



Effect of 2,4-D, Stomp and Glyphosate on Cell Division (Mitosis) in *Sida acuta* Burm. f.

Mhaiskar, M. N.

Associate Professor, Department of Botany, R. S. Bidkar College, Hinganghat, District Wardha, Maharashtra, India

Abstract-- A decrease in the mitotic index was observed after treatment with the herbicides 2,4-D, Stomp and glyphosate in *Sida acuta* Burm. f. The mitotic index decreased from 8.45 to 3.56 at 1000–5000 ppm of 2,4-D, 8.26 to 2.84 at 1000–8000 ppm of Stomp, and 9.44 to 4.62 at 5000–25,000 ppm of glyphosate.

The percentage of abnormalities in root tip cells increased gradually with increasing concentrations of herbicides. The percentage of abnormalities ranged from 0.33 to 3.11 at 2000–5000 ppm of 2,4-D, 1.07 to 2.92 at 2000–8000 ppm of Stomp, and 0.62 to 2.54 at 15,000–25,000 ppm of glyphosate.

The abnormalities observed included binucleate cells, multinucleate cells, clumping of chromosomes, grouping of chromosomes, and lagging chromosomes. The results indicate that herbicides interfere with normal mitosis and induce chromosomal abnormalities in root tip cells of *Sida acuta*.

Keywords-- Mitosis, herbicides, 2,4-D, stomp, glyphosate, *Sida acuta*

I. INTRODUCTION

Sida acuta Burm. f. belongs to the family Malvaceae. It is an erect weed commonly found on roadsides, open grounds, gardens, barren lands and field margins. The plant is a perennial herb or sub-shrub, 30–120 cm in height, with stellate hairs on the branches. Leaves are lanceolate and may be glabrous or sparsely stellate-pilose on both surfaces. The base of the leaf is obtuse, the margin is dentate and the apex is acute. Flowers are solitary in the axils of leaves. The calyx is shallow cup-shaped with five lobes, while the corolla is yellow in colour with a prominent staminal column. The fruit is nearly globose with 4–9 mericarps, each with two awns at the apex.

Plant growth can be described in terms of cell division, cell enlargement and cell differentiation. Herbicides are widely used for weed control in agriculture, but they may also affect cellular activities in plants. The application of herbicides can cause disturbances in metabolic processes and interfere with normal cell division.

The present investigation was undertaken to study the effect of the herbicides 2,4-D, Stomp and glyphosate on mitotic activity and chromosomal behaviour in root tip cells of *Sida acuta*.

II. MATERIALS AND METHODS

Seeds of *Sida acuta* Burm. f. were treated with 50 mL of different concentrations of herbicides:

2,4-D: 1000–5000 ppm

Stomp: 1000–10,000 ppm

Glyphosate: 5000–25,000 ppm

The seeds were exposed to these treatments for 24 hours. Seeds soaked in distilled water for the same period served as the control.

After treatment, the seeds were washed thoroughly with distilled water and allowed to germinate in Petri dishes lined with double-layered moist filter paper under laboratory conditions.

Root tips of germinated seedlings were fixed in Carnoy's fixative (3:1 ethanol: glacial acetic acid) for 24 hours. After fixation, the root tips were washed with distilled water and preserved in 70% ethanol.

The root tips were hydrolysed in 1 N HCl at 60°C for 7–10 minutes. Slides were prepared using the squash technique, with iron alum as mordant and hematoxylin as stain. The slides were made permanent using acetic acid–butanol grades and mounted in DPX.

Dividing cells in metaphase and anaphase were observed under a microscope to record chromosomal aberrations.

III. MITOTIC INDEX CALCULATION

Dividing cells in metaphase and anaphase were scored to determine chromosomal abnormalities. The mitotic index (MI) was calculated using the following formula:

$$\text{Mitotic index (\%)} = \frac{\text{Number of dividing cells}}{\text{Total number of cells observed}} \times 100$$

IV. RESULTS

Mitosis was normal in the control root tips of *Sida acuta*, with a mitotic index of 10.49.

Effect of 2,4-D

2,4-D significantly affected mitosis in root tip cells. The mitotic index decreased with increasing concentrations of the herbicide. The mitotic index values observed were 7.30, 7.46, 6.98, 5.28, 6.55, 5.21 and 5.58 at concentrations of 10, 20, 40, 60, 80, 100 and 200 ppm, respectively.

Various chromosomal abnormalities were observed, including binucleate cells, multinucleate cells, clumping of chromosomes, grouping of chromosomes, laggards and precocious movement of chromosomes. The percentage of abnormalities increased with increasing herbicide concentration, ranging from 3.14% to 10.20%.

Effect of Stomp

Stomp also affected mitosis in root tip cells. The mitotic index values recorded were 8.06, 8.33, 8.39, 8.35 and 5.63 at 100, 1000, 5000, 10,000 and 20,000 ppm, respectively.

