Madras Agric. J., 99 (7-9): 514-517, September 2012
https://doi.org/10.29321/MAJ.10.100128

Allelopathic Effect of Aqueous Leaf Extract of *Parthenium hysterophorus* L. on Seed Germination and Seedling Growth in Greengram, Blackgram and Groundnut

T. Parthasarathi*, V. Suganya and R. Sivakumar
Department of Crop Physiology,
Tamil Nadu Agricultural University, Coimbatore - 641 003

Allelopathic effect of *Parthenium hysterophorus* L. was studied on seed germination and seedling growth of two pulse crops (*Vigna radiata* (L.) R. Wilczek and *Vigna mungo* (L.) Hepper) and one oil seed crop (*Arachis hypogea* L.). The concentrations used were 20 g L^{-1}, 30 g L^{-1} and 50 g L^{-1} leaf extract of *Parthenium hysterophorus*. Seed germination of greengram was completely inhibited at 30 g L^{-1} leaf extract of *Parthenium hysterophorus* but in blackgram and ground nut, failure of seed germination was recorded only at 50 g L^{-1} leaf extract. The seed germination, plumule, radicle length and total biomass production were reduced with increasing concentration of aqueous solution. The study concluded that increasing concentration of leaf extract of *Parthenium hysterophorus* has adverse effect on germination, radicle length, plumule length and biomass production of *Vigna radiata* followed by *Vigna mungo* and *Arachis hypogea* than the control. The leaf extract has strong inhibitory effect on radicle growth than the plumule growth. The tolerance level of parthenium allelopathy of crops represented as Groundnut > Blackgram > Greengram.

Key words: Chromosomal aberrations, Dry Matter Accumulation, noxious weed, *Parthenium hysterophorus*, parthenin, phytotoxicity, *Arachis hypogea*, *Vigna mungo, Vigna radiata*

*Corresponding author email: agrisarathi@yahoo.com

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 chemical analysis of parthenium contains coronopilin, tetraneurin A, 2β-hydroxycoronopilin, hysterones A-D, parthenin and acetylated pseudoguaianolides. These allelochemicals significantly decrease the seed germination and subsequent growth in many crops (Batish *et al*., 2005), by affecting carbohydrate, protein metabolism, physiological changes such as cellular membrane damage, chromosomal aberrations, chlorophyll loss in leaves and loss of dehydrogenase activity in roots of green gram (Rajendiran, 2005).

The previous evidence of negative allelopathic effect of Parthenium on cultivated plants (e.g. Brassica sp., Glycine max, Phaseolus vulgaris, Raphanus sativus, Cicer arietinum and Vigna radiata) have been well documented (Oudhia, 2000;

Batish *et al*. 2005; Singh *et al.* 2005;). Release of parthenin by aqueous extraction of fresh leaf material of Parthenium hysterophorus produce phytotoxic effects of the crude extract could be estimated to 16-100% (Regina *et al.*, 2007).

From this strong reason the allelopathy on crop seed was experimented to study the effect of different concentrations of parthenium on seed germination of pulse and oilseed crops, to know the variation in plumule length and radicle length of crop seeds by parthenium allelopathy, the impact of allelopathy on drymatter production in different crops and to assess the impact of Parthenium allelopathy on pulse and oilseed crop.

Materials and Methods

I. Preparation of Aqueous Extract

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 water at 48 h at room temperature. The concentrations of 2%, 3% and 5% were prepared by soaking 20, 30 and 50 g of powder in one litre of water separately. These aqueous leachates were filtered through three layers of muslin cloth to remove debris. The filtrate was then refiltered through one layer of Whattman No. 1 filter paper

and stored in dark cool place for use by the method of Singh *et al.* (1989). The extract was generally used within a week. The pH of 5%, 3% and 2% solutions were 5.74, 6.52 and 7.39 respectively.

II. Treatments and Experimental Design

The experiment was conducted in the year 2011, at Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore, India. There were four treatments including three concentration levels (0%, 2%, 3% and 5%) of leaf extracts with three replications. Seeds and filter papers were moistened with 10 ml each of 2%, 3% and 5% 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. The treatments were adopted in natural room light condition homogenously to all the petriplates. Twenty seeds of each crop in each petri dishes of 15cm diameter with three replicates were used for each concentration. The Varieties used were CO-6 (Greengram), CO-5 (Blackgram) and VRI-1 (Ground nut). 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. The whole experiment was repeated once and mean data of two experiments were used.

