Allelopathic effect of *Parthenium hysterophorus* L. on the germination and growth of Wheat

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Abstract- *Parthenium* is a potential allelopathic plant which possesses important allelochemicals with known allelopathic activity on other plants. In this, study allelopathic effects of fresh and hot water extracts of leaves, stem, and flowers of *Parthenium hysterophorus* were investigated on germination and seedling growth of wheat in seed bioassay experiments carried out at department of botany university of Peshawar during 2016. Results showed significantly inhibitory effects of aqueous extracts on seed germination, growth and fresh and dry biomass of seedling wheat. Data revealed that phytotoxicity of the extract increases as the concentration increases the results also showed that hot water extract is more inhibitory than fresh water. It is suggested that *Parthenium hysterophorus* L. has a strong allelopathic potential and it might be further studied for its allelopathic activities.

Index Terms- *Allelopathy, Parthenium hysterophorus,* Wheat variety, seed germination and growth.

I. INTRODUCTION

There is an increasing interest in allelopathic studies and recently many researchers have focus on the exploration of plant allelopathy. The development of weed management strategies that make use of allelopathic crop plants is receiving increased national and international attention (Weston, 1996). There are many weed species that are allelopathic in nature. It is viable weed management strategy but needs to be extensively studied under laboratory as well as in the field conditions. It is a natural and environment friendly technique which may prove an effective strategy for weed management and thereby increase crop yields. Among weeds *Parthenium hysterophorus* L., is an aggressive weed native to Southern North America, Central America, the West Indies and Central South America (Picman & Picman, 1984), having allelopathic effect and drastically retards the growth of many species (Tefera, 2002). The idea that plants affect neighbouring plants by releasing chemicals in the environment has been known since 370 BC (Willis, 1985; 1997). Allelopathy may prove harmful as plants containing allelochemicals release these chemicals to the soil, water bodies, plant environment and thus cause tremendous hazards. Apart from its competitive ability, the invasiveness of the noxious weed *P. hysterophorus* L., is thought to be due to an ability to displace other species by means of allelopathy. The sesquiterpene lactone parthenin that is biosynthesized by this species is thought to play a role in its allelopathic interference with surrounding plants (Regina *et al*., 2007). *Parthenium* root extracts decreased the germination and growth of maize and barley (Rashid *et al*., 2008).

Allelochemicals or plant derived chemicals offers a great potential for the pesticides because they are comparatively safer for the environment. In the past two decades, much more work has been done on plant derived compounds as environmentally safe alternatives to herbicides for the weed control (An *et al*., 1998; Duke *et al*., 2002). These chemicals could be used for weed management directly or their chemistry could be used to develop new herbicides. Some trees have negative effect on the seed germination and thus these trees can contribute to the pesticide industry if explored fully (Khan *et al.,* 2005). The inhibitory effects of *P. hysterophorus* L., on germination of many crops have been reported (Narwal, 1994). With the increasing concentration of *Parthenium* extracts the seed germination and growth of Eragrostis decreased significantly (Tefera, 2002). The inhibitory effects of the husk extracts of 7 rice varieties on growth of barnyard grass (*Ehinochola curssgali* (L.) Beauv. Was meaningful (Ko *et al.,* 2005). Adverse effects of water extracts of different *Brassica* sp. against germination and growth of cut leaf ground cherry weed (*Physlis anagulata* L.) have also been reported (Uremis *et al*., 2005). *Prosopis juliflora* significantly inhibited the seed germination in Pearl millet (Sundramoothy *et al*., 1995) while Ibrahim *et al*., (1999) reported allelopathic effects of *Euclayptus camaldulensis* on crops. Release of parthenin by aqueous extraction of fresh leaf material of *P. hysterophorus* under laboratory conditions proved to be sufficient to provide significant phytotoxicity, and the relative role of parthenin to overall phytotoxic effects of the crude extract could be estimated to 16–100% (Regina *et al*., 2007).

Parthenium is rapidly spreading in Pakistan for the last 20-30 years and is now a serious weed of wastelands and grazing lands, especially in rainfed areas (Javaid & Anjum, 2006). Presently *Parthenium* can be found along the roadsides and even in agricultural crops like maize etc., in North West Pakistan, therefore detailed study of this weed will lead towards a better management approach. *Parthenium hysterophorus* Linn. (*Asteraceae*), an alien invasive species, commonly known as *Parthenium* weed is an annual or short-lived ephemeral herb of neo-tropical origin that now has a pan-tropical distribution. In India and Australia, *P. hysterophorus* is considered to be a major weed (Mahadevappa 1997; Navie *et al*., 1996). In Pakistan, this weed is spreading aggressively in wastelands, degraded areas, rocky crevices, along water channels, roadsides and railway tracks. It has recently also been reported in cultivated lands (Shabbir, 2002).

