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RESEARCH ARTICLE

EVALUATION OF PHYTOTOXICITY LEVELS OF *PARTHENIUM HYSTEROPHORUS* L. ON *CAJANUS CAJAN*

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ABSTRACT

In laboratory condition phytotoxicity levels of aqueous extracts of leaves, stems and roots of *Parthenium hysterophorus* L. on the rate of seed germination, length of root and shoot, and Seed Vigour Index of *Cajanus cajan* was evaluated. The different concentrations used in the experiment were 15%, 25%, 50%, 75% and 100% of aquous extracts of leaves, stems and roots of *P.hysterophorus*. A control condition was maintained also. Ten seeds of *C.cajan* were placed in each petri dishes with ten replicates. The decrease in rate of seed germination in different concentrations of leaves ranged from 10.34 to 99.99%; in stem extract from 5 to 62% and in root extract from 1 to 22% only. Similarly root length value decreased from 1.02 to 70.41% in leaf extract; 25.62 to 63.33% in stem extract; and 57.61 to 87.12% in root extract. The decrease in most important parameter Seed Vigour Index ranged from 21.18 to 99.99% in leaf extract; 18.1 to 79.7% in stem extract; and 25.24 to 85.86% in root extract of *Parthenium*. Thus the effect of leaf extract was maximum followed by root extract and minimum in stem extract. The Tukey HSD and Post HOC Tests indicated effects of plant parts, treatments and interactions of plant parts and treatments were significantly different at $p < 0.000$. Thus the present study indicated that the leaves of *Parthenium* is more phytotoxic than root and stem for *C.cajan*.

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INTRODUCTION

Parthenium hysterophorus L. is an annual herbaceous prolific weed belonging to Asteraceae family. *Parthenium* came to India under US PL-480 scheme and invaded all parts of India (Kaur *et al*., 2014). Roxburg (1814) for the first time reported its existence in India. *Parthenium* is a native weed of Mexico and has been widely distributed to the different countries such as Australia, India, China, Kenya, Ethiopia, Nepal etc. through contaminated grains and farm machineries (Mack and Lansdale, 2001). It has been widely distributed and created problems in countries like Kenya, Taiwan, India, West Indies, Nepal etc. (Picman and Picman 1984; Peng et al.1988; Tiwari *et al.,* 2005; Sabbir and Bajwa 2006; Bhowmik *et al.,* 2007; Dhileepan 2009). This weed has achieved major status in India and Australia in last some decades (Navie *et al*., 1996; Evans 1997; Mahadevappa 1997; Kaushik *et al.,* 2005; Bhowmik *et al*., 2007). Dwivedi *et al.* (2009) has reported about two million hactares of land in India has been invaded by *Parthenium*. The presence of *Parthenium* have the drastic effect on the agricultural crops and also causes health hazards in human beings and affects ecosystem and biodiversity (Adkins and Sowerby, 1996; Navie *et al*., 1996; Kumari *et al*., 2014).

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Parthenium is an aggressive colonizer, production of large amount of seeds; shows allelopathic effects; induces changes in the physical, chemical and biological properties of soil; replaces palatable grasses in rangelands and its manual removal is difficult (Tamado and Milberg 2000; Pandey *et al.,* 2003; Tiwari *et al.,* 2005; Oudhia 2000a,b; Batish *et al.,* 2002a, b; Singh *et al.,* 2003, 2005; Batish *et al.,* 2002; Bhowmik *et al.,* 2007; Tudor *et al.,* 1982; Kohli and Rani 1994; Anonymous 2000; Ayele 2007; Wegari 2008; Oudhia 2001). Tamado and Milberg (2000) have showed that *Parthenium* was the most major problem in rangeland and cropland in the Eastern Ethiopia. *Parthenium* fastly grows and is comfortable on alkaline to neutral clay soil (Dale, 1981). Monaco et al.(2001) have reported that the spread of seeds and their ability to remain viable in the soil for many years pose one of the most complex problems for control and this fact makes eradication difficult for many seed producing *Parthenium*. In the human beings it causes various types of allergies particularly through pollen grains like contact dermatitis, hay fever, asthma and bronchitis (Navie *et al.,* 1996; Wiesner *et al.,* 2007).

Cajanus cajan is the most important grain legume crop of rain-fed agriculture in semi-arid tropics. It is both a food crop and a forage crop with high levels of proteins and important amino acids. India is a principal pigeon pea growing country contributing 90% of the total world production. The aim of the

present study was to evaluate the phytotoxicity levels of aqueous extracts of leaves, stems and roots of *P.hysterophorus* on the rate of seed germination, length of root and shoot, and Seed Vigour Index of an important crop *Cajanus cajan* in laboratory condition.

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 *Cajanus cajan* 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, and Tukey HSD and Post Hoc Tests.

