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Evaluation of Allelopathic Effect of Aqueous Leaf Extract of Parthenium (*Parthenium hysterophorus* L.) on Seed Germination and Seedling Growth in Sunflower (*Helianthus annuus* L.), Soybean (*Glycine max* L.) and Green Gram (*Phaseolus mungo* L.)

Dr. Amena¹, Bibi Hafsa Azra², Sumera Nazneen³

¹Assistant Professor, Osmania University College for Women

²Research Scholar, Osmania University

³Research Scholar, Osmania University

Abstract: *Parthenium hysterophorus* an obnoxious, aggressive, Neotropical composite weed has allelopathic effect and drastically retards the growth of many crop species. In the present paper the effect of different concentrations of aqueous leaf extract of *Parthenium hysterophorus* on the germination percentage of seeds, radicle length, plumule length and dry weight of seedlings, elongation ratio of root and shoot, inhibition (–) or stimulation (+) %, phytotoxicity percentage of sunflower, soybean and *Phaseolus mungo* seeds has been studied. The results revealed that the increase in concentration of parthenium extract significantly decreases the seed germination, radicle length, plumule length of seedlings of sunflower, soybean and green gram. The leaf extract has inhibitory effect on radical growth of pulses compare to oil seeds. The tolerance level of parthenium allelopathy of crops represented as sunflower > soybean > green gram. The concentration dependent inhibitory activities of the aqueous extracts of parthenium on the germination and seedling growth of the test species suggest that the plant has allelopathic potentiality and possess allelochemicals. These allelochemicals could be the main reason for the restricted growth of other plant species near their colony. This study showed that allelopathic weed plants pose threat on seed germination, seedlings radicle and plumule lengths of sunflower, soybean and green gram crops. Thus, farmers should give special attention to avoid or minimize those weed species from their farm to contain their adverse effects on crops.

Keywords: Weed, Allelopathy, Phytotoxicity, Inhibition, Stimulation.

I. INTRODUCTION

Parthenium hysterophorus, enlisted in Global Invasive Species database, is a highly prolific and malicious weed, which was first seen growing in Northeast of Mexico. *Parthenium hysterophorus* is an obnoxious, aggressive, Neotropical composite weed that has spread very fast in India and other parts of the world. It exerts negative effects on agriculture, animal husbandry and the environment (Kohli and Rani, 1994; Evans, 1997). Allelopathic properties of this weed have been well demonstrated (Wakjira et al., 2009; Singh et al., 2003). Due to the action of allelochemicals, a large number of physiological functions and biochemical reactions are affected, such as seed germination, cell division, cell elongation, membrane permeability and ion uptake (Ortega et al., 1988; Tomita-Yokotani et al., 2005; Setia et al., 2007). Allelopathy is defined as any direct or indirect positive or negative effect of one plant on the other (including the microbes) through the release of chemicals into the environment (Rice, 1984). It plays a significant role in agro ecosystems, and affects the growth, quality and quantity of the product (Kohli et al., 1998; Singh et al., 2001).

Allelopathy concerns the effects of one plant on another due to biochemicals released by them, or the breakdown products of their metabolites (Willis, 1994). *Parthenium hysterophorus* L. is an aggressive weed having allelopathic effect and drastically retards the growth of many crop species. In India parthenium was found to invade the agriculture lands of sugarcane, rice (Singh et al., 2005) and inhibit the growth of pasture grasses, legumes, cereals, vegetables, forage crops, pulses, oil seeds other weeds and trees. *Parthenium* is considered as a noxious weed due to its allelopathic chemicals. The term Allelopathy, derived from two Greek words Allelon means each other and Pathos means to suffer i.e., the injurious effects of one upon another. However, Molisch (1937) coined this term which refers to all biochemical interactions (stimulatory and inhibitory) among plants, including micro-

organisms. It represents the plant against plant aspect of the broader field of chemical ecology. Some authors have used the term in more restricted scenes to describe only the harmful effect of one higher plant upon another. Allelochemicals which inhibited the growth of some species at certain concentrations may stimulate the growth of same or different species at lower concentrations (Narwal, 1994). Allelopathy is relatively a new branch of science (Lal and Oudhia, 1999). With the help of allelopathy, weed-crop, crop-weed, crop-crop and weed-weed interactions can easily be stimulate the germination increases seed hardness and promote early vigour. In medicinal and aromatic crops use of agrochemicals are not allowed. Abdul Rawoof and Siddiqui (2013) worked on the allelotoxic effect of parthenin on cytomorphology of *Vicia faba* L. have reported that the seeds were treated with different concentrations (100, 200, 300 and 400 IM) of parthenin for 8 h. The higher concentrations significantly reduced germination and seedling growth. A significant reduction in mitotic index was observed in seeds exposed to parthenin compared to control which decreased with an increase in concentration of parthenin. On the basis of these results, it was concluded that all parthenin concentrations significantly affect the cytomorphology of *V. faba*, while higher concentrations of parthenin were found to be more mutagenic and cytotoxic.

