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ASSESSMENT OF AQUEOUS LEAF EXTRACTS OF *PARTHENIUM HYSTEROPHORUS* L. ON SEEDLINGS GROWTH OF WHEAT

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Abstract

An investigation was conducted to assess the effect of *Parthenium hysterophorus* L. leaf extracts on seedling growth of three wheat (*Triticum aestivum* L.) varieties *viz*. Sourav, BARI Gom 22 and BARI Gom 33. It was observed that the growth of wheat seedlings was significantly influenced by the *Parthenium* extract treatments. BARI Gom 22 showed more tolerance to *Parthenium* treatments than BARI Gom 33 and Sourav. Generally, wheat seedlings growth was inhibited by *Parthenium* extract treatments at all periods. The percent inhibition of shoot and root elongation were more visible at 5% treatment concentration at all periods than other extract treatments. On the other hand the number of root of wheat seedlings was not found to be affected by *Parthenium* at 7 and 10-day periods. It was also noted that the effect of *Parthenium* extracts on wheat seedling growth is concentrations dependent manner.

Key words: Leaf extracts, *Parthenium*, growth of seedlings, wheat.

Introduction

Wheat (*Triticum aestivum* L.) is one of the most important cereal crop grown throughout the world. In Bangladesh it is the second most important crop after the rice. It has significant contribution to the livelihood of people of Bangladesh. But the wheat field has affected by *Parthenium* weeds at different regions of Bangladesh. *Parthenium (Parthenium hysterophorus* L.) is one of the most aggressive invasive weeds and widely distributed around the world. It grows in a wide range of habitats having potential characteristics of adaptability, drought tolerance, competition capability, allelopathic quality, high rate of seed production ability, longevity of seeds and small seeds size and capable of long distance dispersal and rapid introduction at new place without any climate barriers (Bajwa et al. 2018). The germination rate of *Parthenium* is also quicker than that of other surrounding weeds present (Prasad 2007). It infests major crops such as wheat, maize and sugarcane and causes considerable yield losses. Recently in Bangladesh, it is being observed that *Parthenium* is moving towards wheat field's affecting wheat seedlings growth and ultimately hampering productivity. With a view of this context, the present investigation was undertaken to study the effect of *Parthenium hysterophorus* leaf extracts on wheat seedlings growth under the laboratory conditions.

Materials and Methods

Plant materials

Three popular wheat varieties of Bangladesh *viz*. Sourav, BARI Gom 22 and BARI Gom 33 were considered as test plants and *Parthenium hysterophorus* leaf extracts was employed as treatment to conduct the experiment.

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Collection and preparation of leaf extracts

Parthenium hysterophorus fresh leaves were collected from Rajshahi University Campus, washed with tap water and air-dried at room temperature. The 100 g leaves of *Parthenium* was soaked in 1 liter distilled water and kept them in a room temperature at 15-20°C for 72 h. Then the aqueous extracts were filtered through the Markin cloth and finally filtrated through Whatman No.1 filter paper. The filtrate was obtained as stock solution of 100% concentration. The following solutions of 1, 5 and 10% were prepared from stock solution by diluted with distilled water and stored it for wheat seed treatments. Good quality seeds of three wheat varieties (Sourav, BARI Gom 22 and BARI Gom 33) were collected from Wheat and Maize Research Centre, Dinajpur, Bangladesh. The seeds were disinfected with 10% solution of sodium hypochlorite then washed with distilled water in several times. Petri dishes were also sterilized for 2 h by oven heat at 70°C. Ten seeds of each wheat variety were placed in the petri dishes. These petri dishes were moistened by subjected extracts as a treatment medium and placed in laboratory (room temperature 15-20°C and light intensity 200-300 lux).

Experimental design and treatment

The experiment was laid out in a Completely Randomized Design (CRD) with factorial arrangements having three replications. The four different concentrations (0, 1, 5 and 10%) of leaf extract of *Parthenium* were applied to three wheat varieties to conduct the experiment.