RESULTS AND DISCUSSION

***Seed germination* (%):** The rate of seed germination in control condition was 96.6%; and in different concentrations of leaf extract of *Parthenium* it varied from 0.0% to 86.67%. The rate of seed germination values decreased from 10.34% to 100%. In stem extract of *Parthenium* the rate of seed germination in control condition was recorded 100%. However, in different treatments the seed germination rate value ranged from 38% to 95% only. It was maximum (95%) for 15% treatment and minimum (38%) in 100% stem extract of *Parthenium*. The rate of seed germination in *C. cajan* decreased with increase in the concentration of stem extract of *Parthenium*. The inhibition in the rate of seed germination ranged from 5% to 62% being minimum 5% for 15% treatment and 62% for 100% treatment. In root extract of *Parthenium* the rate of seed germination in control condition was 100% whereas in 15, 25, 50, 75 and 100% treatments of root extract of *Parthenium* in *C.cajan* the rate of seed germination ranged from 78 to 99%. The rate of decrease in seed germination varied from 1% in 15% treatment to 22% in 100% treatment.

Root length (cm): The values for root length ranged from 1.16 to 5.11cm in different concentrations compared to 3.92 cm in control condition in leaf extract of *Parthenium.*The lowest value 1.16 cm was recorded for 100% and highest value 5.11 cm for 15% concentrations. In 15% treatment root length value

Table 1: Seed Germination rate, Length of root & shoot and Seed Vigour Index in *C.cajan* in Different Concentrations of Leaf, Stem and Root Extract of *P.hysterophorus*.

	Growth parameters	Control	15%	25%	50%	75%	100%
Leaf Extract	Seed Germination (%)	96.6	60%	80	86.67	83.33	0.00
	Root Length (cm)	3.92	5.11	3.88	3.21	2.22	1.16
	Shoot Length (cm)	8.26	9.05	7.72	5.78	5.18	4.41
	SVI	1177.44	849.6	928	779.16	616.64	0.056
Stem Extract	Seed Germination (%)	100	95	91	85	78	38
	Root Length (cm)	4.8	3.57	2.93	2.52	2.43	1.76
	Shoot Length (cm)	3.81	3.85	4.33	3.09	3.51	2.83
	SVI	861	704.9	660.66	476.85	463.32	174.42
Root Extract	Seed Germination (%)	100	99	92	86	86	78
	Root Length (cm)	4.27	2.87	1.81	1.47	1.51	0.55
	Shoot Length (cm)	7.98	6.38	4.9	3.27	2.89	1.67
	SVI	1225	915.75	617.32	407.64	378.4	173.16

Table 2: Per cent increase (+) or decrease (-) in seed germination rate and growth parameters in *C.cajan* in different concentrations of leaf, stem and root extract of *P.hysterophorus*.

Extracts	Growth Parameters	15%	25%	50%	75%	100%
Leaf Extract	Seed Germination (%)	-37.93	-17.24	-10.34	-13.80	-99.99
	Root Length (cm)	+30.36	-1.02	-18.11	-43.37	-70.41
	Shoot Length (cm)	+9.56	-6.54	-30.02	-37.29	-46.61
	SVI	-27.84	-21.18	-33.83	-47.83	-99.99
Stem Extract	Seed Germination (%)	-5	-9	-15	-22	-62
	Root Length (cm)	-25.62	-38.96	-47.5	-49.37	-63.33
	Shoot Length (cm)	1.05	13.65	-18.9	-7.87	-25.72
	SVI	-18.1	-23.3	-44.6	-46.2	-79.7
Root Extract	Seed Germination (%)	-1	-8	-14	-14	-22
	Root Length (cm)	-71.66	-57.61	-65.57	-64.64	-87.12
	Shoot Length (cm)	-20.05	-38.6	-59.02	-63.78	-79.07
	SVI	-25.24	-49.61	-66.72	-69.11	-85.86

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	0.000	0.000	0.000
2	Treatments	0.000	0.000	0.000
3	Plant Parts × Treatments	0.000	0.000	0.002
4	Leaves × Stem	0.019	0.360	0.000
5	Leaves × Root	0.000	0.000	0.000
6	Stem × Root	0.000	0.000	0.000
7	Control / 15%	0.120	0.000	0.414
8	Control / 25%	0.016	0.000	0.002
9	Control / 50%	0.000	0.000	0.000
10	Control / 75%	0.000	0.000	0.000
11	Control / 100%	0.000	0.000	0.000
12	15% /25%	0.975	0.000	0.342
13	15% /50%	0.226	0.000	0.000
14	15% /75%	0.010	0.000	0.000
15	15% /100%	0.000	0.000	0.000
16	25% /50%	0.668	0.331	0.000
17	25% / 75%	0.084	0.064	0.000
18	25% / 100%	0.000	0.000	0.000
19	50% / 75%	0.838	0.972	1.000
20	50% / 100%	0.000	0.000	0.018
21	75% / 100%	0.000	0.001	0.033

increased by 30.36% whereas in 25, 50, 75 and 100% treatments these values decreased by 1.02, 18.11, 43.37 and 70.41%. In stem extract of *Parthenium* the root length value was recorded 4.80cm in control condition. In different treatments root length value ranged from 1.76cm to 3.57cm. It was recorded minimum (1.76cm) for 100% treatment and maximum (3.57 cm) for 15% treatment. The root length values decreased with increase in the concentration of stem extract of *Parthenium* from 15% to 100% concentration. The decrease in root length values ranged from 25.62% to 63.33% being minimum for 15% treatment and maximum for 100% treatment compared to control treatment. In root extract of *Parthenium* in control condition the root length value was 4.27cm whereas in 15, 25, 50, 75 and 100% treatments these values were 2.87cm, 1.81cm, 1.47cm, 1.51cm and 0.55cm, respectively. The per cent decrease in root length values in different treatments were 71.66, 57.61, 65.57, 64.64 and 87.12%, respectively in 15, 25, 50, 75 and 100% treatments compared to control condition.