Eba Muluneh Sorecha and Birhanu Bayissa (2017) investigated the allelopathic effects of *Parthenium hysterophorus* weed on seed germination and early growth stages of peanut and soybean. Leaf, stem, and root aqueous extracts of *Parthenium* at 0, 2, 4, 6, 8, and 10 g/1000 ml concentrations were applied to determine their effect on both crops seed germination and early growth stages under laboratory conditions. They have revealed that peanut seed germination only significantly ($P \leq 0.05$) responded to the parthenium stem and root extracts; where on average 2 and 4 seeds were germinated per Petri dishes, respectively under high concentration treatment of 10 g/1000 ml. whereas, soybean seed germination was significantly responded to all the parthenium plant parts extracts. However, the serious effects have been well observed under the treatments of 10 g/1000 ml stem extracts and 8 g/1000 ml root extracts, where no germination of soybean seed was recorded. Similarly, shoot length was seriously inhibited by the stem extracts for peanut and leaf extracts for soybean, accounting 5.67 and 1 cm, respectively.

II. MATERIALS AND METHODS

A. Aqueous Extract of *Parthenium Hysterophorus* weed Preparation

The *Parthenium hysterophorus* plant samples were collected at flowering stage. The leaves were separated, cut into fine pieces and weighed. The weighed sample of plant material was ground in sterilized mortar and pestle and mixed in the sterilized mineral water at 48 h at room temperature. The concentrations of 2%, 3%, 5%, 8%, 11% and 14% were prepared by soaking 20, 30, 50, 80, 110 and 140 g of powder in one litre of mineral water separately. These aqueous extracts were filtered through three layers of muslin cloth to remove debris. The filtrate was then again filtered through Whatman No. 1 filter paper and stored in dark cool place for use as per the method laid out by Singh *et al.* (1989). This weed extract was used for experimentation within two days of preparation. The pH of 2%, 3%, 5%, 8%, 11%, and 14% extract solutions were 7.85, 7.62, 7.45, 7.10, 6.50 and 6.12 respectively. The Electrical Conductivity of these extracts of 2%, 3%, 5%, 8%, 11%, and 14% were 0.78, 0.96, 1.04, 1.21, 1.36 and 1.42 dS/m respectively. The initial pH and E.C. of mineral water used for experimentation was 8.14 and 0.029 dS/m respectively.

In view of strong allelopathy effect of *Parthenium hysterophorus* on crop plants, the present study was conducted to study the effect of different concentrations of *Parthenium hysterophorus* leaf extract on seed germination of two oilseed crops (Soya bean and Sunflower) and one pulse crop (*Phaseolus mungo* Mung bean) to know the variation in plumule length and radicle length of above crop seeds by parthenium allelopathy and to assess the impact of allelopathy of *Parthenium* allelopathy on oilseed crops and pulse crop seedlings

B. Treatments and Experimental Design

The experiment was conducted in the year 2018, at Iota Laboratories, Hyderabad, India. There were six treatments which include six concentration levels (0%, 2%, 3% and 5%, 8%, 11% and 14%) of parthenium weed leaf extracts with three replications in type of crops. The *Parthenium hysterophorus* plant samples were collected at flowering stage. The leaves of *P. hysterophorus* L. were collected from PJTS Agricultural University campus at Rajedranagar, Hyderabad and Chevalla village in R.R. District in the month of September, 2018, and were air dried in shade for 4 – 5 days. The air dried leaves in shade were grinded in Willey's grinder and further to a fine powder using Sumit mixer. 10grams of leaves powder were mixed with 100ml distilled water and were left for 24h at the room temperature and then filtered through Whatman filter paper in to a container. Aqueous extract thus obtained were filtered through plastic jerry cans. The extract was kept in a beaker for further use. The leaves were separated, cut into fine pieces and weighed. The weighed sample of plant material was ground in sterilized mortar and pestle and mixed in the sterilized water at 48 h at room temperature. The filtrate was taken to study the effect of leaf extract on germination, initial seedling growth of

Sunflower seeds, Soybean seeds and green gram (*Phaseolous mungo* L.) Mung seeds. Seeds and filter papers were moistened with 10 ml each of 2%, 3% and 5%, 8%, 11% and 14% of aqueous extracts. 10 ml of distilled water was added to the untreated control (0%). The treatments were arranged in completely randomized design (CRD) with three replications for each crop seeds. The treatments were adopted at temperature and room light condition homogenously to all the Petri dishes. Twenty seeds of each crop in each Petri dishes of 15cm diameter with three replicates were used for each concentration. The oil seed crop Varieties used were for Sunflower (*Helianthus annus* L) was APSH -11 and for Soybean (*Glicine max* L.) was JS-335, and for pulse crop green gram (*Phaseolous mungo* L.) was CO6. The aqueous extracts were used regularly for moisten the seeds. A separate series of control was set up using distilled water. The Petri plates are kept at room temperature in the lab condition.

