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Cytotoxic Effect of Malathion and Furadan On *Allium Cepa* L. and Growth Parameters of *Oryza Sativa* L.

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ABSTRACT

In the present study, two pesticides i.e., malathion and furadan were used to detect its cytotoxic effect on Allium cepa L. and growth behaviors of Oryza sativa L. Cytological studies of A. cepa root tips treated with four different concentrations of malathion showed the occurrence of chromosome breakages, sticky anaphase, spiral nature of chromosome in telophase stage, normal metaphase with breakage and disruptive nucleus. Further, two concentrations of furadan induced chromosomal aberration and exhibited spiral nature of chromosomes with very few number of dividing cells. The mitotic index reduced greatly with the increase in concentration and duration. Two rice varieties IR64 and Sahbhagi, when treated with various concentrations of malathion and furadan showed various degrees of inhibition on growth of rice. The germination index was greatly reduced by the effect of the two pesticides. Moreover, the plantlets had reduced shoot and root growth with lesser relative water and chlorophyll content as compared to the controlled plants. The effects of pesticides were noticeable on both the tested model plants. Existing data indicates that plant cytogenetical tests are useful battery of tests in monitoring of environmental pollutants. In future researches, it would be interesting to have A. cepa L. test compared to other genotoxicity tests.

Keywords: *Cytotoxic effect, malathion, furadan, Allium cepa L., Oryza sativa L.*

INTRODUCTION

Pesticides are a group of chemicals, which are used to combat the attack of pests in India and other parts of the world. The use of pesticides is a new era in the application of man-made chemicals in the control of pests, which increased the production of food, increased profits for farmers and helped in the eradication of diseases, but this great achievement has resulted in injury and death of a variety of forms of life. Use of enormous quantities of pesticides also spoils the ecosystem directly or indirectly (Mozumdar *et al.,* 2013). There exist a direct relationship between the extent of pesticides used and signs and symptoms of illness due to exposure among farmers (Kishi *et al.*, 1995). According to (Zhang *et al*., (2011), about 4.6 million tons of chemical pesticides with about 500 different types is annually used across the world. Most pesticides used in agriculture today are synthetic organic chemicals that act by interfering with a vital metabolic process in the organisms to which they are targeted (Mathur *et al.*, 2005). Levan (1938) reported the classical test for the effect of chemicals on plant chromosomes where he used the root tips from the bulbs of *Allium cepa* L. of Lilliaceae in an assay system. Malathion [S-(1,2-di-carb-ethoxy-ethyl)-O,O-di-methyl-di-thio-phosphate] is an organophosphate insecticide of relatively low human toxicity which is widely used in

agriculture, residential landscaping, public recreation areas, and in public health pest control programs such as mosquito eradication (Abhilash *et al*., 2009; Quari, 2009; Felsot *et al.*, 1980). Furadan is a systemic acaricide, insecticide and nematicide used on food crops mainly corn-alfalfa, sorghum, canola, sunflower, potatoes, sugarbeet, and other mixed vegetables and on selected non-food crops such as cotton, ornamentals and tobacco (SamakaKincl *et al.*, 1996; Nataranjan 2002; Abu and Mba 2011; Olorunfemi and Ehwre 2011). *Allium cepa* is the most frequently used model organism for higher plant species (Grant, 1994; Pohren *et al.*, 2013).

Rice (*Oryza sativa* L.) belonging to family Poaceae, is a staple food source of more than three billion people, providing 50-80% of their daily calorie intake (Delseny *et al.*, 2001) across the world. The global importance of rice as a food source is evident; however it is also a valuable tool in assessing potential phytotoxicity of organic and inorganic compounds (OECD 1984). The seedling growth as well as other cytological characteristics is generally evaluated for testing mutagenic sensitivity in plants (Amjad *et al.*, 2002). Rice could be a food crop and a model system for scientific research in laboratory conditions (Till *et al.*, 2007). Application of pesticide can affect early life right from germination to growth of the plant, leading to alteration in biochemical, physiological and different enzymatic and non-enzymatic antioxidants that ultimately affect the yield. The resulted residues in plant, vegetables, fruits and different non-target organisms are extremely harmful. Very few studies have been examined the phytoxocity of commonly used pesticides on rice germination and growth in Assam and India as a whole.

