

Allelopathic Effect of *Parthenium hysterophorus* (L.) on the Seed Germination and Seedling Growth of Sorghum Seeds

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ABSTRACT

The allelopathic effect of aqueous leaf extract (25%, 50%, 75% and 100%) of *Parthenium hysterophorus* (L.) was investigated on the germination and early growth of sorghum [*Sorghum bicolor* (L.) Moench] in the laboratory. Among tested concentrations, the significantly maximum seed germination was observed to 25 and 50 % concentration and the germination percentage was suppressed at highest concentration to 75 and 100 %. On other hand root and shoot length of jowar seed was inhibited with increasing concentration of aqueous leaf extract of *Parthenium*. It can be concluded that *Parthenium* leaf aqueous extract contain allelopathic compounds in their tissues which may cause allelopathic effects on jowar crop.

Key words: Allelopathic, Aqueous, Germination, *Parthenium*, Root, Sorghum, Seed, Shoot,

Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is an important cereal crop which is grown globally for food and fodder purpose. It is the fifth important cereal crops of the world after wheat, maize, rice and barley in terms of production and utilization and it is most widely grown in the semi-arid and subtropical regions of Asia and Africa (Kumar *et al.*, 2011). Africa is the centre of origin for sorghum (Kimber 2003). Besides food, it is also used for animal feed, fuel, syrup, ethanol and the production of alcoholic beverages. It is used to make foods such as couscous, sorghum flour porridge and molasses (Bergtold *et al.*, 2017). It is nutritionally superior to other fine cereals such as rice and wheat and hence

it is known as nutritious cereal. Now a days it is gaining importance as 'health food', because of its higher dietary fiber (2.5-6%) it contains 72.6% carbohydrate, 10-12% protein, 1.6% mineral matter and 1.9% fat. It is a rich source of amino acids mainly lysine, thiamine, riboflavin and folic acid along with vitamin-B complex specially niacin (Vitamin B6). Globally, it is cultivated in 42.12 million ha of land with an annual production of 59.34 million tons (USDA2017). The productivity of sorghum in India (854 kg ha⁻¹) is much less than the world average of 1457 kg ha⁻¹ (FAO2016).

There are many factors for loss of yields in sorghum crops field. But, major yields loss due to severe uncontrolled weed infestations in Sorghum fields (Pannacci *et al.*, 2010). Rani *et al.* (2011) was re-

ported that insects pests direct effects on cereals crops, because weeds also serve as alternate host for insects. Similarly, Polley *et al.* (2003) who pointed out that the world's most utilized cereal crop has been increasingly occupied by weeds during the last two centuries. Weeds play an important role in many agro-ecosystems, because they directly or indirectly effect other plants through release of chemical compounds in the environment (Kohil and Batish, 1994). Kruse *et al.* (2000) who reported that allelochemicals are categorized as secondary metabolites. They have stimulatory and inhibitory effects on other plants (Bhowmik and Inderjit, 2003).

Parthenium hysterophorus (L.) is one of the most dangerous weeds in the world belonging to the family Asteraceae. Oudhia (2002) reported that *Parthenium* is considered as worst weed in the India. In India, *Parthenium* is observed in all types of cultivated crops and forests and 35 million ha area was occupied by them (Kumar, 2012). This is affirmed by Batish *et al.* (2005) who reported that the evidence of negative allelopathic effect of *Parthenium* on *Brassica* sp., *Glycinemax*, *Phaseolus vulgaris*, *Cicer arietinum* and *Vigna radiata*. Kohil and Batish (1994) has also reported that allelochemicals are produced by all kinds of plants and plant part although root and leaves were mainly responsible for their production and release. Towers *et al.* (1977) reported that the whole plant parts of *Parthenium* have water soluble phenolics and sesquiterpene lactones compound.

According to Jondhale and Chavan (2021) *P.hysterophorus* and *C. dactylon* has shown positive or negative effects on seed germination and growth of *C.arietinum*. Similarly, Shikha and Jha (2016) reported that the higher concentration of leaf extract of *P.hysterophorus* was more inhibitory than other treatments for *Cajanus cajan*. However, it is necessary to investigate the allelopathic potential of *Parthenium* in Jowar field, then *Parthenium* related problem to inform farmers. Therefore, the present study is intended to investigate the allelopathic effect of *Parthenium* hysterophorous leaf extracts on seed germination and growth of Jowar.

