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Dr. Vishal Narayan Shinde
Department of Botany, ADMSPS, Late Annasaheb R. D. Deore, Arts & Science College, Mhasadi, Tal. Sakri, Dist. Dhule – 434203

Correspondence
Dr. Vishal Narayan Shinde
Department of Botany, ADMSPS, Late Annasaheb R. D. Deore, Arts & Science College, Mhasadi, Tal. Sakri, Dist. Dhule – 434203

Allelopathic effect of *Parthenium hysterophorus* Linn. on crop plants

Dr. Vishal Narayan Shinde

Abstract
Aqueous extract of *Parthenium hysterophorus* L. root and aerial part were tested on six crops for their allelopathic effect on seed germination, growth seedling and seed borne infection at various concentrations in laboratory condition. Aerial part and root extract of *Parthenium hysterophorus* showed inhibitory as well as stimulatory effect against particular crop plants. Germination of groundnut (*Arachis hypogaea* L.) was highly affected followed by mung bean (*Vigna radiata* L.). Where as seed germination in chickpea (*Cicer arietinum* L.) and soya bean (*Glycine max* L.) was increased. In aerial part extract, growth of radicle and plumule of *A. hypogaea* and *V. radiata* were decreased with increasing concentration of extract as compared to that of control. While the length of radicle and plumule of *T. aestivum* and *P. typhoides* were increased. Root extract of *Parthenium* also revealed inhibitory as well as stimulatory effect. Though the extract of *Parthenium* exhibited allelopathic effect but reduced seed borne infection in almost all crop seeds. Among all selected crop, *A. hypogaea* was found to be most susceptible to *P. hysterophorus*

Keywords: Allelopathy, crop plants, aqueous extract, *Parthenium hysterophorus* L.

1. Introduction
Whenever, a group of different species of plants or microbes live together in a common environment or ecosystem, they compete with each other for various live supporting requirements for normal growth, reproduction and development. Sometimes in this competition one species release certain chemicals which could either inhibit or stimulate the growth of adjacent plants this phenomenon is known as allelopathy. *Parthenium hysterophorus* L. is obnoxious weed belongs to Asteraceae family and affecting different agricultural crop plants. It is difficult to control or illuminate from soil. Not only living plants but residues exudates and leachates of plants may also effect the growth, seed germination or seed borne infection on plants which are present in the vicinity. *Parthenium hysterophorus* is one of the worst weed, native to tropical America and Mexico and now occurring widely along the roadside, wasteland and also in crop field in east Africa, India, Australia and Pakistan. It is one of the seven most dangerous weeds of the world (Singla, 1992) [12]. Due to many reasons, like high fecundity, efficient seed dispersal mechanism, allelopathic impact on neighboring plants, high rate of seed production, unsuitable for grazing and wide adaptability to varying adafic and climatic conditions therefore this weed become threat in wasteland and non-cropped areas.
Chemical analysis has indicated that all plants parts contain toxin. Narwal (1999) has isolated many allelochemicals such as parthin, p-coumaric acid, coronopullin and sesquiterpene lactones from the aqueous extract of P. hysterophorus responsible for allelopathic effects on other plants.
Therefore the present research was carried out to study the effect of aqueous extracts of various parts of *Parthenium* on seed germination, growth of seedling and seed borne infection of imported crop plants.

2. Materials and Methods

2.1 Preparation of Extract

Fresh growing *P. hysterophorus* weed was collected from Government Institute of Science campus, Aurangabad in the month of August to September. The plants were thoroughly washed with tap water. Underground and aerial part was separated, cut into small pieces. Pieces of plants parts were crushed into sterilized mortar and pestle.

3. Result

3.1 Effect of aerial part extract on seed germination

Aqueous aerial part extract of *P. hysterophorus* decreased seed germination of some tested seed crop (Table 1). Among selected crop, *A. hypogaea* was highly affected followed by *P. typhoides. T. aestivum* and *V. radiata* were least affected. While in *C. aeritinum* and *G. max* percent of seed germination was increased with increased concentration of extracts (Table 1).

