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Assessment of allelopathic efficacy of *Parthenium hysterophorus* L. plant parts on seed germination and seedling growth of *Triticum aestivum* L

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Abstract
In nature, plants show an allelopathic effect on other plants it may be inhibitory or stimulatory. In our experiment, we study the allelopathic effect of various parts of *Parthenium hysterophorus* L. on germination and seedling growth of *Triticum aestivum* L. Under well-sterilized conditions, we prepared an aqueous extract of root, stem, and leaves of *Parthenium hysterophorus* L. at various concentrations (0%, 5%, 10%, 15%, and 20%). After the effect of root extract, stem extract, and leaves extract on *Triticum aestivum* L. we measured germination percentage, shoot length, root length, wet biomass, and dry biomass. The stem extract and root extract have no significant effect on germination percentage. But leaves extract shows an inhibitory effect on germination percentage.

The leaf extract of *Parthenium hysterophorus* L. shows an inhibitory response on shoot length at all concentrations and the root extract of parthenium shows a stimulatory response on shoot length at all concentrations. Leaves extract of *Parthenium hysterophorus* L. shows a high inhibitory effect on shoot length, root length, germination rate, and wet biomass of *Triticum aestivum* L, the root length of *Triticum aestivum* L. is strongly inhibited than shoot length. It's may because secondary metabolites present in leaf extract inhibit gibberellin and indoleacetic acid function (Tefera T. 2002). The release of allelochemicals from leaves extract of parthenium in low amounts stimulates growth, while greater amounts result in inhibition of other plants (Hassan G. *et al*., 2018).

Keywords: *Parthenium hysterophorus, Triticum aestivum,* allelopathic effect

Introduction

Weeds are unwanted plants growing in crop fields, these are serious pest that affects most crops and grains and is an age-old problem for our agriculture. Weeds present in cultivated fields compete with crops for light, moisture, and other essential nutrients, reducing yield, crop quality, and increasing production costs (Dhole J. A. *et al*., 2013) [1]. Weeds cause annual losses of about 10% of agricultural production (Hanson A. A. 2019) [2]. Allelopathy is a valuable or damaging effect of one plant on another plant by releasing chemicals of various weed or crop plant parts. The allelopathic effect is due to the secondary metabolites present in various plant parts.

These metabolites may inhibit or stimulates the growth of other plant growth (Lotina-Hennsen *et al*., 2006) [3]. *Parthenium hysterophorus* L. The widespread occurrence of this weed can be attributed to its fast growth behaviour, very high seed production potential and inhibitory effects on neighbouring crop and weed plants through allelopathic interactions (Evans, H. C., 1997) [4]. This weed plant *Parthenium hysterophorus* releases toxins from non-living plant parts through the leaching of toxins from litter decomposition, Allelopathic plants can be used to control weeds or their inhibitory effects on crops can be avoided if certain prerequisites are met (Mersie W. *et al*., 1987) [5, 8].

Materials and methods

Sample collection and Preparation of aqueous extract of *P. hysterophorus*

The weed *Parthenium hysterophorus* L. and crop plant wheat *Triticum aestivum* L. were selected for the experiment on allelopathic effect. In the winter of January 2022, the *Parthenium hysterophorus* (without inflorescence) sample was collected from Newasa Tahsil, Ahmednagar District at Latitude 19.504395^0 Longitude 74.965736^0 (Fig. 1.1). After natural shade drying for ten days plant leaves, stems, roots were separated and ground in separate powder forms. Take each 10gm powder and dissolve it in 100ml water. They were placed for leaching 4-5 days.