Description and general information

- **Size**

Parthenium weed is an annual herb with a deep tap root and an erect stem that becomes woody with age. As it matures, the plant develops many branches in its top half and may eventually reach a height of two meters.

- **Leaves**

Its leaves are pale green, deeply lobed and covered with fine soft hairs.

- **Flowers**

Small creamy white flowers occur on the tips of the numerous stems. Each flower contains four to five black seeds that are wedge-shaped, two millimeters long with two thin, white scales.

- **Lifecycle**

Parthenium weed normally germinates in spring and early summer, produces flowers and seed throughout its life and dies around late autumn. However, with suitable conditions (rain, available moisture, mild temperatures), *Parthenium* weed can grow and produce flowers at any time of the year. In summer, plants can flower and set seed within four weeks of germination, particularly if stressed.

Chemical constituents

The volatile constituents of the essential oils from leaves of weed plants *Parthenium hysterophorus* were identified and quantified by GLC-MS and GLC. 27 compounds were identified in the essential oil from *P. hysterophorus*, and the main constituents were germacrene-D (35.9%), *trans*-β-ocimene (8.5%) and β-myrcene (7.6%) (Miranda *et al.*, 2014).

- **Geographical distribution**

Parthenium hysterophorus L is herbaceous weed species native of Mexico, and has become widespread in a number of tropical and subtropical countries. It spreads easily through trade as contaminants of grain and other crop products and by means of farm machineries (Mack and Lansdale, 2001). *Parthenium* was introduced into Asia, Africa and Oceania with cereal and grass seed shipment from America during the 1950s (Bhowmik and Sarkar 2005), and currently the weed is widely distributed and become problematical in countries such as Australia, India, China, Kenya West Indies, Australia, Ethiopia, Israel, Taiwan, India, Nepal (Picman and Picman 1984; Peng *et al*., 1988; Mishra 1991; McFadyen 1992; Medhin 1992; Navie *et al*., 1996; Evans 1997; The weed has achieved major weed status in India and Australia only within the last few decades (Navie *et al*., 1996; Evans 1997; Mahadevappa 1997; Kaushik *et al*., 2005).

II. Materials and Methods

Collection and preservation of plant:

Fresh aerial part of *Parthenium hysterophorus* were collected in February 2016, from Pabbi Nowshera. The leaves branches and flowers were separated from each other. The specimen was cleaned and washed by distilled water. The aerial part were dried under shade till completely dried. The specimen were grinded by electric grinder. The powder drugs were stored in air tight bottles and were used for further study.

Extraction:

The powder is then used to make extract of about 60ml for a variety which is enough for all seeds. 5, 10, and 15 gram powder of stem, leaves and flowers were soaked 60ml of fresh and hot distilled water for making an extract at room temperature of 25ºC. The hot water extract were filtered after 24 hours and fresh water extract were filtered after 72 hours.

Duration:

The hot water extract for each part of plant is then placed for 24 hours in 25ºC and fresh water extract for each part is placed for 72 hours in 25ºC.

Wheat Variety:

One variety of wheat (*Triticum aestivum*) was used (Faisalabad 2008) in this study.

Experiment:

Experiment was performed in the laboratory of department of Botany, University of Peshawar, and Peshawar Pakistan. The experiment performed were based on variety concentration and duration. 60ml extract was enough for the experiment about 72 petri dishes were used in this experiment 18 for control and 54 for the extract of different plant parts.

Double fold filter paper were placed in each petri dish and then 10 seeds of *Triticum aestivum* were placed in every petri dish. After placing seeds 8ml extract of 5, 10 and 15 gram were apply on petri dishes. Distilled water is used for the control petri dishes. After this the petri dishes were placed in incubator for 72 hours at 25ºC. After 72 hours radical and plumule length were taken for every seed and noted in a table. Then the fresh weight of seeds is taken by using digital balance then the seeds are placed in an oven for 72 hours and after this dry weight of the seeds are taken and the data is noted in a tables for further calculation and tabulation following (Rashid *et al.*, 2008).

III. Results & Discussion

***Fresh water bioassay**

(i) Fresh water germination percentage

ANOVA table showed that the differences between mean values of parts are non-significant at α value 0.05 while the differences between different concentrations and part*concentration are significant α value 0.05.

