EVALUATION OF PHYTOTOXICITY LEVELS OF *PARTHENIUM HYSTEROPHORUS* ON *TRITICUM AESTIVUM*

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Abstract: **For the evaluation of phytotoxic levels of aquous extracts of leaf, stem and root of *Parthenium hysterophorus* on the rate of seed germination, length of root and shoot and Seed Vigour Index in *Triticum aestivum*, laboratory experiment in petri dishes was conducted in the Department of Botany, Jai Prakash University, Chapra in 2017. The treatments were 15%, 25%, 50%, 75% and 100% concentrations of aquous extracts of leaf, stem and root of *Parthenium*. Data collected on seed germination, length of root and shoot and SVI values were analysed using SPSS programme for Pearsons Correlation Coefficient, Tukey HSD and Post HOC tests. The inhibition rate in seed germination ranged from 6.49 to 75.32; 6 to 22; and 0 to 2%, whereas inhibition rate in root length varied from 20.06 to 37.46%, 6.45 to 43.45% and 1.69 to 24.78% respectively in leaf, stem and root extracts. The inhibitory impact of leaf extract was observed more on SVI values compared to stem and root extracts. The impact of different plant parts, treatments and interaction of plant parts and treatments did not differed significantly for the rate of seed germination, however root length and shoot length values were significantly different at p < 0.000. The phytotoxic impact was recorded for root length and shoot length of *T.aestivum* however the rate of seed germination was not inhibited significantly. On the basis of phytotoxicity levels the plant parts of *Parthenium* for *T.aestivum* can be arranged as leaves > stems > roots.**

***Index Terms*: *Parthenium hysterophorus*, Pearsons Correlation Coefficient, Post HOC Tests, Root and Shoot length, Seed germination, Seed Vigour Index, *Triticum aestivum*, Tukey HSD**

1. *Introduction*

Parthenium hysterophorus secretes certain allelochemicals (Kanchan and Jayachandra 1980; Khalaj et al. 2013; Bhowmik et al. 2007, etc.) and reduces 40% and 90% loss per annum in agricultural crops and forage crops, respectively (Tomado et al. 2002). Bhadoria (2011) reported that the visible effect of allelochemicals on other plants include inhibition or retardation of germination rate; darkening and swelling of seeds; reduction of root and shoot length; swelling or necrosis of root tips; curling of root axis; decoloration; lack of root hairs; increased number of seminal roots; reduced dry weight accumulation and lowered reproductive capacity. Singh et al. (2005) have shown the strong positive correlation between extract concentration of residues of *Parthenium* and reduction in seedling length in *Brassica species*. Demissie et al. (2013) have studied the effect of root, stem and leaf extract on germination and elongation of onion and beans in Ethiopia. This weed had no place in World's worst weed till 1977 and during 1987 it has become one of the seven most dangerous weed of the world (Kumar 2015). Positive and negative allelopathic effects have been reported of *Parthenium* on many agricultural crops and other plant species (Oudhia et al. 1997; Aggrawal and Kohli 1992). *P.hysterophorus* contains 'Parthenin' an active chemical which is a terpenoid.

Parthenium has infested the croplands, roadsides, forestlands, urban areas etc. heavily after it was reported for the first time in India in 1956 at Pune. In a very short period it covered the agricultural land and affects the production of crops. The Jai Prakash University campus before ten years was a cropland. After abandonment of cropping and establishment of the University campus in about 240 ha of cropland, *Parthenium* has covered the whole campus of the University.

Triticum aestivum is the main cereal crop and mainly a rabi season crop in India. Today wheat is grown on more land than any other commercial crop and continues to be the most important food grain source for humans. Its production leads all crops including rice, maize, potatoes etc. It provides a blanced food to millions of people each day. It is rich in protein, vitamin and carbohydrates. Mainly three varieties of wheat are grown in India, *T.aestivum* or bread wheat being the most commonly grown one. It is produced in almost all the wheat cultivating states of India.

Thus the present study was aimed to evaluate the phytotoxicity levels of different concentrations of aquous extracts of leaves, stems and roots of *P.hysterophorus* on the rate of seed germination and growth of seedling of *T.aestivum*.

