Evaluation of effect of leaf extract of Parthenium hysterophorus L. on seed germination, seedling growth and fresh weight of Phaseolus mungo

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ABSTRACT

Evaluation of effect of different concentrations of leaf extract of Parthenium hysterophorus L. on seed germination, seedling growth and fresh weight of Phaseolus mungo has been done. In the present study allelopathic effect of leaf extract of different concentrations (2% , 4% , 6% , 8% , 10%) were compared with control treatment. After seven days of incubation at room temperature the aqueous leaf extract of various concentrations of P. hysterophorus on seed germination, root & shoot length, R/S ratio, Inhibition(-) or Stimulation(+) per cent, relation elongation of root & shoot and fresh weight of root & shoot of P.mungo have no significant inhibitory effect. This study disclosed that higher concentrations of leaf extract have irregularly affected the growth of P. mungo than lower concentrations.

Keywords : Parthenium, Mung , Allelopathic effect

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INTRODUCTION

Parthenium hysterophorus L. is an annual herbaceous noxious weed (Kohli et al. 2006; Wakjira (2009) belonging to Asteraceae family, which is native to Central America (Haseler 1976), and now it is widely distributed in all parts of the world

(Aneja et al. 1991). Roxburg (1814) for the first time reported its existence in India. Rao (1956) reported from outskrits of Poona. Parthenium came to India under US PL 480 Scheme and invaded all parts of India (Kaur et al. 2014). Kathiresan (2004) and Kathiresan et al. (2005) have reported that the major threats to the native species and ecosystem around the world are invasive species because of their capability to spread rapidly, high competitiveness and colonization in new areas in very short period. It colonizes wide range of habitats and any type of soil, wastelands, pastures, road sides, agricultural lands etc. The productivity of crop is not only affected by Parthenium but animals, animal health, humanbeings and biodiversity of the ecosystems are also affected. In the humanbeings it causes various types of allergies particularly through pollengrains like contact dermatitis, hay fever, asthma and bronchitis (Navie et al. 1996; Wiesner et al. 2007). Sesquiterpene lactones viz. parthenin and coronopilin present in trichomes of leaves and stems of Parthenium are causes of allergies.

Pesticides like atrazine , 2, 4 - D metribuzin, paraquat, trifiuralin and diphenamid do not show any effect on Parthenium (Singh et al. 2004).A single plant of Parthenium produces 10,000 to 25,000 seeds which are deposited in the seed bank. Due to allelochemical potential it has strong effect on both nitrogen fixing and nitrifying bacteria thereby inhibiting the growth of nodule in legumes (Kanchan and Jayachandra 1980; Deyama 1986). Parthenium secretes certain allelochemicals such as: Phenolic acids, Caffeic acid, Vanillic acid, Ferruclic acid, Chlorogenic acid, Para caumeric acid, Para hydroxyl benzoic acid (Kanchan and Jayachandra 1980; Das and Das 1995), and other important chemicals such as pseudoguaionolides, parthenin, anhydroparthenin, ambrosin, coronopilin and damsin which have adverse effect on the growth of plants which grow in its vicinity. Damjanoviae - Vratnica et al. (2008) have reported secondary metabolites in Parthenium such as barbadin, β-Myrcene etc having medicinal property. Khalaj et al. (2013) reported that secondary metabolites are released through volatilization, leaching, root exudation and decomposition of plant residues in the soil. Bhowmik et al. (2007), and Nath (1988) have mentioned that parthenin is the active principal component among all the chemicals secreted by this plant which have the strong allelopathic and allergic effect. It reduces 40% and 90% loss per annum in agricultural crops and forage crops, respectively (Tamado et al. 2002). The visible effect of allelochemicals on other plants include inhibition or retardation of germination rate; darkening and swelling of seeds; reduction of root and shoot length; swelling or

necrosis of root tips; curling of the root axis; diecoloration, lack of root hairs; increased number of seminal roots; reduced dry weight accumulation; and lowered reproductive capacity (Bhadoria, 2011).