MATERIALS AND METHODS

The plant material used for investigation was common model plant for chromosomal study *i.e.*, onion (*Allium cepa* L.) and growth behavior on rice (*Oryza sativa* L.). Medium sized onion bulbs were collected from the local market. Onion bulbs were grown in sand for the initial root growth at room temperature. When young healthy roots came out after one to two day up to a length of 1cm, the roots were properly washed in water to remove the sand particles and were taken for the treatment. The pesticides used in the present study were malathion and furadan.

Preparation of chemicals reactions

Four different concentration of malathion (0.1g/100ml, 0.5g/100ml, 0.75g/100ml and 1g/100ml) used in this experiment were treated with healthy onion bulbs of uniformed size for a period of 24, 48, 72 and 96 hours each respectively. Furadan (50µg/ml and 100µg/ml) solutions were also used for 6 hours and 24 hours each. The onion bulbs grown in tap water were considered as control.

Collection of root tips

Roots were collected maintaining proper time exposure from the treated onion. The collection time ranged between 7:45 - 8:00 am and were fixed in Carnoy's Fluid (3 absolute alcohol: 1 glacial acetic acid) for 6 hours. After fixation, the onion root tips were preserved in70% alcohol for cytological studies. Slides were prepared using acetocarmine stain by squash method and slides were observed under light microscope.

Calculation of mitotic index (MI)

The mitotic index was calculated by dividing the number of cells undergoing mitosis divided to the total no. of cells observed for each treatment (Balog, 1982). The data obtained were analyzed to determine the effects of the treatments (concentration and duration of treatment) on mitotic activities of *A. cepa* root tip cell. Mean value with standard deviation was calculated for each concentration.

$$\text{MI} = \frac{\text{Number of cells divided}}{\text{total number of cells}} \times 100$$

Further, to investigate the effect of malathion and furadan on growth parameters, two different rice (*Oryza sativa* L.) varieties were used *i.e.,* 'Sahbhagi' and 'IR 64'.

Germination Index (GI) was calculated as follows (Association of Official Analyst, 1983).

$$\mathbf{G.I.} = \frac{\mathbf{n}}{\mathbf{d}}$$

Where, n= no of seedlings emerging on day; d= Day after planting

After counting the GI, rice seedlings were transferred to small plastic glasses containing hydroponic culture i.e., Yoshida solution in such a way that their roots could sufficiently reached and be immersed in the nutrient solution. The different nutrient solutions were prepared by dissolving 1.0 g/L, 5.0 g/L, 7.5 g/L and 10 g/L malathion and 0.5 g/L, 1.0 g/L of furadan in the Yoshida solution. The Yoshida solution was used as a control for both the solution (pH 5.8).

Growth was measured in terms of root length, root fresh weight, root dry weight and shoot length, shoot fresh weight and shoot dry weight. Five plants were randomly selected from each roots and shoot samples were taken with the help of weighing balance. Immediately after taking them out of glasses and wiping out the moisture with tissue paper. The roots and shoots were oven dried at 80° C for 72 hours in order to take their dry weight.

Measurement of relative water content (RWC)

Relative water content (RWC) was determined by weighing shoot and floating it on deionized water for four hours at constant temperature in diffused light. When shoot became fully turgid, it was reweighed and dried for 72 hours and weight was determined. The shoot RWC was
calculated by the following formula (Barrs and weatherly, 1962).

$$\text{RWC}(\%) = \frac{(\text{FW} - \text{DW})}{(\text{TW} - \text{DW})} \times 100\%$$

Where, FW=Fresh weight, DW=Dry weight and TW=Turgid weight

RESULTS AND DISCUSION

Effect of malathion on chromosome behavior

In the control, the onion root tips revealed normal behavior of chromosomes comprising all the stages with normal metaphase o 2n = 16. However, when the root tips were collected from 0.1µg/100ml, 0.5µg/100ml, 0.75µg/100ml and 1.0 µg/100ml concentration for 24, 48, 72, and 96 hours of exposure time in malathion solution, various abnormalities were observed. Chromosome breakage occurred in all the concentrations. In the 0.1µg/100ml, 0.5µg/100ml, 0.75µg/100ml and 1.0 µg/100ml concentration for 24 hours, sticky anaphase, and spiral nature of chromosome in telophase stage, normal metaphase with breakage, disruptive nucleus was observed. Among the total number of cells, most were in the prophase stage followed by anaphase, metaphase, telophase respectively (Fig.1; Table 1).