Materials and Methods

The present work was conducted at Botany Department, MJM Arts Commerce and Science College, Karanjali, Tal-Peth, Dist. Nashik, Maharashtra, India during December 2019 to January 2020 under laboratory conditions. The fresh leaf of *Parthenium*

hysterophorus (L.) were collected from around the MJM Arts Commerce and Science College Karanjali. In the germination experiment, the sorghum seeds were collected from commercial agriculture suppliers of Karanjali. 10g of fresh leaf of *P. hysterophorus* weeds were homogenized in 10 ml distilled water individually. Then, aqueous extract was filtered through Whatman No. 1 filter paper and volume was made to 100 ml with distilled water. This solution was treated as a stock solution. 25, 50, 75 and 100% concentration of stock solutions were prepared for the treatment.

Healthy and uniform sizes of sorghum seeds were selected and were kept in petriplates containing 25, 50, 75 and 100% concentrations of *P.hysterophorus* extracts for 12 hours. Simultaneously, control was treated as distilled water. For 12 hours, 10 sorghum seeds were kept in sterile petriplates over filter paper at room temperature. The filter paper was moistened with 10 ml distilled water and distilled water was supplied to the seedlings uniformly, as and when required. The whole experiment was repeated three times and the average values were expressed. The Petri dishes were maintained under laboratory conditions for one week. Equal volume of distilled water was added in the experimental petri-dishes when moisture content of the blotting paper declined. The germination of seeds was observed for up to four days (96h) (Jondhale and Chavan, 2021). The seeds with visible radicles were considered as germinated (Turkey 1969).

The germination of root and shoot length of the seedlings was analyzed after two weeks with the help of scale. Then, to measure the fresh weight, the root and shoot portions of seedlings were weighed. After, they dried in a hot air oven at 70 °C for 24 hr and the dry weight was taken by using a digital balance. The Seed Vigour Index (SVI) was calculated by using the following formula:

$$SVI = (\text{Length of root} + \text{Length of shoot}) \times \text{Seed germination \%}$$

The percentage inhibition of germination was also calculated by using the following equation:

$$I = 100 - (E2 \times 100 / E1);$$

where, I represents percentage inhibition, E1 represents response of control plant and E2 represents response of treated plant (Surendra and Pota, 1978).

The results were calculated for three independent determinations with their means and standard deviations. The data were analysed with one-way

ANOVA. The difference was considered to be significant if p value was less or the same to 0.05 (p = 0.05) (Mungikar, 2003).

Results and Discussion

The present study was conducted to investigate the allelopathic potential effect of aqueous extracts of weed species of *Parthenium hysterophorus* (L.) on seed germination and growth on of *Sorghum vulgare* (Pers.). In the present study observations revealed that leaf extracts of *Parthenium* plant slightly stimulating significantly affects on seed germination and growth in four different concentrations (25%, 50%, 75% and 100%) as compared to control. Similar to these results Mali *et al.* (2021) observed that significant stimulation in the germination rate and seedling growth with response to specific concentrations. All positive and negative results of *Parthenium* leaf extracts for seed germination and seedling growth of Jowar are summarized in Table 1, 2 and 3.

Leaf extract of *P. hysterophorus* caused promoting the seed germination of the *Sorghum* over control (Table 1 and 3). Highest seed germination of Jowar was observed in 25% concentration in leaf extracts of *Parthenium* and lowest seed germination of Jowar was found in 75% concentrations of leaf extracts of *Parthenium* as compared to control. However, 25% and 50% concentration of *Parthenium* leaf extract was showed that stimulating affects on Jowar seeds.

But, in 75% and 100% concentration of *Parthenium* leaf extract was found no stimulating effects on Jowar seeds. Therefore, present results showed that, when increasing concentration of leaf extracts of *Parthenium* was observed decrease in seed germination.

