GLOBAL JOURNAL OF BIO-SCIENCE AND BIOTECHNOLOGY

www.scienceandnature.org

ALLELOPATHIC AND MITODEPPRESSIVE EFFECTS OF *PARTHENIUM HYSTEROPHORUS* L. LEACHATES ON ORNAMENTAL SUNFLOWER

Hridya Mohanan & K. Rajendiran
Department of Botany, K.M. Centre for Post Graduate Studies, Pondicherry, India-605 008.
Corresponding author email: rajeworks@yahoo.com

ABSTRACT
Parthenium hysterophorus L. the noxious exotic weed has achieved the status of the countries "Worst Weed" owing to its allelopathic effects on other plants and harmful effects on people and animals. Its accelerated growth is mainly due to its ability to germinate fast and to suppress the growth of plant species in the surroundings. The allelochemics present in this weed have contributed towards its acquisition of dominant status even among crop plants in various areas. Due to its extraordinary spread, dominance and its naturalisation in India quickly, this weed was taken to assess the allelopathic effects and cytotoxity of aqueous extracts of its root, stem, leaf and inflorescence on the seven day old seedlings of an ornamental variety of sunflower, *Helianthus annuus* L. var. Tall. The LD_{50} concentration for the leaf and inflorescence extracts was recorded as 27%, while 28% concentrations of both root and stem extracts proved to be $LD_{50.}$ All the extracts decreased the mitotic index of the crop with increasing concentrations (5, 10, 15, 20, 25 and 30%). However the chromosomal aberrations were increased rapidly, the highest being with leaf extract (14.33%), followed by inflorescence (10%), root (9%), and stem (8.66%) at 25% concentration. Chromosomal abnormalities like fragments, stickiness, ring chromosomes, micronuclei, laggards and bridges were observed in all extract applications. The leaves and inflorescence of *Parthenium hysterophorus* were more potent clastogenic and spindle poisoning agents which played a vital role in maintaining the dominance of the weed by suppressing the cell divisions of the plants. Hence prevention of this weed leachate from further intrusion into parks, gardens and horticultural fields becomes necessary, as the allelochemics will erode the genotype of the ornamental plants.

KEY WORDS: *Parthenium hysterophorus*, root, stem, leaf and inflorescence extracts, *Parthenium hysterophorus*, Allelopathic effects, Cytotoxicity.

INTRODUCTION

Pathenium hysterophorus L. (Asteraceae) is very common along the road sides, around the agricultural fields and on waste lands. It is considered as a noxious weed because of its prolific seed production and fast spreading ability, allelopathic effect on other plants and strong competitiveness with crops. The allelochemics were liberated by volatilization from aerial parts, exudation from roots, leaching from plants and their residues by rain or by decomposition of residues (Nikki and Scott, 2010). The quantity and concentration of such chemical compounds released into the environment by a species is directly responsible for the survival as well as dominance of that species and reduction or even elimination of associated plant species (Aneja *et. al*., 1991; Rajendiran, 2000a; Rajendiran, 2000c; Bertholdsson, 2012). Even though works on allelopathic potential of this weed on certain crop plants are available, no study on the cytotoxicity of the leachates on ornamental plants is carried out. Hence, it was thought worthwhile to estimate the influence of aqueous extracts of leaf, stem and inflorescence of *Pathenium hysterophorus* L. on seedling establishment of *Helianthus annuus* L. var. Tall, an important and commercially popular ornamental plant which holds a very coveted position in horticulture.

