

## *Withania* as Effective Herbicide Against a Prominent Weed of Mid-Himalaya, *Parthenium Hysterophorus*.



### Plant Physiology

KEYWORDS : Weeds, herbicides, *Withania somnifera*, phytochemicals.

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### ABSTRACT

The present study was designed to evaluate the herbicidal activity of *Withania somnifera* against the noxious weed *Parthenium hysterophorus* L. in a laboratory bioassay. The effect of aqueous root, stem and leaf extracts of *Withania somnifera* were tested against the germination and seedling growth of *Parthenium*. All the aqueous extracts markedly suppressed the germination and seedling growth of *Parthenium*. Generally, the effect of leaf extract was more pronounced than the effect of stem and root extracts. In foliar spray bioassay, aqueous leaf extracts of 100% w/v concentrations were sprayed on two month old seedlings of *Parthenium*. The sprays were applied frequently at interval of 5 days. All the aqueous extracts significantly suppressed shoot length, root length, fresh weight and dry weight of *Parthenium* seedling. In foliar spray bioassay, leaf extract suppressed the stem length, root length, fresh weight, dry weight, no of root branches and no. of shoot branches of studied weed. The present study concludes that leaf, stem and roots of *Withania somnifera* contain herbicidal constituents for the management of *Parthenium* weed which could prove a milestone in weed management in Mid-Himalaya.

### Introduction

Himalaya manages plant communities to obtain useful materials from small set of species called crops. Weeds are unwanted intruders into agro-ecosystem since they compete for resource, reduce crop yields and force the use of large amounts of human labour and technology to prevent greater crop losses (Fickett *et al.*, 2013). Weeds are casting their spell in whole Himalaya which is one of the most threatening problems for plant diversity. Allelopathy is a natural, harmless strategy to overcome the problem of weeds. Every aspect of allelopathy is interlinked with allelochemicals, which are secondary metabolites, produced by the plants as the byproducts of their metabolic processes (Levin, 1976). These allelochemicals could be extracted from the plants and applied over target weed for getting desirable weed management. Such a herbicidal effect of plants against weeds is less toxic and harmful to ecology. All the weed species, which are the part of dynamic ecosystems, originate in natural environment and become hurdle to the crops (Aldrich 1984). These weeds have some diagnostic features, such as short seed dormancy period, high rate of seed germination, rapid seedling growth, high reproductive ability, life cycle of a short span and very high environmental plasticity. As a result of this these weeds are becoming dominant throughout the world (Holm *et al.* 1977), and threaten the native phytodiversity. One of the prominent weed of Himalaya is *Parthenium hysterophorus* which need proper management. *Parthenium hysterophorus* L. (Asteraceae), a noxious plant, inhabits many parts of the world, in addition to its native range in North and South America and the West Indies and prevalent in Himalaya region of India. The weed became a menace around the globe including India, efforts have been made to manage the weed employing different methods such as mechanical, competitive replacement, chemical, and biological control methods. Biological control is gaining momentum as it is an effective and ecofriendly alternative to conventional methods of weed control. *Withania somnifera* having phytochemicals in good quantity is supposed to have herbicidal role against weeds. To elucidate herbicidal effect of chemical constituents of *Withania* on germination and growth of a prominent weeds of Himalaya, *Parthenium hysterophorus*.

### Materials and methods

For the experiment *Withania somnifera* has been grown in nursery area of Shoolini University. Seeds of *Parthenium hysterophorus* were collected from heavily infested field near by Shoolini University. Stem, roots and shoots (50 gm each) of plant were washed, dried and weighted separately. For the treatment, root/shoot/leaves leachates of *W. somnifera* were prepared at two concentrations (50 and 100% of extract) and the control distilled water. Leachates of 50% and 100% concentration were prepared with sterilized distilled water and used for bioassay.

### Seed Germination assays

For germination assays, viable seeds of *P. hysterophorus* were thoroughly washed with tap water to remove dirt and dust, and rinsed with mild detergent solution for 5-7 minutes. The seeds were surface-sterilized and pre-treated groups were soaked in 10 ml of the relevant leachate (root/shoot and leaves) for 4 h, and then placed in petri dishes on filter paper moistened with distilled water. The relative humidity was 82-84 %. Petri dishes were placed in B.O.D. for observation kept undisturbed for 10 d at 25 °C. After 10 days observation was made and 2ml leachate applied to each petri plate for next 10 days.