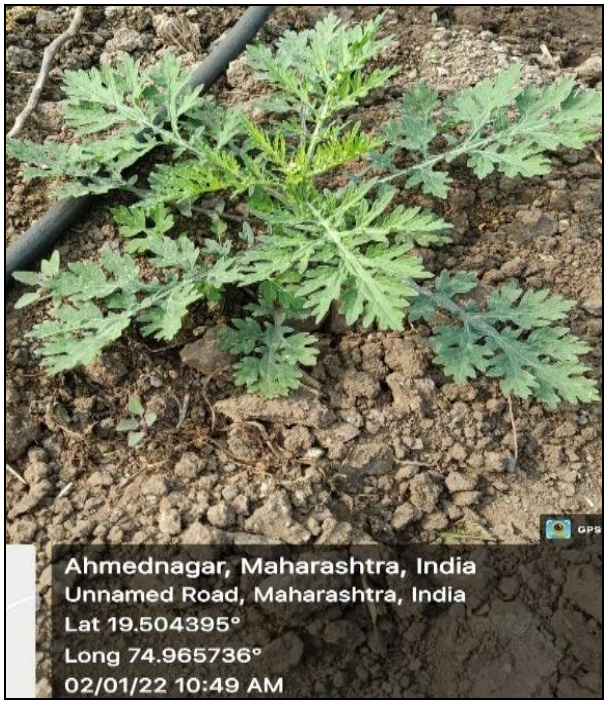


Fig 1: *Parthenium hysterophorus* L. in natural habitat

Preparation of working solution and experimental setup

After leaching those extracts filtered by Whatman's filter paper grade 1, and from those stock solutions prepared various concentrations of working aqueous extract 5%, 10%, 15%, 20% solutions (fig.1.2). The same method was used for root extract, stem extract and leaves aqueous extract preparation (Khaliq A. *et al*., 2013).

Fig 2: Placed *P. hysterophorus* Leaves, Stem, Root parts for leaching

Petri plates (diameter 9.2cm) with cover glass, germination paper, wheat seeds were sterilized by ethanol, autoclave and hot air oven at our department laboratory. For each concentration, in each Petri plate germination paper and ten wheat seeds were placed. A separate experimental setup was placed for roots extract, leaves extract, stems extract. At each concentration control, 5%, 10%, 15%, 20% there was five replicates were made

(fig. 1.3). For daily growth desired extract treatment was given. The treatments were organized in a completely randomized design (CRD) with five replicates in each set.
The experimental set includes four different concentration of aqueous extract 0%, 5%, 10%, 15% and 20%. The treated Petri dishes with distilled water were taken as a control, and it was considered as a zero concentration, while others were treated with approximately 1-2 ml of different aqueous extracts. Petri dishes were kept undisturbed under controlled lab conditions in the laboratory for 6 days until the shoot and root were well developed.

Fig 3: Experimental setup for treatment of *Parthenium hysterophorus* extract on *Triticum aestivum* seeds

Seed germination and seedling growth
Seeds are considered germinated upon radical appearance; germination is determined by counting the number of germinated seeds after two days of the experimental setup. After six days, the germination percentage (GP) was determined by counting the number of seeds germinated during the period of the experiment over the total number of seeds based on Equation (Ahmed T. A. *et al*. 2019) [6]

$$\text{Germination Percentage} = \frac{\text{Number of germinated seeds}}{\text{Total number of germinated seed}} \times 100$$

Shoot length and root length were measured using a centimetre ruler by taking five seedlings at random from each petri dish. Root length was measured from the root-shoot zone to the tip of the longest root by a ruler scale. Shoot length was recorded from the root-shoot zone to the tip of the topmost leaf by ruler scale (fig. 1.5).

Biomass, vigour index and tolerance index
The fresh seedlings were weighed using electrical balance to determine the wet biomass. The seedlings were dried in a hot air oven at 80^0C for 10 hours and then dry weight was estimated on an electrical balance
Vigour index was calculated by using the formula (Amare T. 2018 and Kumar *et al*., 2015) [7, 10]

Vigour index = (Mean root length + Mean shoot length) x Germination percentage

The tolerance index was calculated by using the formula (Amare T. 2018 and Kumar *et al*., 2015) [7, 10]

$$Tolerance\ Index = \frac{Longest\ root\ length\ in\ treatment}{Longest\ root\ length\ in\ control}\ X\ 100$$

Data Analysis
The average data is obtained by scientific calculator manually, Standard Deviation and other data analysis done by MS EXCEL 2019. All graphs are prepared by Origin Pro 2015 software. Table 1.1 Effect of different concentrations of aqueous extracts of Parthenium plant parts on wheat seed germination, seedling growth and biomass production, tolerance index, and vigour index

Table 1: Data table showing observations and results of experimental parameters studied