3.2 Effect of root extract on seed germination

Same effect was also by root extract against specific crop seeds (Table 2). Root extract highly inhibited seed germination of *A. hypogaea* followed by *V. radiata*. On the other hand, percent of seed germination of *G. max* and *C. aeritinum* was increased (14-22 %). While neither inhibited nor promoted effect was observed against *T, aestivum* and *P. typhoides* by root extract.

3.3 Effect of aerial part extract on growth of redicle and plumule

Among all crop seeds *A. hypogaea* and *V. radiata* the length of redicle was decreased as compared to that of control. Whereas the length of redicle and plumule were increased in *T. aestivum* and *P. typhoides* as concentration of extract increases. The length of redicle of *C. aeritinum* and *G. max* were also prompted (Table 3).

3.4 Effect of root extract on growth of redicle and plumule

Root extract of *Parthenium* affected the growth of redicle of *A. hypogaea* and *V. radiata* (Table 4). On contrary, the growth of redicle and plumule were stimulated in remaining seeds after treatment with aqueous extract.

3.5 Effect of aerial part extract on seed borne infection

Though the aqueous extract of *P. hysterophorus* affected the seed germination of certain plants but seed borne infection was reduced significantly in almost all type of seeds. As concentration of extract increases there were decrease in the percent of seed borne infection in *T. aestivum, V. radiata, C. arietinum* and *G. max*. But per cent of seed borne infection was increased in *A. hypogaea* seed with increasing concentration of extract (Fig.).

3.6 Effect of root extract on seed borne infection

The percent of seed borne infection was reduced in all crop seeds except *A. hypogaea* with increasing concentration (Fig.) among all seeds, *G. max* and *A. hypogaea* were found to be highly susceptible to seed borne pathogens whereas *P. typhoides* was least susceptible one.

Table 1: Allelopathic effect of whole plant extract of P. *hysterophorus* on seed germination and fungal infection in different crop plants.

Plant	Conc. (%)	Seed germination in (%) after different (hrs.)				Fungal Infection in (%) after different (hrs)			
		24	48	60	72	24	48	60	72
Wheat (*T. aestivum*)	Control	23	97	97	99	-	2	5	19
	1	23	95	95	98	-	-	-	22
	2	53	96	96	99	-	1	1	13
	4	7	96	97	99	-	1	1	14
	8	61	92	92	96	-	-	-	1
Pearlmillete (*P. typhoides*)	Control	16	84	89	92	-	1	2	5
	1	20	20	25	83	-	-	-	-
	2	24	84	84	88	-	-	-	-
	4	16	89	93	94	-	-	-	-
	8	15	82	82	82	-	-	-	-
Mungbean *(V. rediata)*	Control	30	69	72	89	-	2	4	10
	1	-	13	13	59	-	-	-	1
	2	2	86	96	96	-	-	6	6
	4	1	89	89	89	-	-	-	-
	8	1	48	84	86	-	2	2	4
Chickpea *(C. aeriatinum)*	Control	7	42	44	50	-	12	13	28
	1	2	8	9	13	-	4	4	24
	2	-	-	-	4	-	-	6	6
	4	-	10	10	13	-	1	1	2
	8	22	48	67	78	-	-	2	4
Soyabean *(G. max)*	Control	-	2	2	6	1	30	44	87
	1	-	-	-	-	-	4	8	30
	2	-	8	8	32	1	28	62	96
	4	-	-	-	7	3	8	14	27
	8	-	1	1	8	1	7	7	26
Groundnut *(A. hypogea.)*	Control	7	39	43	52	3	20	38	56
	1	-	-	-	20	-	5	5	36
	2	-	5	15	52	-	21	34	44
	4	-	-	-	20	-	5	6	34
	8	-	-	-	3	2	43	63	70.20

Table 2: Allelopathic effect of root extract of *P. hysterophorus* on seed germination and fungal infection in different crop plants.