Parthenium is an annual plant with a deep tap-root and an erect much-branched stem. Mature stems are greenish and longitudinally grooved, covered with small stiff hairs (trichomes). It usually grows 1-2m. tall. Leaves are simple, pale green, lobed, sessile, irregularly dissected, hairy and alternately arranged with stalk (petioles) up to 2cm long and form a basal rosette during the early stages of growth. The number of leaves per plant is 6 to 55. The flowers are arranged in capitulam, cremy white in colour, borne in profusion at the tips of the stems. Small flower heads are arranged in clusters and its colour changes to light brown, when seeds are mature. Flowering can occur at any time of the year, but is most common during the rainy season. Each flower contains five seeds, which are wedge-shaped, black, 2mm long with thin white scales. The seeds are dispersed by wind, water, animals, vehicles and farm machinery.

Parthenium commonly called as congress grass or carrot weed, feverfew, regweed Parthenium and white top. In India, it is locally known as Gajar Ghans. It contains special characters such as: high germination ability, large seed production capacities, high survival rate, extreme adaptability in different habitats, easy dispersal of seeds, high allelopathic impact and completes life-cycles within four weeks. Pandey (1994) and Kanchan and Jayachandra (1979) have reported that Parthenium was one of the best-known plant encroacher in the world, a phenomenon linking allelopathy to exotic invasion. According to Evans (1997) the invasive ability and allelopathic properties of Parthenium possess a great risk to interrupt the ecosystems. Maharajan et al. (2007) have reported the inhibitory effect of leaf extract on seed germination and seedling growth in rice, maize, wheat, two wild species and cultivated crucifers. Tefera (2002) has reported that the aqueous leaf extract of Parthenium resulted in complete failure of seed germination in Eragrostis tef . Singh et al. (2005) have shown the strong positive correlation between extract concentration of residues of Parthenium and reduction in seedling length of Brassica species. Demissie et al. (2013) also studied the effect of root, shoot and leaf extract on the germination and elongation of onion and beans in Ethiopia. Further Dogra and Sood (2012) analyzed the phytotoxicity of Parthenium on three native plants of Himachal Pradesh under *in-vivo* condition and found that soil mixed with residues of the Parthenium adversely affect the per cent of seed

germination and seedling growth. Mawal et al. (2015) have reported that allelochemical is produced by Parthenium root having allelopathic and autotoxic effect which causes increment in the contents of organic carbon and nitrogen in the rhizosphere soil of Parthenium compared to the control and root leachet soil. Bashir (2003) has reported that growth inhibitors secreted by Parthenium suppress the growth and yield of native plants. Pimentel et al. (2000) have mentioned that the structure and composition of the native vegetation is disturbed due to the invasion of invasive plants on a large scale and creates pressure on the food chain and web of the ecosystem. Rajendiran (2005) has shown the extract of Parthenium induced a variety of chromosomal aberrations in dividing cells, which increased significantly with increasing concentration and duration of exposure. Karim and Forzwa (2010); and Biswas (2010) have mentioned that Parthenium has deadly allelopathic effect on rice, wheat, chickpea, soyabean and mustard. Tefera (2002) also found that the inhibitory allelopathic impact of leaf extract was more powerful than the other vegetative parts.

The main reason for the decreased amount of photosynthates due to inhibition of photosynthesis is caused by decreased biosynthesis of chlorophyll or degradation of photosynthetic pigments. The reason behind the decreased dry matter is inhibition of photosynthesis by allelochemicals (Pandey,1994; Chetti et al.,1997; Kohli et al.,1997; Bajaj et al.,2004). Moreland and Novitzky (1987) have reported that electron transport in mitochondria and impaired enzyme activity are targets of allelochemicals, which results in reduced ability to metabilize reserve materials. Politycka (2002) has shown the meagre synthesis of carbohydrate precursors of amino acids, protein and of lipids.

The present study was conducted to know the impact of different concentrations of leaf extract of Parthenium on seed germination and seedling growth of an important leguminous plant Phaceolus mungo. P. mungo is cultivated in this region on large scale and Parthenium is invading the cropland, grassland, wasteland etc. of Chapra on large scale rapidly.