### Impact on seedlings

The impact on seedlings of above mentioned weeds was assessed by raising seedlings in plastic Pots (12 cm × 25 cm), containing sterilized soil, sand and FYM (1:1:1) in green house at temperature range with 28/18 °C Day/Night through a combination of heating (16 kW) and venting during the day, and heating at night. Seedlings were sprayed with shoot leachate and assessed after 24, 48 and 72 hrs. Regular observation was done at the interval of 5 days. Statistical analysis of the one way and two-anova used for analysis of variance, with the 5% level of significance.

### Results & Discussion

**Seed germination:** *Withania* extract exerted inhibitory effect on the seed germination of *P. hysterophorus*. Seeds germinated on 2<sup>nd</sup> day in control, 4<sup>th</sup> day in root extract, 6<sup>th</sup> day in stem extract and 8<sup>th</sup> day in leaf extract (Fig.1.3). However, number of germinated seeds in control was maximum (92%) and lowest in the leaf extract (30%).

The stem length of *Parthenium hysterophorus* revealed that maximum inhibition in stem length was shown in leaf extract treated plants by 21%, stem extract treated plants by 19% and root extract treated plants by 10% in comparison to control plants (Table.1.1). Root length in *Parthenium hysterophorus* was also negatively influenced by extract treatment. Comparison with control revealed that leaf extract reduced root length to considerable extent by 55% followed by 78% in stem extract and by 91% in root extract (Table 1.1). Plant length in *Parthenium hysterophorus* was considerably affected by the *Withania* extract. It is evident from Table.1.1 that leaf extract reduced plant length to maximum extent by 40% followed by 21% in stem extract and by 15% in root extract in comparison to control plants. A significant decrease was observed in fresh weight of *Parthenium hysterophorus* in response to *Withania* extract (stem, root and length). Maximum inhibition was found in leaf extract treated seedlings which was by 58% followed by 48% in stem

extract and 32% in root extract in comparison to control plants. Tukey's test of variance analysed that control showed significant differences from all the studied

**Foliar spray Bioassay**

Stem length in *Parthenium hysterophorus* was reported to be reduced in all the extract treatment. However, maximum inhibition was reported in leaf extract where it decreased by 66% against control plants (Fig. 1.4). Stem extract and root extract were found to have less effect on seedling of *Parthenium hysterophorus* which showed 33% and 17% reduction in stem length in comparison to control plants (Table 1.2). It was evident that maximum inhibition of root length was found in the leaf extract treated plants followed by stem extract and root extract. Analysis was done using one way ANOVA by Tukey's test of variance. It was evident that a significant differences was found in different treatment except root extract with leaf and stem extract as given in Table1.2. Fresh weight in *Parthenium hysterophorus* was found to be minimum in leaf extract which was 48% followed by stem extract (61%) and root extract (85%) compared to control plants (water treatment). Similarly, minimum dry weight was found in the plants sprayed with leaf extract where it reduced to 47% followed by stem extract and root extract where dry weight was 86% and 89%, respectively, in comparison to control plants. Shoot branches in seedlings treated with leaf extract showed minimum number which was 53% than seedling treated with stem extract and root extract where it was 63% and 77% respectively, in comparison to control plants (water). Similarly, leaf extract reduced number of root branches to 51% whereas 81% in seedlings treated with root extract and 82% in stem extract compared to control plants. Root extract and stem extract have almost similar effect on no .of root branches.