According to the mean table Maximum germination % was noted in control (100%) followed by 5g (33.33^{B} %), 10g (24.44^{B} %) and 15g (23.33^{B} %). So there is a gradual decrease in germination percentage as concentration values are increasing. While in part * concentration interaction the highest value of germination % was found in control level of all the three parts i.e. leaves, stem and flowers while the lowest are found in 10g concentration in flowers (10.00%). (Table 1).

(ii) Fresh water (radical length mm)

The statistical analysis for radical average showed that the alpha values for part, concentration and part *concentration are less than 0.05 i.e. non-significant (0.2494), (0.0690), and (0.2346) respectively. So this data revealed that radical growth is not effected by fresh water extract of this plant at any concentration. The maximum radical growth is noted in control (108.82^{A}) followed by 5g (2.76^{A}), 10g (2.63^{B}), 15g (2.44^{B}). So there is a gradual decrease in radical length as the concentration of the extract increases. while in part * concentration interaction the highest value for radical length was found in control level of all the three parts i.e. leaves, stem and flowers

while the lowest are found in 10g concentration in flowers (0.67) (Table 2).

(iii) Fresh water (Plumule length mm)

The statistical analysis for plumule average showed that the alpha values for part and part * concentration are non-significant having values of (0.4665) and (0.4460) respectively. While the difference between different concentrations are significant having value of (0.0096). So the data showed that different concentrations affect the plumule growth. The maximum plumule growth is noted in control (31.361^{A}), followed by 5g (3.033^{B}), 10g (1.592^{B}), 15g (1.389^{B}). So there is a gradual decrease in plumule length as the concentration of the extract increases. while in part * concentration interaction the highest value for plumule length was found in control level of all the three parts i.e. leaves, stem and flowers while the lowest are found in 5g concentration in leaf and flower 10g flowers and 15g leaf (1.16) (Table 3).

(iv) Fresh water (Fresh weight of Leaves, stem, Flowers)

The statistical analysis for fresh weight showed that the alpha values for part and part * concentration are non-significant having values of (0.3039), and (0.2049) respectively. While the difference between different concentrations are significant having value of (0.0000). So the data showed that moisture content is affected by different concentrations. The maximum moisture content was observed in control (0.9244^{A}), followed by 15g (0.3967^{B}), 5g (0.3333^{B}), 10g (0.3244^{B}). while in part * concentration interaction the highest value of fresh weight was found in control level of all the three parts i.e. leaves, stem and flowers while the lowest are found in 10g flower (0.2100) (Table 4).

(v) Fresh water (Dry weight of Leaves, stem, Flowers)

The statistical analysis for dry weight showed that the alpha values for part and part * concentration are non-significant having values of (0.2639) and (0.0675) respectively. While the difference between different concentrations are significant having value of (0.0000). So the data showed that dry weight is affected by different concentrations. The maximum dry weight was observed in control (0.3556^{A}), followed by 5g (0.1678^{B}), 10g (0.1544^{B}), 15g (0.1511^{B}). while in part * concentration interaction the highest value of moisture content was found in control level of all the three parts i.e. leaves, stem and flowers while the lowest are found in 10g flower (0.0833) (Table 5).

(vi) Fresh water (Moisture in Leaves, stem, Flowers)

The statistical analysis for moisture content showed that the alpha values for part and part * concentration are non-significant having values of (0.2872) and (0.2241) respectively. While the difference between different concentrations are significant having value of (0.0426). So the data showed that moisture content is affected by different concentrations. The maximum moisture content was observed in 15g (56.578), followed by 10g (52.378), 5g (34.748), control (15.922). While in part * concentration interaction the highest value of moisture content was in 15g stem (92.800) while the lowest value are found in 5g leaf (12.367) (Table 6).

****Hot water bioassay**

(i) Hot water with germination percentage

ANOVA table showed that the differences between mean values of a part, part * concentrations and differences between different concentrations are significant having values of (0.0178), (0.0076) and (0.0000) respectively. Maximum germination % was noted in control (100^{A}%) followed by 5g (50.00^{B} %), 10g (26.67^{c}%), 15g (10.00^{D} %). So there is a gradual decrease in germination percentage as concentration values are increasing while in part * concentration interaction the highest value of germination % was found in control level of all the three parts i.e. leaves, stem and flowers while the lowest are found in 15g concentration in stem (3.33%) (Table 7).