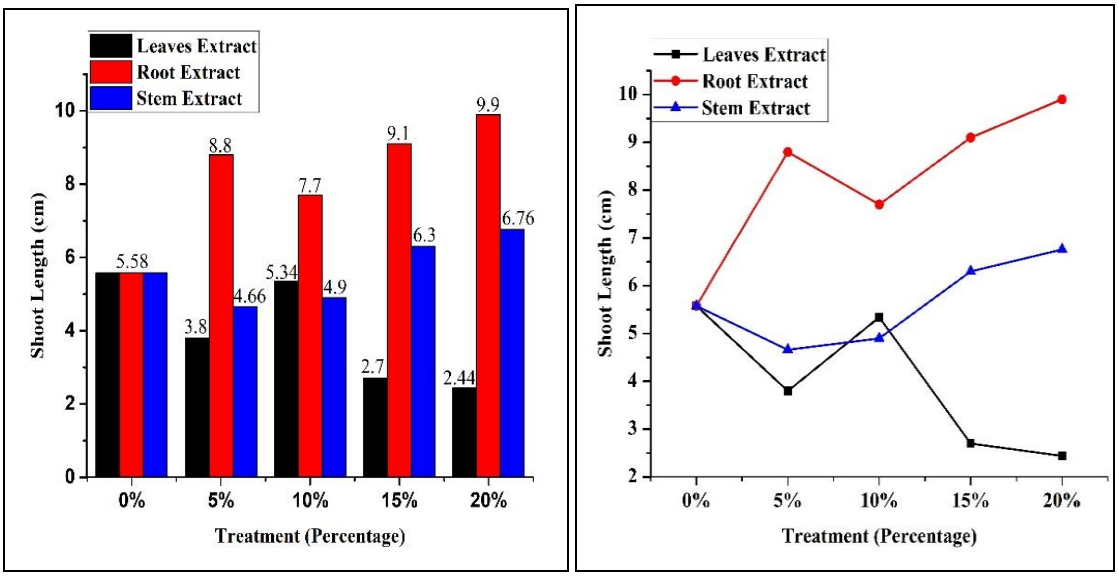
Treatment	***Parthenium hysterophorus* Leaves Extract**								
	G.P.	**R.L.**	**S.D.**	**S.L.**	**S.D.**	**W.B.**	**D.B.**	**V.I.**	**T.I.**
Control	94	5.3	0.97	4.2	1.68	0.19	0.054	893	100
5%	90	4.7	0.67	3.8	1.44	0.16	0.036	765	91.66
10%	82	4.98	0.77	5.34	2.05	0.154	0.044	846.24	98.33
15%	84	4.22	1.57	2.7	1.14	0.14	0.056	581.28	100
20%	92	3.24	0.78	2.44	0.84	0.13	0.052	522.56	66.66
Treatment	*Parthenium hysterophorus* Root Extract								
	G.P.	R.L.	S.D.	S.L.	S.D.	W.B.	D.B.	V.I.	T.I.
Control	100	9.5	2.18	7	2.32	0.236	0.042	1650	100
5%	100	11.3	1.20	8.8	2.94	0.316	0.042	2010	108.3
10%	100	12.4	3.84	7.7	3.35	0.296	0.05	2010	150
15%	98	12.5	0.71	9.1	2.16	0.318	0.036	2116.8	108
20%	98	13.7	1.85	9.9	1.89	0.274	0.036	2312.8	135
Treatment	*Parthenium hysterophorus* Stem Extract								
	G.P.	R.L.	S.D.	S.L.	S.D.	W.B.	D.B.	V.I.	T.I.
Control	100	6.64	3.27	5.54	2.32	0.106	0.044	1218	100
5%	100	6.62	1.29	4.66	1.38	0.104	0.04	1128	65
10%	100	6.46	1.30	4.9	1.86	0.11	0.038	1136	70.8
15%	98	5.86	1.15	6.3	2.45	0.12	0.036	1191.68	58.3
20%	98	7.76	1.97	6.76	2.99	0.124	0.034	1422.96	87.5

**G.P. Germination percentage, R.L. Root length (cm), S.D. Standard deviation, S.L. Shoot length (cm), W.B. Wet biomass (gm), D.B. Dry biomass (gm), V.I. Vigour index, T.I. Tolerance index.

