (0.28)	8.89 (10.45)
B_{14}	80.00 (63.93)	23.33 (28.78)	20.00 ()26.07	41.11 (39.59)
B_{15}	63.33 (53.06)	0.00 (0.28)	0.00 (0.028)	21.11 (17.88)
B_{16}	50.00 (45.00)	0.00 (0.28)	0.00 (0.28)	16.67 (15.19)
B_{17}	66.66 (54.78)	0.00 (0.28)	0.00 (0.28)	22.22 (18.45)
B_{18}	43.33 (41.07)	0.00 (0.28)	0.00 (0.28)	14.44 (13.88)
B_{19}	90.00 (78.74)	50.00 (45.00)	46.66 (43.07)	62.22 (55.60)
B_{20}	83.33 (69.98)	36.66 (37.14)	33.33 (35.21)	51.11 (47.44)
Mean	67.16 (58.89)	26.33 (24.18)	24.50 (22.94)	
Control	100 (89.71)			
	B	C	B x C	
S.Ed	4.35	1.68	7.54	
CD (P=0.05)	8.61	3.34	14.92	

Figures in parenthesis are (arc sine) transformed values

B_1-*A.indicum*
B_2- *A. spinosus*
B_3- *A. viridis*
B_4 – *A. indica*
B_5-*C. gigantea*
B_6- *C. bonplandianum*
B_7- *C. dactylon*
B_8-*C rotundus*
B_9- *D. metel*
B_{10}- *E. crusgalli*
B_{11}- *H. annuus*
B_{12}- *L. inermis*
B_{13}- *M. indica*
B_{15}- *S. nigrum*
B_{16}- *S. bicolor*
B_{18}- *T .erectus*
B_{19}- *T. indica*
B_{20}- *T. purpurea*

Root length

Observations recorded on root length (mm) are presented in Table (2). The data revealed that significant differences among treatments were observed.

Among the aqueous leaf extracts, *Datura metel* caused (91.10%) reduction in root length as compared to control. This was followed by *Mangifera indica, Azadirachta indica, Tagetes erectus, Helianthus annuus* and *Sorghum bicolor* which also showed reduced root length.

Though, *Solanum nigrum* and *Amaranthus viridis* with 50 and 75% concentration completely inhibited the root length but the reduction was less at 25% concentration as compared to *Datura metel, Mangifera indica, Azadirachta indica, Tagetes erectus, Helianthus annuus* and *Sorghum bicolor.*

Seedling root length was reduced significantly with 50 and 75% concentration (4.88 and 4.85) and they were on par with each other followed by 25 per cent concentration (12.00). Whereas, distilled water (control) recorded maximum seedling root length of 20.58.

Similarly, interaction effects between concentrations and botanicals were also significant. *Datura metel* with maximum concentrations of 50 and 75% completely inhibited the root length. This was followed by *Mangifera indica, Azadirachta*

indica, *Tagetes erectus*, *Helianthus annuus*, *Sorghum bicolor*, *Solanum nigrum* and *Amaranthus viridis* with increased concentration 50 and 75% as compared to other interactions.

Table 2: Influence of botanicals on root length (mm) of *Parthenium hysterophorus* L.

Botanicals	Root length (mm)			
	Concentration			Mean
	C_1 – 25%	C_2 – 50%	C_3 – 75%	
B_1	11.78 (2.75)	5.67 (2.26)	5.60 (2.25)	7.68 (2.43)
B_2	11.47 (2.73)	2.16 (1.81)	2.12 (1.80)	5.25 (2.12)
B_3	11.14 (2.71)	0.00 (1.39)	0.00 (1.39)	3.71 (1.82)
B_4	8.04 (2.48)	0.00 (1.39)	0.00 (1.39)	2.68 (1.75)
B_5	8.98 (2.56)	7.58 (2.44)	7.53 (2.43)	8.03 (2.48)
B_6	14.56 (2.92)	8.17 (2.49)	8.13 (2.48)	10.29 (2.64)
B_7	19.29 (3.14)	13.42 (2.85)	13.38 (2.84)	15.36 (2.95)
B_8	18.22 (3.10)	11.78 (2.75)	11.71 (2.74)	13.90 (2.87)
B_9	5.49 (2.25)	0.00 (1.39)	0.00 (1.39)	1.83 (1.67)
B_{10}	20.21 (3.18)	14.56 (2.92)	14.48 (2.91)	16.42 (3.00)
B_{11}	8.26 (2.50)	0.00 (1.39)	0.00 (1.39)	2.75 (1.76)
B_{12}	17.25 (3.05)	11.14 (2.71)	11.10 (2.70)	13.16 (2.82)
B_{13}	7.02 (2.39)	0.00 (1.39)	0.00 (1.39)	2.34 (1.72)
B_{14}	12.59 (2.80)	6.85 (2.38)	6.80 (2.37)	8.75 (2.52)
B_{15}	10.12 (2.64)	0.00 (1.39)	0.00 (1.39)	3.37 (1.80)
B_{16}	8.51 (2.52)	0.00 (1.39)	0.00 (1.39)	2.84 (1.76)
B_{17}	10.55 (2.67)	0.00 (1.39)	0.00 (1.39)	3.52 (1.81)
B_{18}	8.15 (2.49)	0.00 (1.39)	0.00 (1.39)	2.72 (1.75)
B_{19}	15.00 (2.94)	8.55 (2.52)	8.43 (2.51)	10.66 (2.66)
B_{20}	13.42 (2.85)	7.79 (2.46)	7.73 (2.45)	9.65 (2.59)
Mean	12.00 (2.74)	4.88 (2.007)	4.85 (2.003)	
Control	20.58 (3.20)			
	B	C	B x C	
S.Ed	0.01	0.00	0.01	
CD (P=0.05)	0.02	0.01	0.03	