(ii) Hot water with Radical length (mm)

Statistical analysis for plumule average showed that alpha values for part, part *concentration and the difference between mean values of different concentrations are less than 0.05 i.e. significant having values of (0.0006), (0.0000), and (0.0001) respectively. The maximum radical growth is noted in control (46.483^{A}) followed by 5g (4.997^{B}), 10g (1.497^{B}), 15g (0.333^{B}). So there is a gradual decrease in radical length as the concentration of the extract increases. while in part * concentration interaction the highest value for radical length was found in control level of all the three parts i.e. leaves, stem and flowers while the lowest are found in 15g concentration in leaf and stem (0.00) (Table 8).

(iii) Hot water with Plumule length (mm)

The statistical analysis for plumule average showed that the alpha values for part * concentration are non-significant having value of (0.333). While value of part and the difference between different concentrations are significant having value of (0.0465) and (0.0000) respectively. So the data showed that plumule growth is affected by part and different concentrations. The maximum plumule growth is noted in control (15.950^{A}), followed by 10g (2.167^{B}), 15g (1.367^{BC}) 5g (0.953^{B}). while in part * concentration interaction the highest value for radical length was found in control level of all the three parts i.e. leaves, stem and flowers while the lowest are found in 10g concentration in (0.333) (Table 9).

(iv) Hot water & Fresh weight of leaves, stem and flowers

The statistical analysis for fresh weight average showed that the alpha values for part and part * concentration are non-significant having value of (0.0615) and (0.2112) respectively. While value of the difference between different concentrations are significant having value of (0.0000). So the data showed that fresh weight is affected by different concentrations. The maximum fresh weight is noted in control (0.8000^{A}) followed by 5g (0.5100^{B}), 10g (0.3844^{BC}), 15g (0.2144^{B}). So there is a gradual decrease in radical length as the concentration of the extract increases. while in part * concentration interaction the highest value for radical length was found in control level of all the three parts i.e. leaves, stem and flowers while the lowest are found in 15g concentration in stem (0.0833) (Table 10).

(v) Hot water with dry weight of leaves, stem and flowers

The statistical analysis for dry weight average showed that the alpha values for part and part * concentration are non-significant having value of (0.4860) and (0.5128) respectively. While value of the difference between different concentrations are significant having value of (0.0000). So the data showed that dry weight is affected by different concentrations. The

maximum dry weight is noted in control (0.3578^{A}), followed by 5g (0.2289^{B}), 10g (0.1611^{BC}), 15g (0.0811^{B}). So there is a gradual decrease in dry weight as the concentration of the extract increases. while in part * concentration interaction the highest value for dry weight was found in control level of all the three parts i.e. leaves, stem and flowers while the lowest are found in 15g concentration in flower (0.0433) (Table 11).

(vi) Hot water & moisture of leaves, stem and flowers

The statistical analysis for moisture content showed that the alpha values for part * concentration are non-significant having value of (0.1120). While value of part and the difference between different concentrations are significant having values of (0.0394) and (0.0122) respectively. So the data showed that moisture content is affected by part and different concentrations. The maximum moisture content is noted in 10g (60.156^{AB}) followed by15g (51.591^{AB}) 5g (29.241^{AB}) 15g (0.0811^{AB}). while in part * concentration interaction the highest value for dry weight was found in 15g flower (101.81) while the lowest value are found in control stem (11.34) (Table 12). Similar study was performed by other scientists like Devi & Dutta, (2012) studied the allelopathic effect of aqueous extract of *Parthenium hysterophorus* and *Chromoaena odorata* on the seed germination and seedling vigour of *Zea mays* L. *In vitro.* Msafiri *et al.*, (2013) studied allelopathic effects of *Parthenium hysterophorus* on seed germination, seedling growth, fresh and dry mass production of *Alysicurpus glumaceae* and *Chloris gayana*. Results revealed significant allelopathic effect. Srivastava *et al.*, (2011) studied allelopathic potential of *Parthenium hysterophorus* L. to reduce water absorption in germinating cowpea seeds. The stimulatory effect was recorded on other germination and seedling growth parameters of cowpea (Table 13,14).

***Table 1*:** Fresh water germination percentage

Conc.	leaf	Stem	Flower	Mean conc.
Con	100	100	100	100^{A}
5g	23.33	56.67	20.00	33.33^{B}
10g	43.33	20.00	10.00	24.44^{B}
15g	20.00	13.33	36.67	23.33^{B}
Mean	**47.50**	**46.67**	**41.67**	

Standard Error for Comparison=4.6647, 5.3863, and 9.3294 for part, conc and part*conc respectively while Critical Value for Comparison= 9.6274, 11.117, and 19.255 for part, con, and part* conc respectively.