C. Treatment Details

T0 - Control

T1 - 20 g L⁻¹ (2 %) Parthenium Aqueous Leaf Extract

T2 - 30 g L⁻¹ (3%) Parthenium Aqueous Leaf Extract

T3 - 50 g L⁻¹ (5%) Parthenium Aqueous Leaf Extract

T4 - 80 g L⁻¹ (8%) Parthenium Aqueous Leaf Extract

T5 - 110 g L⁻¹ (11%) Parthenium Aqueous Leaf Extract

T6 - 140 g L⁻¹ (14%) Parthenium Aqueous Leaf Extract

III. PHYSICAL PARAMETERS

After seven days, the germination percentage of seeds, radicle length (cm), plumule length (cm) and dry weight (mg) of seedlings were determined. Evaluation of effect of different concentrations of leaf extract of *Parthenium hysterophorus* L. on seed germination, seedling growth and fresh weight of sunflower, soybean and *Phaseolous mungo* has been done. In the present study allelopathic effect of leaf extract of different concentrations (2%, 3%, 5%, 8%, 11%, 14%) were compared with control treatment. A representative soil from Telangana region was taken for the above study in the experiment and *Parthenium hysterophorus* plants were uprooted, cleaned and grinded with distilled water to prepare aqueous extracts of *parthenium hysterophorus*. The following objectives were the details of its materials and methods employed.

To find out 1) percentage of seed germination of each oil seed crop and pulse crop. 2) Radicle length and Plumule length at the end of the experiment of each crop variety 3) Elongation ratio of root and shoot 4) Inhibition (-) or Stimulation (+) % of each crop variety 5) Phytotoxicity percentage of each crop variety through computation and 6) Lastly to arrive and conclude about the impact of allelopathy effect of *parthenium* on oil seeds and pulse crops.

For this experiment 200 seeds were pre-soaked for 9 hours in mineral water. The seeds were divided into three replicates. One treatment was run as control with distilled water only and six *parthenium* weed extract concentrations (2%, 5%, 8%, 11%, & 14%) of the leaf extract were used for this experiment to study the above observation and find out the allelopathic effect of *Parthenium hysterophorus* weed. Ten seeds were placed in each Petri dishes with filter paper. All the Petri dishes were maintained under laboratory conditions (room temperature). Equal volume of distilled water was added in the Petri dishes and periodically distilled water was added to each Petri dish when it nearly drying out of water. After 7 days interval, Plumule and radical length number of germinated seeds were counted and the root (radical) and shoot (plumule) length were measured. All root and shoots from each treatment of Petri dishes were carefully removed and cut separately and fresh weights were taken through the electronic balance, and were oven-dried.

The relation elongation ratio of root and shoot were calculated following the formula :

$$\text{Relation elongation ratio of root} = \frac{\text{Mean root length of tested plant}}{\text{Mean root length of control}} \times 100$$

$$\text{Relation elongation ratio of shoot} = \frac{\text{Mean shoot length of tested plant}}{\text{Mean shoot length of control}} \times 100$$

The values for calculation of inhibition (-) or stimulation (+) per cent were calculated as per the formula given below:

Inhibition (-) or Stimulation (+) % =

$$\frac{\text{Germination of seeds in Extract} - \text{Germination of seeds in control}}{\text{Germination of seeds in control}} \times 100$$

$$\text{Phytotoxicity \%} = \frac{\text{Radicle Length of control} - \text{Radicle length of treated sample}}{\text{Radicle Length of Control}} \times 100$$

IV. RESULTS AND DISCUSSION

A. Germination Test and Germination Percentage

Seed germination of Sunflower, Soybean and Green gram was significantly ($P \leq 0.01$) decreased to the parthenium aqueous leaf extracts (Table 1 and Fig 1). In the present study allelopathic effect of leaf extract of different concentrations (2%, 3, 5%, 8%, 11%, and 14%) were compared with control treatment. High aqueous leaf concentrations at 8, 11 and 14% had drastic effect on the germination of all species. The parthenium extract effect on crops showed that the concentrations of Parthenium significantly affected the germination of all the test species. The per cent seed germination was 96.4% in control treatment and it was ranging from 91.5 to 23.50, 92.7 to 21.4 and 89.6 to 20.7% in sunflower, soybean and green gram respectively by different treatment concentrations of leaf extract of Parthenium (Table 1). The minimum rate of seed germination was observed in 14% leaf extract of Parthenium hysterophorus weed and it was 20.8% in green gram with 14% of aqueous leaf concentration tested. Significant inhibitory effect of leaf extract on seed germination of green gram was noticed. Highest inhibition rate was noticed in 14% extract addition and lowest was recorded by 2% extract of 89.6%. This shows that Parthenium hysterophorus has a strong allelopathic effect on Sunflower, Soybean and Green gram when it was added as an extract. The germination percentage of pulses decreased with increasing concentration of Parthenium. The similar effect also recorded in the three crop species (Table 1 and Fig 1). The pulses recorded lowest germination percentage at 20 g L⁻¹ of extract in green gram (89.6%). The Soybean registered highest germination percentage of 92.7% at a concentration of 20 g L⁻¹ (2%). The allelochemicals present in the leaf extract prevented the embryo development and embryo growth and caused death. The extract of Parthenium hysterophorus induced a variety of chromosomal aberrations in dividing cells, which increased significantly with increasing concentrations and durations of exposure. These similar experimental findings were observed in vigna radiata by Parthenium leaf extract (Rajendiran, 2005). Similar results on germination of seed were recorded in the Brassica species (Singh et al. 2005) by increase of parthenium concentration.