Plant	Conc. (%)	Seed germination in (%) after different (hrs.)				Fungal Infection in (%) after different (hrs)			
		24	48	60	72	24	48	60	72
Wheat (*T. aestivum*)	Control	23	97	97	99	-	2	5	19
	1	29	95	96	99	-	2	2	20
	2	38	98	98	99	-	-	-	2
	4	07	96	98	100	-	1	1	10
	8	78	94	94	98	-	-	-	1
Pearlmillete (*P. typhoides*)	Control	16	84	89	92	-	1	2	5
	1	43	85	85	89	-	-	-	2
	2	18	90	90	93	-	-	-	-
	4	19	97	97	97	-	-	-	-
	8	43	60	92	92	-	-	-	-
Mungbean *(V. rediata)*	Control	30	69	72	89	-	2	4	10
	1	-	13	13	76	-	-	-	1
	2	2	40	91	97	-	-	1	1
	4	-	84	86	91	-	2	2	2
	8	-	18	45	73	8	8	8	8
Chickpea *(C. aeriatinum)*	Control	7	12	44	50	-	12	13	28
	1	1	9	9	19	-	1	1	22
	2	-	-	-	2	-	-	6	8
	4	7	37	39	84	-	-	-	3
	8	5	23	25	64	-	-	-	3
Soyabean *(G. max)*	Control	-	2	2	6	1	30	44	87
	1	-	-	-	-	2	9	9	19
	2	-	6	6	41	2	12	73	80
	4	-	7	12	22	3	22	32	87
	8	-	12	14	28	10	24	32	78
Groundnut *(A. hypogea.)*	Control	7	39	43	52	3	20	38	56
	1	3	41	45	7	-	2	70	22
	2	-	2	4	20	1	23	31	49
	4	-	7	14	55	-	2	4	21
	8	-	2	6	27	1	22	44	59

Table 3: Effect of aqueous whole aerial plant extract of *P. hysterophorus* on growth of redicle & plumule.

Plant	Conc. (%)	Average Length of Plumnule. (mm.)				Average Length of redicle (mm.)			
		24	48	60	72	24	48	60	72
Wheat (*T. aestivum*)	Control	0.24	1.59	2.08	4.05	0.03	0.41	0.67	1.5
	1	-	1.39	1.81	3.18	-	0.34	0.78	1.18
	2	0.29	1.6	1.92	3.68	-	0.85	1.88	2.57
	4	0.3	1.54	2.1	4.13	-	0.45	0.72	1.48
	8	0.48	2.85	3.43	5.24	0.27	1.08	1.74	3.0
Pearlmillete (*P. typhoides*)	Control	0.35	1.59	1.95	2.70	-	0.51	0.87	1.72
	1	-	0.83	0.98	1.76	-	-	-	0.57
	2	0.64	2.11	2.56	2.92	-	0.28	0.48	1.55
	4	0.34	1.61	2.23	3.15	-	0.69	1.76	3.19
	8	0.29	2.45	2.92	3.56	0.1	0.75	1.49	3.02
Mungbean *(V. rediata)*	Control	0.41	1.83	1.93	3.05	-	-	-	-
	1	-	0.41	0.47	1.71	-	-	-	-
	2	0.35	1.24	1.28	2.33	-	-	-	-
	4	0.4	1.27	1.47	2.27	-	-	-	-
	8	0.1	1.12	1.97	2.11	-	-	-	-
Chickpea *(C. aeriatinum)*	Control	0.14	1.25	1.28	2.34	-	-	-	-
	1	-	1.56	1.56	3.52	-	-	-	-
	2	-	-	-	0.3	-	-	-	-
	4	-	0.45	0.66	1.71	-	-	-	-
	8	0.66	2.75	2.82	4.83	-	-	-	-
Soyabean *(G. max)*	Control	-	0.21	0.31	0.54	-	-	-	-
	1	-	-	-	-	-	-	-	-
	2	-	0.5	0.9	1.8	-	-	-	-
	4	-	-	-	0.7	-	-	-	-
	8	-	0.4	0.18	1.17	-	-	-	-
Groundnut *(A. hypogea.)*	Control	0.06	0.69	0.74	1.41	-	-	-	-
	1	-	0.46	0.71	0.95	-	-	-	-
	2	-	-	-	0.72	-	-	-	-
	4	-	0.29	0.50	1.52	-	-	-	-
	8	-	0.35	0.48	0.59	-	-	-	-