Table 2: Fresh water radical length

Conc.	Leaf	Stem	Flower	Mean conc.
Con	265.34	30.55	30.55	108.82^{A}
5g	1.50	5.78	1.00	2.76^{B}
10g	5.67	1.00	0.67	2.63^{B}
15g	1.33	1.00	5.57	2.44^{B}
Mean	**68.460**	**9.584**	**9.447**	

Standard Error for Comparison=39.668, 45.804and 79.335 for part, conc and part*conc respectively while Critical Value for Comparison= for part, con, and part* conc respectively.

Table 3: Fresh water with plumule length

Conc.	Leaf	Stem	Flower	Mean conc.
Con	57.350	18.367	18.367	31.361^{A}
5g	1.167	2.443	1.167	3.033^{B}
10g	1.500	1.500	1.167	1.592^{B}
15g	1.167	1.333	6.600	1.389^{B}
Mean	**15.296**	**5.911**	**6.825**	

Standard Error for Comparison=0.0576, 0.0665 and 0.1151 for part, conc and part*conc respectively while Critical Value for Comparison= 0.1188, 0.1372 and 0.2376 for part, con, and part* conc respectively.

Table 4: Fresh water with fresh weight

Conc.	Leaf	Stem	Flower	Mean conc.
Con	0.9067	0.9333	0.9333	0.9244
5g	0.2867	0.4100	0.3033	0.3333
10g	0.4667	0.2967	0.2100	0.3244
15g	0.5267	0.2633	0.4000	0.3967
Mean	**0.5467**	**0.4758**	**0.4617**	

Standard Error for Comparison=0.0576, 0.0665 and 0.1151 for part, conc and part*conc respectively while Critical Value for Comparison= 0.1188, 0.1372 and 0.2376 for part, con, and part* conc respectively.

Table 5: Fresh water with dry weight

Conc.	Leaf	Stem	Flower	Mean conc.
Con	0.3733	0.3467	0.3467	0.3556^{A}
5g	0.1333	0.2233	0.1467	0.1678^{B}
10g	0.2200	0.1600	0.0833	0.1544^{B}
15g	0.1600	0.1233	0.1700	0.1511^{B}
Mean	**0.2217**	**0.2133**	**0.1867**	

Standard Error for Comparison=0.0218, 0.0252 and 0.0436 for part, conc and part*conc respectively while Critical Value for Comparison= 0.0544, 0.0694 and 0.1571For part, con, and part* conc respectively.

Table 6: Fresh water with moisture content

Conc.	Leaf	Stem	Flower	Mean conc.
Con	13.667	17.267	16.833	15.922
5g	12.367	15.503	62.373	34.748
10g	40.467	44.033	72.633	52.378
15g	33.633	92.800	43.300	56.578
Mean part	**28.533**	**42.401**	**48.785**	

Standard Error for Comparison= 12.865, 15.00, and 27.908 for part, conc and part*conc respectively while Critical Value for Comparison =32.227, 41.520 and 101.04 for part, con, and part* conc respectively.

Table 7: *Hot water with germination percentage*

Conc.	Leaf	Stem	Flower	Mean conc.
Con	100	100	100	100^{A}
5g	23.33	76.67	50.00	50.00^{B}
10g	23.33	36.67	20.00	26.67^{C}
15g	6.67	3.33	20.00	10.00^{D}
Mean	**38.333**	**54.167**	**47.500**	

Standard Error for Comparison= 5.1370, 5.9317 And 10.274 for part, conc and part*conc respectively while Critical Value for Comparison =12.832, 16.366 and 37.036 for part, con, and part* conc respectively.

Table 8: Hot water with radical length

Conc.	Leaf	Stem	Flower	Mean conc.
Con	29.460	40.857	69.133	46.483^{A}
5g	4.3333	3.9567	6.7000	4.997^{B}

10g	1.00	1.8233	1.6667	1.497^{B}
15g	0.00	0.00	1.00	0.333^{B}
Mean	**8.698**	**11.659**	**19.625**	

Standard Error for Comparison= 2.5066, 2.8944 and 5.0133 for part, conc and part*conc respectively while Critical Value for Comparison =6.2612, 7.9861 and 18.072 for part, con, and part* conc respectively.