Figures in parenthesis are log (x+4) transformed values

B_1-*A.indicum*
B_2- *A. spinosus*
B_3- *A. viridis*
B_4 – *A. indica*
B_5-*C. gigantea*
B_6- *C. bonplandianum*
B_7- *C. dactylon*
B_8-*C rotundus*
B_9- *D. metel*
B_{10}- *E. crusgalli*
B_{11}- *H. annuus*
B_{12}- *L. inermis*
B_{13}- *M. indica*
B_{15}- *S. nigrum*
B_{16}- *S. bicolor*
B_{18}- *T .erectus*
B_{19}- *T. indica*
B_{20}- *T. purpurea*

Shoot length

Data on shoot length (mm) are presented in Table (3). Significant variation in shoot length of parthenium among the botanicals was observed.

The effect of *Datura metel* was more pronounced and reduced the shoot length by (91.77%) as compared to control. This was followed by in the order of *Mangifera indica*> *Azadirachta indica*> *Tagetes erectus*> *Helianthus annuus*> *Sorghum bicolor*.

All the concentration of aqueous leaf extracts significantly minimized the shoot length by (41.05 to 75.84%) as compared to control.

Higher concentrations of 50 and 75% significantly recorded lower shoot length (3.23 and 3.20) and par with each other. Whereas maximum shoot length was noticed at 25% concentration and control.

Interaction effects between concentrations and botanicals also registered significantly. It was found that complete inhibition of shoot length of *P. hysterophorus* was observed in the order of *Datura metel* > *Mangifera indica* > *Azadirachta indica* > *Tagetes erectus* > *Helianthus annuus* > *Sorghum bicolor* > *Solanum nigrum* > *Amaranthus viridis* with higher concentrations of 50 and 75% as compared to other interactions.

Table 3: Influence of botanicals on shoot length (mm) of *Parthenium hysterophorus* L.

Botanicals	Shoot length (mm)			
	Concentration			Mean
	C_1 – 25%	C_2 – 50%	C_3 – 75%	
B_1	8.69 (2.54)	3.37 (2.00)	3.34 (1.99)	5.13 (2.18)
B_2	8.25 (2.50)	1.28 (1.66)	1.24 (1.65)	3.59 (1.94)
B_3	7.93 (2.48)	0 .00 (1.39)	0.00 (1.39)	2.64 (1.75)
B_4	5.37 (2.24)	0 .00 (1.39)	0.00 (1.39)	1.79 (1.67)
B_5	7.10 (2.39)	4.25 (2.11)	4.21 (2.10)	5.19 (2.20)
B_6	9.23 (2.58)	5.45 (2.25)	5.40 (2.24)	6.69 (2.36)
B_7	10.93 (2.70)	9.13 (2.57)	9.08 (2.56)	9.71 (2.62)
B_8	9.83 (2.63)	8.69 (2.54)	8.64 (2.24)	9.05 (2.57)
B_9	3.26 (1.98)	0.00 (1.39)	0.00 (1.39)	1.09 (1.58)
B_{10}	12.25 (2.79)	9.23 (2.58)	9.19 (2.57)	10.22 (2.64)
B_{11}	5.81 (2.28)	0.00 (1.39)	0.00 (1.39)	1.94 (1.69)
B_{12}	9.69 (2.62)	7.93 (2.48)	7.88 (2.47)	8.50 (2.52)
B_{13}	4.22 (2.10)	0.00 (1.39)	0.00 (1.39)	1.40 (1.63)
B_{14}	8.75 (2.54)	4.01 (2.08)	3.94 (2.07)	5.57 (2.23)
B_{15}	7.16 (2.41)	0.00 (1.39)	0.00 (1.39)	2.37 (1.73)
B_{16}	6.41(2.34)	0.00 (1.39)	0.00 (1.39)	2.14 (1.70)
B_{17}	7.39 (2.443)	0.00 (1.39)	0.00 (1.39)	2.46 (1.74)
B_{18}	5.48 (2.24)	0.00 (1.39)	0.00 (1.39)	1.82 (1.67)
B_{19}	9.46 (2.60)	6.06 (2.30)	5.98 (2.40)	7.17 (2.40)
B_{20}	9.13 (2.57)	5.19 (2.21)	5.11 (2.20)	6.48(2.33)
Mean	7.81 (2.45)	3.23 (1.86)	3.20 (1.86)	
Control	13.25 (2.85)			
	B	C	B x C	
S.Ed	0.01	0.00	0.01	
CD (P=0.05)	0.02	0.01	0.02	

Figures in parenthesis are log (x+4) transformed values.