Growth records and data collection

The leaf extract of each treatment was added to each petri dish daily in such an amount just enough to wet the tested seeds. The control was only with distilled water. The experiment was extended over a period of ten days to allow the last seed germination. A seed was considered as germinated when radicle emerged and its length ≥0.2 cm. The data were recorded on shoot (S) length, root (R) length, number of roots initiation, percentage of stimulatory/inhibitory effect, % phytotoxicity and tolerance index of wheat seedlings. The tolerance index (TI), percentage of phytotoxicity, and percentage of inhibition or stimulation were calculated by using the following formulas:

$$TI = \frac{\text{Longest root length in treatment}}{\text{Longest root length in control}} \times 100$$ (Turner and Marshal 1972)

$$\text{Phytotoxicity (\%)} = \frac{\text{Root/shoot length in control - root/shoot length in treatment}}{\text{Root/shoot length in control}} \times 100$$ (Chiou and Muller 1972)

$$\% \text{ of inhibition (-) or stimulation (+)} = \frac{\text{Root/shoot length in treatment - Root/shoot length in control}}{\text{Root/shoot length in control}} \times 100 \text{ (Chung et al. 2001)}$$

The values of variable factors were evaluated by ANOVA and means were separated by Duncan's Multiple Range Test (DMRT) at 5% significance level.

Results

Shoot length: ANOVA of Table 1 indicates that wheat varieties and treatment concentrations both were significantly affected in wheat shoot length. Among the varietal performances, Sourav produced the highest shoot length (13.05 cm) followed by other wheat varieties at 10-day period (Table 2, Fig. 1). It was noted that with increasing concentration of extracts, the shoot length of wheat seedlings decreased significantly (Table 3). The trends may not be same for other wheat varieties as the inhibitory magnitude of plants is species-depended with varietal differences.

Table 1. F-value for shoot length, root length and number of roots of wheat seedlings grown after 3, 7 and 10 days of germination in *Parthenium* extract treatments.

Sources	df	F-value								
		After 3 days			After 7 days			After 10 days		
		Shoot length (cm)	Root length (cm)	No. of roots initiation	Shoot length (cm)	Root length (cm)	No. of roots initiation	Shoot length (cm)	Root length (cm)	No. of roots initiation
Cultivar (C)	2	1.72^{ns}	11.37**	0.00	8.89*	12.30*	11.62**	9.79*	9.70*	14.77**
Treat. (T)	3	7.50*	19.70**	0.00	37.33**	218.68**	33.50**	39.23**	293.02**	24.11**
C x T	6	1.02^{ns}	1.90^{ns}	0.00	4.99*	3.28*	6.12*	0.92^{ns}	1.83^{ns}	10.33**
Error	24									

*, Significant; **, highly significant at 5% level of significance.