Table 1. Allelopathic effect of Parthenium extract Germination Percentage of Sunflower, Soybean and Green gram seeds

S. No.	Parthenium hysterophorus Leaf extract concentrations	Germination Percentage		
		Sunflower	Soybean	Green gram
1.	T0 Control 0.0g L ⁻¹ (0 %)	98.2	96.5	94.5
2.	T1 - 20 g L ⁻¹ (2 %)	91.5	92.7	89.6
3.	T2 - 30 g L ⁻¹ (3 %)	83.5	86.2	74.5
4.	T3 - 50 g L ⁻¹ (5 %)	76.5	74.5	63.5
5.	T4 - 80 g L ⁻¹ (8 %)	68.2	62.5	52.7
6.	T5 - 110 g L ⁻¹ (11 %)	45.5	47.5	41.5
7.	T6 - 140 g L ⁻¹ (14 %)	23.2	21.4	20.8
8.	Mean of Treatments	64.7	64.1	57.1
9.	S. Ed.	23.50	24.21	22.29
10.	F test CD (0.01)	1.98	0.95	0.86

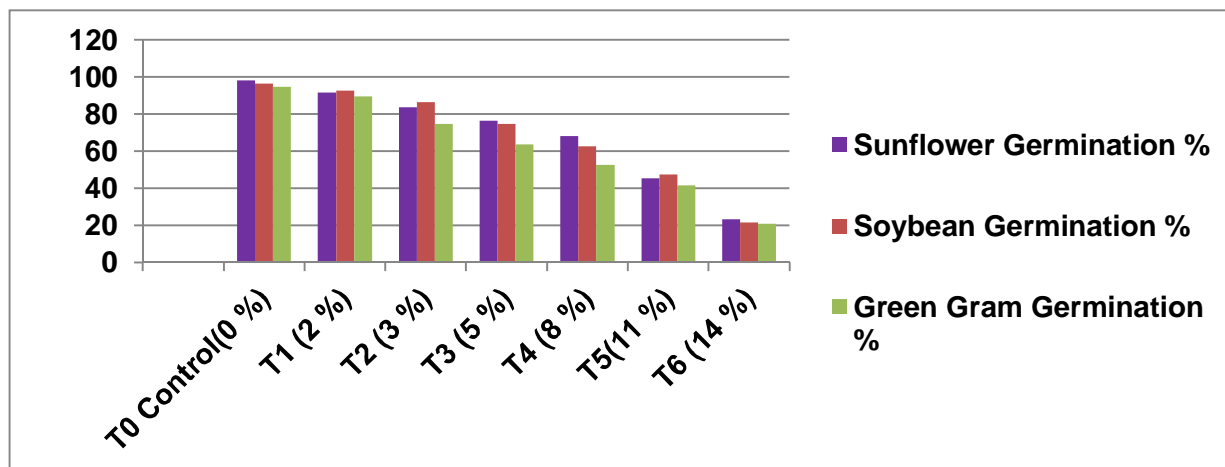


Fig. 1. Allelopathic effect of Parthenium extract Germination Percentage of Sunflower, Soybean and Green gram seeds

B. Radicle Length

The length of root and shoot was measured after ten days of seed germination. The length of root value varied from 8.7 to 2.1, 7.8 to 2.3 and 5.5 to 1.6 cm in sunflower, soybean and green ram respectively by different treatment concentrations (2% to 14.0%) of leaf extract of *Parthenium* (Table 2 and Fig.2) in sunflower, soybean and green gram respectively where as these values were 9.7 to 7.8 cm for control Treatment for the above crops. The maximum value of radical length of 8.7 cm was recorded for 2% and minimum value 1.6 cm recorded by 14% of concentration of the extract in sunflower and green ram seedlings.

C. Plumule Length

The length of plumule length (shoot) values varied from 10.4 to 1.9, 7.5 to 1.6 and 12.2 to 2.5 cm in sunflower, soybean and green ram respectively by different treatment concentrations (2% to 14.0%) of leaf extract of *Parthenium* (Table 3 and Fig.3) in sunflower, soybean and green ram respectively where as these values were 13.5 to 8.7 cm for control Treatment for the above crops. The maximum value of plumule length of 13.5 cm was recorded for 2% in green gram and minimum value 1.6 cm recorded by 14% of concentration of the extract in green ram and soybean seedlings.