B_1-*A.indicum*
B_2- *A. spinosus*
B_3- *A. viridis*
B_4 – *A. indica*
B_5-*C. gigantea*
B_6- *C. bonplandianum*
B_7- *C. dactylon*
B_8-*C rotundus*
B_9- *D. metel*
B_{10}- *E. crusgalli*
B_{11}- *H. annuus*
B_{12}- *L. inermis*
B_{13}- *M. indica*
B_{15}- *S. nigrum*
B_{16}- *S. bicolor*
B_{18}- *T .erectus*
B_{19}- *T. indica*
B_{20}- *T. purpurea*

Seedling vigor index

Observations on seedling vigor index are presented in Table (4). Among the botanicals, *Datura metel* registered the lesser seedling vigor index (98.85%) followed by *Mangifera indica* (97.04%) and *Azadirachta indica* (94.71%) as compared to control.

In general, maximum concentration of 50 and 75% showed significantly minimum seedling vigor index (473.12 and 441.03) which was comparatively (67.99 and 70.16%) less than the lower concentration (25%).

Similarly, the interaction between concentrations and botanicals were found significant. *Datura metel*, *Mangifera indica*, *Azadirachta indica*, *Tagetes erectus*, *Helianthus annuus* and *Sorghum bicolor* with 50 and 75% concentration reduction the seedling vigor index as compared to control. Similarly, though *Solanum nigrum* and *Amaranthus viridis* showed positive effect on reducing seedling vigor index at higher concentration but effect was less pronounced at lower concentration.

Table 4: Influence of botanicals on seedling vigor index of *Parthenium hysterophorus* L.

Botanicals	Seedling vigor index			
	Concentration			Mean
	C_1-25%	C_2 – 50%	C_3-75%	
B_1	1569.23 (7.36)	150.6 (5.04)	119.17 (4.81)	613.00 (5.74)
B_2	1784.11 (7.49)	22.70 (3.28)	11.18 (2.71)	606.00 (4.50)
B_3	1334.9 (7.20)	0.00 (1.39)	0.00 (1.39)	444.97 (3.32)
B_4	536.40 (6.29)	0.00 (1.39)	0.00 (1.39)	178.80 (3.02)
B_5	804.00 (6.64)	394.29 (5.99)	352.20 (5.87)	516.83 (6.18)
B_6	2061.64 (7.63)	590.15 (6.39)	541.20 (6.30)	1064.33 (6.77)
B_7	2921.06 (7.98)	1879.09 (7.54)	1796.80 (7.49)	2198.98 (7.67)
B_8	2711.31 (7.90)	1569.23 (7.36)	1492.26 (7.31)	1924.27 (7.52)
B_9	116.63 (4.79)	0.00 (1.39)	0.00 (1.39)	38.88 (2.52)
B_{10}	2845.67 (7.95)	2061.64 (7.63)	1972.42 (7.58)	2293.24 (7.72)
B_{11}	656.50 (6.49)	0.00 (1.39)	0.00 (1.39)	218.83 (3.08)
B_{12}	2514.31 (7.83)	1334.9 (7.19)	1265.20 (7.14)	1704.80 (7.39)
B_{13}	299.65 (5.71)	0.00 (1.39)	0.00 (1.39)	99.88 (2.82)
B_{14}	1707.20 (7.44)	253.36 (5.55)	214.8 (5.38)	725.12 (6.12)
B_{15}	1090.54 (6.99)	0.00 (1.39)	0.00 (1.39)	363.51 (3.25)
B_{16}	746.00 (6.62)	0.00 (1.39)	0.00 (1.39)	248.67 (3.13)
B_{17}	1195.88 (7.08)	0.00 (1.39)	0.00 (1.39)	398.63 (3.28)
B_{18}	590.58 (6.38)	0.00 (1.39)	0.00 (1.39)	196.86 (3.05)
B_{19}	2201.4 (7.69)	730.5 (6.59)	627.37 (6.44)	1186.42 (6.91)
B_{20}	1879.09 (7.54)	475.84 (6.17)	427.95 (6.06)	927.63 (6.59)
Mean	1478.31 (7.05)	473.12 (4.06)	441.03 (3.98)	
Control	3383 (8.12)			
	B	C	B x C	
S.Ed	0.01	0.00	0.02	
CD (P=0.05)	0.02	0.01	0.04	

