

## SEEDLING INJURY AND CHROMOSOME ABERRATIONS INDUCED BY BLADEX, DOWPON, PRINCEP AND TENORAN

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### ABSTRACT

Four herbicides were evaluated for their effect on seedling height and on chromosomes of barley shoot tips. Dowpon and Bladex produced slight seedling injury while Princep and Tenoran were essentially non-toxic. Bladex and Tenoran induced chromosome aberrations that were significant at .01 level of probability. High frequency of dicentric bridges and multipolar anaphase irregularities were also observed. Percent cells with aberrations increased two to three times as compared to control. There was also a slight increase in the number of cells showing chromosome abnormalities in Dowpon and Princep treated seedlings.

### INTRODUCTION

The control of pests is basically an ecological problem. Chemicals are among the most effective weapons available to control pests. It is important, however, that we be concerned and knowledgeable about the effects of pesticides on man's total environment.

Chemicals recently introduced into the environments for which there is little natural resistance must be thoroughly tested for their long term effects. Since chemicals can be activated by some enzymes and in-

activated by others, it is impossible to predict whether a compound that is strongly mutagenic in one organism will be mutagenic in another. Nor is it possible to assure that a compound which is not mutagenic in one organism will be mutagenic in another. Nevertheless owing to common evolution of vegetative cell properties, many biochemical reactions are similar in different organisms and the existence of similar protective mechanisms can be expected (Freese 1971). This study was undertaken to determine the biological effects of four herbicides, on the seedling height and on the chromosomes of shoot tips of barley.

### MATERIALS AND METHODS

Barley grains (Caryopses), *Hordeum vulgare* cv. Trent were exposed to four herbicides: Bladex, Dowpon, Princep and Tenoran. Bladex is recommended for the control of annual grasses and broad leaf weeds in corn at the rate of 4 lbs. per acre in 20 gallons of water and is a photosynthetic inhibitor. Dowpon is recommended for annual as well as perennial grasses at the rate of 0.75 lbs. per acre in 20 gallons of water. Princep is a selective herbicide for broad leaf and grassy weeds in corn, citrus etc. Princep is a photosynthetic inhibitor and is used at the rate of 2-4 lbs. per acre in 20 gallons of water. Tenoran is recommended for most annual grasses and broad leaf weeds at the rate of 2-8 lbs. per acre in 40 gallons of water spray. The

common name, active ingredient percent and source of these chemicals is listed in Table 1.

Seeds were presoaked in distilled water for 12 hours. At the end of presoaking period, the seeds were placed in flasks containing 0, 250, 500 or 1,000 parts per million (ppm) active ingredients of the pesticides to be tested in 0.1 molar phosphate buffer at an approximate pH of 6.5. Air was constantly bubbled through the flasks containing 75 seeds in 100 ml of suspensions of various pesticides. After this treatment period, the seeds were rinsed twice with distilled water to remove the chemicals from the surface of seeds. Fifty surface washed seeds from each flask were planted according to the technique described by Myhill and Konzak (1967). The remaining seeds were planted on blotters in petri dishes for shoot tip studies. The shoot tips were collected when the length of the tip was  $\frac{1}{2}$  to  $\frac{3}{4}$  the length of the seed and fixed in Carnoy's Solution (4 parts 95 percent ethyl alcohol, 3 parts chloroform and 1 part glacial acetic acid). A total of 300 cells were cytologically examined for chromosome aberrations by the aceto-orcin technique. The seedling injury was measured as percent reduction in seedling height as compared to control and was recorded after 5 days of planting.

#### RESULTS AND DISCUSSION

Frequency and type of aberrations, percent cells with aberrations and seedling injury (percent reduction in height as compared to control) is summarized in Table 2 and figures 1-4. Seedling injury for Dowpon at 250, 500 and 1000 ppm concentrations was 6.9%, 10.2% and 18.5% respectively. There was a slight increase in percent cells with aberrations in treated shoot tips. However, this difference was not statistically significant. Increase in the frequency of dicentric bridges indicates that Dowpon did cause some chromosome breakage. There was essentially no difference in percent cells with aberrations and frequency of various types of aberrations between low and high concentrations of Dowpon. Princep did not appear to show any toxicity as the percent injury was 1.7, 2.5 and 0.6 for 250, 500 and 1000 ppm concentrations respectively. However, there was a slight increase in percent cells with aberrations in treated plants. It appears that Princep caused some increase in chromosome breaks as the frequency of dicentric bridges more than doubled in treated plants. There was no increase in the frequency of aberrations with increasing concentrations of Princep. Princep used was a wettable powder containing 80% active ingredient and had only 20 ppm solubility in water. It appears that barley seeds may not have absorbed any more chemical from 500 ppm and 1000 ppm concentrations than from 250 ppm concentration as the frequency of cells with aberrations was very similar in these treatments.