MATERIAL AND METHODS

The leaves of P. hysterophorus L. were collected from J.P.University, Chapra, campus in the month of August 2015, and were air dried in shade for 3 - 4 days. The dried leaves were grinded to powder using laboratory blender. 10grams of leaves powder were mixed with 100ml distilled water and were left for 24h at the room temperature and then filtered. Aqueous extract thus obtained were filtered through plastic kip with whatman filter paper. The extract was kept in a beaker for further use. The filtrate was taken to study the effect of leaf extract on seedling growth of Phaseolous mungo. For this experiment 180 seeds were pre-soaked for 7 hours in tap water. The seeds were divided into three replicates. One treatment was run as control with distilled water only and five concentrations (2% , 4% , 6% , 8% , 10%) of the leaf extract were used to check the allelopathic effect of Parthenium. Ten seeds were placed in each petridishes with filter paper. All the petridishes were maintained under laboratory conditions (room temperature). Equal volume of distilled water was added in the petridishes when moisture content of the filter paper declined. After one week number of germinated seeds were counted and the root (radical) and shoot (plumule) length were measured. All root and shoot from each petridishes were cut separately and fresh weight was 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 following the formula given below :

$$\text{Inhibition } (-) \text{or Stimulation } (+) \% = \frac{Germinated\ seeds\ in\ extract - Germinated\ seeds\ in\ control}{Germinated\ seeds\ in\ control} \times 100$$

RESULTS

Seed Germination

The rate of seed germination (%) was recorded after seven days of setting up of the experiment. Sharp differences in the rate of seed germination was not observed in different concentrations of leaf extract compared to control condition. The per cent seed germination was 96.6% in control condition and 90 to 96.6% in different concentrations of leaf extract of Parthenium (Table 1). The minimum rate of seed germination was observed in 10% leaf extract of Parthenium . No inhibitory effect of leaf extract on seed germination of P. mungo was observed (Fig.1).

Table 1: Impact of leaf extract of Parthenium on seed germination, root length, shoot length, R : S ratio and inhibition (-) or stimulation (+) on P . mungo

S.No	Treatment	Germination (%)	Radicle length (cm)	Plumule length (cm)	R/S ratio	Inhibition(-) or Stimulation(+) (%)
1	Control	96.6 %	1.36 ± 0.38	9.28 ± 1.29	0.14	____
2	2 %	93.3 %	3.28 ± 0.56	12.29 ± 0.80	0.26	-3.44
3	4%	93.3 %	5.26 ± 0.85	10.98 ± 1.22	0.47	-3.44
4	6%	96.6 %	3.31 ± 0.65	8.39 ± 0.75	0.39	0
5	8%	96.6 %	3.24 ± 0.71	10.42 ± 1.03	0.31	0
6	10%	90 %	1.72 ± 0.36	5.39 ± 0.67	0.31	-6.89

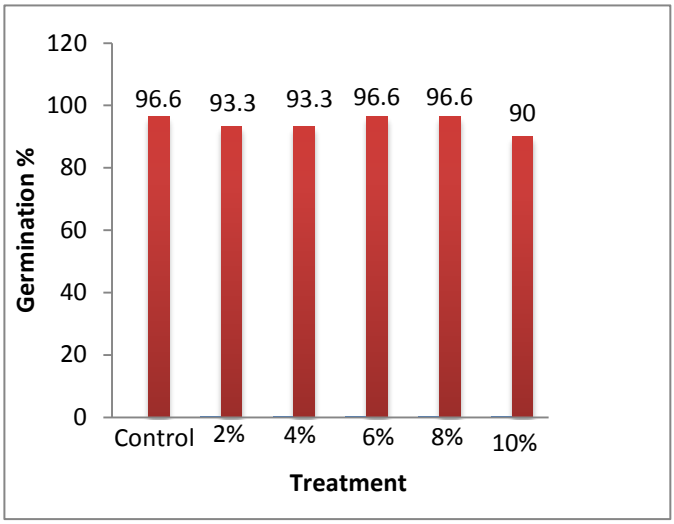

Fig.1. Seed germination of *P . mungo*.

Root and Shoot length

The length of root and shoot was measured after seven days of seed germination. The length of root value varied from 1.72 cm to 5.26 cm in different concentrations of leaf extract of Parthenium where as this value was 1.36cm for control condition (Table 1). The maximum value 5.26 cm was recorded for 4% and minimum value 1.72 cm for 10% (Fig.2).