In the 48 hours exposure of different concentrations chromosome breakage into short and thick fragments, disoriented anaphase, disappearance of nucleolus, multipolar anaphase, sticky anaphase, chromosome laggards, adherent chromosomes, distortion of pole in anaphase were observed. Stickiness may be produced by the physical adhesion of chromosomal proteins (Patil and Bhat, 1992) or due to disturbances in the nucleic acid metabolism of the cell or the dissolution of protein covering the DNA in chromosomes (Mercykutty and Stephen, 1980). A considerable proportion of nuclear lesions can be recorded most of which may be due to the disintegration of a portion of nuclear material by the action of pesticides (Omanakumari *et al.*, 2006). In the 72 hours of exposure time, chromosomal aberration such as chromosomal bridge, lagging chromosomes, unequal distribution of nucleus, chromosome divergence, uncoiling abnormality, and laggards were observed (Fig. 1) [Chutia *et al.*, 2012; Hore and Tanti 2014; Sarma and Tanti 2014; Sarma and Tanti 2015; Tanti *et al.*, 2009; Tanti *et al.*, 2012; Toijam *et al.*, 2013].

In the 72 and 96 hours of exposure time sticky metaphase, C-metaphase, dead cells, irregular binucleate ellipsoidal cell, disoriented anaphase with discontinuous laggards, clumped chromosomes in metaphase, sticky anaphase, spiral telophase cells with bridge, swollen chromosomes were observed more commonly. The occurrence of binucleate and tetra nucleate cells arise as a consequence of the inhibition of cell plate formation. Failure of cell plate formation in already binucleate cells may give rise to multinucleate condition (Fig. 1). The chromosome aberration induced was dose dependent and exposure time specific.

Effect of furadan on chromosome behavior

The two concentrations *i.e.*, 50 µg/ml and 100µg/ml for 6 hours and 24 hours each induced chromosomal aberration. This test also revealed relationship between dose-dependent upon the exposure period. The number of dividing cells was very few. Both the concentrations induced breakage of chromosomes. At 50 µg/ml for 6 and 24 hours spiral nature of chromosomes was most common. Bridges and laggards were not seen.

At 100µg/ml for 6 and 24 hours period of treatment, most of the dividing cells were broken in metaphase and anaphase stage. Besides, spirally arranged chromosomes, disoriented anaphase were seen. Laggards and chromosomal bridges were seen in treatment of 100 µg/ml for 24 hours. Occurrence of lagging chromosomes might be due to the hindrance of pro-metaphase movement of chromosomes accompanied by adhesion of centromere to the nuclear membrane (Nagpal and Grover, 1994). Kabir *et al.*, (1980) claimed that anaphase

bridges might be due to the formation of dicentric chromosomes as a result of breakage and reunion of broken chromosomes. Sax, (1938) opines that anaphase bridges may be due to unequal exchange of dicentric chromosomes.

From the present study, it is noted that malathion was most successful in inducing greater numbers of chromosomal aberrations than furadan. The percentage of typical bridge formation, laggards, C-mitosis, clumping of metaphase chromosomes, binucleated elongated cells, were not common in root tips treated with furadan. Few bridges were observed in 100µg/ml for 24 hours. However, breakage of chromosomes was of common occurrence. The chromosomal aberrations occurred more frequently during longer exposure. Clearly, a distinct dose dependent increase in chromosomal anomalies was observed in all treatments. Thus, the cumulative effect of malathion and furadan on the chromosomal behavior was noteworthy.

The mitotic index (MI) reduced greatly with the increase in concentration and duration. Lowering of MI in treated root meristems could be due to inhibition of DNA synthesis (Sudhakar *et al.*, 2001), arrest of one or more mitotic phases (Kabarity and Mallalah, 1980) or blocking of G2 phase in the cell cycle preventing the cell from entering mitosis. Wide spectrum abnormalities exhibited by the treatment proved that even exposure to relatively smaller concentrations have significant effects on mitotic index and structure of chromosome and disturbs mitotic spindle formation. Reduction in MI with increasing concentrations clearly demonstrates the ability of chemical to inhibit DNA synthesis.