Different concentrations of *Parthenium* had significant effects on Plumule length of pulse and oilseeds. Seedling length of green gram, soybean and sunflower was significantly decreased with the increase in concentration of *Parthenium* extracts from 2.0 g L⁻¹ to 140 g L⁻¹. Similar trend was observed by Parthasarathy et.al., (2012) in groundnut but the slight decrease in the seedling length. They have reported that the reduction in plumule length is observed in green gram (12.5 cm) in 50 g L⁻¹ concentration followed by black gram and lowest by groundnut Parthasarathy et.al., (2012).The shoot length of all the test species (Green gram, Black gram and Groundnut) at 20 g L⁻¹ concentration was significantly different from that of control; whereas at the same concentration (20 g L⁻¹) root length was significantly different from the control Parthasarathy et.al., (2012). In the present study, the reduction in plumule length was observed in increasing concentration of parthenium. Higher concentration of *Parthenium* retarded the growth of plants which might be due to inhibition of cell division as allelopathic chemicals have been found to inhibit gibberellin and indole acetic acid function (Tomaszewski and Thimann, 1966) which

Table 2. Allelopathic effect of *Parthenium* extract on Radicle length(cm) of Sunflower, Soybean and Green gram seedlings

S. No.	Parthenium hysterophorus Leaf extract concentrations	Radicle length(cm)		
		Sunflower	Soybean	Green gram
1.	T0 Control 0.0g L ⁻¹ (0 %)	9.4	9.7	7.8
2.	T1 - 20 g L ⁻¹ (2 %)	8.7	7.8	5.5
3.	T2 - 30 g L ⁻¹ (3 %)	8.2	6.4	5.5
4.	T3 - 50 g L ⁻¹ (5 %)	7.1	5.1	4.2
5.	T4 - 80 g L ⁻¹ (8 %)	5.5	4.5	2.8
6.	T5 - 110 g L ⁻¹ (11 %)	4.2	3.2	2.1
7.	T6 - 140 g L ⁻¹ (14 %)	2.1	2.3	1.6
8.	Mean of Treatments	5.97	4.88	3.62
9.	S. Ed.	2.31	1.85	1.55
10.	F test CD (0.01)	0.112	0.406	0.979

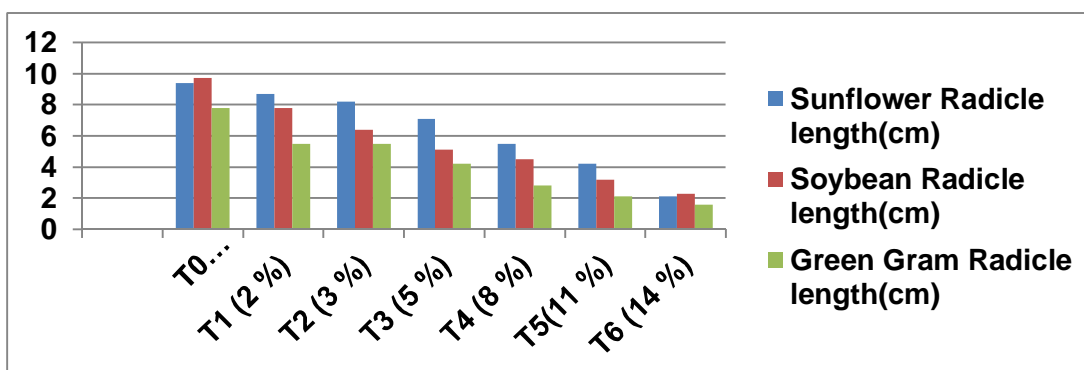


Fig. 2. Allelopathic effect of *Parthenium* extract on Radicle length(cm) of

D. Sunflower, Soybean and Green gram seedlings

causes reduced plumule length. The reduction in plumule length was due to the presence of allelochemical (Parthenin) in leaf extract. The parthenin content present in aqueous extract leads to phytotoxicity of the emerged plumule growth in the seeds. The inhibition of shoot elongation caused by allelochemical leads to reduced plumule length. This positive relation between extract concentration of Parthenium and reduction in seedling length followed the findings in Lettuce (Wakjira, 2009). Eba Muluneh Sorecha and Birhanu Bayissa (2017) in their study revealed that peanut seed germination only significantly ($P \leq 0.05$) responded to the parthenium stem and root extracts; where on average 2 and 4 seeds were germinated per Petri dishes, respectively under high concentration treatment of 10 g/1000 ml. whereas, soybean seed germination was significantly responded to all the parthenium plant parts extracts. However, the serious effects have been well observed under the treatments of 10 g/1000 ml stem extracts and 8 g/1000 ml root extracts, where no germination of soybean seed was recorded. Similarly, shoot length was seriously inhibited by the stem extracts for peanut and leaf extracts for soybean, accounting 5.67 and 1 cm, respectively. Among the plumule and radicle length, the radicle length trend showed a rapid reduction than the plumule length in all the crops (Fig. 2 & 3). Because the radicle had more area of root surface exposed to the allelochemical. The strong inhibitory effects of *Parthenium hysterophorus* on root elongation might be due to direct contact of root than the shoot with the extract and subsequently with inhibitory chemicals as described in early works with various crops and weeds (Quasem 1995).

E. Root: Shoot Ratio

The Root: Shoot ratio was calculated in different treatments of different concentrations of leaf extract of *Parthenium hysterophorus* weed in all species of seedlings tested. This value in control treatment was 0.79, 1.11 and 0.58 in sunflower, soybean and green gram seedlings respectively. The minimum value of 0.40 was recorded for 14% of parthenium aqueous extract in green gram and maximum value was 1.44 in soybean seedlings.