Figures in parenthesis are log (x+4) transformed values

B_1-*A.indicum*
B_2- *A. spinosus*
B_3- *A. viridis*
B_4 – *A. indica*
B_5-*C. gigantea*
B_6- *C. bonplandianum*
B_7- *C. dactylon*
B_8-*C rotundus*
B_9- *D. metel*
B_{10}- *E. crusgalli*
B_{11}- *H. annuus*
B_{12}- *L. inermis*
B_{13}- *M. indica*
B_{15}- *S. nigrum*
B_{16}- *S. bicolor*
B_{18}- *T .erectus*
B_{19}- *T. indica*
B_{20}- *T. purpurea*

Fresh weight

The data on seedling fresh weight (mg) of *P. hysterophorus* are presented in Table (5). Fresh weight was adversely affected by aqueous leaf extract of various botanicals. *Datura metel* reduced the fresh weight to the tune of 94.31% followed by other botanicals in the order of *Mangifera indica* > *Azadirachta indica* > *Tagetes erectus* > *Helianthus annuus* > *Sorghum bicolor* which recorded (92.09, 91.01, 89.34, 88.14 and 86.34%) respectively as compared to control.

In general, there was an increase in inhibitory effect with increase in aqueous leaf extract concentrations. Higher concentration 50 and 75% registered significant reduction in fresh weight (1.86 and 1.84) but on par with each other as compared to 25% extract concentration and control.

Among the interaction effects between concentrations and botanicals, *Datura metel* with 50 and 75% concentrations showed complete reduction in fresh weight followed by *Mangifera indica, Azadirachta indica, Tagetes erectus, Helianthus annuus and Sorghum bicolor* with higher concentrations.

From the laboratory bioassay study, it could be inferred that among twenty botanicals screened for the control of *P. hysterophorus*, six botanicals viz., *Datura metel, Mangifera indica, Azadirachta indica, Tagetes erectus, Helianthus annuus* and *Sorghum bicolor* caused significant deleterious effect on Parthenium seed germination and seedling growth parameters. The present study also indicated that concentrations of botanicals extract also have significant effect in expressing the herbicidal effect on *P. hysterophorus.* Therefore, the above botanicals were chosen along with concentrations for further investigations through pot culture study.

Table 5: Influence of botanicals on fresh weight (mg) of *Parthenium hysterophorus* L.

Botanicals	Fresh weight (mg)			
	Concentration			Mean
	C_1 – 25%	C_2 – 50%	C_3 – 75%	
B_1	5.23 (2.22)	1.51 (1.70)	1.48 (1.69)	2.74 (1.88)
B_2	5.02 (2.20)	0.72 (1.55)	0.69 (1.54)	2.14 (1.76)
B_3	4.98 (2.19)	0.00 (1.39)	0.00 (1.39)	1.66 (1.65)
B_4	2.25 (1.87)	0.00 (1.39)	0.00 (1.39)	0.75 (1.54)
B_5	5.12 (2.21)	3.25 (1.98)	3.21 (1.97)	3.86 (2.05)
B_6	6.15 (2.31)	2.60 (1.88)	2.57 (1.87)	3.77 (2.2)
B_7	7.11 (2.40)	5.98 (2.30)	5.94 (2.29)	6.34 (2.33)
B_8	6.95 (2.39)	5.21 (2.22)	5.18 (2.21)	5.78 (2.27)
B_9	1.42 (1.69)	0.00 (1.39)	0.00 (1.39)	0.47 (1.48)
B_{10}	7.21 (2.41)	6.15 (2.31)	6.11 (2.30)	6.49 (2.35)
B_{11}	2.98 (1.96)	0.00 (1.39)	0.00 (1.39)	0.99 (1.58)
B_{12}	6.74 (2.37)	4.81 (2.17)	4.78 (2.16)	5.44 (2.23)
B_{13}	1.98 (1.78)	0.00 (1.39)	0.00 (1.39)	0.66 (1.51)
B_{14}	5.53 (2.25)	1.80 (1.76)	1.75 (1.74)	3.03 (1.92)
B_{15}	3.87 (2.06)	0.00 (1.39)	0.00 (1.39)	1.29 (1.61)
B_{16}	3.41 (1.91)	0.00 (1.39)	0.00 (1.39)	1.14 (1.59)
B_{17}	4.52 (2.14)	0.00 (1.39)	0.00 (1.39)	1.51 (1.64)
B_{18}	2.68 (1.93)	0.00 (1.39)	0.00 (1.39)	0.89 (1.57)
B_{19}	6.42 (2.34)	2.86 (1.92)	2.81 (1.91)	4.03 (2.06)
B_{20}	5.98 (2.30)	2.36 (1.85)	2.30 (1.84)	3.55 (1.99)
Mean	4.78 (2.15)	1.86 (1.71)	1.84 (1.70)	
Control	8.35 (2.51)			
	B	C	B x C	
S.Ed	0.01	0.00	0.02	
CD (P=0.05)	0.02	0.01	0.04	