**Discussion**

Aqueous extracts of *Withania somnifera* exhibited phytotoxic activity against germination and early seedling growth of the noxious weed *Parthenium hysterophorus*. The leaf extract of *Withania* was comparatively more inhibitory to germination and seedling growth of the test weeds than corresponding stem and root extract in laboratory and foliar spray bioassays. Germination is the most critical stage in the establishment of weeds (Rao, 2000). The inhibitory effects of *Cassia uniflora* on *Parthenium hysterophorus* and its suppression in nature was reported by Joshi (1991), Kandasamy (1999) and Tefera (2002). Zhang *et al.* (2005) studied the inhibitory effect of Prasad *et al.* (2006), Thapar and Singh (2006) noted the effects of *Cassiatora* and many other weeds on the germination, growth and metabolism of *Parthenium hysterophorus* in the open fields and even in laboratory. Abdur Rahman (2006) reported reverse trend and indicated that *Parthenium hysterophorus* had negative influence on different species of *Cassia*, through seed germination bioassay studies. The results of present investigations are in agreement with the above findings because *Withania somnifera* produce huge quantity of seeds and possess variety of allelochemicals. The germination of all the weeds were effected by leaf extract to large extent as it delay germination in all the studied weeds. The greater inhibitory effect of aqueous extract of aerial parts on germination and growth of test species has also been reported in other plant species ( Kil & Yun,1992;Noor & Khan,1994). Seedling spray in foliar spray bioassay also supported the earlier results. The stem and root length in this stage is also negatively influenced by all the aqueous extract of *Withania*. *Withania* extract also reduced no. of shoot and root branches in all the studied weeds. Javid *et al.*, (2009) conducted studies on effect of *Withania somnifera* on *Rumex dentatus*, *Parthenium hysterophorus* and *Tagetes erectus* L whose finding supported our results. Similarly, Shafique *et al.* (2011) on the *Parthenium hysterophorus* have provided very encouraging results. Inhibition in the germination of *Parthenium* seeds has also been reported due to aqueous leaf extract of other allelopathic tree species i.e *Azadirachta*

*indica* (L.).A. Juss., *Ficus bengalensis* L., and *Melia azaduarachta* L.(Shafique *et al.*,2005).Our results are also in the accordance with Javid *et al.*,2005. However little attention was given on other studied weeds as no such remarkable work has been yet done. So our findings are new to this field.

**Conclusion**

*Withania somnifera* extract has significantly suppressed the seed germination and growth of *Parthenium hysterophorus*. Applied extract have reduced the stem length, root length, fresh weight, dry weight and no. of root and shoot branches. The suppression of *Parthenium* growth could be attributed to phytochemicals present in *Withania somnifera*. Leaf possesses large amount of phytochemicals hence showed greater suppression. Role of medicinal plants as herbicide need more exploration and research in this field in future

**Acknowledgement:**

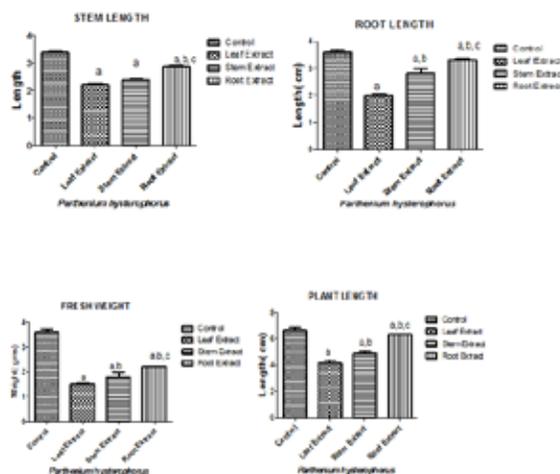
The authors thank Shoolini University for their support and technical work.

**Table: 1.1: Variation in stem length, root length, total plant length and fresh weight of *Parthenium hysterophorus* in treated and untreated condition. Values are of mean ± standard error.**

Treatment	Stem length	Root Length	Fresh weight	Total Plant Length
Control	5.36±0.02	3.60±0.60	5.13±0.23	5.30±0.12
Leaf Extract	4.22±0.05	2.00±0.05	3.09±0.11	2.24±0.03
Stem Extract	4.39±0.05	2.83±0.14	4.10±0.09	2.80±0.46
Root Extract	4.86±0.16	3.30±0.05	4.43±0.21	3.63±0.21

**Table: 1.2 : Variation in stem length, root length, fresh weight, no. of shoot branches and no. of root branches of *Parthenium hysterophorus* in treated and untreated condition. Values are of mean ± standard error.**

Treatment	Shoot length	Root length	Fresh weight	Dry weight	Number of shoot branches	Number of root branches
Control	8.4±0.76	12.17±0.66	6.81±0.22	2.26±0.05	8.2±0.42	18.8±0.88
Leaf Extract	3.76±0.14	6.6±0.38	3.32±0.02	1.07±0.00	4.4±0.22	9.2±0.70
Stem Extract	5.7±0.24	8.9±0.19	4.18±0.02	1.95±0.14	5.2±0.33	14.6±0.65
Root Extract	6.98±0.28	11.62±0.26	5.83±0.078	2.03±0.17	6±0.30	15.6±0.56



**Fig. 1.1: Variation in stemm length, root length, fresh weight and total plant length in *Parthenium hysterophorus*. Values**

are of mean  $\pm$ standard error where n=6; <sup>a</sup>p<0.05 vs control, <sup>b</sup>p<0.05 vs leaf extract, <sup>c</sup>p<0.05 vs stem extract, <sup>d</sup>p<0.05 vs root extract.