2. *Materials and Methods*

Parthenium hysterophorus has invaded the Jai Prakash University campus of about 240 ha area in just ten years. Earlier the whole area was a cropland. The study site is situated between 25^0 36'-26^0 15' N latitude and 84^0 25'-85^0 15' E longitude in the southern part of the newly - created Saran Division of North Bihar. Total area of the Saran district is 2641 sq. km.

After abandonment of cropping *P.hysterophorus* invaded the whole area. Plant samples were collected from the University campus from vegetative phase of *P.hysterophorus* during the period 2017. Root, stem and leaves were separated and air dried in shade and crushed with the help of laboratory blender. Dried samples were powdered and were used in the conduction of the experiment. 15%, 25%, 50%, 75% and 100% concentrations were prepared. A separate control condition was set up by using only distilled water. Experiments were set up in petri dishes covered with whatman's filter paper. For each treatment ten replicates were maintained and each petridish ten seeds of *Triticum aestivum* was placed. Distilled water was added when needed in petridishes. The rate of seed germination, length of root and shoot were determined after seven days of setting up of the experiment. Seed Vigour Index (SVI) was calculated by using the following formula:

SVI = (Length of root + Length of shoot) × Seed germination %

Data collected were statistically analysed by using the SPSS programme through Pearsons Correlation Coefficient, Tukey HSD and Post Hoc Tests.

3. *Results and Discussion*

The data recorded for the rate of seed germination, length of root and shoot, and Seed Vigour Index are presented in Tables 1 and 2. The data analysed statistically are presented in Table 3.

3.1 Seed Germination Rate (%): The rate of seed germination value in control condition of *T.aestivum* was 77% only and in different concentrations of leaf extract of *P. hysterophorus* it ranged from 19% to 78%. Seed germination rate decreased with increase in concentration of leaf extract of *Parthenium*. The rate of inhibition in seed germination varied from 6.49% in 25% treatment to 75.32% in 100% treatment.

The rate of germination in different concentrations of stem extract of *P.hysterophorus* ranged from 78 to 94% whereas this value was 100% in control condition. The rate of inhibition in seed germination ranged from 6% in 15% concentration to 22% in 100% treatment. This clearly indicated that with increase in concentration of stem extract from 15% to 100% the rate of inhibition in germination of seeds of *T.aestivum* also increased from 6% to 22%.

The effect of aqueous root extract of *P.hysterophorus* on seed germination in control condition was 100%. Similarly in 15% and 25% treatments there was no change in the values of rate of seed germination. However in higher concentrations 50%, 75% and 100% treatments the rate of seed germination values were recorded as 99%, 99% and 98%. The per cent decrease in seed germination rate was minor 1% in 50% and 75% treatments, and 2% only in 100% treatment.

3.2 Root Length (cm): The length of root value was 10.57 cm in control condition and 8.45 cm to 6.61 cm in 15% to 100% concentration of leaf extract. The root length values also decreased with increase in concentration of leaf extract of *Parthenium*. The per cent decrease in root length values were 20.06, 22.99, 34.63, 23.18 and 37.46% in 15, 25, 50, 75 and 100% treatments, respectively.

In aquous extract of stem the values for root length ranged from 5.61cm for 100% treatment to 11.34cm for 50% treatment whereas this value was 9.92cm for control condition. The length of root did not decreased with increase in concentration of stem extract. Thus the effect of different concentrations of stem extract of *P.hysterophorus* on root growth was not consistent compared to control condition. The per cent increase in root length in 15% and 25% treatments were 7.66% and 4.94%, respectively whereas in 50, 75 and 100% treatments these values decreased by 14.31, 6.45 and 43.45%, respectively.

In aquous extract of root the root length value in control condition was recorded 11.26cm whereas in different treatments these values ranged from 8.47cm to 12.69cm being minimum in 100% treatment and maximum in 25% treatment. In 15% and 25% treatments the root length values increased by 2.9% and 12.70% only; and in 50%, 75% and 100% treatments these values decreased by 1.69%, 6.75% and 24.78%.

3.3 Shoot Length (cm): The values for shoot length of *T.aestivum* in different concentrations of leaf extract of *Parthenium* ranged from 5.33 cm to 7.28 cm whereas in control condition this value was 8.11 cm. The decrease in shoot length values in different concentrations of leaf extract varied from 10.23% in 15% treatment to 34.28% in 50% treatment. The root length value decreased in all treatments compared to control condition.