Result and Discussion

Germination Percentage: There was no significant effect of *P. hysterophorus* root and stem extract on germination of *T. aestivum* seeds was seen in our experiment but parthenium leaves extract at 10% and 15% treatment germination percentage is decreasing. According to Tefera T. (2002) [11], at 10% aqueous leaves extract of parthenium is strongly inhibit the germination rate.

Shoot Length: Different concentrations of Parthenium had significant effects on the shoot length of the wheat seedlings. As data shown in table 1.1 and figure 1.4 indicated the shoot length highest 9.9cm at 20% root extract treatment to the seedlings. Shoot length lowest 2.44cm at 20% leaves extract treatment. The lower concentration of stem extract of parthenium shows inhibitory response on shoot length and the higher concentration of stem extract of parthenium show stimulatory response on shoot length. The leaves extract of parthenium shows an inhibitory response on shoot length at all concentrations. The root extract of parthenium shows a stimulatory response on shoot length at all concentrations.

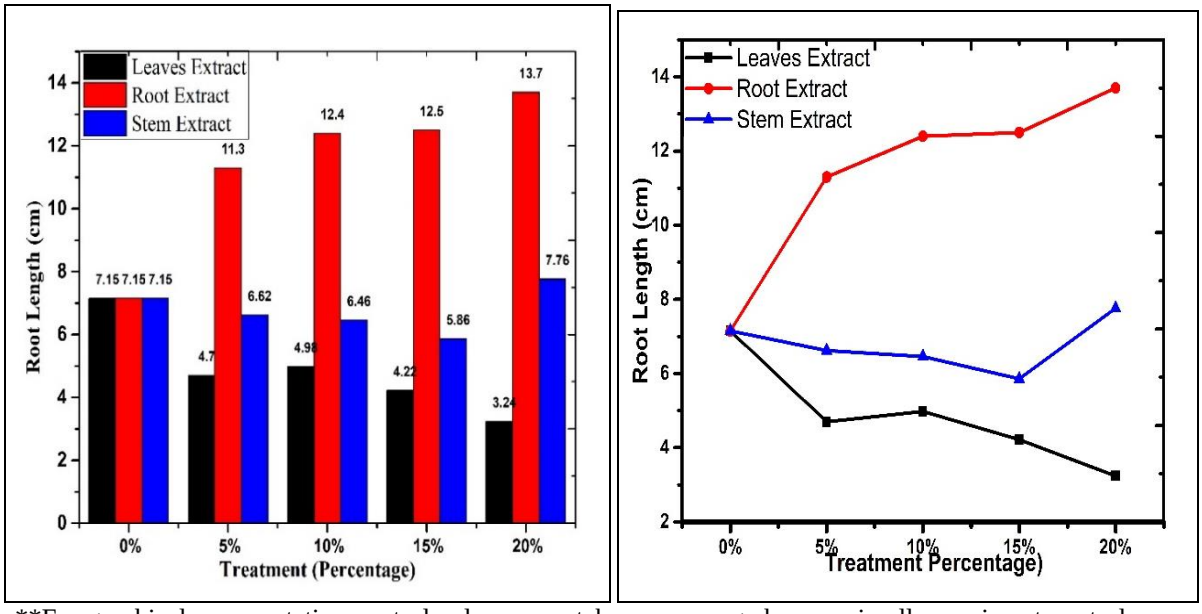


**For graphical representation control values were taken as average because in all experiment control were the same.

Fig 4: Clustered bar mean and multiple lines mean of shoot lengths by treatments of leaves extract, root extract and stem extract of parthenium at various concentrations

Fig 5: Photograph showing the method of measurement of the shoot and root lengths