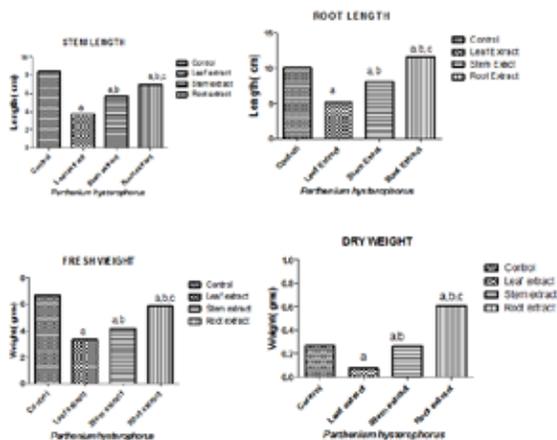


Fig.1.2 : Variation in stem length, root length, fresh weight and dry weight in seedling of *Parthenium hysterophorus*. Values are of mean  $\pm$ standard error where n=6 ; <sup>a</sup>p<0.05 vs control, <sup>b</sup>p<0.05 vs leaf extract, <sup>c</sup>p<0.05 vs stem extract, <sup>d</sup>p<0.05 vs root extract.

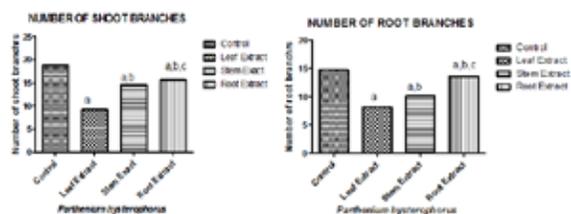


Fig. 1.3: Variation in no of shoot branches and no. of root branches in seedling of *Parthenium hysterophorus*. Values are of mean  $\pm$ standard error where n=6; <sup>a</sup>p<0.05 vs control, <sup>b</sup>p<0.05 vs leaf extract, <sup>c</sup>p<0.05 vs stem extract, <sup>d</sup>p<0.05 vs root extract.

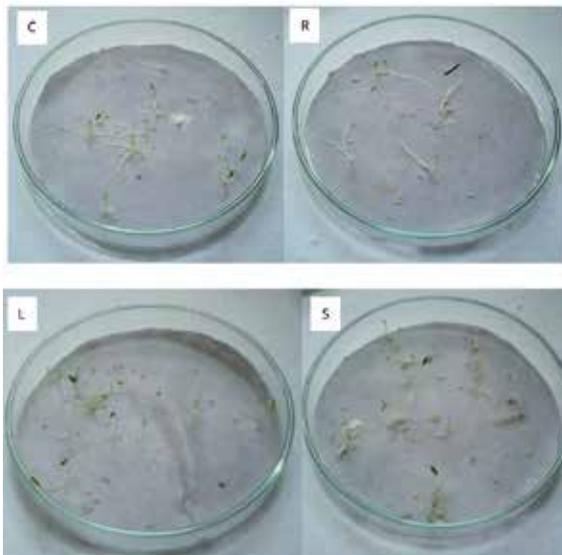


Figure 1.3 : Variation in germination percentage in *Parthenium hysterophorus* treated with leaf (L), stem (S) and root (R) extract of *Withania somnifera*.

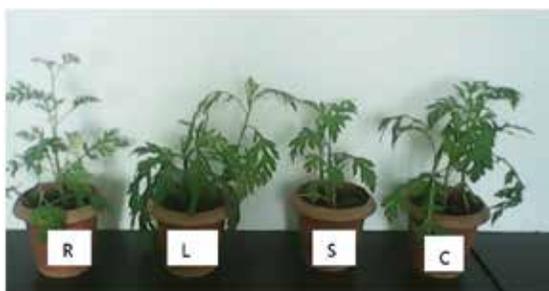


Figure 1.4: Variation in growth in *Parthenium hysterophorus* treated with leaf (L), stem (S) and root (R) extract of *Withania somnifera* in foliar spray bioassay.

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