Effects of pesticides on growth parameters of rice

Treatment with various concentrations of malathion and furadan showed various degrees of inhibition. Similarly, Moore and Kroger, (2010) reported inhibition of germination, radical and coleoptile growth of rice seeds exposed to three insecticides and two herbicides, commonly used in agriculture. Triadimenole and triticonazole, applied as seed treatments at various rates affected plant growth, shoot development and root axis production adversely (Montfort *et al.*, 1996). As the concentration and duration of the pesticides was increased, the seedling growth was found to be affected indicating toxic effects on the cell division of root and shoot meristems as well as the elongation. The pesticides allowed growth of the plumule but played an adverse effect and delayed the growth of radical (Gaikwad, 1979; Gupta *et al.*, 1983, Benjamini, 1986), indicating greater decrease in root shoot ratio.

Effect on germination rate

As compared to the untreated seeds, the germination was greatly reduced and delayed by the effect of the two pesticides (Reddy, *et al.*, 1994; Chakravarty, 1986). This might be due to their injurious action on osmotic relation. However, the complete inhibition and germination of seedling growth of *Oryza sativa* L. were observed in higher concentration of Sivic solutions (Sathees *et al.*, 2014). In the present study, the control plant Sahbhagi, has the highest germination index value obtained, which was 2.77 ±1.114, while it was 2.60±1.00 in the control of IR64 (Table 2).

Effect of malathion on shoot and root length

From the Table 3, it is clear that the shoot length of both the rice varieties was highest in control which is 17.31cm in IR64 and 17.2cm in Sahbhagi. The shoot length of the rice varieties decreased with increase in concentration of the pesticide. In 0.1µg/ml, the shoot

length of the treated seedlings was highest which are 16.36cm in IR64 and 16.83cm in Sahbhagi. The shoot length was lowest in 1µg/ml of both the rice varieties which is 12.86cm in IR64 and 14.23cm in Sahbhagi. This might be due to higher dose of the pesticide. There was no appreciable difference in the shoot height of treated rice varieties, but the continuous application of the pesticide will definitely decrease the seedling height. Fig. 2 showed the rice varieties treated with pesticides.

According to Table 3, the root height decreased with increase in concentration. The root height was maximum in the control. It was 11.21cm in IR64 and 7.6cm in Sahbhagi. Among the tested plants, it was maximum at 10.46cm in IR64 and 7.3cm in Sahbhagi respectively. The lowest was 6.93cm in IR64 and 6.33cm in Sahbhagi. The root height was more affected in Sahbhagi.

Effect of furadan on shoot and root length

Table 3 showed the shoot length of rice varieties decreased with increase in concentration of the pesticide. The control attained the highest height in both the cases which is 14.8cm in IR64 and 14.46cm in Sahbhagi. While in 50µg/ml, the shoot height of IR64 was 13.2 cm and in 100 µg/ml it was 11.36cm. The seedling height was 13.96 cm in 50µg/ml and 13.16 cm in 100 µg/ml in case of Sahbhagi. This indicates that the seedling of Sahbhagi reacted less to the two concentrations of pesticides in comparison to IR64. Besides, the effect of furadan on reduction of seedling height was more than malathion (Fig. 3).

In Table 3, the root length at 50µg/ml was 6.7cm and 7.4cm in IR64 and Sahbhagi respectively. At 100µg/ml, it was 4.46cm in IR64 and 5.13cm in Sahbhagi. In both the rice varieties the root height was maximum in the control which is 7.93cm and 8.2cm in IR64 and Sahbhagi respectively. The overall reduction in root length by the effect of furadan is a distinguishable feature in comparison to that of malathion (Fig. 4).

Effect of malathion on shoot and root fresh weight and dry weight

Fresh weight was highest in control in both the rice varieties i.e., 0.163mg in IR64 and 0.2822mg in Sahbhagi (Table 4). The fresh weight decreased with increase in concentration of the pesticides. It was 0.159mg in IR64 and 0.2645mg in Sahbhagi at the lowest concentration i.e. 0.1µg/ml. The fresh weight at 1µg/ml was 0.090mg and 0.213mg in IR64 and Sahbhagi respectively. The shoot dry weight was highest in control which was 0.047mg and 0.066mg in IR64 and Sahbhagi respectively. The shoot dry weight at the lowest and highest concentration was 0.046 and 0.0376mg in IR64. The dry weight in Sahbhagi at the lowest and highest concentration was 0.496 and 0.396 mg respectively.