MATERIALS & METHODS

The certified seeds of sunflower (*Helianthus annuus* L. var. Tall) were obtained from Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu. The fresh roots, stem, leaves and inflorescence of *Parthenium hysterophorus* L. collected from Pondicherry, were washed and ground separately in an electric grinder and the extracts were prepared in each case by boiling 10 gm of ground plant material in 100 ml of distilled water at 100^{o}C for 25 minutes. After filtration with Whatman No.1 filter paper, stock solutions were prepared. For determining the LD_{50} concentration of the four extracts, three separate sets of experiments each with triplicates were carried out and the data presented in Table 1. In the first set, various concentrations of root, stem, leaf, and inflorescence extracts (25, 50, 75, and 100%) of *Parthenium hysterophorus* L. were made in distilled water. Viable seeds of sunflower (*Helianthus annuus* L. var. Tall), soaked in distilled water for 6 hours were allowed to germinate in petri plates lined with moist Whatman No.1 filter paper. Seven days old seedlings with healthy roots were chosen to accommodate 25 seedlings in a petriplate for each treatment. The healthy seedlings were treated separately with 5 ml of each concentration of the extracts for three days. Seedlings watered with distilled water served as control. The second treatment of different concentrations of the weed extracts (25, 30, 35, 40, 45,

50% concentrations) was given to fresh set of seedlings grown in petri plates. The third set of treatment consisted of 25, 26, 27, 28, 29, and 30% concentrations of the weed extracts to a new set of seven day old seedlings.

TABLE 1. Lethality of the leaf, stem, root and inflorescence extracts of *Parthenium hysterophorus* L. on the 7 day old seedlings of *Helianthus annuus* L. var. Tall after 3 days of treatment.

Expt. Set No.	Extract Concentration	Root (%)	Stem (%)	Leaf (%)	Inflorescence (%)
1	25 %	41	42.3	47.3	46.7
	50 %	100	100	100	100
	75 %	100	100	100	100
	100 %	100	100	100	100
2	25 %	41	42.3	47.3	46.7
	30 %	54	60.3	69	61.7
	35 %	96.7	96.7	100	100
	40 %	100	100	100	100
	45 %	100	100	100	100
	50 %	100	100	100	100
3	25 %	41	42.3	47.3	46.7
	26 %	44.3	47	48.3	48.7
	27 %	46.3	47.3	50	50
	28 %	50	50	56.7	54
	29 %	53.3	58	63.3	60.3
	30 %	54	60.3	69	61.7

The root tips of 10 day old seedlings were highly injured after treatment with 30% concentrations of the weed extracts. Even though few seedlings survived, their root tips were unhealthy for preparing root tip squash. Hence the cytological studies with three test plants were restricted to 5, 10, 15, 20 and 25% concentrations of the weed extracts. For the cytotoxic studies root tips were excised from the control and treated seedlings (5, 10, 15, 20 and 25% concentrations of the four extracts) after three days of extract treatment, washed in distilled water and fixed in Carnoy's fixative for 24 hours. Root tip squash technique of Rajendiran (2005) was followed. The mitotic index in control and treated root tip cells were calculated. The prepared slides were thoroughly examined for the presence of different types of chromosomal aberrations, important stages photographed in Labomed Photo Microscope and the data presented in Table 2.

TABLE 2. Mitosis and chromosomal aberrations induced by *Parthenium hysterophorus* L. extracts in *Helianthus annuus* L. var. Tall root tip cells.

Extract	Conc. (%)	Dividing cells (%)	Abnormal cells (%)	Stickiness (%)	Laggards (%)	Bridge (%)	Chromosome breakage (%)	Polyploidy (%)	Micronuclei (%)	Ring chromosomes (%)
Control		36.00	-	-	-	-	-	-	-	-
Root	5	35.00	1.66	1.00	0.66	-	-	-	-	-
	10	30.66	3.99	1.66	1.33	1.00	-	-	-	-
	15	28.35	5.00	2.33	1.67	0.67	-	0.33	-	-
	20	26.33	7.33	2.67	1.67	1.33	1.33	0.33	-	-
	25	23.66	9.00	2.67	2.33	1.67	1.33	1.00	-	-
Stem	5	34.00	2.33	1.00	0.33	1.00	-	-	-	-
	10	30.66	4.33	1.00	1.33	1.00	1.00	-	-	-
	15	27.00	5.33	1.67	1.33	1.00	1.33	-	-	-
	20	25.33	6.66	1.66	2.00	2.00	1.00	-	-	-
	25	23.00	8.66	3.00	2.33	2.33	1.00	-	-	-
Leaf	5	26.66	3.00	1.00	1.00	0.67	0.33	-	-	-
	10	25.00	5.66	1.67	1.33	1.33	1.33	-	-	-
	15	22.66	8.00	2.00	2.00	2.33	1.33	0.34	-	-
	20	21.66	10.66	2.33	2.34	2.33	1.33	1.00	0.33	1.00
	25	20.66	14.33	3.33	3.67	2.67	1.33	1.00	1.33	1.00
Inflorescence	5	31.00	2.66	1.00	1.00	0.66	0.00	-	-	-
	10	28.33	4.66	1.33	1.67	1.66	0.00	-	-	-
	15	26.33	6.66	1.67	1.67	1.66	1.00	0.66	-	-
	20	22.00	8.66	2.33	1.67	1.33	1.33	1.00	1.00	-
	25	19.66	10.00	2.33	2.33	1.67	1.33	1.00	0.67	0.67