Table 9: Hot water with plumule length

Conc.	Leaf	Stem	Flower	Mean conc.
Con	15.367	18.600	15.950	16.639^{A}
5g	1.267	4.917	1.953	2.712^{B}
10g	0.333	1.600	2.167	1.367^{B}
15g	0.500	0.333	1.667	0.833^{B}
Mean	**4.3667**	**6.3625**	**5.3625**	

Standard Error for Comparison= 0.7552, 0.8721 and 1.5104 for part, conc and part*conc respectively while Critical Value for Comparison =1.8865, 2.4061 and 5.4449for part, con, and part* conc respectively.

Table 10: Hot water with fresh weight

Conc.	Leaf	Stem	Flower	Mean conc.
Con	0.7167	0.7767	0.9067	0.8000^{A}
5g	0.4700	0.5933	0.4667	0.5100^{B}
10g	0.3333	0.3967	0.4233	0.3844^{BC}
15g	0.1400	0.0833	0.4200	0.2144^{C}
Mean	**0.4150**	**0.4625**	**0.5542**	

Standard Error for Comparison= 0.0565, 0.0652 and 0.1129 for part, conc and part*conc respectively while Critical Value for Comparison = 0.1410, 0.1799 and 0.4070 for part, con, and part* conc respectively.

Table 11: Hot water with dry weight

Conc.	Leaf	Stem	Flower	Mean conc.
Con	0.330	0.3633	0.3800	0.3578^{A}
5g	0.2500	0.2133	0.2233	0.2289^{B}
10g	0.1467	0.1833	0.1533	0.1611^{B}
15g	0.0600	0.0433	0.1400	0.0811^{C}
Mean	**0.1967**	**0.2008**	**0.2242**	

Standard Error for Comparison= 0.0243, 0.0281 and 0.0486 for part, conc and part*conc respectively while Critical Value for Comparison = 0.0607, 0.0774 and 0.1752for part, con, and part* conc respectively.

Table 12: Hot water with moisture content

Conc.	Leaf	Stem	Flower	Mean conc.
Con	11.73	11.34	13.80	12.289^{A}
5g	39.13	23.92	24.67	29.241^{AB}
10g	26.07	64.63	89.77	60.156^{AB}
15g	22.20	30.77	101.81	51.591^{AB}
Mean	**24.782**	**32.666**	**57.510**	

Standard Error for Comparison= 12.538, 14.478 and 25.077 for part, conc and part*conc respectively while Critical Value for Comparison = 31.319, 39.947 and part, con, and part* conc respectively.

Table 13: ANOVA for fresh bioassay activity

Source	DF	Germ %	RL	PL	Fresh wt	Dry wt	Moist. Cont
Parts	2	119.4^{NS}	13897^{NS}	321.34^{NS}	0.02489^{NS}	0.0041^{NS}	$1231.^{NS}$
Conc	3	121.3^{*}	25377.9^{NS}	1943.85*	0.74795*	0.0888*	298.4*
Part* conc	6	808.3^{*}	13763.5^{NS}	409.58^{NS}	0.03081^{NS}	0.0066^{NS}	137.6
Error	24	130.6	9441.1	408.21	0.01988	0.0028	934.65^{NS}

Table 14: ANOVA for hot bioassay activity

Source	DF	Germ %	RL	PL	Fresh wt	Dry wt	Moist cont.
Parts	2	758.3*	383.2*	11.96*	0.06005^{NS}	0.004^{NS}	3501.7*
Conc.	3	13800.0*	4432.5*	511.97*	0.54876*	0.123*	4238.8*
Part* conc	6	613.9*	292.2*	4.151^{NS}	0.02926^{NS}	0.00318^{N}	1847.26^{NS}
Error	24	158.3	37.70	3.422	0.01913	0.00354	943.27

