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ALLELOPATHIC AND CYTOTOXIC EFFECTS OF *PARTHENIUM HYSTEROPHORUS* LEACHATES ON *CUCUMIS SATIVUS* L. var. CO1

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ABSTRACT
Parthenium hysterophorus L. belonging to the family Asteraceae is a noxious exotic weed, spreading rapidly through the country. Its rapid growth has been attributed mainly due to its ability to germinate fast and to inhibit growth of other associated plant species. Moreover, the presence of inhibitory chemicals (allelochemics) in this weed has contributed towards its acquisition of dominant status even among crop plants in various areas. Keeping in view of its extraordinary spread, dominance and its naturalisation in India in a short time, this noxious exotic weed was taken for this study to obtain qualitative as well as quantitative data of the cytotoxic effects of aqueous extracts of its root, stem, leaf and inflorescence on the root tip cells of an important vegetable crop cucumber (*Cucumis sativus* L. var. CO 1) and their allelopathic effects on the seven day old seedlings. The LD_{50} concentration for the leaf and inflorescence extracts was recorded as 26%, 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 (24.37%), followed by inflorescence (21.65%), stem (16.64%) and root (14.34%) at 25% concentration.Various chromosomal abnormalities like fragments, stickiness, micronuclei, laggards and bridges were observed in all extract applications. The leaves and inflorescence of *Parthenium hysterophorus* were more potent mitodepressive agents and they played a vital role in maintaining the dominance of the weed by suppressing the cell cycle of the crop. The results indicate that prevention of this weed leachate from further intrusion into cultivable land becomes necessary to advance soil organic matter for sustainable farming system.

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

INTRODUCTION

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). *Parthenium hysterophorus* L. belonging to the family Asteraceae is a noxious exotic weed, spreading rapidly through the country. Its rapid growth has been attributed mainly due to its ability to germinate fast and to inhibit growth of other associated plant species. Cucumber (*Cucumis sativus* L. var. CO 1) is an important and commercially popular cucurbitaceous vegetable crop which holds a very coveted position in the vegetable market. The crop, native to India, is one of the most nutritive vegetables rich in vitamins and minerals such as phosphorus, potassium, calcium and iron. It is mainly grown for its fruits both in tropics and subtropics of the world and produces tender fruits continuously. Hence, it was thought worthwhile to estimate the influence of aqueous extracts of leaf, stem and inflorescence of the weed *Pathenium hysterophorus* L. (Asteraceae) on seedling establishment of an important vegetable crop *Cucumis sativus* L. var. CO 1.

MATERIALS AND METHODS

The certified seeds of *Cucumis sativus* L. var. CO 1 were obtained from Department of Vegetable crops, Tamil Nadu Agricultural Univeristy, Coimbatore. 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 extracts three separate sets of experiments each with triplicates were conducted 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 *Cucumis sativus* L. var. CO 1, 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 treated with 10 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 extracts to a new set of seven day old seedlings. For the cytotoxic studies root tips were excised from the control and treated seedlings (5, 10, 15, 20, 25 and 30% concentrations of the four extracts), 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 and the data presented in Table 2.

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

Expt. Set No.	Extract Concentration	Root (%)	Stem (%)	Leaf (%)	Inflorescence (%)
1	25 %	40	41.7	46.7	45
	50 %	100	100	100	100
	75 %	100	100	100	100
	100 %	100	100	100	100
2	25 %	40	43.3	46.7	45
	30 %	55	56.7	68.3	63.3
	35 %	96.7	96.7	100	100
	40 %	100	100	100	100
	45 %	100	100	100	100
	50 %	100	100	100	100
3	25 %	40	41.7	46.7	45
	26 %	43.3	46.7	50	50
	27 %	46.7	48.3	53.3	51.7
	28 %	50	50	56.7	53.3
	29 %	53.3	58.6	63.3	61.7
	30 %	55	60	68.3	63.3

TABLE 2. Mitosis and chromosomal aberrations induced by *Parthenium hysterophorus* L. extracts in *Cucumis sativus* L. var. CO 1 root tip cells.