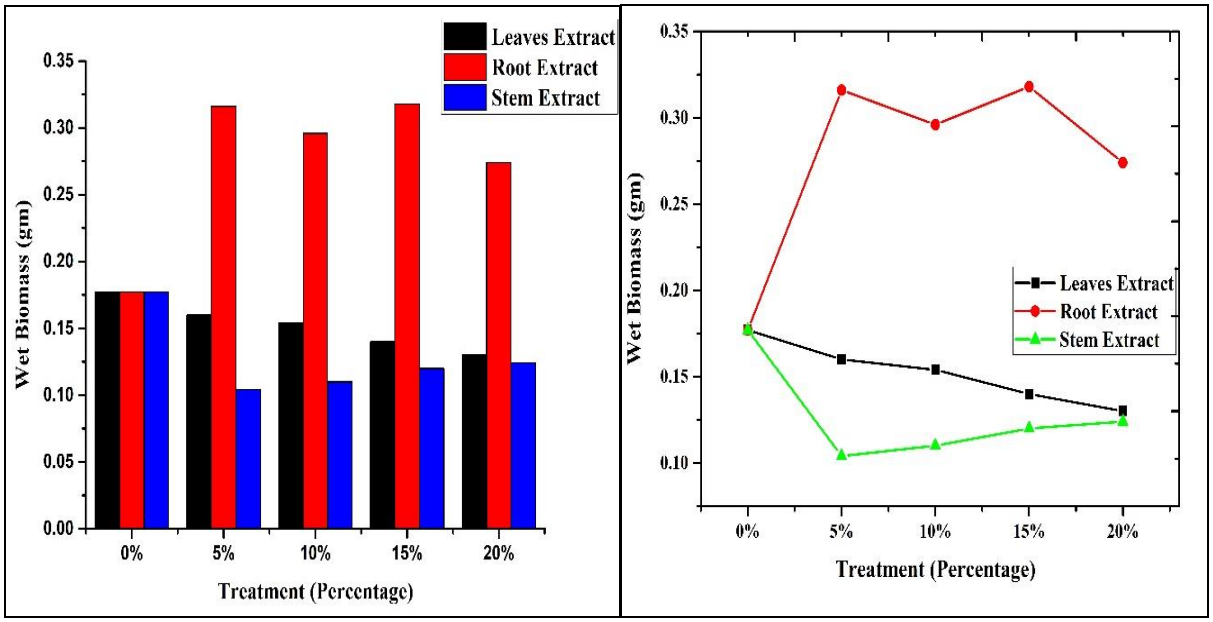
Root Length: As data shown in table 1.1 and figure 1.6 indicated that root length is highest 13.7cm at 20% root extract treatment. The lower concentration of stem extract of parthenium shows an inhibitory response on root length and the higher concentration of stem extract of parthenium shows a stimulatory response on root length. The leaves extract of parthenium shows an inhibitory response on root length at all concentrations. The results may be due to leaves of parthenium containing more phenolic compounds than stem extract (Mersie W. *et al*., 1987 and Patel V. *et al*., 2010) [8, 9]. The reduction in root length may show that cell division was affected as allelopathic chemicals (secondary metabolites) have been found to inhibit gibberellin and indoleacetic acid function (Tefera T. 2002) [11].



**For graphical representation control values were taken as average because in all experiment control were the same.

Fig 6: Clustered bar mean and multiple line mean of root lengths by treatments of leaves extract, root extract and stem extract of parthenium at various concentrations