RESULT & DISCUSSION

The growth of *Helianthus annuus* L. var. Tall seedlings was affected by the root, stem, leaf and inflorescence extracts of *Parthenium hysterophorus* L. The seedlings recorded 100% lethality in 50, 75, and 100% concentrations in the first set (Table 1). The seedlings treated with 25% concentration of the extracts survived as the lethality was between 41 to 47.3%. In the second set the full lot of seedlings treated with 35, 40, 45, 50% concentrations of the four extracts died, while in 25 and 30% concentrations the lethality was 41 to 69% respectively. In the third set of experiments the LD_{50} concentration for the leaf and inflorescence extracts was recorded as 27%, while 28% concentrations of both root

and stem extracts proved to be LD_{50} (Table 1). Severe inhibition of seedling growth was recorded at the highest concentration of leaf extract treatment (Table 1). The differential effect of the extracts on seedling growth revealed the presence of highest concentration of inhibitory allelochemics in the leaves of the weed followed by inflorescence, stem and root. Similar results were reported by Rajendiran (2000a) in *Helianthus annuus* L. seedlings and Hridya and Rajendiran (2013) in C*ucumis sativus* L.

PLATE 1. Somatic metaphase and chromosomal abnormalities induced by *Parthenium hysterophorus* L. extracts in the root tip cells of *Helianthus annuus* L. var. Tall. (1000x)

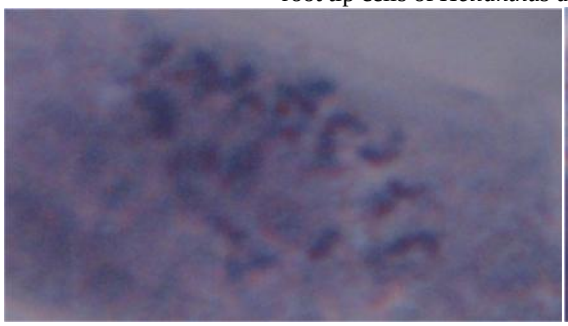

FIGURE 1 - Normal somatic metaphase (2n=34)