Shoot length (cm): The value for shoot length ranged from 4.41 to 9.05cm in different concentrations and 8.26 cm in control condition in leaf extract of *Parthenium*. The lowest value 4.41cm was recorded for 100% and highest value 9.05cm for 15% concentrations. In 15% treatment shoot length value increased by 9.56% compared to control condition whereas in 25, 50, 75 and 100% treatments these values decreased by 6.54, 30.02, 37.29 and 46.61%, respectively. In stem extract of *Parthenium* the shoot length value was recorded 3.81cm in control condition whereas in different treatments this value ranged from 2.83 cm to 4.33 cm. The lowest value was observed 2.83cm for 100% treatment and highest value 4.33cm for 25% treatment. The shoot length value increased 1.05% in 15% treatment and 13.65% in 25% treatment compared to control condition. The shoot length values decreased 7.87%, 18.90 and 25.72% compared to control condition in 75%, 50% and 100% treatments, respectively. Thus higher concentrations of stem extract of *Parthenium* inhibited the growth of shoot. In root extract of *Parthenium* control condition the shoot length value was 7.98cm whereas in 15, 25, 50, 75 and 100% treatments these values were 6.38, 4.90, 3.27, 2.89 and 1.67cm, respectively. The per cent decrease in shoot length values in different treatments were 20.05, 38.60, 59.02, 63.78 and 79.07, respectively in 15, 25, 50, 75 and 100% treatments.

Seed vigour index (SVI): In different concentrations of leaf extract of *Parthenium hysterophorus* the SVI values ranged from 0.056 to 928 in comparison with control condition 1177.44. In 15, 25, 50, 75 and 100% treatments SVI values decreased by 27.84, 21.18, 33.83, 47.63 and 99.99%, respectively. In stem extract of *Parthenium* in control condition the SVI value was 861 whereas for different treatments it ranged from 174.42 to 704.9 being minimum for 100% treatment and maximum for 15% treatment. The per cent decrease in SVI value ranged from 18.1% to 79.9%. Maximum decrease was observed in 100% treatment and minimum decrease in 15% treatment. Thus the SVI of *C. cajan* decreased with increase in the concentration of stem extract of *P. hysterophorus* in *C. cajan*. In root extract of *Parthenium* in control condition this value was 1225; and in 15, 25, 50, 75 and 100% treatments these values were 915.75, 617.32, 407.64, 378.4 and 173.16, respectively. The per cent decrease in SVI values in 15, 25, 50, 75 and 100% treatments were 25.24, 49.61, 66.72, 69.11 and 85.86%, respectively. Pearsons correlation coefficient test between root length and shoot length of *C.cajan* showed positive and highly significant correlation having Pearsons correlation coefficient value 0.524, $p < 0.000$. Tukey HSD and Post HOC tests indicated that the effects of different plant parts of *Parthenium* i.e. root, stem and leaf; different treatments i.e. 15%, 25%, 50%, 75% and 100% concentrations of aquous extracts of root, stem and leaf; and interactions between plant parts and treatments were highly significantly different at $p < 0.000$ for seed germination, root length and shoot length in *C.cajan* (Table 3). Except for the values of root length for leaves × stems, other interactions were highly significantly different at $p < 0.000$.

In the present study the inhibition in the rate of seed germination ranged from 10.34 to 99.99% in leaf extract; 5 to 62% in stem extract and 1 to 22% in root extract of *Parthenium* in *C.cajan*. The values for inhibition in root length in leaf extract varied from 1.02 to 70.41%; in stem extract from 25.62 to 63.33% and in root extract from 57.61 to 87.12%. The decrease in shoot length values in leaf extract varied from 6.54 to 46.61%; in stem extract from 7.87 to 25.72% and in root extract from 20.05 to 79.07%. The SVI value decrease in leaf extract varied from 21.18 to 99.99%; in stem extract from 18.1 to 79.7% and in root extract from 25.24 to 85.86%. Thus the present study indicated that the different concentrations of leaf of *Parthenium* was more phytotoxic for *C.cajan* followed by root and stem extract. Leaf extract had the strongest allelopathic effect on seed germination as earlier reported by Khan et al.(2012) on wheat; Devi and Dutta (2012) on *Zea mays;* Oudhia (1998) on rice and other crops in India; Oudhia and Tripathi (1998) on chickpea, mustard and linseed; and Shikha (2018); Shikha and Jha (2016 a,b,c,d; 2017 a,b).

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