In Table 4, it was seen that the root fresh weight was highest in both the control plants. It was 0.0287mg and 0.11983 mg in IR64 and Sahbhagi respectively. At the lowest concentration it was 0.0282mg and 0.0839mg in IR64 and Sahbhagi. While at the maximum concentration the root fresh weight was 0.0185mg and 0.0176mg in IR64 and Sahbhagi respectively. The root dry weight was highest in the control plants. At 0.1µg/ml and 1 µg/ml the weight was 0.0226mg and 0.015mg in IR64. But in Sahbhagi it was 0.018mg and 0.012mg in 0.1µg/ml and 1.0 µg/ml respectively.

Effect of furadan on shoot and root fresh weight and dry weight

In the Table 4, the shoot fresh weight of seedlings was maximum in the control plants. It was 0.042mg and 0.0438mg in IR64 and Sahbhagi respectively. The shoot fresh weight decreased

with increase in concentration of pesticide. It was 0.0416mg and 0.032mg at 50 and 100 µg/ml in IR64. On the other hand, it was 0.042mg and 0.0276mg at 50 and 100 µg/ml in Sahbhagi. The shoot dry weight of the treated seedlings also decreased with increase in concentration of pesticide. The control plants in both the cases obtained the maximum dry weights. At the minimum dose the shoot dry weight of the rice varieties was the same i.e., 0.013mg. While at 100µg/ml the weights were 0.0113mg in IR64 and 0.01mg in Sahbhagi.

Table 4 depicted that the root dry weight decreased with increase in concentration of pesticide. It was maximum in the control plants. It was 0.006 and 0.005mg at 50 and 100µg/ml in IR64, and in Sahbhagi it was 0.0062 and 0.0046 at 50 and 100 µg/ml in Sahbhagi.

Relative water content (RWC)

The relative water content was reduced with the increase in the concentration of the pesticide (Table 5). Both the pesticides had almost similar inhibiting capacity. The highest was observed in the control. It was 86.99% and 82.67% in IR64 and Sahbhagi respectively. In malathion treated rice, the highest percentage of RWC was observed in 0.1 and lowest in 1µg/ml in IR64 and Sahbhagi respectively. Treatment with furadan showed highest percentage in 5 and lowest in 10µg/ml in IR64 and Sahbhagi respectively.

Total chlorophyll content

The chlorophyll content in both the rice varieties decreased with the effect of furadan (Table 6). Rehab, (2016) also observed reduction in percentages of chlorophyll a, b when treated with a group of pesticides. The control plant contained the highest total chlorophyll content i.e., 16.833 and 12.86. While, it was lowest i.e., 12.578 and 10.83 in IR64 and Sahbhagi at 10µg/ml respectively.

CONCLUSION:

The effects of pesticides were noticeable on both the tested model plants. Various types of chromosomal aberrations occurred in onion root meristem. While growth parameters of *Oryza sativa* L. like the decreasing germination index, decreasing shoot length, decreasing root length, lowering of shoot fresh weight, shoot dry weight, root fresh weight, root dry weight, relative water content and also the total chlorophyll content can be claimed to be a direct indication of the treated pesticide being harmful to all these essential aspects of a plant life during the initial stages of its growth and development which may affect the plants even during the later stages of flowering and percentages of healthy yields.

In future, *A. cepa* L. test, a quick, available and easily performed test, may be useful alternative for analysis of genotoxicity of chemical substances of environment in animal models. In future researches, it would be interesting to have *A. cepa* L. test compared to other genotoxicity tests.

Since, very little works have been done to understand the effects of malathion and furadan on chromosomal studies on root meristems of onion and growth parameters of rice plant, the present study can be a of great help to those dealing with cytological studies as well as growth and development of plants by the application of pesticides related to agricultural and

food products in the future. The results obtained throughout the tests were new, interesting and also informative. It tallied well to earlier research publications in well known papers and journals.