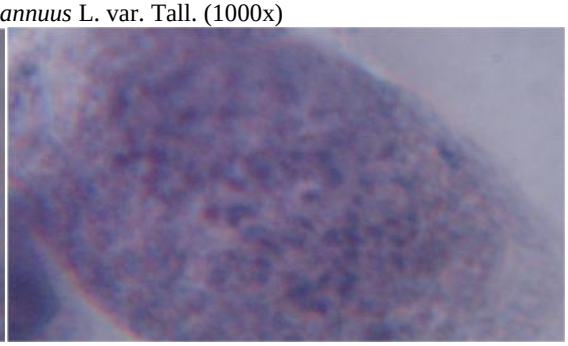

FIGURE 2 - Chromosome fragments

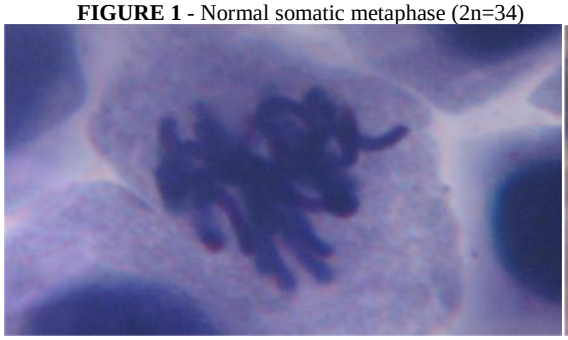

FIGURE 3 - Stickiness of chromosomes

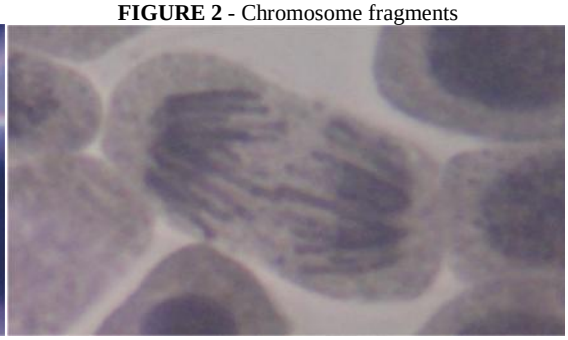

FIGURE 4 - Chromosome bridge

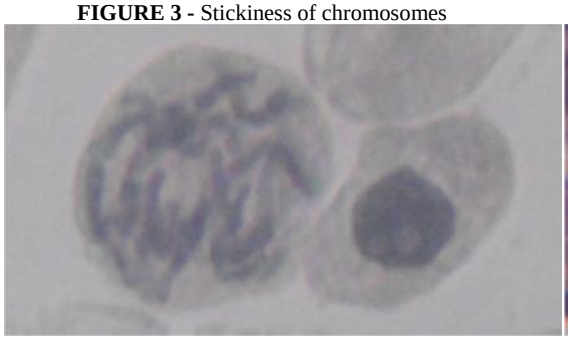

FIGURE 5 - Anaphasic laggards

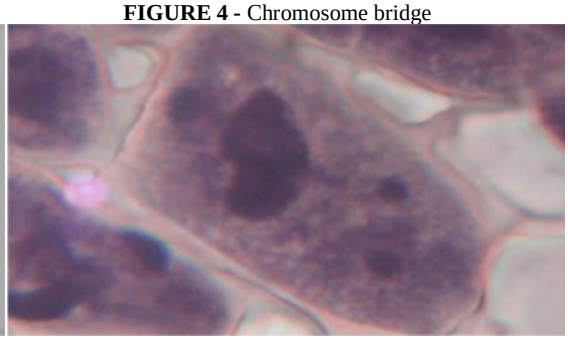

FIGURE 6 - Micronuclei

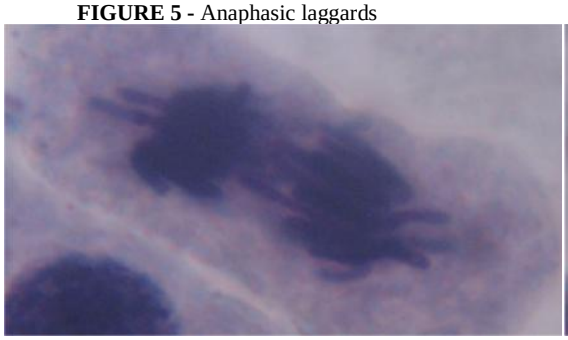

FIGURE 7 - Precocious movements

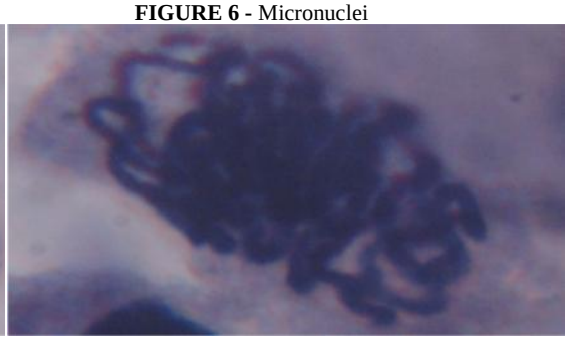

FIGURE 8 - Polyploid cell

The cell division in the root tips of *Helianthus annuus* L. var. Tall control plants was normal (Plate 1, Fig.1). Mitotic index of *Helianthus annuus* L. var. Tall showed a steady decrease with increasing concentrations of all the extracts (Table 2). The percentage value of mitotic index in control was 36% and after treatment with root, stem, leaf and inflorescence extracts it declined rapidly to the minimum of 23.66%, 23%, 20.66% and 19.66% respectively in 25% concentration (Table 2; Plate 1, 2). Similar observations were reported in *Ammi majus* (Adam and Rashad, 1984*)*, *Datura stramonium* (Rajendiran, 1996), *Azadirachta indica* (Rajendiran 1998a),

