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Biocontrol of noxious weed *Parthenium hysterophorus* L. by application of *Tamarindus indica*

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Abstract
Parthenium hysterophorus L. is considered as one of the harmful weeds because of its invasiveness, rapid multiplication rate and adverse impacts on environment and human health. The novelty of this work is to manage the weeds by employing organic matters instead of harmful chemical weedicides which have an adverse environmental impact due to accumulation in soil and leaching to water bodies. Researchers have studied the allellopathy impact of the plant, however there is little report available on the use of this extract as natural herbicide. This study was carried out to assess the allellopathic effect of the aqueous extract of leaves of *Tamarindus indica* on the control of noxious weed *Parthenium historephorus* L. The extracts of the leaves were used in same concentration (00 % - 100%) and their impact on seed germination and growth of seedlings were observed. The results obtained from utilizing *Tamarindus indica*. extract showed more effective in terms of inhibition of germination, seedling growth, seedling vigour indices and tolerance indices. The experiment also showed complete inhibition in germination of seed. The current study gives an idea about the use of organic products from plants considered as better alternatives to harmful synthetic herbicides which is the eco-friendly way to biocontrol the weeds to reduce environmental pollution.

Keywords: biocontrol, *Parthenium histerophorus*, allelopathy, *Tamarindus indica*

Introduction
Weeds are an important issue which influence the production of crop through competition for availing nutrition from environmental resources and cause productivity loss (Hossain and Begum, 2015) [12]. Weeds are also responsible for degradation of environment in terms of threatened the biodiversity. (Kim *et al*. 2007 and Chandrasena 2014) [16, 18]. *Parthenium histerophorus* L. is one of the harmful and allergy causing weeds which is resistant to traditional methods of weed management due to its invasiveness and rapid spreading potential. *Partheniumhysterophorus* L. has spread in land area about 35 million hectares in India (Sushilkumar and Varshney, 2010) [20]. As *Parthenium hysterophorus* L. affects natural ecosystem like agriculture, human and animal health so it is the need of the day to find out the management options for *Parthenium hysterophorus* L. There is ever-increasing interest globally for reducing the use of synthetic herbicides in the all sectors to reduce the herbicide level in human diet (JFCRF, 2011; FAO, 2011; Al-Samarrai *et al*., 2012) [14, 11, 3].

This weed has been managed by continuous use of chemical herbicides by which causes environmental pollution is much more. There is another approach like allelopathy is an eco-friendly and a viable option. Allellopathy is the beneficial or harmful effects of one plant parts on another through the liberation of certain chemicals into its surroundings (Ashrafi *et al.* 2008) [5]. In a study *Eucalyptus globules* Labil. and *Hyptis suavolens* is also having the property of allellopathy potential (Arzoo *et al*., 2016) [4]. The allelo-chemicals affect in crop/weed by interactions for availing nutrients (Duke, 2015) [10]. Application of allello-chemicals is an actively precious and sustainable management process managing weeds. *Tamarindus indica* L. is important tree species, which are indigenous to tropical Africa, but has been cultivated for so long on the Indian subcontinent. Aside from these tamarind plant grows up to 40-80 meters according to the soil condition and the environmental factor. Also, the tamarind fruit is popular because of its medicinal benefits (ICRAF, 2007). The genus *Tamarindus* is a monotypic genus containing the individual species *T. indicus* and belongs to the sub-family Caesalpinioideae of the family Fabaceae (*Leguminosae*). On the other hand, tamarind leaves retain a more empiric use. Apart from this, tamarind leaves can use to some essential oil with benzyl benzoate and limonene as major compounds (Pino JA, Escalona JC, Licea I, Perez R, Aguero J. *J Essent Oil Res*; 14:187-8, 9 (2002).