Table 1. Mitotic indices and chromosomal aberrations observed in *A. cepa* root meristem treated with malathion and furadan:

Name of the pesticide	Conc. (µg/ml)	Duration (hr.)	Total analysed cells	No. of cells showing division	Total aberrant cells	Mitotic index (%)	Chromosomal aberration (%) (Mean±SE)
Malathion	control	24	639	503	45	78.71	15±2.16
	0.1		432	305	60	70.60	20±0.471
	0.5		426	297	73	69.71	24.33±1.90
	0.75		479	315	84	65.76	28±1.24
	1		542	351	91	64.76	30.33±0.72
	0.1	48	618	296	94	64.07	31.33±0.98
	0.5		513	323	97	62.95	32.33±1.18
	0.75		441	275	105	62.35	35±2.35
	1		522	315	111	60.34	37±3.29
	0.1	72	594	353	130	59.42	36±3.09
	0.5		540	315	108	58.33	43.33±1.44
	0.75		516	299	140	57.94	46.66±1.36
	1		647	349	147	53.94	49±0.47
	0.1	96	476	255	164	53.57	56.33±1.78
	0.5		723	374	169	51.72	59.66±2.59
	0.75		452	216	186	47.78	62±1.24
	1		314	137	203	43.62	67.66±1.51
Furadan	50	6	512	316	120	61.71	40±1.414
	100		587	350	179	59.62	59.66±0.544
	50	24	567	322	186	56.79	62±1.24
	100		550	359	193	65.27	64.33±2.12

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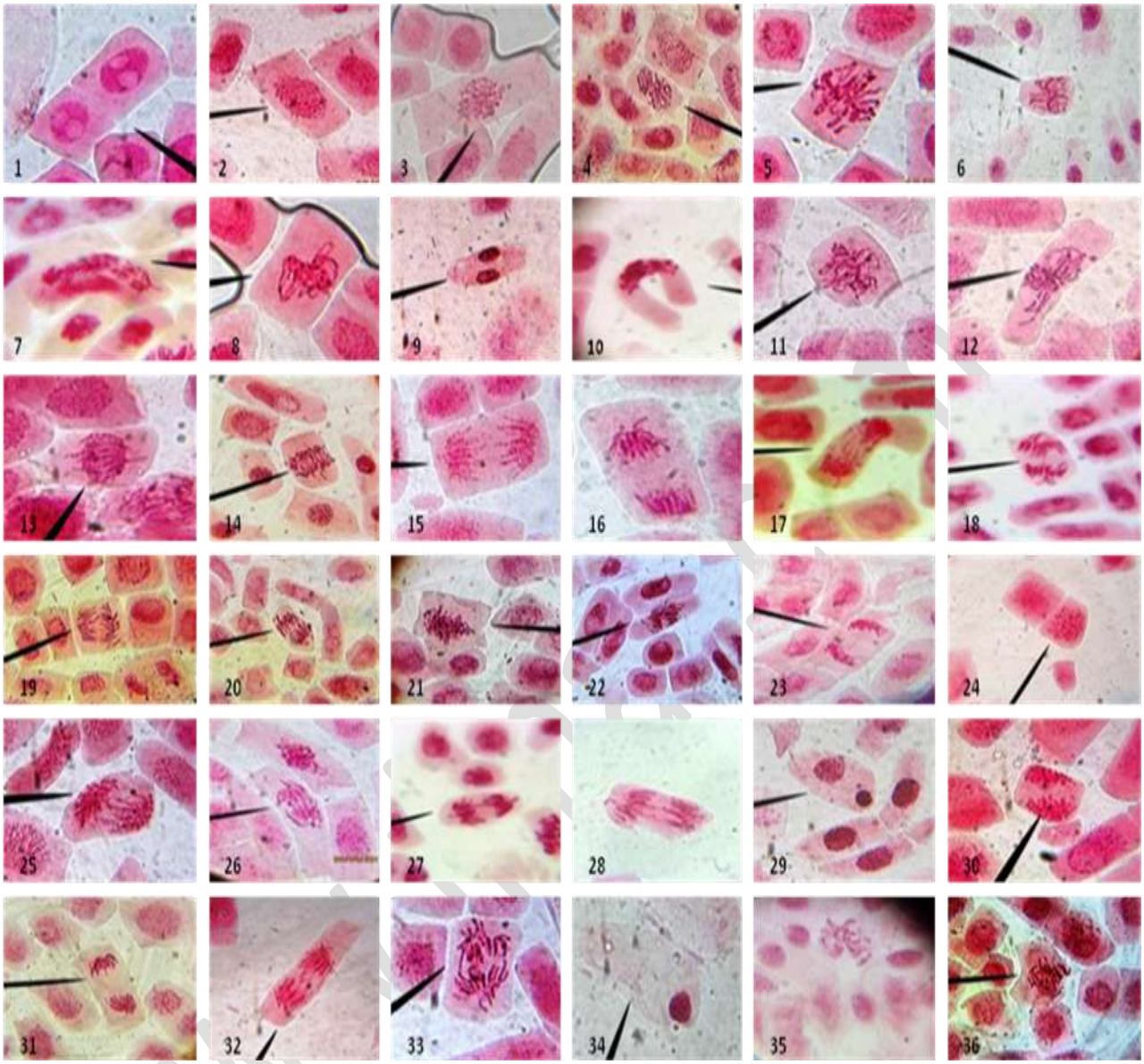