Table 3. Allelopathic effect of *Parthenium* extract on Plumule length (cm) of Sunflower, Soybean and Green gram seedlings

S. No.	Parthenium hysterophorus Leaf extract concentrations	Plumule length(cm)		
		Sunflower	Soybean	Green gram
1.	T0 Control 0.0g L ⁻¹ (0 %)	11.9	8.7	13.5
2.	T1 - 20 g L ⁻¹ (2 %)	10.4	7.5	12.2
3.	T2 - 30 g L ⁻¹ (3 %)	8.2	6.9	10.5
4.	T3 - 50 g L ⁻¹ (5 %)	6.5	5.6	9.3
5.	T4 - 80 g L ⁻¹ (8 %)	4.7	4.3	7.4
6.	T5 - 110 g L ⁻¹ (11 %)	3.2	2.3	5.3
7.	T6 - 140 g L ⁻¹ (14 %)	1.9	1.6	2.5
8.	Mean of Treatments	5.82	4.70	8.32
9.	S. Ed.	2.90	2.20	3.75
10.	F test CD (0.01)	0.098	0.833	0.296

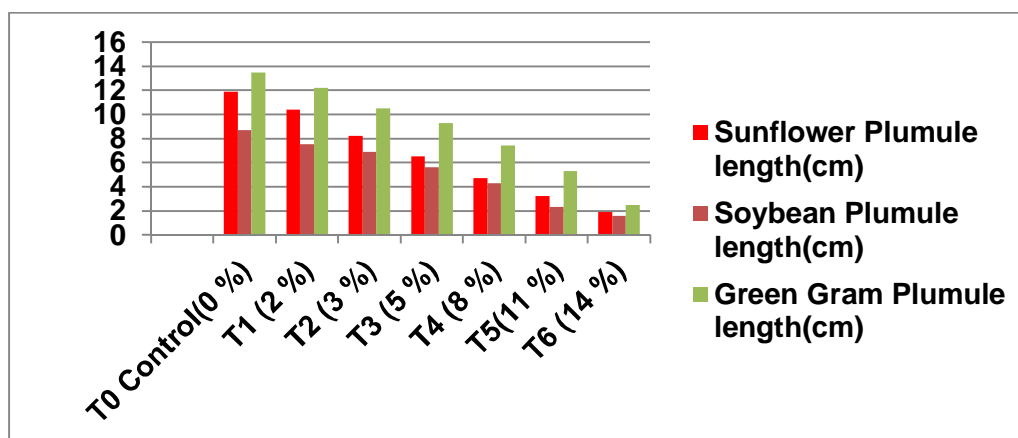


Fig. 3. Allelopathic effect of *Parthenium* extract on Plumule length (cm) of Sunflower, Soybean and Green gram seedlings

F. Germination Inhibition / Stimulation (%)

In the present study, no stimulatory effect was observed but only inhibitory effect on seed germination of green gram (*Phaseolus mungo* L.) was observed which was calculated by using the formula proposed by Singh & Chaudhary (2011), (Table 4 and Fig.4). Inhibition in rate of germination ranged from -3.94 to -77.99 % in case of 2%, 5%, 8%, 11 and 14% treatments, respectively. Seed inhibition of Sunflower, Soybean and Green gram was significantly ($P \leq 0.01$) decreased to the parthenium aqueous leaf extracts (Table 4 and Fig. 4). In the present study allelopathic effect of leaf extract of different concentrations (2%, 3, 5%, 8%, 11%, and 14%) were compared with control treatment. High aqueous leaf concentrations at 8, 11 and 14% had drastic effect on the inhibition of all species. The parthenium extract effect on crops showed that the concentrations of Parthenium significantly affected the drastically affected inhibition of all the test species. The per cent inhibition was ranging from -6.82 to -76.37, -3.94 to -77.82 and -5.19 to -77.99% in sunflower, soybean and green gram respectively by different treatment concentrations of leaf extract of Parthenium (Table 4 and Fig.4). The maximum rate of seedling inhibition was observed in 14% leaf extract of Parthenium hysterochorus weed and it was 77.99% in green gram with 14% of aqueous leaf concentration tested. Significant inhibitory effect of leaf extract on seedlings of green gram was noticed. Highest inhibition rate was noticed in 14% extract addition and lowest was recorded by 2% extract of 3.94% in sunflower seedlings. This shows that Parthenium hysterochorus has a strong allelopathic effect on Sunflower, Soybean and Green gram when it was added as an extract. The seedling inhibition percentage of pulses increased with increasing concentration of Parthenium. The similar effect also recorded in the three crop species. In the present study, significant inhibitory effect of leaf extract of Parthenium on seed germination of *P.mungo* was observed, and similar the inhibitory allelopathic impacts of leaf extract of Parthenium on seed germination have been reported by Tefera (2002) on *Eragrostis tef*; Netsere & Mendesil (2011) on *Glycine max* L. and *Phaseolus vulgaris* L.; Wakjira (2009) on onion; Maharajan et al. (2007) on cultivated and herbaceous species; Demissie et al. (2013) on *Allium cepa* and *Phaseolus vulgaris*; Singh et al. (2005) on Brassica; Wakjira et al. (2005) on Lettuce; and Karim and Forzwa (2010) on rice, wheat, chickpea, soybean and mustard.