The length of shoot value varied from 5.39 cm to 12.29 cm in different concentrations of leaf extract of Parthenium , where as this value was 9.28 cm for control treatment. The minimum value 5.39 cm was recorded for 10% and maximum value 12.29 cm for 2% (Table. 1, Fig.2).

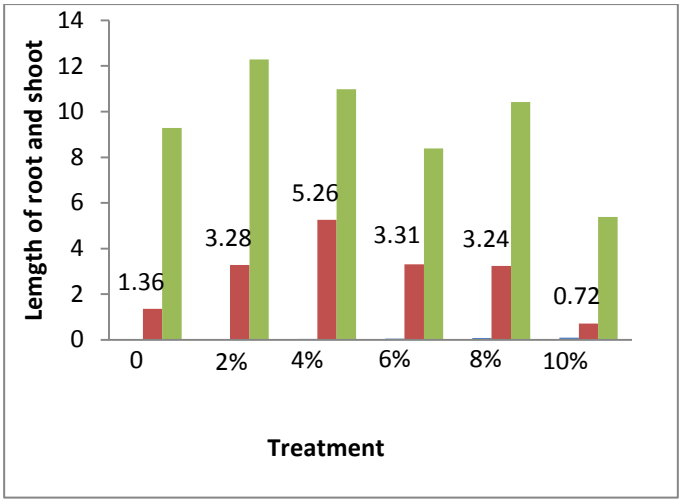

Fig.2. Root & Shoot length of *P. mungo*.

Root : Shoot Ratio

The root : shoot ratio was calculated in different treatements of leaf extract of Parthenium . This value in control condition was 0.146 . The minimum value 0.266 was recorded for 2% and maximum value was 0.479 for 4% concentration of leaf extract (Table.1, Fig.3).

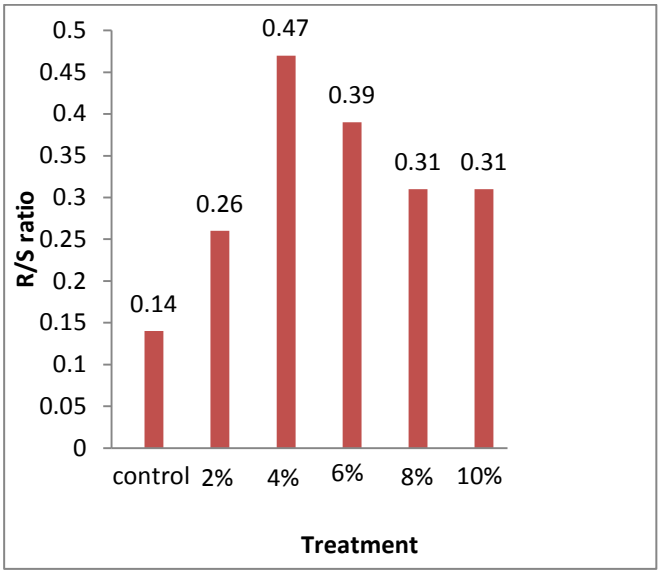

Fig 3: R / S ratio of *P . mungo*.

Germination Inhibition / Stimulation (%)

In this study, no stimulatory only inhibitory effect on seed germination of P. mungo was observed which was calculated by using the formula proposed by Singh & Chaudhary (2011) , (Table1, Fig.4). Inhibition in rate of germination ranged from -3.44 to -6.89 % in case of 2%, 4% and 10% treatments, respectively.

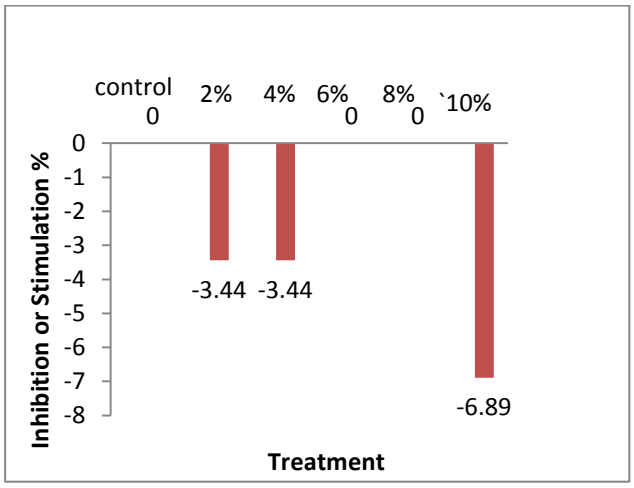

Fig 4-: Inhibition(-) or Stimulation(+) %.