Similar results were also obtained by (Hanan and El-Ghit 2016), who observed that significant stimulation in the germination percentage of pea by treatment of different aqueous extracts of concentrations of cucumber and carrot. These results showed that leaf extract of *Parthenium* significant promoting effect on seed germination of Jowar than the control as reported by Mali *et al.* (2021). The present study revealed that increase in the concentration of *Parthenium* plant extracts inhibited the germination of Jowar. Similar findings have been reported by Golparvar *et al.* (2015) and Memon *et al.* (2023). They reported that aqueous extracts of *C.dactylon* had strong allelopathic and inhibitory effects on different traits of Basil and common Purslane.

In *Parthenium* leaf extracts of all concentrations showed that maximum enhancement was observed in root length as compared to control seeds of Jowar. Though, shoot length showed that minimum enhancement as compared control seeds of Jowar (Table 2 and 3). The Jowar seeds maximum root and shoot length was observed in 25% concentration of *Parthenium* leaf extracts, i.e 5.23 cm and 9.25 cm, respectively, whereas in control root and shoot length

Table 1. Effect of aqueous leaf extract of *Parthenium hysterophorus* (L.) on seed germination of Jowar.

Time [After Germination] 24h	Germination percentage Plant Extracts Treatments			
	Control	25%	50%	75%
48h	60	52	45	42
72h	73	75	65	68
96h	84	89	85	85
24h	96	97	98	92

Table 2. Effect of aqueous leaf extract of *Parthenium hysterophorus* (L.) on seedling length (cm), fresh weight of seedling (g), dry weight of seedling (g), R:S ratio and SVI values on seed of Jowar.

Treatments	Root length (cm)	Shoot length (cm)	Fresh wt.of seedling(g)	Dry wt. of seedling (g)	R:S ratio	SVI
Control	3.88±0.33	10.03±0.22	2.36	1.12a	0.38	1335.36
25%	5.23±0.36	9.25±0.72	2.48	1.15	0.56	1404.56
50%	5.10±1.33	8.77±1.40	2.42	1.05	0.58	1303.78
75%	4.99±2.10	8.35±1.77	1.88	0.88	0.59	1227.28
100%	5.22±1.24	7.66±0.45	1.63	0.79	0.68	1249.36

Means within same column followed by the same letter(s) are not significantly different at the 0.05% level of probability.

was found 3.88 cm and 10.03 cm, respectively. On the other hand, minimum root length was observed in 75% concentration (4.99cm) and minimum shoot length was observed in 100% concentration (7.66 cm) of *Parthenium* leaf extracts. However, shoot length of Jowar seeds was significantly inhibited in all concentration of *Parthenium* leaf extracts. But, Root length of Jowar seeds was significantly stimulating effects in all concentrations of *Parthenium* leaf extracts. Therefore, present resulting observation concluded that all concentration of *Parthenium* leaf extracts promoting root length and slightly inhibition shoot length in Jowar seeds. These observations recorded in the present investigation are in conformity with the findings of Wakjira (2009) who reported that the inhibition of shoot elongation caused by allelochemical lead to reduced plumule length. Ghodake *et al.* (2012) reported that allelopathic effect of three *Euphorbia* species on seed germination and seedling growth of wheat. These observations are in agreement with the findings of earlier workers Mali *et al.* (2021), who reported that the effect of *P.hysterophorus* L. root growth of Jowar indicted stimulatory effects with respect to concerned concentration of extracts while in case of shoot growth, 50% and 100 % concentrations lower plumule.