Catharanthus roseus (Rajendiran, 1998b), *Lantana camara* (Rajendiran, 1999a), *Ricinus communis* (Rajendiran, 1999b), *Adhatoda vasica* (Rajendiran, 1999c), *Boerhaavia diffusa* extracts (Rajendiran, 2000b) and in *Cucumis sativus* (Hridya and Rajendiran, 2013). All the extracts of the weed induced different types of chromosomal aberrations in dividing cells, which increased with increasing concentration and the maximum was recorded at the highest concentration (Table 2). The extracts of leaves and inflorescence caused severe inhibition and greater number of chromosomal abnormalities (14.33% and 10% respectively) than the stem and root extracts (8.66% and 9% respectively) in 25% concentrations (Table 2; Plate 1, 2). Application of the weed extracts to the test plants caused changes in the somatic cell divisions, producing chromosome fragments (Plate 1, Fig. 2), stickiness of chromosome ends (Plate 1, Fig. 3), chromosome bridges during telophase (Plate 1, Fig. 4), laggard formation during anaphase (Plate 1, Fig. 5) and favouring micronuclei formation (Plate 1, Fig. 6). The treated cells also induced precocious movement of chromosomes (Plate 1, Fig. 7) and polyploidy (Plate 1, Fig. 8).

PLATE 2. Mitotic divisions, chromosomal abnormalities and their types induced by 25% concentrations of weed extracts in *Helianthus annuus* L. var. Tall.

