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Original Research Paper

Allelotoxicity of *Chromolaena odorata* (L.) King & Robinson on Growth, Cytology and Biochemicals of *Allium cepa* L.

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ABSTRACT

The paper deals with toxic effects of leaf leachate of *Chromolaena odorata* on *Allium cepa*. Leaf leachate impeded plant growth and decreased chlorophyll, protein and catalase contents. Cell division efficiency declines gradually with a concomitant distortion of the chromosomal conformity. Impaired cell division and chromatin structure seem to be the root cause of all other adverse effects. The reduction in catalase content made plants incompetent to eradicate free radicals that led their fast ageing.

INTRODUCTION

Chromolaena odorata (L.) King & Robinson, a member of the family Asteraceae and a native of Central America, now grows wild in different parts of the world and poses to be a menace as weed in India (Moni & George 1959, Muniappan & Marutani 1988). It is often the most successful forerunner plant on the fallow land than any other plant coming up there. It is even seen to get established amongst the thicket of other plants and gradually faze them out. The species is a nuisance for many agricultural crops, orchard plants and forest plants**.** The most probable cause of it seems to be the allelopathy of the species; the property has been reported in the earlier works on this species (Adetayo et al. 2005, Hoque et al. 2003, Sharma et al. 1999) as well as other congeneric species (Kil & Shim 2006, Rai & Tripathi 1984). The chemicals instrumental for this phenomenon become operative after being soluble in water and leached out to soil from the dead tissue of plant. Aqueous extracts of these chemicals is known to affect different vital life processes like protein synthesis, photosynthesis, enzyme actions, cell elongation and cell division and thereby impairing the normal growth of the affected plants. The present study attempts to reveal the impact of leaf leachate of *C. odorata* on the test plant *Allium cepa* L. at some biochemical levels like the amount of chlorophyll, buffer soluble protein, catalase activity and also on cell division and chromosome morphology.

MATERIALS AND METHODS

Chromolaena odorata (L.) King & Robinson was used as donor species of aqueous leaf leachate, while *Allium cepa* L. was selected as the receptor plant. Dried fallen leaves of the donor species were collected from wild grown plants at Medinipur, West Bengal during February-March in the year 2008. After treating *Allium cepa* bulbs with the leachate, they were placed in shallow pits made in a mixture of soil and sand (2:1) filled in earthen pots. The bulbs covered with soil were allowed to grow for fifteen days. All studies were carried out with 15 days old plants.

For preparing aqueous leachate, 200 g fresh mature leaves were soaked in 1 litre double distilled

water for 48 hours. The leachate was first strained through 0.053mm sieve and filtered through Whatman No. 40 filter paper. The filtrate was defined as 100% extract and was further diluted to 10%, 25% and 50% with distilled water.

To measure growth, leaf and root length and their fresh and dry weight (at 50°C in a hot air oven) were measured after fifteen days both in control and leachate treatments. Besides, protein by Lowry method (Lowry 1951), chlorophyll by Arnon's method (Arnon 1949) and catalase contents (Snell & Snell 1971) were also estimated. Squash method has been followed for the cytological studies from the root tips of treated plants. Aceto-orcein stain was used to stain the material. Mitotic index and abnormality percentage have been deduced from the study and considered as indices to reveal the impact of leachate. Respective calculations have been made in the following way.

Mitotic index (MI) = (Dividing cells per field/Total cells per field) × 100

Abnormality percentage = (Abnormal cells per field/Dividing cells per field) × 100

Data have been statistically analysed using SPSS and Microsoft Excel. Pearson correlation has been derived amongst different parameters under influence of different concentrations of leaf leachate (10%, 25%, 50% and 100% aqueous leachate) of *C. odorata*.

RESULTS

Aqueous leaf leachate of *C. odorata* at different concentrations showed different degrees of impact on growth of the seedlings, the biochemicals and cell division process. The leaf and root length and their weights (fresh and dry weight) decreased with the increase of leachate concentration (Table 1). The leachate was cytotoxic as it not only impeded cell division but also induced anomalies to the chromosome structure and cell divisional process (Table 1). A variety of morphological anomalies of chromosomes noted were erosion of chromatin, stickiness of chromosome, clumping of chromatin, irregular separation of chromosomes, etc. (Figs. 1a and 1b). The amount of chlorophyll and protein, and catalase activity of leaves decreased with an increase in leachate concentration (Table 2).

DISCUSSION

The reduction in *Allium cepa* growth as an impact of leaf leachate of *C. odorata* in the present study corroborates the works of earlier authors (Adetayo et al. 2005, Hoque et al. 2003, Sharma et al. 1999). It seems to be caused by the cumulative effect of many other impaired life processes under the influence of leachate and also shows a clear dependence on the concentration thereof**.** A gradual decline in the contents of all the three biochemical elements dealt here with adduces the assumption. Reduced chlorophyll content seems to affect photosynthetic efficiency, and a decline in protein con-

Table 1: Effect of leaf leachate of *C. odorata* on different parameters of *Allium cepa* plants on 15th day of growth.