The values for shoot length in *T.aestivum* ranged from 5.15cm for 100% treatment to 12.02cm for 25% treatment in different concentrations of stem extract of *P.hysterophorus*. The maximum decrease in length was observed in 100% treatment and in all other treatments the shoot length increased compared to control condition. The per cent increase in shoot length values were 4.34, 10.89, 10.33 and 3.41% in 15, 25, 50 and 75% treatments whereas in 100% treatment decreased by 52.49% compared to control condition.

In root extract the shoot length value in control condition was recorded 10.03cm; and in different treatments these values ranged from 8.75cm in 100% treatment to 10.15% in 15% treatment. In 15% and 50% treatments the shoot length values increased by 1.20% and 1.10% respectively whereas in 25%, 75% and 100% these values decreased by 2.19%, 3.29% and 12.76%, respectively.

4. **Seed Vigour Index (SVI):** The most significant parameter Seed Vigour Index (SVI) value in control condition was 1438.36 which decreased in different treatments from 227.24 in 100% treatment to 1226.94 in 15% treatment. It was observed that the seed vigour index values decreased with increase in concentrations of leaf extract of *Parthenium* in *T.aestivum*. The per cent decrease in SVI values in 15, 25, 50, 75 and 100% treatments were 14.70, 22, 50.93, 45.93 and 84.20%, respectively.

In stem extract the seed vigour index (SVI) value was 2076 for control condition and for other treatments it ranged from 839.28 to 2067.06. This indicated that the SVI decreased with increase in the concentration of stem extract of *P.hysterophorus* in *T.aestivum*. The per cent decrease in SVI values in 15, 25, 50, 75 and 100% treatments decreased by 0.43, 9.08, 4.60, 11.17 and 59.57%, respectively, compared to control condition.

In root extract the SVI value for control condition was 2129; and in different treatments these values ranged from 1687.56 to 2250. This value increased by 1.22% in 15% treatment. These values decreased by 2.02%, 0.07%, 4.09% and 14.62%, respectively, in 25%, 50%, 75% and 100% treatments.

Pearsons Correlation Coefficient value between root length and shoot length was 0.788 ($p < 0.000$). Tukey HSD and Post HOC tests indicated that the different plant parts such as leaf, stem and root extracts; treatments such as 15%, 25%, 50%, 75% and 100% concentrations and interactions of plant parts and treatments of *Parthenium* no significant differences in the rate of seed germination however the length of root and shoot differed significantly. Thus the impact of higher concentration i.e. 100% treatment was significant for root length and shoot length, however no impact among different treatments of lower concentrations were recorded on the rate of seed germination, root length and shoot length (Table 3).

In earlier studies we have recorded the phytotoxic impact of aquous extract of leaves of *Parthenium* on the rate of seed germination and growth of seedlings of *Phaseolus mungo*, *Cicer aeritinum*, *Pisum sativum* and *Cajanus cajan* and aquous extract of stem on *Pisum sativum* and *Zea mays* (Shikha and Jha 2016 a, b, c, d; 2017 a, b). In the present study the decrease in SVI values were more in leaf extract than stem and root extract. The plant parts for phytotoxicity levels can be arranged as leaf > stem > root for *T.aestivum*. However in other experiments in case of *Macrotyloma uniflorum* it was leaf > root > stem (Shikha 2018). This indicated that the phytotoxic impact of *Parthenium* in different crop plants differed differently. Thus the phytotoxic impact is species specific.

The allelopathic effects of different parts of *Parthenium* on seed germination and seedling growth have been evaluated by Maharajan et al. (2007) and Karim and Forzwa (2010) on wheat and other crop plants. Kanchan (1975) have reported that toxins are released to the soil from *Parthenium* through leaching and decay which inhibit the yield of tomato. Sukhda and Jayachandra (1979) also have suggested that *Parthenium* suppresses local vegetation by releasing the growth inhibitors through leaching, exudation of roots, decay of roots, decay of residues etc. All parts of *Parthenium* (leaves, stems, leaf hairs, flowers, pollengrains etc.) contain toxic and inhibitory constituents terpenoids, Sesquiterpene lactones, volatile oils, amino sugars, phenolic derivatives, flavonoids etc. (Pareek et al. 2011). Different concentrations of parthenin have been reported in different plant parts on dry weight basis such as leaf (3.40%), stem (0.12%), flower (1.08%), trichomes (1.20%) etc.