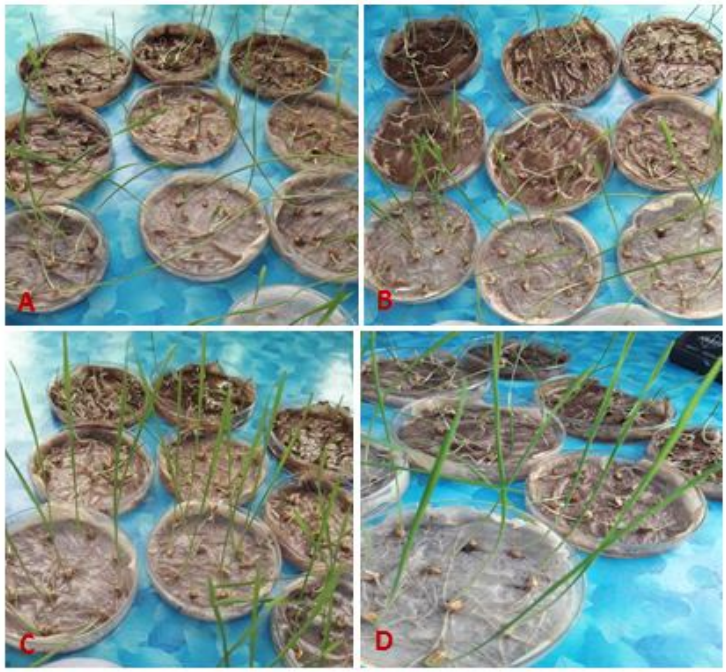

Fig. 1(A-D): Wheat seedlings grown in response to *Parthenium* leaf extracts in petri dishes after 10 days.

Root length: The root elongation of wheat seedlings was significantly affected by extract treatments at all periods (Table 1). Root length was also significantly different among the wheat varieties. At the end period, BARI Gom 33 yielded the highest root length (11.17 cm) than Sourav and BARI Gom 22 (Table 2). The root length was drastically reduced with higher extract concentrations (5 and 10%). Root elongation was highly stressed by *Parthenium* extract treatment especially at 7 and 10-day period (Table 3).

No. of roots initiation: Initiation of root number was significantly different among the wheat varieties. At the end period, the highest number of roots was noted in Sourav (5.58) and the lowest was BARI Gom 22 (4.50). It was interestingly noted that root number increased with the increased of extract concentrations at 7 and 10-day periods (Table 3).

Table 2. Performances of wheat cultivars on growth response after 3, 7 and 10 days.

Wheat cultivars	After 3 days			After 7 days			After 10 days		
	Shoot length (cm)	Root length (cm)	No. of roots initiation	Shoot length (cm)	Root length (cm)	No. of roots initiation	Shoot length (cm)	Root length (cm)	No. of roots initiation
Sourav	0.4250a	0.85b	0.000	6.11ab	5.62b	5.25a	13.05a	9.10b	5.58a
BARI Gom 22	0.4167a	1.12a	0.000	7.26a	6.24ab	4.91ab	11.74ab	9.20 b	4.50b
BARI Gom 33	0.3667a	0.84b	0.000	5.58b	7.28a	4.33b	9.68b	11.17a	4.83b
LSD (p≤0.05)	-	0.24	-	1.45	1.20	0.68	2.74	1.89	0.74

Table 3: Performances of *Parthenium* leaf extract concentrations on wheat growth response after 3, 7 and 10 days.

	After 3 days			After 7 days			After 10 days		
	Shoot length (cm)	Root length (cm)	No. of roots initiation	Shoot length (cm)	Root length (cm)	No. of roots initiation	Shoot length (cm)	Root length (cm)	No. of roots initiation
Extracts (%)									
Control	0.51a	1.24a	0.000	8.73a	10.32a	4.22b	14.69a	16.61a	4.44b
1	0.40ab	0.98ab	0.000	7.18a	9.43a	3.88b	14.82a	15.81a	4.11b
5	0.35b	0.66c	0.000	4.18b	2.30b	5.66a	6.90b	2.98b	5.77a
10	0.34b	0.86bc	0.000	5.17b	3.47b	5.55a	9.55b	3.87b	5.55a
LSD (p≤0.05)	0.14	0.27	-	1.68	1.39	0.79	3.16	2.18	0.85

In each column followed by different letters are significantly different according to DMRT p≤0.05.

Tolerance index: Tolerance index of wheat seedlings significantly affected by the *Parthenium* extracts. The highest tolerance index was recorded in control (no extracts added) whereas the tolerance index became lowest at 1% treatment concentration. Noted that tolerance index of wheat seedlings was gradually decreased with the increased of *Parthenium* extract concentrations (Table 4).

Table 4. Tolerance and phytotoxicity effect of *Parthenium* leaf extracts on wheat seedlings after 3, 7 and 10 days.