Treatments Parameters	Control	10%	25%	50%	100%
Plant Height (cm)	11.16±2.18	10.93±2.24	10.81±2.28	10.34±1.73	9.83±1.85
Root Length (cm)	8.00±1.99	7.75±1.98	7.49±1.91	7.26±1.69	6.59±1.84
Fresh Leaf Weight (mg)	860.20±482.73	857.80±482.68	856.50±483.13	854.40±482.77	852.20±482.16
Dry Leaf Weight (mg)	54.25±21.76	52.80±20.77	51.00±21.30	49.8±21.25	48.70±20.27
Fresh Root Weight (mg)	63.55±58.29	62.40±58.00	61.50±57.97	60.40±57.56	59.10±56.97
Dry Root Weight (mg)	11.65±6.05	10.65±5.69	10.25±5.71	9.85±5.28	9.10±4.70
Mitotic index (%)	31.44±29.07	42.82±2.81	36.51±3.03	27.43±2.43	16.24±2.37
Abnormality (%)	4.06±13.75	13.50±3.54	16.65±4.33	26.59±7.75	54.80±12.78

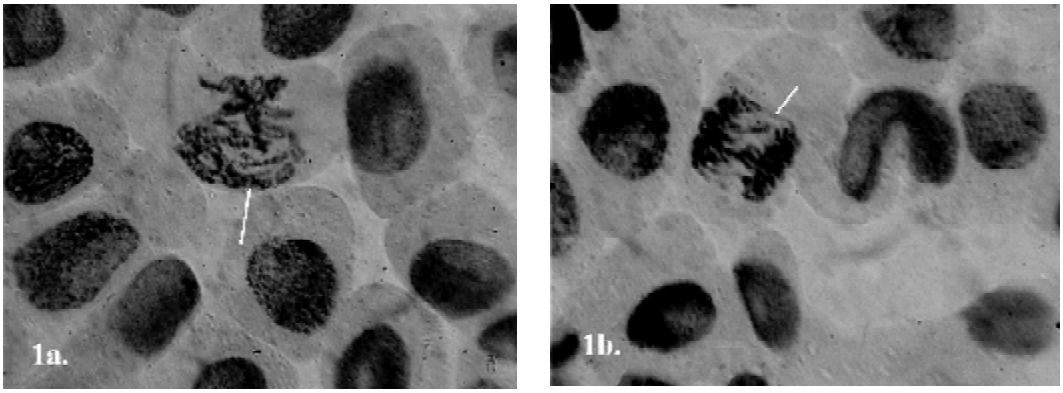

Fig. 1a & 1b: Chromosomal anomalies in the root tip cells of *Allium cepa* in response of leaf leachate of *Chromolaena odorata* (a. eroded and spindle disturbed chromosomes at metaphase; b. sticky bridges of chromosome at anaphase).

Table 2: Impact of different concentrations of leachate on buffer soluble protein, catalase activity and chlorophyll content of *Allium cepa.*

Treatments Parameters	Control	10%	25%	50%	100%
Chlorophyll (mg/g/unit)	0.151±4.87	0.145±8.87	0.098±4.64	0.069±1.37	0.040±1.25
Protein (mg/g)	34±1.05	29±1.19	26±1.13	17±1.15	09±.82
Catalase (unit/min/g tissue)	0.604±2.66	0.585±5.87	0.577±1.22	0.555±2.16	0.511±9.45

Table 3: Pearson correlations amongst different parameters under influence of leaf leachate of *C. odorata.*

	Root Length	Fresh Leaf Weight	Dry Leaf Weight	Fresh Root Weight	Dry Root Weight	Mitotic Index	Abnor-mality Index	Protein Content	Chloro-phyll Content	Catalase Content
Plant Height	.972**	.976**	.943*	.978**	.942*	.830	-.972**	.998**	.958*	.987**
Root Length		.997**	.992**	.994**	.986**	.737	-.945*	.985**	.983**	.969**
Fresh Leaf Weight			.987**	.999**	.991**	.713	-.946*	.988**	.968**	.971**
Dry Leaf Weight				.989**	.980**	.682	-.897*	.962**	.981**	.931*
Fresh Root Weight					.987**	.736	-.950*	.989**	.977**	.973**
Dry Root Weight						.627	-.927*	.960**	.940*	.951*
Mitotic Index							-.819	.802	.803	.809
AbnormalityIndex								-.968**	-.912*	-.996**
Protein Content									.968**	.986**
Chlorophyll Content										.939*

*Significant at 5% level ; ** Significant at 1% level.

tent may well represent the lowering of productivity. The less activity of catalase indicates the affected plants to lose gradually the ability to sequester detrimental hydrogen peroxide, which gets accumulated within the cell by different means and causes aging. A similar type of physiological inhibition, typically in the protein, chlorophyll and catalase activity of seedling due to such influence has been reported by other workers (El-Darier 2002, Hoque et al. 2003). All these facts rather point to the overall regress of the plants under influence.

Cytological studies unveil toxicity of different natures and degrees. This effect was also concentration dependent for induction of anomalies, but mitotic index was promoted at the lower concentrations. Still then it can not contribute to the better growth of plants, possibly due to a simultaneous increase of abnormality in chromosome structure and cell division. Moreover, the higher concentration of leachate prominently inhibit mitosis. Pearson correlations (Table 3) revealed insignificant relationship between mitotic index with rest of the parameters, whereas relations between rest of the parameters were statistically significant.

It becomes quite apparent here that the leachate induces chromosomal as well as cell divisional abnormalities, which in turn cause significant lowering of protein and catalase activity and also deterioration of plant growth. The major allelochemicals in the species have been found to be alkaloids, phenols and amino acids. Since alkaloids are available only in methanolic extract (Akinmoladun et al. 2007), the main water soluble allelochemicals in leachate seem to be the phenolic compounds. Thus, *Chromolaena odorata* leaf leachate was allelopathic to *Allium cepa* (recipient plant), though its mitosis promoting ability at a lower concentration may have a prospective use.

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