Figures in parenthesis are log (x+4) transformed values

B_1-*A.indicum*
B_2- *A. spinosus*
B_3- *A. viridis*
B_4 – *A. indica*
B_5-*C. gigantea*
B_6- *C. bonplandianum*
B_7- *C. dactylon*
B_8-*C rotundus*
B_9- *D. metel*
B_{10}- *E. crusgalli*
B_{11}- *H. annuus*
B_{12}- *L. inermis*
B_{13}- *M. indica*
B_{15}- *S. nigrum*
B_{16}- *S. bicolor*
B_{18}- *T .erectus*
B_{19}- *T. indica*
B_{20}- *T. purpurea*

Discussion

Per cent germination

Aqueous leaf extracts of all the twenty botanical species exhibited allelopathic potential against the germination of *P. hysterophorus.* However, extracts of all test species were not equally toxic against germination of test weed. Aqueous leaf extracts of *Datura metel, Mangifera indica, Azadirachta*

indica, *Tagetes erectus*, *Helianthus annuus* and *Sorghum bicolor* were Higher inhibitory than extracts of rest of test botanicals. The aqueous leaf extracts of maximum concentration of 50 and 75% of the above six botanicals also significantly record the germination of *P.hysterophorus*. The highest level effective treatment in suppressing the germination of *P.hysterophorus* was 50 and 75% extracts of *Datura metel Mangifera indica*, *Azadirachta indica*, *Tagetes erectus*, *Helianthus annuus Sorghum bicolor* where germination was found to the zero as compared to control (100.00) (Fig. 1).

Germination is the resumption of metabolic activities and growth by the seed tissues and initial step in germination is absorption of water which takes place through imbibitions and osmosis which causes activation of enzymes and increased in metabolic activity. The seeds imbibed with different aqueous leaf extracts which delayed and inhibited the germination in comparison to control. The inhibitory effect in different concentration of leaf extracts on seed germination might be also due to imbalance in metabolism regulated by various enzyme activities (Oyun, 2006) [18]. Further reduction in germination percentage might be also due to herbicidal activity of flavonaids compounds (Javaid *et al*., (2010) [10]. Similar inhibitory effects of aqueous leaf extracts of *Datura metel* and *Mangifera indica* on germination of *P.hysterophorus* was reported by Javaid *et al*., (2009) and (2010) [9, 10]. These results are also in conformity with the findings reported by Sing *et al*., 2013 [20] where in a laboratory petri dish assays, showed that the highest concentration of leaf leachate of *Cassia occidentalis* L. at vegetative stage resulted in complete failure of seed germination of *P.hysterophorus*.

Effect on seedling growth

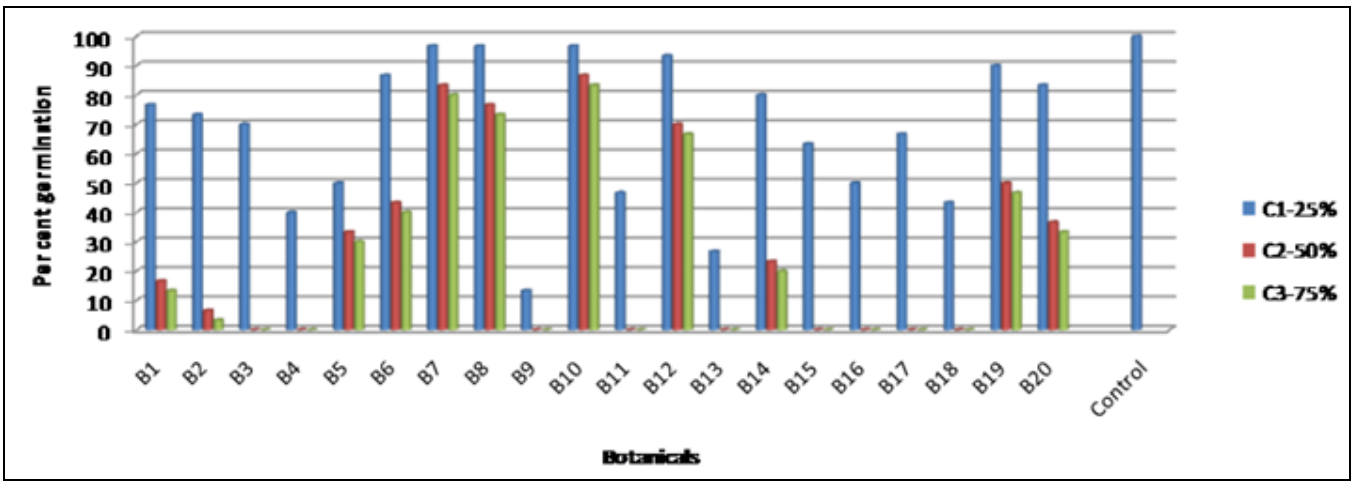
Aqueous leaf extracts of *Datura metel* proved as the most effective botanicals in reducing both root and shoot length of *P.hysterophorus* seedlings. All the applied concentration of 25 to 75% aqueous leaf extracts significantly declined the root and shoots length, seedling vigor index and seedling fresh weight.