Thus the phytotoxic impact of leaf, stem and root extracts of *Parthenium* showed different levels of impact on the rate of seed germination and growth of seedlings in *T.aestivum*.

Table1: Seed Germination rate, Length of root and shoot and Seed Vigour Index in *Triticum aestivum* in Different Concentrations of Leaf, Stem and Root Extract of *P.hysterophorus*.

Extract	Growth Parameters	Control	15%	25%	50%	75%	100%
Leaf Extract	Seed Germination	77	78	72	58	51	19
	Root Length	10.57	8.45	8.14	6.91	8.12	6.61
	Shoot length	8.11	7.28	6.6	5.33	7.31	5.35
	SVI	1438	1227	1061	710	778	227
Stem Extract	Seed Germination	100	94	88	85	90	78
	Root Length	9.92	10.68	9.43	11.34	9.28	5.61
	Shoot length	10.84	11.31	12.02	11.96	11.21	5.15
	SVI	2076	2067	1888	1981	1844	839
Root Extract							
	Seed Germination	100	100	100	99	99	98
	Root Length	11.26	11.59	12.69	11.07	10.5	8.47
	Shoot length	10.03	10.15	9.81	10.14	9.72	8.75
	SVI	2129	2174	2250	2100	2002	1688

Table 2: Percent Increase (+) or Decrease (-) in Seed Germination Rate and Growth Parameters in *T.aestivum* in Different concentrations of leaf, Stem and Root Extract of *P.hysterophorus*.

Extract	Growth Parameters	15%	25%	50%	75%	100%
Leaf Extract	Seed Germination	1.3	-6.49	-24.68	-33.77	-75.32
	Root Length	-20.06	-22.99	-34.63	-23.18	-37.46
	Shoot length	-10.23	-18.62	-34.28	-12.08	-34.03
	SVI	-14.7	-22	-50.93	-45.93	-84.2
Stem Extract	Seed Germination	-6	-12	-15	-10	-22
	Root Length	7.66	4.94	-14.31	-6.45	-43.45
	Shoot length	4.34	10.89	10.33	3.41	-52.49
	SVI	-0.43	-9.08	-4.6	-11.17	-59.57
Root Extract	Seed Germination	0	0	-1	-1	-2
	Root Length	2.93	12.7	-1.69	-6.75	-24.78
	Shoot length	1.2	-2.19	1.1	-3.29	-12.76
	SVI					

Table 3: Significance levels when data were analysed using Tukey HSD and Post HOC Tests.

Sl no.		Seed Germination Rate (%)	Root Length (cm)	Shoot length (cm)
1	**Plant Parts**	0.314	0.000	0.000
2	**Treatments**	0.376	0.000	0.000
3	**Plant Parts × Treatments**	0.441	0.002	0.000
4	**Leaves × Stem**	0.320	0.000	0.000
5	**Leaves × Root**	0.953	0.000	0.000
6	**Stem × Root**	0.485	0.000	0.174
7	**Control / 15%**	0.507	0.983	1.000
8	**Control / 25%**	0.494	0.903	0.999
9	**Control / 50%**	0.474	0.581	0.917
10	**Control / 75%**	0.471	0.106	0.991
11	**Control / 100%**	0.422	0.000	0.000
12	**15% /25%**	1.000	0.999	1.000
13	**15% /50%**	1.000	0.936	0.957
14	**15% /75%**	1.000	0.407	0.998
15	**15% /100%**	1.000	0.000	0.000
16	**25% /50%**	1.000	0.992	0.987
17	**25% / 75%**	1.000	0.634	1.000
18	**25% / 100%**	1.000	0.000	0.000
19	**50% / 75%**	1.000	0.929	0.999
20	**50% / 100%**	1.000	0.000	0.000
21	**75% / 100%**	1.000	0.000	0.000

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