Relation elongation ratio of root and shoot

The relation elongation ratio of root and shoot was recorded in different concentrations of leaf extract of Parthenium. These values were compared for 2% to 10% treatments.

The minimum value for root elongation ratio was 126.47 recorded for 10% and maximum value 386.76 for 4% concentration of leaf extract (Table2., Fig.5).

Table 2: Impact of leaf extract of Parthenium on relation elongation ratio of root and shoot of P . mungo.

S. No.	Treatment	Relation elongation of Root (%)	Relation elongation of Shoot (%)
1	2 %	241.18	132.43
2	4 %	386.76	118.31
3	6 %	243.38	90.41
4	8 %	238.23	112.28
5	10 %	126.47	58.08

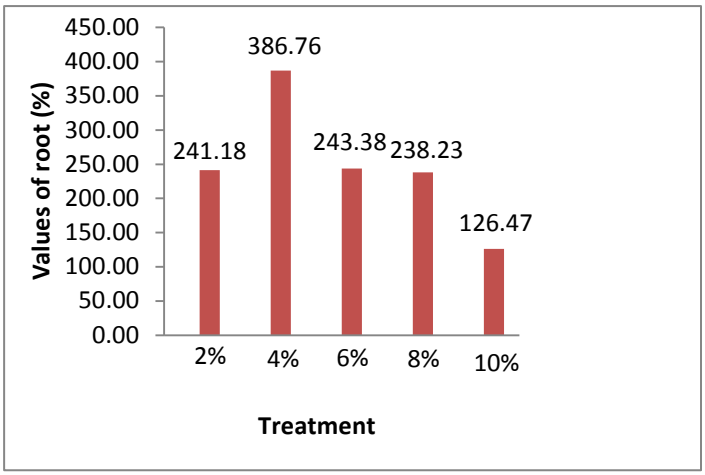

Fig 5-: Relation elongation ratio of root (%).

The minimum value for shoot elongation ratio was recorded 58.08 for 10% treatment and maximum value 132.43 for 2% concentration of leaf extract (Table.2, Fig.6)

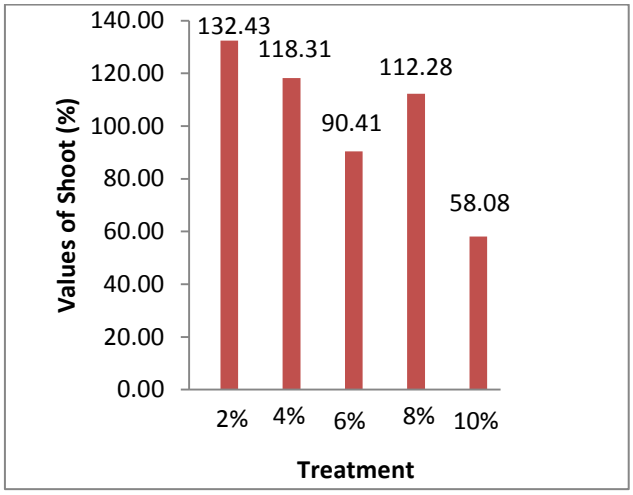

Fig.6. Relation elongation ratio of soot (%).

DISCUSSION

In this study, no inhibitory effect of leaf extract of Parthenium on seed germination of P.mungo was observed, but 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 Lettuca ; and Karim and Forzwa (2010) on rice, wheat, chickpea, soyabean and mustard.

In the present study , the impact of leaf extract of Parthenium on root length was erratic compared to control treatment . The root length values decreased when seeds were treated with leaf extract of Parthenium in 4% , 6% , 8% and 10% of leaf extract which were higher than control condition (Table 1). Similarly, 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.