Generally, toxicity of the extract increased by increasing the concentration (Fig. 1 and 2). Among the concentration, 50 and 75% significantly suppressed root, shoot length and seedling vigor index as compared to lower concentration.

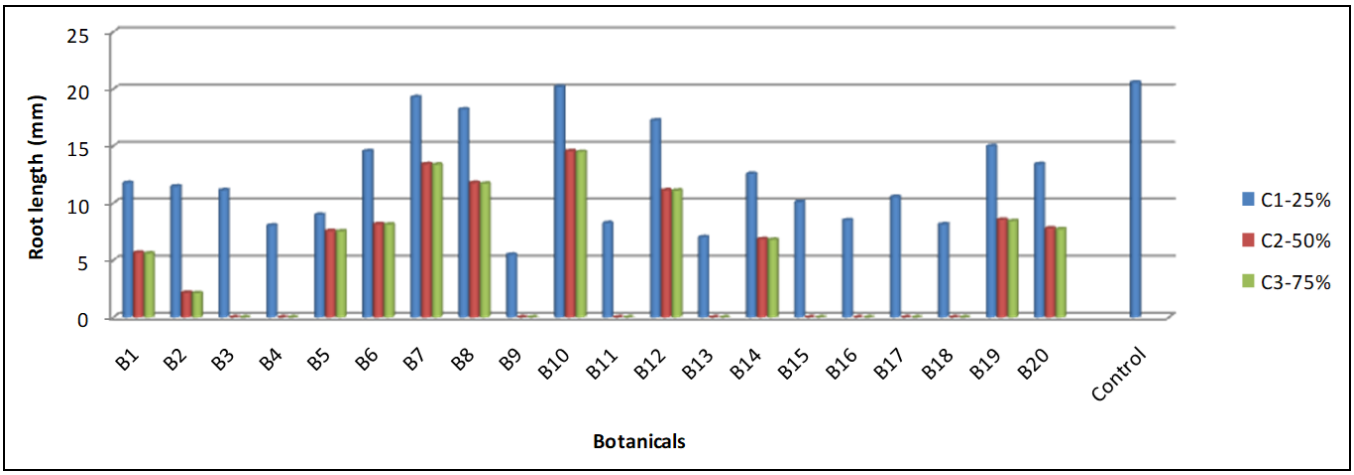
The botanicals of leaf extracts in the order of *Datura metel* > *Mangifera indica* > *Azadirachta indica* > *Tagetes erectus* > *Helianthus annuus* > *Sorghum bicolor* were very effective in retarding root and shoot length and seedling vigor index.

Efficacy of aqueous leaf extracts of botanicals viz., *Datura metel*, *Mangifera indica*, *Azadirachta indica*, *Tagetes erectus*, *Helianthus annuus* and *Sorghum bicolor* on seedling biomass was similar to that of their effect on root and shoot length.

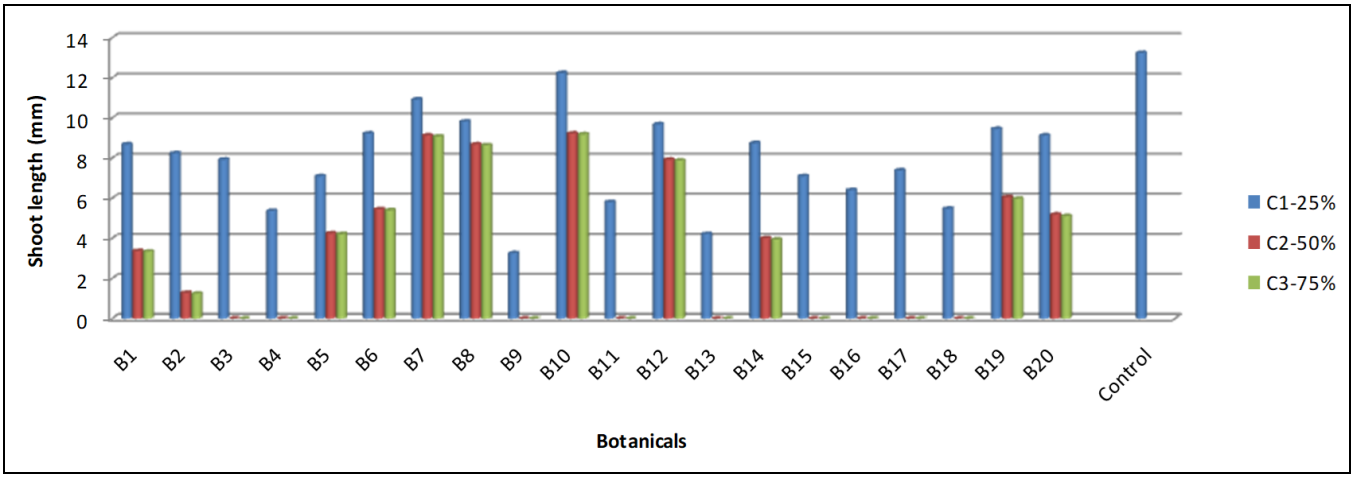
The reduction in seedling root and shoot length, seedling vigor index and seedling fresh weight might be attributed to the reduced rate of cell division and cell elongation due to the presence of allelochemicals present in the aqueous leaf extracts. The remaining botanicals also showed inhibit effect on the growth of parthenium but the effect was not much pronounced as compared to above treatments.