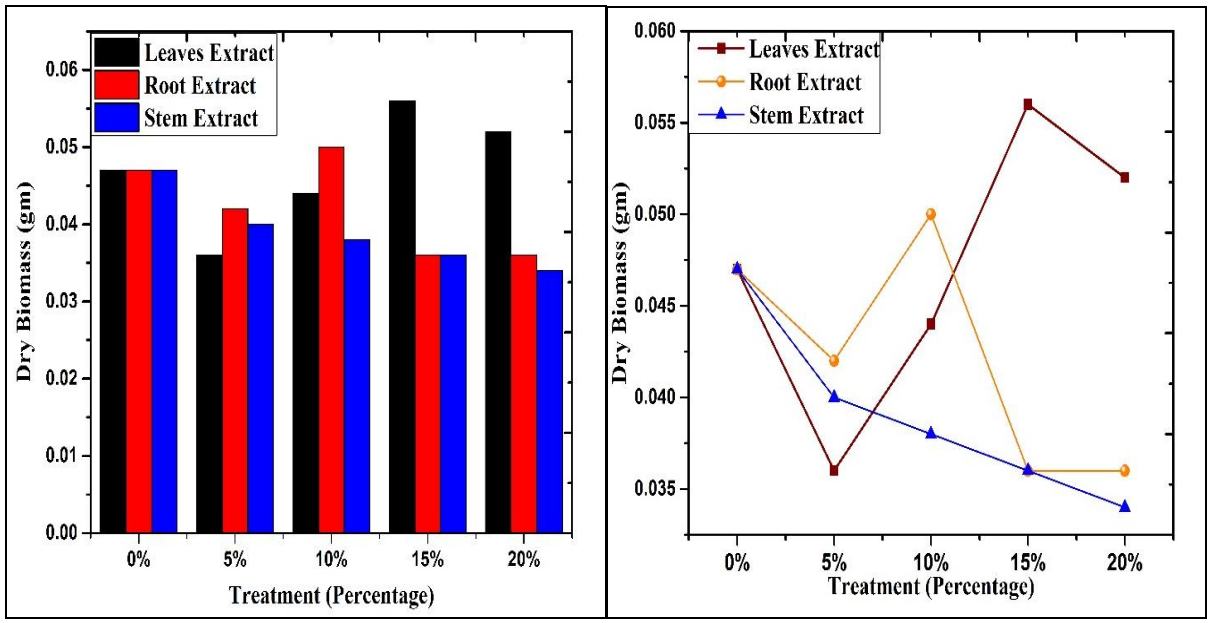
Wet Biomass: According to data table 1.1 and figure 1.7 show that stem and leaves parthenium extract had an inhibitory effect on the wet biomass of wheat seedlings. Effect of root extract of parthenium shows the stimulatory effect on wet biomass of wheat seedlings.



**For graphical representation control values are taken as average because in all experiments control were the same

Fig 7: Clustered bar mean and multiple line mean of wet biomass by treatments of leaves extract, root extract and stem extract of parthenium at various concentrations

Dry Biomass- According to data table 1.1 and figure 1.8 stem extract of parthenium has an inhibitory response on dry biomass of wheat. At 15% leaves extract of parthenium shows a higher response on dry biomass of wheat. At 10% Root extract of parthenium shows the stimulatory response to dry biomass of wheat.



**For graphical representation control values were taken as average because in all experiment control were the same.

Fig 8: Clustered bar mean and multiple line mean of dry biomass by treatments of leaves extract, root extract and stem extract of parthenium at various concentrations

Conclusion

According to our study, we conclude that the lower concentration of stem extract of *Parthenium hysterophorus* shows inhibitory response on shoot length and a higher concentration of stem extract of *Parthenium hysterophorus* show stimulatory response on shoot length. The leaves extract of *Parthenium hysterophorus* shows an inhibitory response on shoot length at all concentrations. The root extract of parthenium shows a stimulatory response on shoot length at all concentrations. The lower concentration of stem extract of *Parthenium hysterophorus* shows inhibitory response on root length and the higher concentration of stem extract of *Parthenium hysterophorus* shows stimulatory response on root length of *Triticum aestivum*. The leaves extract

of *Parthenium hysterophorus* shows an inhibitory response on root length at all concentrations. The root extract of *Parthenium hysterophorus* shows a stimulatory effect on the wet biomass of *Triticum aestivum* seedlings.
Leaves extract of *Parthenium hysterophorus* shows a high inhibitory effect on shoot length, root length, germination rate and wet biomass of *Triticum aestivum*, the root length of *Triticum aestivum* is strongly inhibited than shoot length. It may be because secondary metabolites present in leaf extract inhibit gibberellin and indoleacetic acid function (Tefera T. 2002) [11]. The release of allelochemicals from leaf extract in low amounts stimulates growth, while greater amounts result in inhibition of other plants (Hassan G. *et al*., 2018) [13].
The effects obtained under laboratory conditions are not necessarily significant in the field, it can be concluded that there are compounds in the tissues of *Parthenium hysterophorus* which may cause allelopathic effects also under field conditions if the compounds are released in the same way. The allelopathic mechanisms might have allowed the Parthenium weed to compete strongly with *Triticum aestivum* and spread itself widely in *Triticum aestivum* fields.

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