Table 4: Effect of root extract of *P. hysterophorus* on growth of redicle & plumule on different crop plants.

Plant	Conc. (%)	Average Length of Plumnule. (mm.)				Average Length of redicle (mm.)			
		24	48	60	72	24	48	60	72
Wheat (*T. aestivum*)	Control	0.24	1.59	2.08	4.5	0.03	0.41	0.67	1.5
	1	-	1.29	1.31	1.79	-	0.4	0.21	-
	2	0.34	1.54	2.08	4.1	-	0.74	1.25	2.38
	4	0.17	1.64	2.47	3.98	-	0.47	0.56	1.21
	8	0.6	2.6	3.55	5.11	0.29	0.96	1.45	2.69
Pearlmillete (*P. typhoides*)	Control	0.35	1.59	1.95	2.70	-	0.31	0.87	1.72
	1	-	1.21	1.53	1.92	-	-	0.43	1.15
	2	0.32	2.74	2.97	3.78	-	0.8	0.95	2.13
	4	0.32	2.25	3.33	4.25	-	0.75	1.63	2.75
	8	0.64	1.38	1.48	2.9	0.13	0.45	0.54	2.52
Mungbean *(V. rediata)*	Control	0.41	1.83	1.93	3.05	-	-	-	-
	1	-	0.38	0.40	-	-	-	-	-
	2	0.15	1.22	1.28	2.28	-	-	-	-
	4	-	1.59	1.81	2.75	-	-	-	-
	8	-	0.73	0.76	1.91	-	-	-	-
Chickpea *(C. aeriatinum)*	Control	0.14	1.25	1.28	2.34	-	-	-	-
	1	0.4	0.8	0.8	2.18	-	-	-	-
	2	-	-	-	0.4	-	-	-	-
	4	0.18	1.69	1.72	3.94	-	-	-	-
	8	0.24	2.13	2.18	3.76	-	-	-	-
Soyabean *(G. max)*	Control	-	0.21	0.31	0.54	-	-	-	-
	1	-	-	-	-	-	-	-	-
	2	-	0.1	0.8	1.73	-	-	-	-
	4	-	0.84	0.91	1.9	-	-	-	-
	8	-	0.88	1.19	1.93	-	-	-	-
Groundnut *(A. hypogea.)*	Control	0.06	0.69	0.74	1.41	-	-	-	-
	1	0.3	0.82	0.97	1.54	-	-	-	-
	2	-	0.3	0.5	1.11	-	-	-	-
	4	-	0.29	0.5	1.52	-	-	-	-
	8	-	0.35	0.38	0.59	-	-	-	-