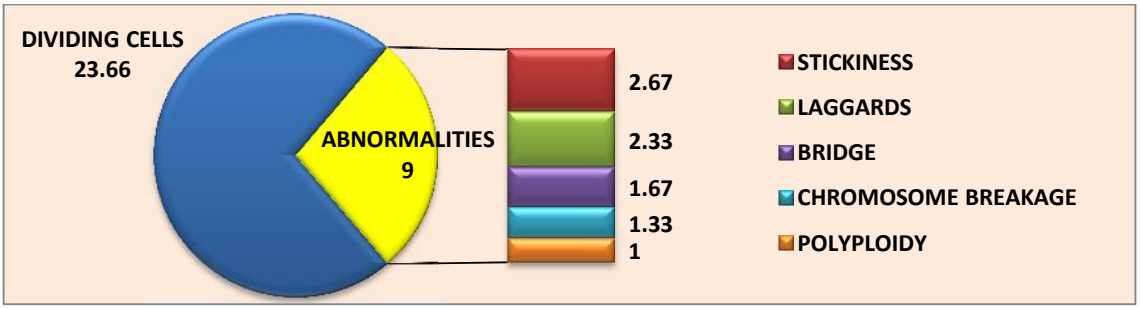

FIGURE 1 - Root extract

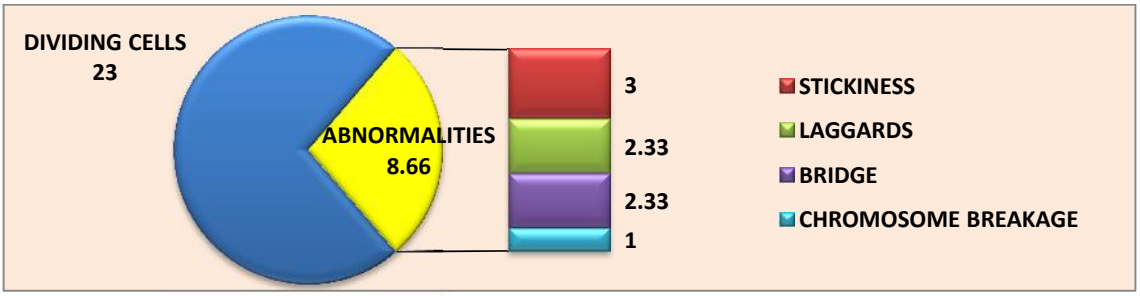

FIGURE 2 - Stem extract

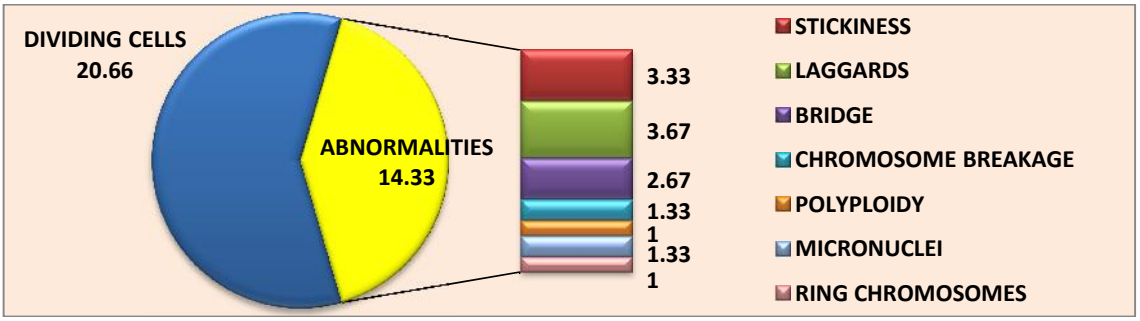

FIGURE 3 - Leaf extract

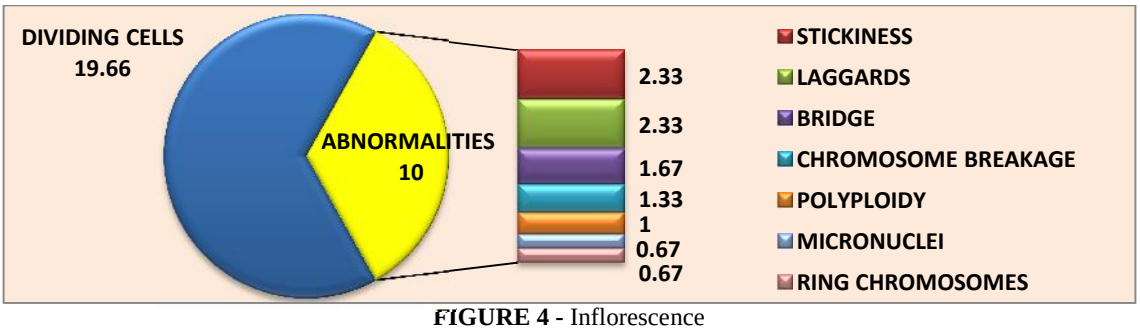

FIGURE 4 - Inflorescence

The leaves and inflorescence of the weed showed severe inhibitory effects and were extremely clastogenic and spindle poisoning when compared with the extracts of the stem and root. This result correlated with the report of Kanchan (1975) and Pandey (2009) that the toxins *viz.* parthenin and phenolic acids such as caffeic acid, vanillic acid, anisic acid, chlorogenic acid, parahydroxy benzoic acid, p-anisic acid and p-coumaric acid were maximum in the leaves of *Parthenium hysterophorus* L. followed by inflorescence, stem and roots. The present study with *Helianthus annuus* L. var. Tall revealed that the leaves and inflorescence of *Parthenium hysterophorus* L. were more potent mitodepressive agents and they played a vital role in maintaining the dominance of the weed by suppressing the growth of surrounding plant species. Prompt action to check the population of this weed is urgent as the leachates of *Parthenium hysterophorus* L. have proved to be an effective agent in eroding the genotype of sunflower. The rapid spread of *Parthenium hysterophorus* L. in India would be a bigger risk to the ornamental plants in the gardens, parks and horticultural farms.