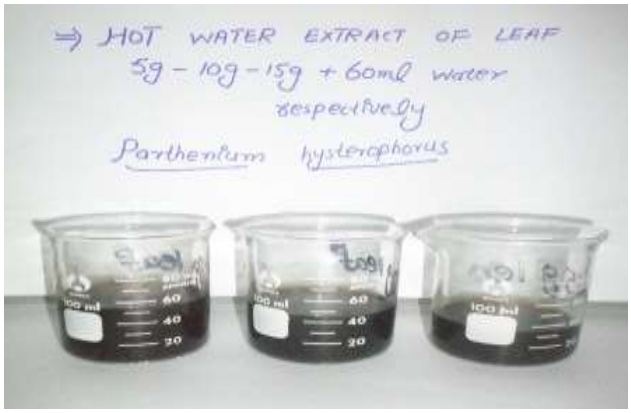

Fig. 1: Effect of Hot Water extract of Leaf

Fig. 2: Effect of Hot Water extract of Stem

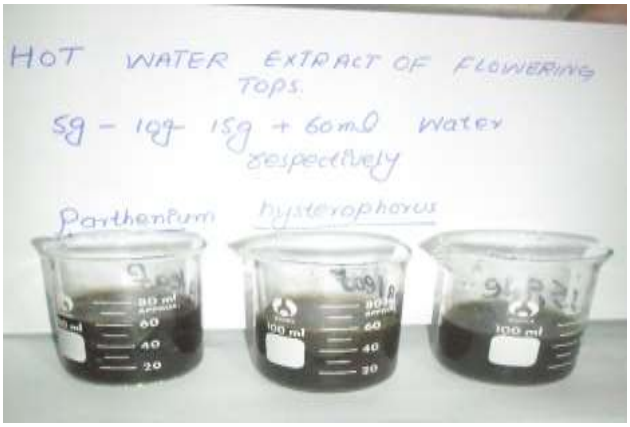

Fig. 3: Effect of Hot Water extract of Flowering tips

Fig. 4: Effect of Cold Water extract of Leaf

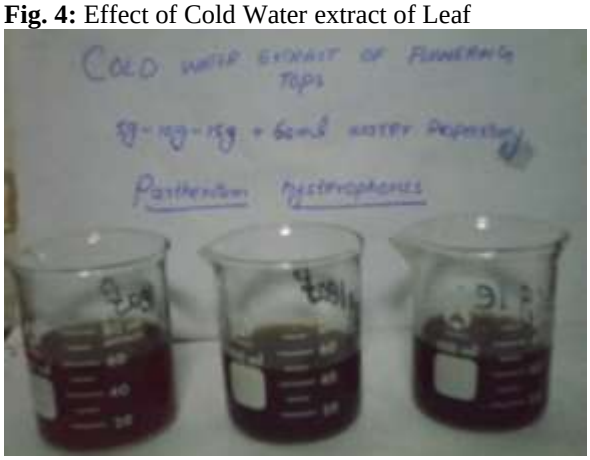

Fig. 5: Effect of Cold Water extract of Flowering tops

Fig. 6: Effect of Cold Water extract of stem

IV. CONCLUSION

From this study it was concluded that different growth parameters of the plant i.e. germination %, radical length, plumule length, fresh and dry weight and moisture content was significantly affected by extract of different concentration of *Parthenium hysterophorus.* So this plant can be further explored for future research in the field of allelopathy.

REFERENCES

[1] An, M., J. Pratley and T. Haig. 1998. Allelopathy: from concept to reality. Proceedings of the 9th Australian Agronomy Conference, Charles Sturt University Convention Centre.

[2] Bhowmik, P. C. and Sarkar, D. 2005. Parthenium hysterophorus L.: Its world stat and potential Management. In: Proceeding of the second International conference on Parthenium management 5-7 December 2005. *University of Agricultural Science Bangaloer*, pp: 1-6.

[3] Devi, O. I., and B. K. Dutta. 2012. Allelopathic effect of aqueous extract of *Parthenium hysterophorus* and *Chromoaena odorata* on the seed germination and seedling vigor of *Zea mays* L. *In vitro. Acad .J. Plant Sci*, 5(4): pp 110-113.

[4] Duke, S.O., F. E. Dayan, G. Aliota and I. G. Rongani. 2002. Chemicals form nature for weed management. *Weed Science*, 50: pp: 138-151.

[5] Evans, H. C. 1997. *Parthenium hysterophorus*: a review of its weed status and the possibilities for biological control. *Biocontrol*, 18 (3): pp: 89-98.

[6] Ibrahim, E. E., H. A. Mohammed and A. F. Mustafa. 1999. Allelopathic effects of *Euclayptus camaldulensis* and canocarpus plantations on germination and growth of two sorghum species. *Sudan Journal of Agricultural Research*, 2: 9-14.

[7] Javaid, A. and T. Anjum. 2006. Control of *Parthenium hysterophorus* L. by aqueous extracts of allelopathic grasses. *Pakistan Journal of Botany*, 38: 139-145.

[8] Khan, M. A., K. B. Marwat, G. Hassan and Z. Hussain. 2005. Bio herbicidal effects of tree extracts on seed germination and growth of crops and weeds. *Pakistan Journal of Weed Science Research*, 11: 179-184.

[9] Ko, J., S.H. Eom, M.J.C. Kim, Y. Yu and Y.S. Lee.2005. Allelopathy of rice husk on barnyard grass. *Journal of Agronomy*, 4: 288-292.