The results for fresh and dry weight of sorghum are summarized in Table 2. Fresh and dry weight for sorghum were significantly allopathic affected ($P=0.05$) by *P. hysterochorus* aqueous leaf extract except 25% and 50% concentrations. The values for fresh weight of seedling together ranged from 2.48 to 1.63 g in different concentrations of *P.hysterochorus*, respectively as compared to 2.36g in the control. Similarly, the dry weight of seedling in control was 1.12g, while it was recorded ranged from 1.15g to 0.79g in various concentrations of *P.hysterochorus*, respectively. The minimum fresh and dry value was observed in 100% concentration and maximum fresh and dry value was recorded in lower concentration (25%) leaf extract of

P.hysterochorus. Similar to these results Jondhale and Chavan (2021) recorded fresh weight of seedling, which varied from 1.6 to 2.7 g and 1.3 to 2.7g in different concentrations of *C.dactylon* and *P. hysterochorus*, respectively as compared to 2.7g in the control. These results are in conformity with the findings of Mali, *et al.* (2021), who observed that higher concentrations of leaf extract of *P.hysterochorus* reduced seed germination and seedling growth and weight in sorghum. The observations recorded in the present investigation are in conformity with the findings of Mali and Kanade (2014) who found that the aqueous leaf extracts of *A. sessilis*, (L.) R.Br and *C. dactylon* (L.) Pers. causes significant seed germination and root shoot length in Jowar seedlings.

In the present study seed vigour index values of sorghum in leaf extracts of *Parthenium* varied from 1249 to 1404 in different concentrations, respectively in comparison with control (1335) (Table 2). The seed vigour index values decreased with increasing concentrations of leaf extract of tested weed plants as compared to control. Similarly, the values for R:S ratio of sorghum in leaf extracts of *Parthenium* varied from 0.56 to 0.68 in different concentrations, respectively. Shikha and Jha (2016) found that the different concentration of leaf extract of *Parthenium* the SVI values ranged from 1.20 to 548.11 with control conditions (802.41). These observations are in agreement with the findings of earlier workers Shikha and Jha (2018), who reported that SVI value decreased from 25.53 to 100%, 3.33 to 26.21% and 32.44 to 100%, respectively, in leaf, stem and root extracts of *Parthenium* compared to control treatment. The significantly allopathic effects on seed germination and seedling growth of greengram, blackgram and groundnut was reduced as the increase in concentration of *Parthenium* leaf extracts which was in agreement with Parthasarathi *et al.* (2012). Khan *et al.* (2011) reported that the assaying the allelopathic effects of *Parthenium* on maize. However, Masum *et*

Table 3. Inhibition effect in seed germination rate and growth parameters in Jowar in different concentration of leaf extract of *Parthenium hysterochorus* (L.).

Treatments	Seed germination (%) (I)	Root length (cm)	Shoot length (cm)	SVI
25%	1.01	34.79	-7.77	5.18
50%	-2.08	31.44	-12.56	-2.36
75%	-4.16	28.60	-16.74	-8.09
100%	-1.04	34.53	-23.62	-6.44

al. (2012) also showed that the maximum inhabitation was only at 100% concentration. So, this varied effects occur because of higher concentration of those selected of allelochemicals on the target plants (Inderjit and Duke, 2003). According to Narwal (1994) harmful allelopathic effects of these weeds on germination and seedling vigour of many agricultural crops are reported. Therefore, as per our laboratory research study, I strongly suggested that early stage farmers must remove the weeds in the field of Jowar. Because, it will directly effect on growth and yield Jowar crops. Hence, in the present situation where timely weeding is not feasible due to paucity and high cost of labour as well as unfavourable weather and soil condition, integrated weed management though herbicidal various treatments in combination with mechanical weed control were found comparable to weed free treatment in soybean crop (Deshkari *et al.*, 2019). Similar results were reported by Yenpreddiwar *et al.* (2017) who observed that, the treatment of weed free check showed their significance and superiority over rest of the treatments with significantly higher yield and yield attributing characters in cotton plants.

Conclusion

The present result concluded that the specific leaf extract of *Parthenium* at different concentrations was observed to have a significant stimulating and inhibitory effect on the seed germination and seedling growth of Jowar. *Parthenium* leaf was identified as harmful leaf as these leaves resulted in reduced seedling growth due to the presence of many lethal allelochemicals. Therefore, as per above mentioned results and discussion, we advise that the presence of *P.hysterophorus* in sorghum fields should be early stage for removal of these weeds, to avoid the yield losses. Present investigation was conducted in the laboratory conduction, so further future studies under field conditions will investigate the inhibitive effects of these weeds against the sorghum.

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