ACKNOWLEDGEMENT

The authors thank Prof. Dr. V. Ramassamy, Head, Department of Botany, KMCPGS, Puducherry for providing research facilities. The authors also thank Department of Science, Technology and Environment, Government of Puducherry, Puducherry for the financial support through a Minor Research Project.

REFERENCES

Adam, Z.M. and Rashad, T. H. (1984) Cytological effects of water extracts of medicinal plants L. Influence of *Ammi majus* extract on root tips of *Vicia faba. Cytologia* 49: 265-271.

Aneja, K. R., Dhawan, S.R. and Sharma, A.B. (1991) Deedly weed *Parthenium hysterophorus* L. and its distribution. Indian *J. Weed Sci.* 23: 14-18.

Bertholdsson. N. O. (2012) Allelopathy - A Tool to Improve the Weed Competitive Ability of Wheat with Herbicide-Resistant Black-Grass (*Alopecurus myosuroides* Huds.). *Agronomy*, 2: 284-294.

Hridya, M. and Rajendiran, K. (2013) Allelopathic and cytotoxic effects of *Parthenium hysterophorus* L. leachates on *Cucumis sativus* L. var. CO 1. International Journal of Science and Nature 4(3): 441-444.

Kanchan, S.D. (1975) Growth inhibitors from *Parthenium hysterophorus* L. *Curr. Sci.* 44: 358-359.

Nikki L. P. and Scott J. M. (2010) Relative allelopathic potential of invasive plant species in a young disturbed woodland. The Journal of the Torrey Botanical Society, 137(1): 81-87.

Pandey, D. K. (2009) Allelochemicals in *Parthenium* in response to biological activity and the environment. *Indian Journal of Weed Science* 41(3&4): 111-123.

Rajendiran, K. (1996) Mitodepressive effects of water extract of *Datura stramonium* fruit on *Helianthus annuus. Geobios* new Reports 15: 116-118.

Rajendiran, K. (1998a) Mitodepressive effects of water extract of *Azadirachta indica* leaf on *Helianthus annuus. Environment and Ecology.* 16*:* 839-841

Rajendiran, K. (1998b) Mitodepressive effects of water extracts of *Catharanthus roseus* leaf on *Helianthus annuus. Geobios* 25: 183-185.

Rajendiran, K. (1999a) Cytological effects of *Lantana camara* leaf extract on *Helianthus annuus* root tip cells. *Journal of Ecotoxicology and Environmental Monitoring.* 9(1): 23-27.

Rajendiran, K. (1999b) Cytological studies in *Helianthus annuus* treated with leaf extract of *Ricinus communis*. *Environment and Ecology*. 17(3): 682-684.

Rajendiran, K. (1999c) Cytological effects of water extract of leaf of *Adhatoda vasica* Nees on *Helianthus annuus*. L. *Journal of Swamy Botanical Club.* 16: 31-34.

Rajendiran, K. (2000a) Allelopathic effects of *Parthenium hysterophorus* L. on seed germination, seedling establishment and growth of *Helianthus annuus* L. *Indian Journal of Environment and Ecoplanning.* 3(1): 103-105.

Rajendiran, K. (2000b) Cytological effects of water extract of *Boerhaavia diffusa* root on *Helianthus annuus*. *Advances in Plant Science.* 13 (1): 133-137.

Rajendiran, K. (2000c) Cytotoxicity of aqueous extracts of *Parthenium hysterophorus* on *Helianthus annuus*. *Pollution Research.* 19(2): 261-265.

Rajendiran, K. (2005) Simple and rapid squash schedule for the root tips of *Helianthus annuus*. *Journal of Ecotoxicology and Environmental Monitoring*. 15(3): 291-295.