Treatment Details

T_0 - Control

T_1 - 20 g L^{-1} (2 %) Parthenium Aqueous Leaf Extract

T_2 - 30 g L^{-1} (3%) Parthenium Aqueous Leaf Extract

T_3 - 50 g L^{-1} (5%) 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. The root and shoot length were determined manually while the dry weight with the help of 4 digit digital balance of Scientech, Model ZSA 120, Colorado (USA).

Statistical analysis

The treatments were tested and analysed by one-way analysis of variance at P =<0.05 and P <0.01 using the ANOVA package (Analysis of Variance package). The means were separated by Duncan's multiple Range Test (Steel and Torrie, 1980) at P = 0.05.

Results and Discussion

Germination Percentage

The parthenium extract effect on crops showed that the concentrations of *Parthenium* significantly affected the germination of all the test species. There was slight inhibitory effect of *Parthenium* extract concentration on the Groundnut seed germination while inhibitory effect on the rest of the species was comparatively greater.

The germination percentage of pulses decreased with increasing concentration of *Parthenium.* The similar effect also recorded in the three crop species (Table 1). The pulses recorded lowest germination percentage at 50 g L^{-1} of extract in Black gram (76%). The groundnut registered highest germination percentage of 81% at a concentration of 50 g L^{-1} . 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).

Table 1. Allelopathic effect of *Parthenium* extract on seed germination Percentage (%) of different crops

Concentration	Greengram	Blackgram	Groundnut
0 (Control)	92.8$_a$	91.6$_a$	96.7$_a$
20 (g L^{-1})	87.7$_a$	86.5$_a$	91.6$_a$
30 (g L^{-1})	72.2$_b$	81.4$_b$	90.9$_a$
50 (g L^{-1})	61.9$_c$	76.3$_b$	81.4$_b$
Mean	78.6	83.9	90.1
S.Ed	1.5	2.4	3.5
CD (0.01)	3.5	5.6	8.2

In this study, the reduction in seed germination was observed with increasing concentration of aqueous extract of parthenium in pulses. But in case of groundnut reduction in germination percentage was less with increase in concentration. The similar results on germination of seed were recorded in the *Brassica* species (Singh *et al.* 2005) by increase of parthenium concentration.

Plumule length

Different concentrations of *Parthenium* had significant effects on Plumule length of pulse and oilseed. Seedling length of green gram and black gram was significantly decreased with the increase in concentration of *Parthenium* extracts from 0 g L^{-1} to 50 g L^{-1}. The similar trend was observed in groundnut but the slight decrease in the seedling length. The reduction in plumule length is observed in greengram (12.5 cm) in 50 g L^{-1} concentration followed by blackgram and lowest by groundnut. The shoot length of all the test species (Greengram, Blackgram 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

(Table 2) . In the present study, the reduction in plumule length was observed in increasing concentration of parthenium. Higher concentration of *Parthenium* retard 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 & Thimann, 1966) which causes reduced plumule length.

Table 2. Allelopathy effect of Parthenium extract on plumule length, radicle length and dry matter accumulation on different crops

Concentration	Greengram	Blackgram	Groundnut
Plumule Length (cm)			
0 (Control)	19.3$_a$	19.4$_a$	7.3$_a$
20 (g L^{-1})	17.1$_b$	18.3$_b$	6.5$_a$
30 (g L^{-1})	15.1$_c$	16.1$_c$	5.7$_b$
50 (g L^{-1})	12.5$_d$	13.8$_d$	4.5$_c$
Mean	16.0	16.9	6.0
S.Ed	0.6	1.5	2.2
CD (0.01)	0.7	1.8	2.6
Radicle Length (cm)			
0 (Control)	8.7$_a$	7.1$_a$	9.9$_a$
20 (g L^{-1})	5.4$_b$	6.2$_a$	9.4$_a$
30 (g L^{-1})	5.2$_b$	5.4$_b$	8.0$_a$
50 (g L^{-1})	2.5$_c$	4.3$_b$	6.9$_b$
Mean	5.4	5.7	8.5
S.Ed	0.6	0.5	0.5
CD (0.01)	1.3	1.1	1.2
Dry Matter Accumulation (g)			
0 (Control)	0.639$_a$	1.544$_a$	12.183$_a$
20 (g L^{-1})	0.573$_a$	0.882$_b$	11.700$_a$
30 (g L^{-1})	0.403$_b$	0.799$_b$	10.970$_b$
50 (g L^{-1})	0.290$_c$	0.760$_c$	9.908$_c$
Mean	0.476	0.996	11.190
S.Ed	0.024	0.033	0.273
CD (0.01)	0.054	0.077	0.629

The reduction in plumule length was due to the presence of allelochemical (Parthenin) in leaf extract. This 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).