Tenoran also did not cause any significant reduction in seedling height, and therefore, appears to be non-toxic. However, the frequency of dicentric bridges and percent cells with aberrations increased substantially in treated seedlings. It appears that slight decrease in height may be due to genetical damage (chromosome aberrations) as the frequency of aberrations was high. Bladex caused considerable chromosomal damage. The percent cells with aberrations were 23.7, 29.0 and 24.7 for 250, 500 and 1000 ppm concentrations respectively. The frequency of dicentric bridges was significant at .01 level of probability. The seedling injury which was 6 to 16 percent was probably due to chromosomal damage rather than toxicity. According to Conger and Stevenson (1969) chromosome aberrations

above 25-30% depress seedling height. There was essentially no difference in aberrations frequency between different concentrations of Bladex probably due to low

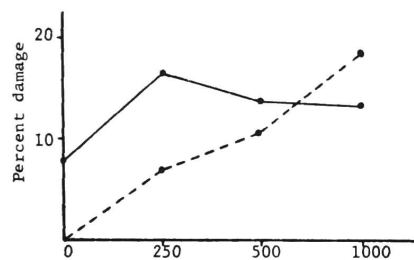


FIG. 1: Concentration of Dowpon in ppm.  
— Chromosome Aberrations  
- - - Seedling Injury

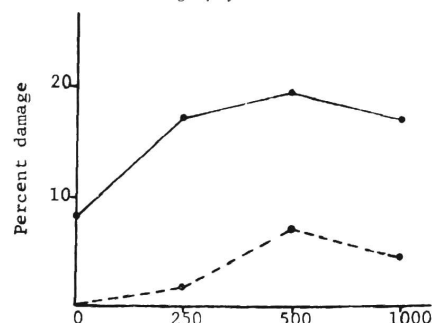


FIG. 2: Concentration of Princep in ppm.  
— Chromosome Aberrations  
- - - Seedling Injury

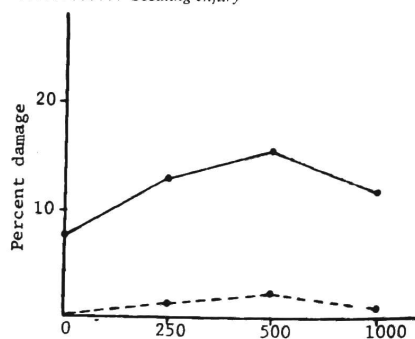


FIG. 3: Concentration of Tenoran in ppm.  
— Chromosome Aberrations  
- - - Seedling Injury

TABLE 1. Common or Trade Name, Active Ingredient Percent and Source of Pesticides.

Pesticide	Active Ingredient	Source
Bladex (Cyanazine)	2-(4-chloro-6-ethylamino-s-triazin-2-ylamino)-2-methylpropionitrile (94%)	Shell Chemical Co.
Dowpon (Dalapon)	2,2 dichloropropionic acid (74%)	The Dow Chemical Co.
Princep 80w (simazine)	2-chloro-4,6-bis(ethylamino)-s-triazine (80%)	Geigy Chemical Co.
Tenoran (Cloroxuron)	3-p-(p'-chlorophenoxy) phenyl-1,1-dimethylurea (50%w)	Ciba Corp.

\* Chemicals were donated by the manufacturers for these studies.

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TABLE 2. The Effect of Dowpon, Princep, Tenoran and Bladex on Seedling Height and Chromosomes in Barley Shoot Tips.

Name of Chemical	Concentration ppm	Frequency and type of Aberrations			Percent of Cells with Aberrations	Percent Seedling Injury
		Dicentric Bridges	Multipolar Anaphases	Laggards		
Control	0	11	10	3	8.0	0.0
Dowpon	250	24*	19	11	16.3	6.9
	500	19	16	4	13.3	10.2
	1000	14	19	4	13.3	18.5
	250	27*	11	11	13.3	1.7
Princep	500	30*	10	10	16.0	2.5
	1000	27*	9	5	12.0	0.6
	250	24*	21	9	17.0	1.7
Tenoran	500	27*	10	4	19.5	7.0
	1000	31**	6	3	17.0	4.5
	250	32**	19	24	23.7	15.8
Bladex	500	46**	20	28	29.0	6.0
	1000	37**	18	15	24.7	5.6

\* Comparison of each treatment data with the control data, using individual 2 X 2 contingency Chi Square tests showed the treatment deviated significantly from the control at the 0.05 level of probability

\*\* Significant at the 0.01 level of probability