Extracts (%)	Wheat varieties								
	Sourav			BARI Gom 22			BARI Gom 33		
	Days of seedling								
	3	7	10	3	7	10	3	7	10
	Tolerance index (%)								
Control	100	100	100	100	100	100	100	100	100
1	81.81	74	96	88.23	98	112	76.92	108	104
5	63.63	25	25	47.05	23	15.15	53.84	25.83	20.94
10	63.63	30	28.12	76.47	41	30.30	61.53	41.66	22.51
	Phytotoxicity (%)								
Control	0	0	0	0	0	0	0	0	0
1	19.41	23.70	3.80	23.56	-3.11	5.24	17.69	5.74	5.26
5	34.95	78.67	66.93	55.41	78.92	84.45	44.24	76.00	81.57
10	12.62	64.80	73.6	34.39	65.11	77.89	40.70	68.55	78.10

Each value is an average of 3 replications. Each replication consisted of 10 seeds.

Phytotoxicity: Phytotoxicity of wheat seedlings at different extract concentrations was found to be significantly affected. Phytotoxicity effect was increased with the increase of treatment concentrations. BARI Gom 22 showed more phytotoxic effect than BARI Gom 33 and Sourav (Table 4, Fig. 2).

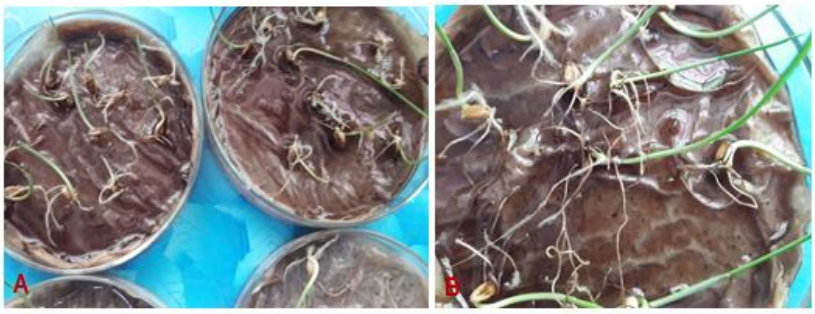

Fig. 2(A-B): Wheat seedlings growth inhibited by *Parthenium* leaf extracts in petri dishes after 10 days.

% of inhibition/stimulation

Generally it was observed that shoot and root elongation of wheat seedlings was mostly inhibited by *Parthenium* treatments at all interval periods (Table 4). But the initial number of roots inhibition was totally stimulated by extract treatments followed by BARI Gom 22 at 10-day and BARI Gom 33 at 7-day period (Table 5).

Table 5. Stimulatory and inhibitory effect of *Parthenium* leaf extracts on wheat seedlings growth after 3, 7 and 10 days.

Wheat variety									
	Sourav			BARI Gom 2			BARI Gom 33		
Stimulation/inhibition (%)									
Days of seedling									
Extract Treats. (%)	3	7	10	3	7	10	3	7	10
Shoot length (cm)									
Control	0	0	0	0	0	0	0	0	0
1	-20	-46.50	-10.41	-24.52	3.73	7.78	-40	-8.53	13.54
5	-20	-51.96	-50.58	-37.73	-38.84	-51.16	-34	-66.21	-56.20
10	-20	-34.59	-32	-24.52	-35.78	-24.27	-54	-50.80	-48.09

Contd.

Root length (cm)									
Control	0	0	0	0	0	0	0	0	0
1	-19.81	-23.70	-3.8	-23.56	3.11	-5.24	-17.69	-5.24	-5.26
5	-34.95	-78.67	-66.93	-55.41	-78.92	-84.45	-44.24	-76.00	-81.57
10	-12.62	-64.80	-73.6	-34.39	-65.92	-77.89	-40.70	-68.55	-78.10
Number of roots									
Control	0	0	0	0	0	0	0	0	0
1	0	0	0	0	-28.69	22.33	0	11	-35.76
5	0	13.4	0	0	21.41	89	0	89	28.47
10	0	6.6	-5.99	0	28.47	89	0	77.66	21.41

Each value is an average of 3 replications. Each replication consisted of 10 seeds. +, stimulation; -, inhibition.