Radicle length

The root length of the crop decreased by increase in concentration of Parthenium*.* The maximum decrease in root length was recorded in greengram (2.5 cm) followed by blackgram (4.3) and the least by groundnut (6.9) in 50 g L^{-1} concentration. The reduction in radicle length (Table 2) was observed in all the test crops with increasing concentration of extracts. The radicle length was affected more, because of reduction in root elongation. This is due to contact of root outer surface to the leaf extract*.* Similar effect of leaf aqueous extract of *Parthenium hysterophorus* was reported in cereals (Regina *et al.,* 2007; Rashid *et al.,* 2008).

Among the plumule and radicle length, the radicle length trend showed a rapid reduction than the plumule length in all the crops (Fig. 1). Because the radicle had more area of root surface exposed to the allelochemical. The strong inhibitory effects that *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).

Dry matter acculation

The accumulation of drymatter in all the crops was reduced with increasing concentration of extract. The groundnut drymatter accumulation shows a slow decline while increasing concentration of extract. In pulses the drymatter accumulation were decreased with increasing concentration of *Parthenium.* The similar effect also recorded in the three crop species (Table 2.). The pulses recorded minimal drymatter accumulation at 50 g L^{-1} of extract in greengram (0.290 g) and blackgram (0.760 g)). The groundnut registered a higher drymatter accumulation (9.908 g) at a concentration of 50 g L^{-1}. The Parthenin effects on crops mainly affect the pulses (Greengram and Blackgram) followed by the oilseed crops (Groundnut). The increased concentration of Parthenium leads to reduction in drymatter accumulation in all the crops similar to radicle length. The reduced radicle length by the inhibitory effect of allelopathy causes reduction in water uptake and nutrient uptake, which lead to reduced drymatter accumulation. The reduction in drymatter accumulation was followed the finding of Sisodia and Siddiqui, 2009 with different concentration of *Croton bonplandianum* extracts on *Lantana camera*.

The dry matter accumulation of groundnut shows a very slow decline in trend at increasing concentrations. In greengram, a gradual decreases while increase in concentration of *Parthenium*. But in case of black gram sudden decrease at initial concentration after that accumulation is maintained (Fig. 1). Similar drymatter reductions were observed in the previous study of Parthenium effect on Phaseolus (Kumar and Kumar. 2010).

The increase in concentration of parthenium extract significantly decreases the seed germination, radicle length, plumule length and dry matter of the crops. The leaf extract has inhibitory effect on radicle growth of pulses compare to oil seeds. Seed germination of greengram was inhibited at 30 g L^{-1} leaf extract of *Parthenium hysterophorus* but other crops like blackgram and groundnut, failure of seed germination was recorded only at 50 g L^{-1} concentration of leaf extract. The parthenium infected field, groundnut is recommended for the next season crop among the three. Because the groundnut crop is less affected by the allelopathy effect than the pulses. The tolerance level of parthenium allelopathy