Based on the present study the impact of leaf extract of Parthenium on shoot length was compared to control condition. No clear trend either increasing or decreasing was observed for shoot length data when the seeds of mung were treated with different concentrations of leaf extract of Parthenium (Table 1). 10% concentration of leaf extract of Parthenium reduced the length of shoot of mung (5.39 cm) compared to control treatment (9.28 cm). From preliminary screening such erratic results have not been reported by other workers. Several workers such as Netsere and Mendesil (2011) on soyabean (Glycine max L.) and haricot bean (Phaseolus vulgaris L.), Tefera (2002) on Eragrostis tef ; Maharajan et al. (2007) on cultivated species , cereal crops and wild species ; Singh et al. (2005) on Brassica species ; and Wakjira et al (2005) on Soyabean and haricot bean have reported inhibitory effect of Parthenium on the growth of shoot length .

In the present study , the effect of leaf extract of Parthenium on fresh weight of root and shoot were compared with control treatment . The values of root and shoot were

irregular , when the seeds of mung were treated with different concentrations of leaf extract of Parthenium (Table 3).

Table 3: Average fresh weight (gm) of root and shoot of P . mungo treated with different concentrations of leaf extract of Parthenium.

S. No.	Treatment	Root(gm)	Shoot(gm)
1	Control	0.04	1.50
2	2%	0.58	3.18
3	4%	0.49	2.62
4	6%	0.24	1.85
5	8%	0.3	2.08
6	10%	0.16	1.60

An et al. (2005) stated that there could be marked differences among species in their susceptibility towards the effects of allelochemicals.The other factors such as soil pH, organic matter content, nutrient and moisture content and microorganisms extended the allelopathic effects of allelochemicals concentration (Blum 1995).Thus the impact of leaf extract of Parthenium on seed germination and seedling growth of mung is not clear cut inhibitory.

CONCLUSION

The effect of leaf extract of Parthenium on seed germination and seedling growth on various cultivated and wild species are inhibitory but , An et al. (2005) reported the differences in susceptibility of different species towards the effect of allelochemicals. Thus the effect on seed germination and growth parameters of mung are erratic in the present study . i.e. stimulatory on shoot length and inhibitory on root length.

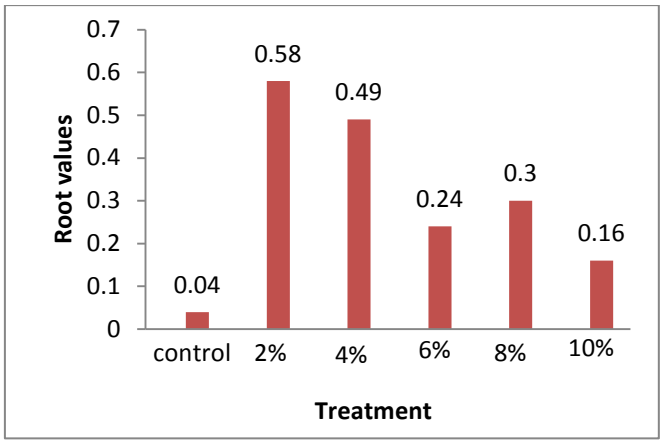

Fig. 7: Fresh weight of Root (gm).

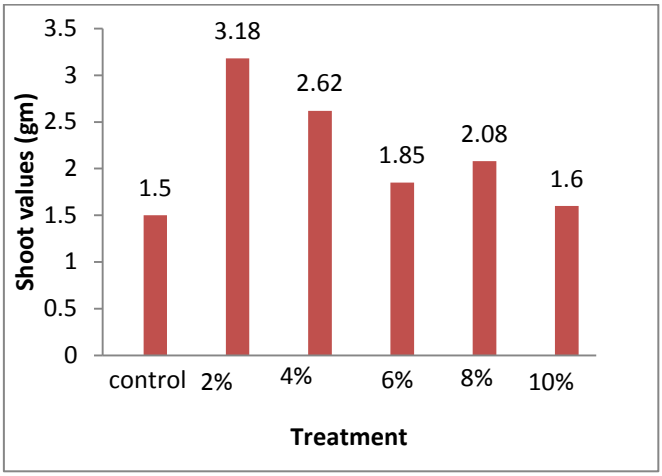

Fig 8: Fresh weight of Shoot (gm).

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