The use of herbicides globally is approximately 48 % of the total output of different pesticides like herbicide, fungicide and insecticide (Chyxx, 2015) [9]. China produced herbicide approximately 1.77 million tons which is the 55 % of total output of different pesticides used in agriculture (Agropages, 2015) [2]. Hence a study was undertaken to study the allellopathic potential of aquous leaf extract of Tamarindus *indica* L. on controlling *Parthenium hysterophorus* L. Current research is focused on the weed management by using an effective biocontrol method by using plant extracts as an eco-friendly and cost-effective alternative for replacement of synthetic weedicides in weeds management. The present study is aim to explore the use of plant extracts as one of the future solutions for the use of a natural, cost effective and eco-friendly approach for an effective alternative in the weed management like *Parthenium hysterophorus* L.

Materials and Methodology
Collection of samples: Fresh tamarind leaves were collected from the garden of Centurion University of Technology and Management, BBSR in a polyethylene bag

and labelled for easy identification. Then, the samples were properly washed with tap water and sun dried it about 10-15 days. After drying it ground it on a mortar pestle to a finely powder form. Then the sample were repacked with proper labelling and preserved for further analysis.

Analysis of different elemental content in the sample

The ground sample were taken into elemental analysis by using X-ray fluorescence through which we can recognized the different element present in the sample. Again, fresh tamarind leaf were collected and washed it properly with tap water and tapped with tissue paper to soak the moisture in it. Then, ground it on a mortar pestle and made solution of this fresh leaves as well as the dry powder of leaves. This solution was taken about six set of the centrifuge tubes of about 10 ML of each in which 3 of which are dry leaves solution and another three are fresh leaf solution. Then centrifuge it, and keep aside the clear solution in 30 ml of glass jar. Then the clear solutions were taken for the X-ray fluorescence analysis.

Seed of *Parthenium hysterophorus* L. were collected from road sides and near agricultural fields of Khordha district, Odisha where the plants grown densely. The seeds which were healthy and free from pathological conditions were collected and repeatedly washed in tap water to remove adsorbed dust particles. The seeds were left for one day and then soaked the water by using tissue paper until dry and then kept in a plastic container for further use. For allelopathy study, allelopathic plant like *Tamarindus indica* was selected for the preparation of extract. Stock solution of aqueous leachates was prepared by using distilled water (1:10 w/v) for 24 hours and filtered the aqueous extract by using Whattman No.1 filter paper. This stock extract was diluted with distilled water to prepare required concentration (00% to 100%) of leachate. Four replicates of each 50 healthy seeds of *Parthenium hysterophorus* L. were placed on extracted treated germination paper in properly sterilized petridishes. The petridishes were maintained at 26°C and 94 % humidity with exposure to 20 ml of different concentration of aqueous leachates of extract and distilled water for comparison as control.

Percentage of germination (G %) was calculated by the formula (Al- Hammad and Al-Ammari, 2017) [6]:

$$G\,\% = \frac{\text{Total no. of seed germinated}}{\text{Total no. of seed tested}} \times 100$$

The percentage of phytotoxicity of the was calculated by the formulae suggested by Chou *et al* (1978) [8].

$$\text{Phytotoxicity } (\%) = \frac{\text{Radicle length of control} - \text{Radicle length of test}}{\text{Radicle length of control}} \times 100$$

According to Baki and Anderson (1973) [1] Seedling vigour indices (SVI) were calculated by using the formulae:

SVI = Germination percentage × Radicle length

According to Turner and Marshal (1972) [21], The tolerance indices (TI) of the seedlings were calculated by using the formula:

$$TI = \frac{\text{Radicle length of seed in test}}{\text{Radicle length of control}} \times 100$$

Statistical analysis

The statistical implication of various parameters were studied utilizing one way Annova by MS-Excel. The p-value less than 0.05 implies significant contributions.