Abnormalities such as binucleate cells, multinucleate cells, premetaphase chromosomes and abnormal chromosome movement were observed. The percentage of abnormalities ranged from 0.47 % to 3.00 %. The percentage of abnormalities increased gradually with concentration.

Effect of Glyphosate

Glyphosate also reduced mitotic activity in root tip cells. The mitotic index values recorded were 8.90, 8.59, 8.65, 8.10, 7.60 and 7.53 at 100, 1000, 5000, 10,000, 20,000 and 40,000 ppm, respectively.

Chromosomal abnormalities such as grouping of chromosomes and abnormal movement of chromosomes were observed. The percentage of abnormalities ranged from 0.44% to 3.13%. The percentage of abnormalities increased gradually with increasing herbicide concentration.

V. DISCUSSION

The results demonstrate that all three herbicides induced chromosomal abnormalities and reduced mitotic activity in *Sida acuta* root tip cells.

Among the herbicides tested, 2,4-D showed the strongest inhibitory effect on mitosis, producing the highest frequency of chromosomal aberrations. Similar cytological effects of 2,4-D have been reported in several plant species including *Allium cepa*, *Triticum*, and *Vicia faba* (Ryland, 1948; Nygren, 1949; Sawamura, 1964; Dharurkar, & Dnyansagar, 1974).

The occurrence of binucleate and multinucleate cells may result from inhibition of cytokinesis, whereas chromosome clumping may arise due to disturbances in chromosome condensation during metaphase (Nygren, 1949; Crocker, 1953; Jain, 1993; Kamble, 1999; Dudhe, 2002).

Stomp and Glyphosate also caused chromosomal abnormalities, though to a lesser extent. The reduction in the mitotic index observed in herbicide-treated roots suggests inhibition of DNA synthesis and cell division, which has also been reported by several earlier investigators (Mohandas and Grant, 1972; Badr, 1986; Jain, 1993; Kamble, 1999; Dudhe, 2002).

The progressive decrease in mitotic activity with increasing herbicide concentration indicates the cytotoxic effect of herbicides on meristematic cells.

VI. CONCLUSION

The results of the present study indicate that herbicides significantly affect mitosis in *Sida acuta*. The mitotic index decreased with increasing herbicide concentration, while chromosomal abnormalities increased.

Among the herbicides tested, 2,4-D showed the highest cytotoxic effect, followed by Stomp, whereas glyphosate showed comparatively lower toxicity.

These findings suggest that herbicides can interfere with normal cellular processes and induce cytological abnormalities in plant cells.

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Table 1.
Mitotic index and frequency of various aberrations in the seedling of *Sida acuta* Burm.f. at different concentrations of herbicides.

Herbicides	Conc. in ppm	Total no. of cells observed	Total no. of dividing cells	Mitotic index	Binucleate cells	Multinucleate cells	Clumping	Grouping	Precocious movement	Laggards	Premetaphase	Total % of abnormalities
2, 4-D	Control	2515	264	10.49	-	-	-	-	-	-	-	-
	10	2600	190	7.30	1.57	1.05	-	-	0.52	-	-	3.14
	20	1957	146	7.46	1.36	0.68	0.68	-	2.05	-	-	4.77
	40	0988	069	6.98	4.14	-	1.24	-	-	-	-	5.38
	60	2120	112	5.28	2.35	1.68	1.80	-	-	-	-	5.83
	80	1800	118	6.55	0.84	0.84	0.84	2.54	0.84	0.84	-	6.74
	100	1879	098	5.21	-	2.04	-	3.06	2.04	1.02	-	8.16
Stomp	200	0878	049	5.58	4.08	2.04	-	4.08	-	-	-	10.20
	100	2630	212	8.06	-	-	-	-	0.47	-	-	0.47
	1000	2412	201	8.33	-	-	-	0.49	0.99	-	-	1.48
	5000	2120	178	8.39	-	-	0.56	1.12	-	-	0.56	2.24
	10,000	1890	158	8.35	0.63	0.51	1.26	-	0.63	-	-	3.00
Glyphosate	20,000	2200	124	5.63	1.61	-	-	-	-	-	0.80	2.41
	100	2526	225	8.90	0.44	-	-	-	-	-	-	0.44
	1000	2210	190	8.59	0.52	0.52	-	-	-	-	-	1.04
	5000	1884	168	8.65	1.19	0.59	-	0.59	-	-	-	2.37
	10,000	2000	162	8.10	-	0.61	1.23	-	1.23	-	-	3.07
	20,000	1840	140	7.60	-	-	1.42	-	0.71	-	-	2.13
40,000	1420	127	7.53	-	-	0.78	0.78	1.57	-	-	3.13	