Table 4. Allelopathic effect of Parthenium extract on Inhibition(-) Or Stimulation(+) of Sunflower, Soybean and Green gram seedlings

S. No.	Parthenium hysterochorus Leaf extract concentrations	Inhibition(-) Or Stimulation(+) %		
		Sunflower	Soybean	Green gram
1.	T0 Control 0.0g L ⁻¹ (0 %)	--	--	--
2.	T1 - 20 g L ⁻¹ (2 %)	-6.82	-3.94	-5.19
3.	T2 - 30 g L ⁻¹ (3 %)	-14.97	-10.67	-21.16
4.	T3 - 50 g L ⁻¹ (5 %)	-22.10	-22.80	-32.80
5.	T4 - 80 g L ⁻¹ (8 %)	-30.55	-35.23	-44.23
6.	T5 - 110 g L ⁻¹ (11 %)	-53.67	-50.78	-56.08
7.	T6 - 140 g L ⁻¹ (14 %)	-76.37	-77.82	-77.99
8.	Mean of Treatments	-34.08	-33.54	-39.58
9.	S. Ed.	28.04	27.48	34.78
10.	F test CD (0.01)	0.0018	0.0015	0.002

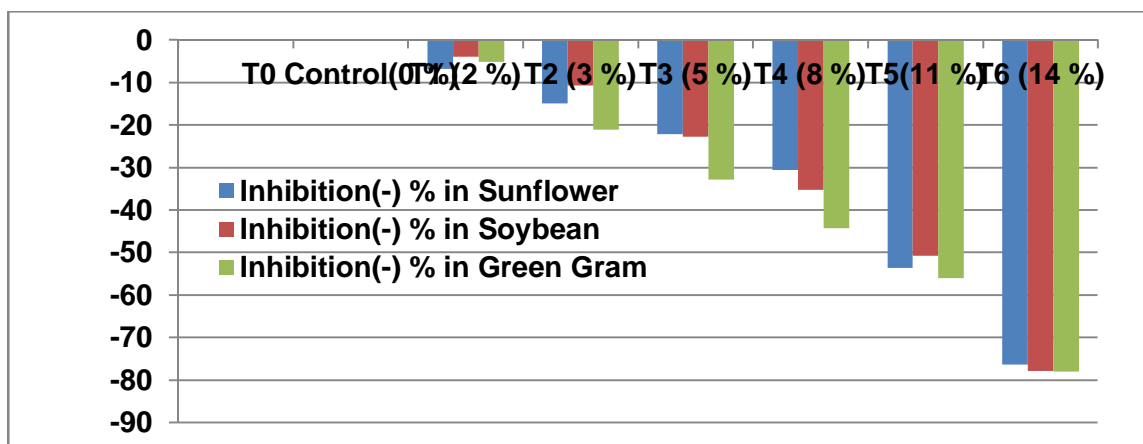


Fig. 4. Allelopathic effect of Parthenium extract on Inhibition(-) of Sunflower,

G. Soybean and Green gram seedlings

In the present study, the impact of leaf extract of Parthenium on root length was incriminating with increase in concentration of Parthenium extract compared to control treatment. The root length values decreased when seeds were treated with leaf extract of Parthenium in 2%, 5%, 8%, 11%, and 14% of leaf extract which were higher than control condition (Table 4). In support of the present study earlier researchers were also reported like Tamado et al. (2002) on maize and sorghum, multipurpose trees, pumpkin and tomato ; Maharajan et al. (2007) on three cereal crops (*Oryza sativa* L., *Zea mays* L. and *Triticum aestivum* L.), three cultivated crucifers (*Raphanus sativus* L. , *Brassica compestris* L. and *Brassica oleracea* L.) and two wild species of family Asteraceae (*Artemisia dubia* wall ex . *Ageratina adenophora*) ; Singh et al . (2005) on *Brassica* species ; Tefera (2002) on *Eragrostis tef* zucc) ; Wakjira et al. (2005) on Soyabean and Haricot bean ; and Netsere and Mendesil (2011) on *Glycine max* L. and *Phaseolus vulgaris* have reported inhibitory effect of leaf extract of Parthenium on root length.

H. Allelopathic effect of Parthenium extract on Phytotoxicity

Phytotoxicity percentage of sunflower, soybean and green gram were computed formula proposed by Singh & Chaudhary (2011). It was noticed that incriminating enhancement of phytotoxicity was observed in the entire crop species tested. The parthenium extract effect on crops showed that the concentrations of *Parthenium* significantly affected the drastically affected phytotoxicity of all the tested crop species. The per cent phytotoxicity was ranging from 7.40 to 77.66, 19.59 to 76.29 and 29.49 to 79.49% in sunflower, soybean and green ram respectively by different treatment concentrations of leaf extract of Parthenium (Table 5 and Fig.5). The maximum rate of seedling phytotoxicity was observed in 14% leaf extract of Parthenium hysterothorus weed and it was 79.49% in green gram with 14% of aqueous leaf concentration tested. Significant phytotoxicity effect of leaf extract on green gram seedlings was noticed. Highest phytotoxicity rate was noticed in 14% extract addition and lowest was recorded by 2% extract of 7.4% in sunflower seedlings.