Extract	Conc. (%)	Dividing cells (%)	Abnormal cells (%)	Stickiness (%)	Laggards (%)	Bridge (%)	Chromosome breakage (%)	Polyploidy (%)	Micronuclei (%)	Ring chromo somes (%)
Control		24.64	-	-	-	-	-	-	-	-
Root	5	19.01	1.24	1.24	-	-	-	-	-	-
	10	17.77	4.42	1.47	1.15	0.94	0.86	-	-	-
	15	15.46	6.94	2.11	1.62	1.46	1.19	0.56	-	-
	20	13.79	9.57	2.86	2.14	1.97	1.59	1.01	-	-
	25	11.41	14.34	3.64	2.66	2.42	2.05	1.66	1.05	0.86
Stem	5	18.89	2.57	1.33	0.62	0.62	-	-	-	-
	10	17.62	5.02	1.58	1.22	1.06	0.89	0.27	-	-
	15	15.20	8.37	2.32	1.77	1.58	1.27	0.67	0.27	0.49
	20	12.34	11.03	2.92	2.53	2.08	1.67	1.27	0.56	-
	25	10.27	16.64	4.12	3.13	2.89	2.41	1.96	1.27	0.86
Leaf	5	14.05	6.18	1.83	1.42	0.27	1.00	-	0.66	-
	10	11.42	8.79	2.68	1.99	1.82	1.44	0.86	-	-
	15	9.39	13.35	3.51	2.56	2.32	1.92	1.67	0.82	0.55
	20	6.72	18.45	4.37	3.37	3.11	2.76	2.12	1.63	1.09
	25	5.14	24.37	6.21	4.14	4.07	3.40	2.90	2.42	1.23
Inflores cence	5	16.25	4.35	1.68	1.00	0.78	0.89	-	-	-
	10	12.57	6.87	2.17	1.58	1.25	1.12	0.75	-	-
	15	10.11	10.47	3.07	2.08	1.89	1.68	1.21	0.27	0.27
	20	7.55	15.81	3.97	2.90	2.98	2.25	1.86	0.89	0.96
	25	6.04	21.65	5.86	3.82	3.70	2.98	2.42	1.87	1.00

RESULTS & DISCUSSION

The root, stem, leaf and inflorescence extracts of *Parthenium hysterophorus* L. affected the process of seedling growth in *Cucumis sativus* L. var. CO 1. All the seedlings treated with 50, 75, and 100% concentrations in the first set died. In the second set the whole lot of seedlings treated with 35, 40, 45, 50% concentrations of the four extracts died, while in 25 and 30% concentrations the lethality was 45 and 65% respectively. In the third set of experiments the LD_{50} concentration for the leaf and inflorescence extracts was recorded as 26%, while 28% concentrations of both root and stem extracts proved to be LD_{50} (Table 1). The maximum inhibition of seedling growth was recorded at the highest concentration of leaf extract treatment. As evident from the tabulated data, differential effect of the extracts on seedling growth indicated 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. In control, the root tips showed normal cell division (Fig.1). Mitotic index of *Cucumis sativus* L. var.

CO 1 showed a steady decrease with increasing concentrations of all the extracts and durations of the treatment (Table 2). The percentage value of mitotic index in control was 24.64% and after treatment with root, stem, leaf and inflorescence extracts it declined rapidly to the minimum of 11.41%, 10.27%, 5.14% and 6.04% respectively in 25% concentration (Table 2). Similar observations were reported with *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) and with *Boerhaavia diffusa* extracts (Rajendiran, 2000b). All the extracts of the weed induced different types of chromosomal aberrations in dividing cells, which increased with increasing concentration and duration and the maximum was recorded at the highest concentration (Table 2). However, the extracts of leaves and inflorescence caused severe inhibition and greater number of chromosomal abnormalities (24.37% and 21.65% respectively) than the stem and root extracts (16.64% and 14.34% respectively), the least being with root extract (Table 2). Application of extracts of the weed caused changes in the normal cycle of events of mitosis, producing chromosome fragments (Fig. 2), resulting in stickiness of chromosome ends (Fig. 3), facilitating fusion of both ends forming ring chromosomes (Fig. 4), and fusion of dicentric chromosomes which ultimately created chromosome bridges during telophase (Fig. 5) and favouring laggard formation (Fig. 6) from the stress of anaphase movement. These laggards and chromosome fragments became surrounded by nuclear membrane forming micronucleus (Fig. 7), while inhibition of spindle mechanism by the extracts resulted in polyploidy (Fig. 8). The data revealed that the leaves and inflorescence of the weed showed intensive inhibitory effects and were severely clastogenic and spindle poisoning as compared to stem and root extracts. This result correlated with the report of Kanchan (1975) that organic inhibitors viz., Parthenin, Caffeic acid and p-coumaric acid were maximum in the leaves followed by inflorescence, stem and roots. The present study with *Cucumis sativus* L. var. CO 1 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 associated plant species. Thus it is concluded that immediate measure is necessary to check the population of this weed as the leachates of *Parthenium hysterophorus* L. are more vulnerable in eroding the chromosomes of crop plants.