Discussion

Statistical analysis of the data indicated that all the parameters had significant effect on wheat seedling growth by *Parthenium* leaf extracts irrespective to interval periods. At the end period, it was observed that Sourav produced the highest shoot elongation and root number than BARI Gom 22 and BARI Gom 33 whereas BARI Gom 33 produced the longest root than BARI Gom 22 and Sourav. The shoot and root length were gradually decreased with increased *Parthenium* treatment strengths at the end period. The extract treatments differentially affected towards wheat seedlings growth. The tolerance percentages of wheat seedlings were also decreased with the increase of treatment concentrations. These findings is in agreement with the findings of Tshseen et al. (2015) who found tolerance index significantly reduced with increasing *Parthenium* concentration when compared to control.

At control, no phytotoxic effect was observed but it was gradually increased with higher treatment concentration. So, it is noted that wheat seedlings was drastically affected by *Parthenium* treatments. BARI Gom 22 had the highest phytotoxicity effect (84.45%) at 5% treatment followed by BARI Gom 33 at the same treatment. These findings is in agreement with the work of Tshseen et al. (2015) who found strong relation between increased extract concentrations of *Parthenium* and increased toxicity to some agronomic crops and weed plants. In most of the cases wheat seedlings showed inhibition whereas number of roots showed stimulation effect at 5 and 10% treatments. Tefera (2002) found that the inhibitory impact of *Parthenium* leaf extract was more powerful than of other vegetative parts. Phytochemical analysis already reported high accumulation growth inhibitors in leaves of *Parthenium hysterophorus* (Kanchan 1975). The present study demonstrated that leaf extracts of *Parthenium hysterophorus* exhibited significant inhibitory effects on wheat seedling growth (either shoot or root length). Earlier works have also reported that foliar leachates of *Parthenium hysterophorus* reduced root and shoot elongation of *Oryza sativa* and wheat (Singh 1991), maize

and soyabeans (Bhatt et al. 1994) as well as some common Australian pasture grasses (Adkins and Sowerby 1996). Wakjira et al. (2009) reported that fresh *Parthenium* plants have been reported to reduce the lettuce (*Lactuca sativa* L.) radicle and plumule length more than the composing *Parthenium* plants.

The present results suggest that a higher concentration of *Parthenium* extract is more harmful than lower concentrations. Tefera (2002) reported that higher concentrations of *Parthenium* allelochemicals have detrimental effects on germination, seedling growth and yield of crops, lower concentrations are reported to have stimulation effects. The densely populated *Parthenium* weeds in a crop field can contribute or accumulate more allelochemicals in the soil and ultimately pollute the soil environment. Sing et al. (2003) reported that with increasing concentrations of *Parthenium* weed extracts, the inhibition of radish and check-pea also increased. Stimulatory effect of *Parthenium* extracts on many crops and weeds present interesting phenomena that draw the attention of scientists. Amin et al. (2007) reported that the response of different species to *Parthenium* weed extract was different. The inhibitory magnitude of plants is species dependent with varietal differences (Xuan et al. 2003, Hong et al. 2004).

Conclusion

Parthenium has the potential to adversely affect crops, resulting in low yields due to the release of allelochemicals into the soil. Dense stands of parthenium in crop field adversely affect the growth and reduced yield by releasing allechemicals. These allelochemicals can be used as bioherbicide for weed control. At higher concentrations, this species will cause more losses to crop plants than lower concentrations. The results indicated that wheat was more sensitive to *Parthenium* extracts. Some encouraging results could be leading a better understanding for agricultural scientists since allelochemicals can be used both for weeds and pest management. The harmful impact of allelopathy can be exploited for pest and weed control.

Conflict of interest: The authors hereby declare no conflict of interest regarding the publication of this article.

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