Results and discussion

The effect of leaf extract of *Tamarindus indica* showed that the percentage of germination was significantly decreased with increasing concentration of leachate. Similarly, the radicle length of the seedling were also found to be decreased significantly with increasing concentration of leachate of the extract. The other paremeters like Seedling vigour indices and tolerance indices was also found to be decreased whereas the level of phytotoxicity was found to be increased with increasing leachate concentration. The data of the present study are presented in table-1 and 2. The results were in argument with the findings of a research (Jabran and Farooq, 2013; Joanna *et al*., 2012) [13, 15] that the aqueous extract of the plant showed a negative effect on the seed germination and seedling growth of all weeds studied and which type and what are the element present in the plant was mentioned in table-3. In another study, reduction in seedling growth was also reported under allellopathy stress (Batish *et al*., 2006 and Singh *et al*., 2008) [7, 19]. Similar result on the growth of tomato, radish, cucumber and banyard grass was found with the application of *Lantana camara* extract (Liu and Jia, 2002) [17]. Based on the presented research results, it was found that the use of the leaves of the plant species are alternative to using weedicides to control *Parthenium hysterophorus* L.

Table 1: Impacts of tamarind extract on germination of Parthenium seeds.

Conc. of extract (From stock of 1:10 w/v)	% ge of germination	Radicle length
Control (00 %)	83.5±1.201	4.925±0.275
20 %	56.25±1.5	4.4 ± 0.283
40 %	24.25 ± 1.708	3.5 ± 0.115
60 %	11 ± 1.633	2.675±0.171
80 %	3.25 ± 0.957	1.725±0.096
100 %	1.25 ± 0.957	0.525±0.512
	*0.046	*0.003

Values of four replicates ± SD

*indicates the p-values

Table 2: Impact of different concentration of aquous Tamarind extract on seedling vigour indices (SVI), tolerance indices (TI) and percentage of phytotoxicity.

Conc. of extract (From stock of 1:10 w/v)	Seedling Vigour Indives	Tolerance Indices	Percentage of phyto-toxicity
Control (00 %)	411.237	100	00
20 %	247.5	89.340	10.660
40 %	84.875	71.066	28.934
60 %	29.425	54.315	45.685
80 %	5.606	35.025	64.974
100 %	0.656	10.660	89.340

Table 3: Elemental analysis of *Tamarindus indica*

Compound	Conc. (In %)	Conc (In ppm)
SiO_2	1.910	-
P_2O_5	4.112	-
SO_3	4.592	-
Cl	0.904	-
K_2O	11.444	-
CaO	73.928	-
TiO_2	0.241	-
MnO	0.711	-
Fe_2O_3	1.612	-
CuO	-	752.6
ZnO	-	446.7
Br	-	102.2
Rb_2O	-	260.5
SrO	-	714.6
CeO_2	0.145	-
Eu_2O_3	0.171	-
CO_2	-	0.0
Re	-	14.3

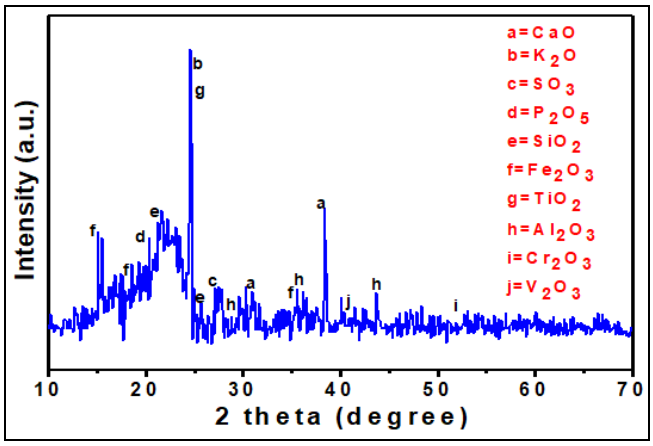

Fig 1

Conclusion

The aqueous extract of *Tamarindus indica* leaves produced better inhibiting effect on seed germination and seedling growth, hence this extract can be used in eco-friendly, cost effective and bio-control method for weed management like *Parthenium hysterophorus* L. More future studies are required to find the inducing agents which are responsible for these inhibitions of germination.

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