A



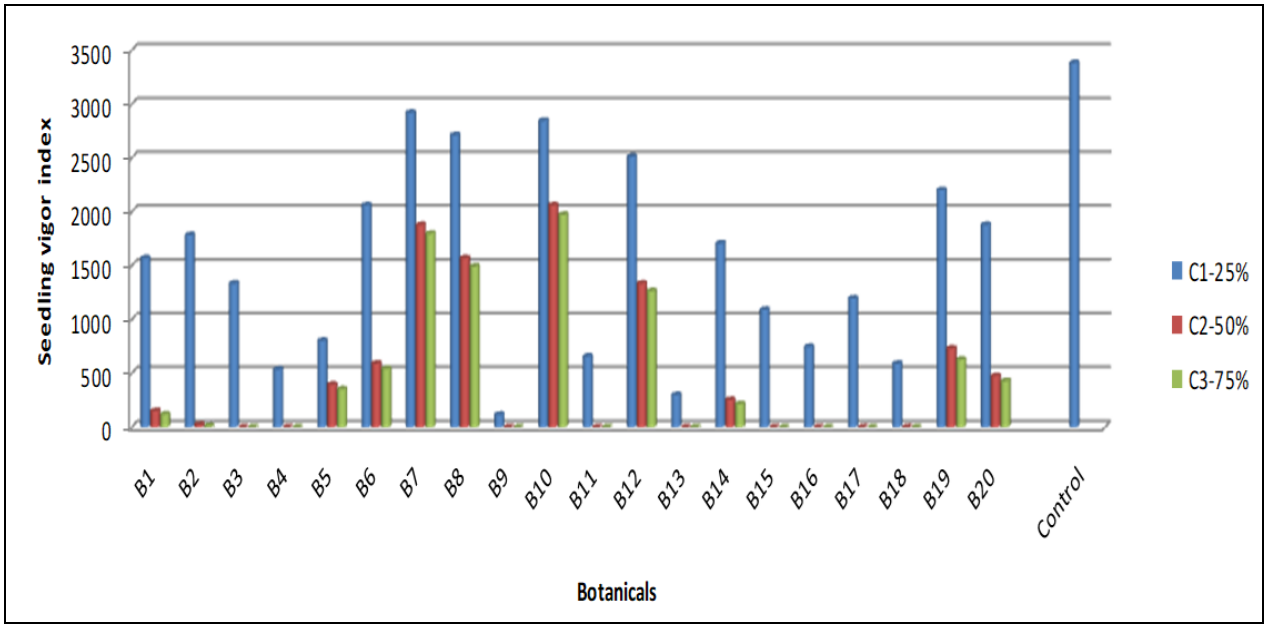
B



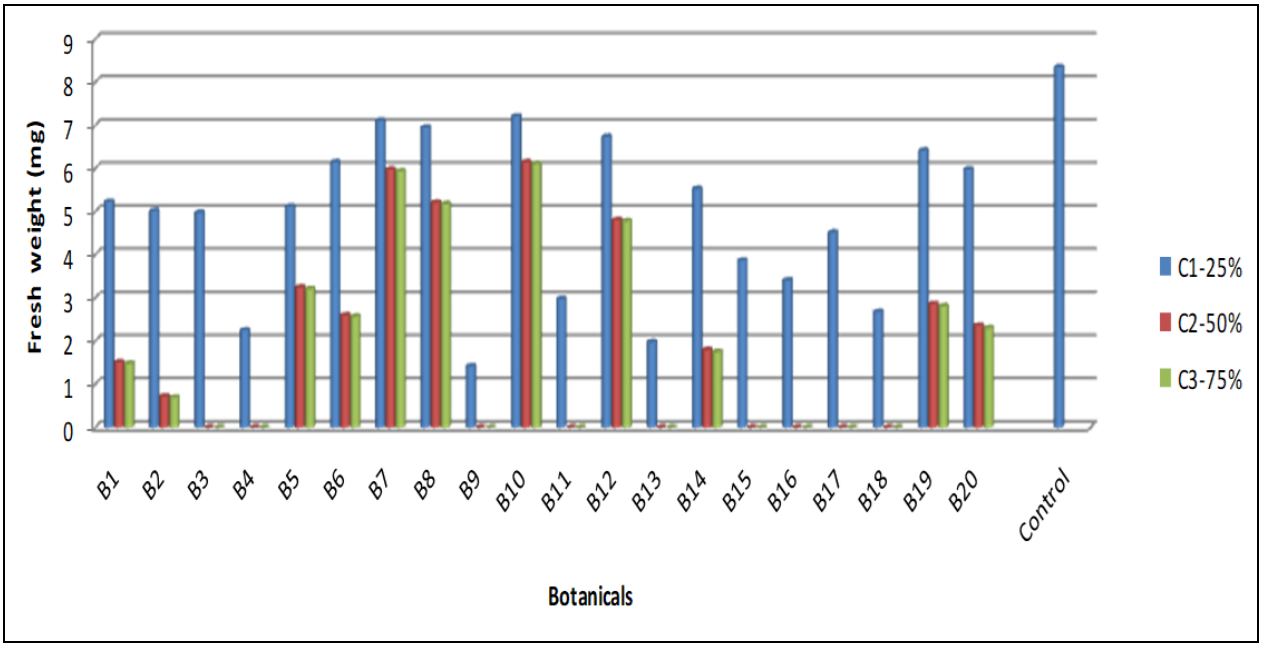
C

B_1-*A.indicum* B_2- *A. spinosus* B_3- *A. viridis* B_4 – *A. indica* B_5- *C. gigantea*
B_6- *C. bonplandianum* B_7- *C. dactylon* B_8-*C rotundus* B_9- *D. metel* B_{10}- *E. crusgalli*
B_{11}- *H. annuus* B_{12}- *L. inermis* B_{13}- *M. indica* B_{14}- *P. juliflora* B_{15}- *S. nigrum*
B_{16}- *S. bicolor* B_{17}- *S. halepense* B_{18}- *T. erectus* B_{19}- *T. indica* B_{20}- *T. purpurea*

Fig 1: Influence of botanicals on per cent seed germination (A), root length (B) and shoot length (C) of *Parthenium hysterophorus* L.



A



B

B_1-*A.indicum*	B_2- *A. spinosus*	B_3- *A. viridis*	B_4 – *A. indica*	B_5- *C. gigantea*
B_6- *C. bonplandianum*	B_7- *C. dactylon*	B_8-*C rotundus*	B_9- *D. metel*	B_{10}- *E. crusgalli*
B_{11}- *H. annuus*	B_{12}- *L. inermis*	B_{13}- *M. indica*	B_{14}- *P. juliflora*	B_{15}- *S. nigrum*
B_{16}- *S. bicolor*	B_{17}- *S. halepense*	B_{18}- *T. erectus*	B_{19}- *T. indica*	B_{20}- *T. purpurea*

Fig 2: Influence of botanicals on seedling vigor index (A) and fresh weight (B) of *P.hysterophorus* L

Summary

In laboratory petri plate bioassay studies, the per cent germination of *P.hysterophorus* seeds was reduced significantly due to application of botanical extract viz., *Datura metel, Mangifera indica, Azadirachta indica, Tagetes erectus, Helianthus annuus* and *Sorghum bicolor* both at 50 and 75% concentration. Increased concentration (50 and 75%) pronounced more detrimental effects on per cent germination of *P.hysterophorus*. All the botanicals extracts exhibited a negative impact on germination percent over control. Higher reduction in seedling