Table 5. Allelopathic effect of *Parthenium* extract on Phytotoxicity Percentage of Sunflower, Soybean and Green gram seedlings

S. No.	Parthenium hysterothorus Leaf extract concentrations	Phytotoxicity Percentage of		
		Sunflower	Soybean	Green gram
1.	T0 Control 0.0g L ⁻¹ (0 %)	--	--	--
2.	T1 - 20 g L ⁻¹ (2 %)	7.45	19.59	29.49
3.	T2 - 30 g L ⁻¹ (3 %)	12.77	34.02	29.49
4.	T3 - 50 g L ⁻¹ (5 %)	24.47	47.42	46.15
5.	T4 - 80 g L ⁻¹ (8 %)	41.49	53.61	64.10
6.	T5 - 110 g L ⁻¹ (11 %)	55.32	67.01	73.08
7.	T6 - 140 g L ⁻¹ (14 %)	77.66	76.29	79.49
8.	Mean of Treatments	36.52	49.66	53.63
9.	S. Ed.	23.97	20.88	21.81
10.	F test CD (0.01)	0.0016	0.0053	0.0043

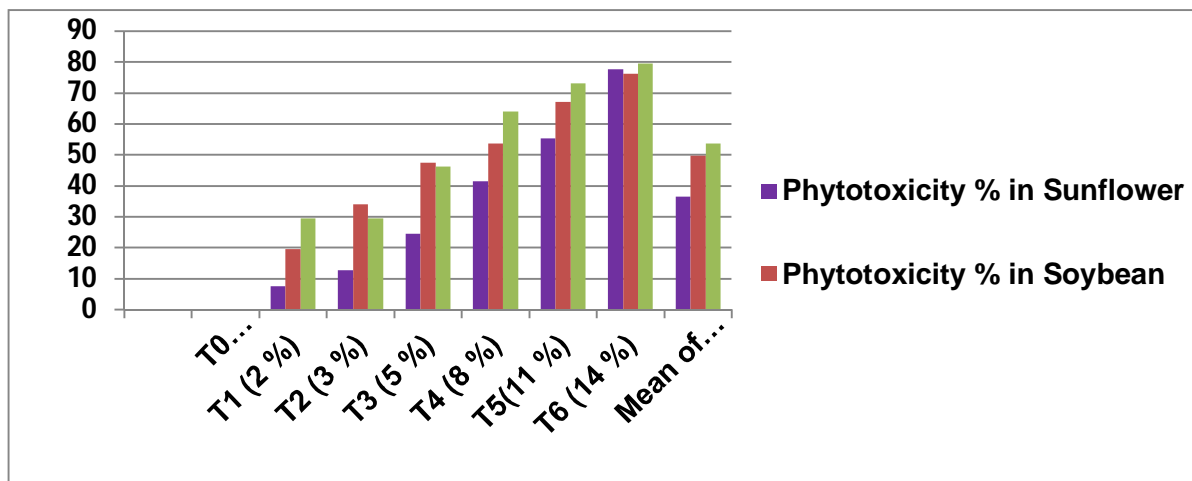


Fig. 5. Allelopathic effect of *Parthenium* extract on Phytotoxicity Percentage of Sunflower, Soybean and Green gram seedlings

V. CONCLUSIONS

This research study was attempted to investigate the allelopathic effects of parthenium plant parts specially leaf on the germination and early growth of sunflower, soybean and green gram seeds. In line with this, it could generalize that germination of all these three species seeds have been seriously inhibited with the aqueous extracts of parthenium plant aqueous extract. The severity of parthenium against seeds, sunflower, soybean and green gram increases with the increasing aqueous concentration of the extracts from 2% to 14%. This implies that in areas with high infestation of this weed, growing these kinds of crops might be at risk. Therefore, further investigation how to control this weed is critical.

The increase in concentration of parthenium extract significantly decreases the seed germination, radicle length, plumule length of seedlings of sunflower, soybean and green gram. The leaf extract has inhibitory effect on radical growth of pulses compare to oil seeds. The tolerance level of parthenium allelopathy of crops represented as sunflower > soybean > green gram.

Parthenium hysterophorus on seedling germination and seedling growth of three crop species were tested and observed that there was drastic reduction of germination percentage of seeds, radicle and plumule length of these three species were also much affected at higher leaf aqueous concentrations (5, 8, 11 and 14%). The concentration dependent inhibitory activities of the aqueous extracts of parthenium on the germination and seedling growth of the test species suggest that the plant has allelopathic potentiality and possess allelochemicals. These allelochemicals could be the main reason for the restricted growth of other plant species near their colony. In line with this, this study showed that allelopathic weed plants pose threat on seed germination, seedlings radicle and plumule lengths of sunflower, soybean and green gram crops. Thus, farmers should give special attention to avoid or minimize those weed species from their farm to contain their adverse effects on crops.

In the present study allelopathic effect of *P. hysterophorus* on seed germination and seedling growth of sunflower, soybean and green gram explains the allelochemicals secreted by *P. hysterophorus* as suggested by several workers regulate allelopathy. In conclusion, the result of the present study showed that the parthenin has considerable inhibitory effect on seed germination, seedling growth of various crops.

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