4. Discussion

In present investigation, both extracts of *P. hysterophorus* showed inhibitory as well as stimulatory effect against particular crop seeds. Aqueous extract of the species employed in various concentrations caused significant inhibition in germination and growth of redicle in *A. hypogaea* and *V. radiata.* Among all tested crop species *A. hypogaea* was found to be highly susceptible to *P. hysterophorus* followed by *V. radiata.* Dosage effect was highly pronounced and directly proportional to the increasing concentration of extracts against *A. hypogaea* and *V. radiata*. The present results are in line with earlier finding (Bajwa *et al*. 2004) [1]. against sunflower. The reduced seed germination and seedling growth inhibition have been attributes to the presence of water soluble inhibitors (Hussain and Abidi 1991) [4]. Seed germination is an important process for plant growth in which metabolic activity increased and depends on number of factors. Allelochemicals may affect in different ways to reduced uptake of material (Kolesnichenko and Aleikina 1976) [6], suppress the activity of growth hormones such as IAA and Gibbrellins (Kefeli and Turetskayan 1976) [5], disturb the process of photosynthesis (Bakosky *et al* 1999) [2]. And due to reduce mitotic activity of root cells (Bukolova 1971) [3]. Which may results in decline length of redicle, plumule and seed germination. It has been suggested that other basic plant process such as respiration, chlorophyll production, protein synthesis, permeability and plant water relation may alter by allelochemicals. The effect allelochemicals from *Parthenium* was specific against particular crop seeds. This specificity may be due to thickness of seed coat, permeability of cell membrane, sensitive enzyme present in the seeds, pH of extracts, etc. The toxicity is associated with the presence of strong electrophilic and nucleophilic system, which act on specific proteins or enzymes at specific position alter their configuration and affect their activity (Mauas *et al*. 1992) [8]. Extract of *P. hysterophorus* have varying degree of inhibitory and stimulatory effect on germination, redicle and plumule. The present findings are in compliance with (Oudhia 2000) [11]. In chickpea, (Krishna *et al*. 2007) [7]. Against *Oryza sativa* and (Bajwa *et al*. 2004) [1]. on sunflower.

Weeds are rich source of allelochemical metabolites which improved certain kind of environment system of other plants growing in their vicinity. Therefore allelochemical analysis was carried out of both root and aerial part of extracts. Some of the phytochemicals were present in aqueous extracts. It means that the allelochemicals are water soluble. Chemical analysis has indicated that all plant parts contain toxin from the chemical group of sesquiterpene lactones (Oudhia and Tripathi 1998) [10]. Narwal (1999) has isolated many allelochemicals such as parthin, p-coumaric acid, coffeic acid, coronopillin and sesquiterpene lactones from the aqueous extract of *P. hysterophorus* responsible for allelopathic effects on other plants, which support the present results.

Allelopathy is a potential field of research all over the world. Which are helpful for the proper management of weeds, highlight their impact on agricultural yield. There is need to research this type of work to elucidate the allelopathic effect each and every weed even inter crop against major crop in the field as they compete for space, water, light and nutrient with main crop which ultimately reduced the yield of crop. It also helpful for the cultivation

of proper crop in a particular field where specific weed are abundant, since allelopathic effect of plant are specific.

On the other hand, seed borne disease are difficult to control but these allelochemicals (secondary metabolites) can inhibit the growth of seed borne pathogens and act as biocontrol, safe, easily degradable as compared to the synthetic pesticides.

The present study revealed that aqueous extract of *P. hysterophorus* showed allelopathic effect especially against *A. hypogaea* and *V. radiata*. Overall legumes are more susceptible to allelopathic effect of *P. hysterophorus* as compared to cereals. Whenever, these crops (*A. hypogaea* and *V. radiata*) are cultivating, proper management of the *Parthenium* is necessary or should be avoid the cultivation of crop where the *Parthenium* are dominant. Sometimes, not only living plants but dead plant part such as leachate exhibits allelopathic effect by releasing allelochemicals in the soil or surrounding. Leachate of different plant species may contain phytotoxic compound, the leachate were either slightly phytotoxic or non-phytotoxic. The interaction of crop species with leachate indicated that phytotoxic effects may be more than one chemical compound present in different leachates and the crop species react differently to these compounds. Therefore the dead plant part should either burn or throw outside from the field.

5. Conclusion

The extract of *Parthenium* exhibited allelopathic effect and reduced seed borne infection in almost all crop seeds. Among all selected crop, *A. hypogaea* was found to be most susceptible to *P. hysterophorus*. Fungal genera such as *Aspergillus* spp. and *Fusarium* spp. were commonly found on control seeds.

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