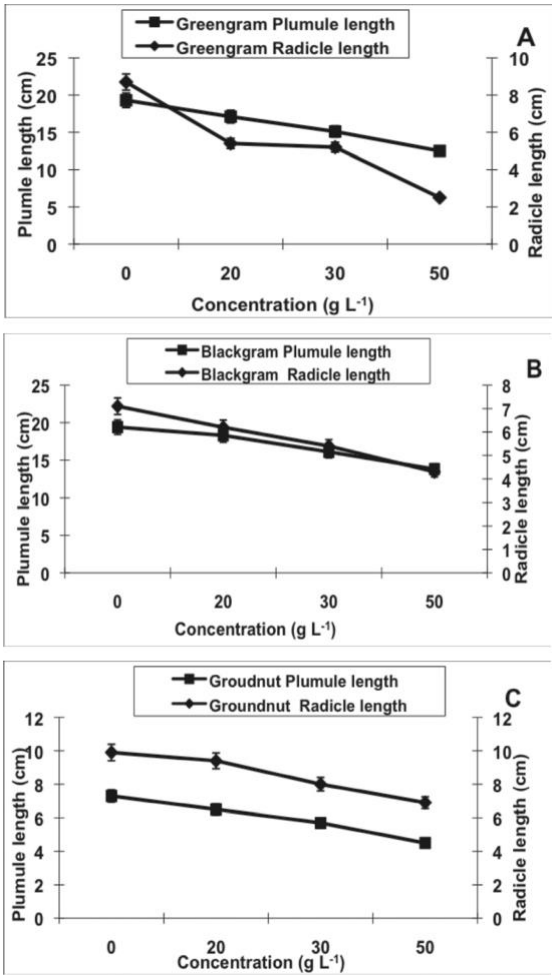

Figure 1. Allelopathy effect of Parthenium on Plumule length and Radicle length of Greengram (A), Blackgram (B) and Groundnut (C) (Each bar represents standard deviation of mean at 5 %)

of crops represented as Groundnut > Blackgram > Greengram. So, in field condition, the incorporation of parthenium plants to the soil affect the growth and yield of succeeding crops. To decrease the impact of parthenin (Allelo chemical of Parthenium) effect on crop, the removal of Parthenium plants before it's flowering or before sowing of crop may be recommended, after further research.

Acknowledgement

The authors thank the Department of Pulses and Oil seeds of Tamil Nadu Agricultural University for providing the seed materials.

References

Batish, D.R., Singh, H.P., Pandher, J.K. and Kohli, R.K. 2005. Allelopathic Interference of Parthenium hysterophorus residues in *soil. Allelo. J.,* **15**: 267-273.

Kumar, M. and Kumar, S. 2010. Effect of *Parthenium hysterophorus* ash on growth and biomass of *Phaseolus mungo. Acad. Arena*., **2**: 98-102.

Oudhia, P. 2000. Allelopathic effect of some obnoxious weeds on germination of soybean. *Indian Journal of Plant Physiol.,* **5**: 295-296.

Quasem, J.R. 1995. The allelopathic effect of three *Amaranthus* spp. (Pigweeds) on wheat (*Triticum durum*). *Weed Res.,* **35**: 41-49.

Rajendiran, K. 2005. Mitodepressive effects of aqueous extracts of *Parthenium hysterophorus* L. on *Vigna radiata* (L) Wilczek. *Geobios.,* **32**: 237-240.

Rashid, H., Khan, M.A., Amin, A., Nawab, K., Hussain, N. and Bhowmik, P.K. 2008. Effect of *Parthenium hysterophorus* L., root extracts on seed germination and growth of maize and barley. *The Americas J. Plant Sci. Biotech.,* **2**: 51-55.

Regina, G.B., Reinhardtb, C.F., Foxcroftc, L.C. and Hurlea, K. 2007. Residue allelopathy in *Parthenium hysterophorus* L.-Does parthenin play a leading role? *Crop Protect.,* **26**: 237-245.

Singh, S.P., Pal, U.R. and Luka, K. 1989. Allelopathic effect of three serious weeds of Nigerian Savana on germination and seedling vigour of soybean and maize. *J. Agron. Crop Sci.,* **162**: 236-240.

Singh, H.P., Batish, D.R., Kohli, R.K. Saxena, D.B. and Arora, V. 2002. Effect of parthenin – a sesquiterpene lactone from *Parthenium hysterophorus* on early growth and physiology of *Ageratum conyzoides*. *J. Chem. Ecol.,* **28**: 2169-2179.

Singh, H.P., Batish, D.R., Setia, N. and Kohli, R.K. 2005. Herbicidal activity of volatile oils from Eucalyptus citriodora against *Parthenium hysterophorus* L. *Annal. App. Biol.,* **146**: 89-94.

Sisodia, S. and Siddiqui, M.B. 2009. Allelopathic potential of rhizosphere soil of Croton bonplandianum on growth and establishment of some crop and weed plants. *Afr. J. Agric. Res.,* **4**: 461-467.

Steel and Torrie, 1980. Principles and Procedures of Statistics, McGraw Hill Book Co., Inc, New York, USA 1980.

Tomaszewski, M. and Thimann, K.V. 1966. Interactions of phenolic acids, metallic ions and chelating agents on auxin induced growth. *Plant Physiol.,* **41**: 1443-1454.

Wakjira, M. 2009. Allelopathic effects of Parthenium hysterophorus L. on onion germination and growth. *Allelo. J.,* **24**: 351-362.

Willis, R.J. 1994. Terminology and trends in allelopathy. *Allelo. J.,* **1**: 6-28.

Received: January 9, 2012; Accepted: May 5, 2012