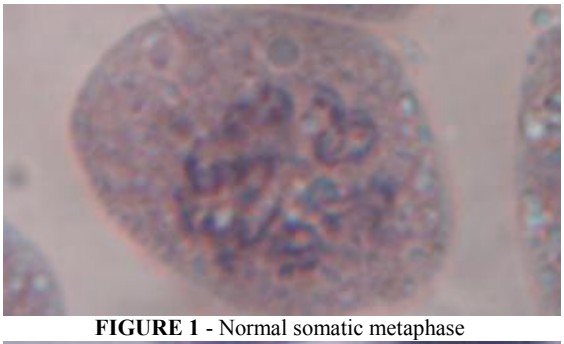

FIGURE 1 - Normal somatic metaphase

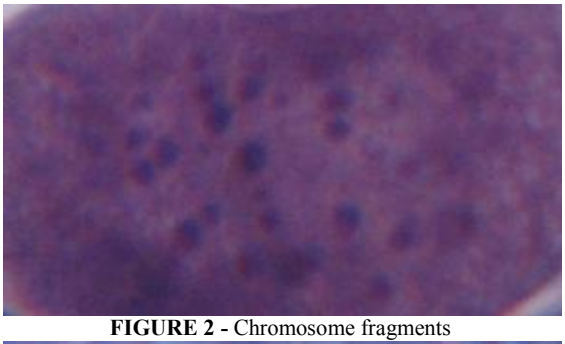

FIGURE 2 - Chromosome fragments

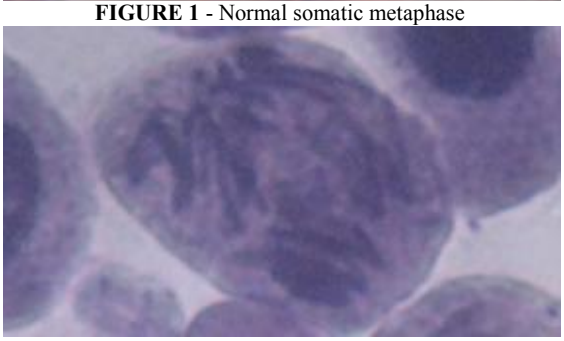

FIGURE 3 - Stickiness of chromosome ends

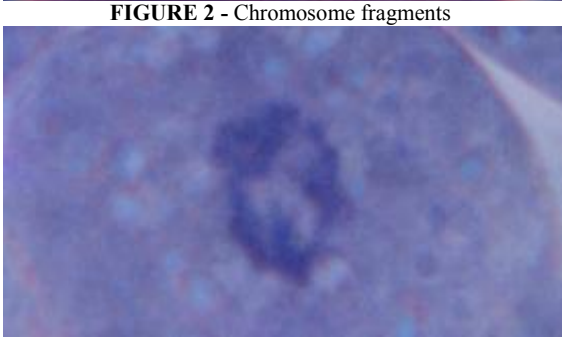

FIGURE 4 - Ring chromosomes

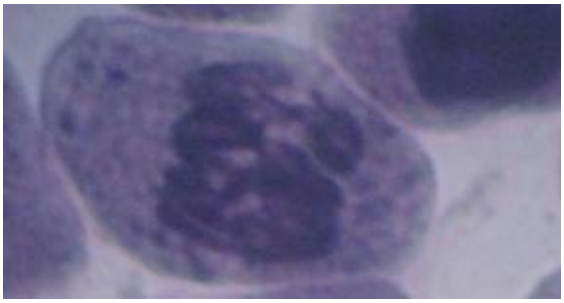

FIGURE 5 - Chromosome bridges

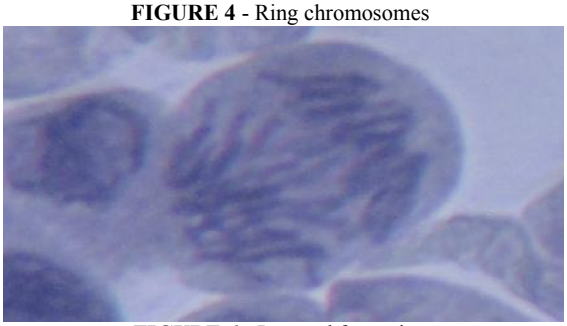

FIGURE 6 - Laggard formation

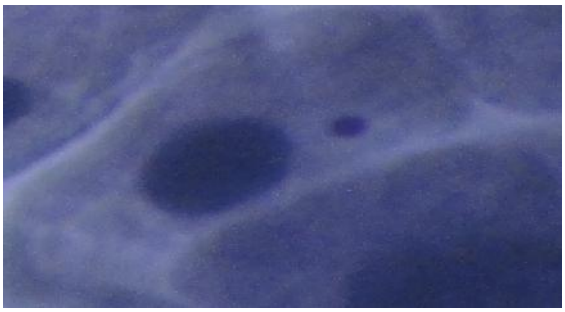

FIGURE 7 - Micronucleus

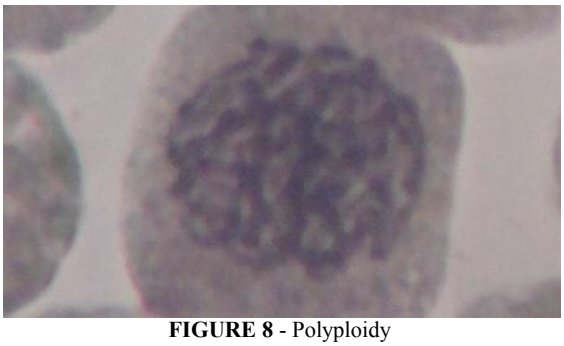

FIGURE 8 - Polyploidy

(Figs. 1-8: 1000x)

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