[10] Mack, R. N. and Lonsdale, W. M. 2001. Humans are global plant dispersers: getting more than we have bargained for. Bioscience 51: 95-102.

[11] Mahadevappa, M. 1997. Ecology, distribution, menace and management of *Parthenium*. In: Proceedings of the 1st International Conference on Parthenium Management, (Eds.): M. Mahadevappa

and V.C. Patil. 6-8 October 1997, University of Agricultural Sciences, Dharwad, India, 1-12.

[12] McFadyen, R. E. 2000. Biology and host specificity of the stem galling weevil (Contrechelus albocinerus) fielder: a potential biocontrol agent for *Parthenium* weed *Parthenium hysterophorus* L. (*Astereceae*) in Queensland, Australia, *Biocontrol Science and Technology* 10:195-200.

[13] Medhin, B. G. 1992. *Parthenium hysterophorus* L.: a new weed problem in Ethiopia. FAO Plant Protection Bulletin 40: 49p.

[14] Miranda, C. A. S. F., M. G. Cardoso, M. L. M. de Carvalho, A.C. S. Figueiredo, D. L. Nelson, C. M. Oliveira, M.S. Gomes, J. Andrade, J. A. Souza, L. R. M. Albuquerque. 2014. Chemical Composition and Allelopathic Activity of *Parthenium hysterophorus* and *Ambrosia polystachya* Weeds Essential Oils. *American Journal of Plant Sciences.* PP. 1248-1257.

[15] Mishra, K. K. 1991. Parthenium hysterophorus L. A new record for Nepal. Journal of Bombay Natural History Society 88: 466-467.

[16] Msafiri, C. J., M. T. Tarimo., and P. A. Ndakidemi. 2013. Allelopathic effects of *Parthenium hysterophorus* on seed germination, seedling growth, fresh and dry mass production of *Alysicurpus Glumaceae* and *Chloris gayana*. *American journal of research communication*, 1(11): 190- 205.

[17] Narwal, S. S. 1994. Allelopathy in crop production. *Scientific Publishers, Jodhpur* pp. 145.

[18] Navie, S. C., McFadyen, R. E., Panetta, F. D. and Adkins, S. W. 1996. The biology of Australian weeds 27. *Parthenium hyterophorous* L. Plant Protection Quaterly 11: 76- 88.

[19] Navie, S.C., R.E Mc Fadyen, F.D. Panetta and S.W. Adkins. 1996. The biology of Australian weeds 27, *Parthenium hysterophorous* L. *Plant Protect. Quart*, 11: 76-88.

[20] Picman, J. and A. K. Picman. 1984. Authotoxicity in *Parthenium hysterophorus* and its possible role in control of germination. *Biochemical Systematics and Ecology*, 12: 287-297.

[21] Rashid, H., M. A. Khan, A. Amin, K. Nawab, N. Hussain, and P. K. Bhowmik. 2008. Effect of *Parthenium hysterophorus* on root extract of seed germination and growth of maize and barley. *The American journal of plant sciences and biotechnology*, 2(2): 51-55.

[22] Regina, G.B., C.F. Reinhardtb, L.C. Foxcroftc and K. Hurlea. 2007. Residue allelopathy in *Parthenium hysterophorus* L. Does parthenin play a leading role? *Crop Protection*, 26: 237-245.

[23] Shabbir, A. 2002. *Parthenium hysterophorus* L; An exotic weed threatening the biodiversity and agricultural lands of Islamabad and adjoining districts. M. Phil thesis Department of Botany University of the Punjab, Lahore, Pakistan.

[24] Tefera, T. 2002. Allelopathic effects of *Parthenium hysterophorus* extracts on seed germination and seedling growth of Eragrostis tef. *Journal of Agronomy and Crop Science*, 188: 306-310

[25] Uremis, I., M. Arslan and A. Uludag. 2005. Allelopathic effects of some Brassica species on germination and growth of cutleaf ground cherry (*Physalis angulata* L.). *Journal of Biological Sciences*, 5: 661-665.

[26] Weston, L.A. 1996. Utilization of allelopathy for weed management in agro ecosystems. *Agronomy Journal*, 88: 860-866.

[27] Willis, R. J. 1985. The historical basis of the concept of allelopathy. *Journal of the History of Biology*, 18: 71-102.

[28] Willis, R. J. 1997. The history of allelopathy: 2.The second phase (1900-1920). The era of S.U. Pickering and the USDA Bureau of Soils. *Allelopathy Journal*, 4: 7-56.

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