length and seedling vigor index were also noticed in *P.hysterophorus* with 50 and 75% concentrations of botanical extract in the order of *Datura metel> Mangifera indica> Azadirachta indica> Tagetes erectus> Helianthus annuus > Sorghum bicolor* as compared to other botanicals. Similarly reduction in growth of parthenium seedlings was observed through seedling biomass due to higher concentration (50 and 75%) of botanical extracts. Among twenty botanicals, the higher inhibition of growth was observed in the order of *Datura metel> Mangifera indica> Azadirachta indica> Tagetes erectus> Helianthus annuus > Sorghum bicolor*.

Conclusion and future Suggestions

The present study reveal that the Higher reduction in seedling length and seedling vigor index were also noticed in *P.hysterophorus* with 50 and 75% concentrations of botanical extract in the order of *Datura metel> Mangifera indica> Azadirachta indica> Tagetes erectus> Helianthus annuus > Sorghum bicolor* as compared to other botanicals. This needs further studies, to test the efficacy of these crude extract under field conditions. Furthermore, the allelochemicals present in these extracts responsible for germination and growth reduction should be identified and isolated.

There is a possibility of using these allelochemicals directly (or) structural leads for discovery and development of environment friendly herbicides to control one of the world's worst weed. Secondly, the movement of allelochemicals, mode of action, selectivity etc should be broadly studied. Finally, the impact of use of allelochemicals from agronomic and environmental point of view needs special attention.

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