Fig. 1 Few of the chromosomal aberrations observed in the root tip meristems of onion after treatment with malathion and furadan: 1.Binucleate cell 2. Spiral chromosome 3. Late prophase 4. Despiralised prophase 5,6. Chromosome breakage in metaphase 7.Disoriented metaphase 8.Vagrant metaphase 9. Cell with two distinct nucleus 10. Sticky chromosomes in metaphase 11. Clumped metaphase 12. Disoriented metaphase 13. Sticky anaphase 14. Laggards and bridges 15. Chromosome breakage 16. Sticky anaphase 17. Breakage and bridges 18. Anaphase laggards 19. Disoriented anaphase with laggards 20. Laggards 21. Broken clumped chromosomes 22. Late anaphase with laggards 23. Star anaphase 24. Spiral chromosomes 25. Sticky anaphase with spiral bridges 26. Disoriented anaphase 27, 28. Chromosome with single and double bridge respectively 29. Dead cell 30. Disoriented anaphase 31. Star anaphase 32. Bridge in anaphase 33. Disoriented metaphase 34. Dead cell 35. Clumped chromosome 36. Chromosome stickiness.

Table: 2 Effect of malathion and furadan on germination of rice

Pesticide	Concn.(µg/ml)	IR64	Sahbhagi
	Control	2.60±1.00	2.771±1.114
Malathion	0.1	2.44±0.966	2.64±1.08
	0.5	2.33±0.950	2.614±1.07
	0.75	2.292±0.937	2.50±1.06
	1	2.145±0.190	2.50±1.06
Furadan	50	2.554±1.053	2.682±1.073
	100	2.448±1.026	2.505±1.025

Table: 3 Shoot length and root length under the effect of pesticides- malathion and furadan.

Rice variety	Chemical conc. (µgm/ml)	Shoot length (cm)	Root length (cm)
		MALATHIAN	
IR64	Control	17.31±0.190	11.21±0.321
	0.1	16.36±0.47	10.46±0.422
	0.5	14.833±0.47	9.966±1.242
	0.75	14.63±0.50	8.733±0.763
	1	12.86±1.174	6.933±0.89
Sahbhagi	Control	17.2±1.157	7.666±0.489
	0.1	16.83±0.360	7.3±0.282
	0.5	15.2±1.720	6.933±0.422
	0.75	14.76±0.276	6.5±0.623
	1	14.233±0.438	6.333±0.732
		FURADAN	
IR 64	Control	14.8±0.169	7.933±0.699
	50	13.2±0.094	6.7±0.294
	100	11.366±0.465	4.466±0.589
Sahbhagi	Control	14.466±0.190	8.2±0.169
	50	13.9666±0.212	7.4±0.094
	100	13.166±0.151	5.13±0.118

Table: 4 Shoot weight (fresh and dry), root weight (fresh and dry) under the effect of malathion and furadan.

Rice variety	Chemical conc. (µg/ml)	Shoot fresh weight (mg)	Shoot dry weight (mg)	Root fresh weight (mg)	Root dry weight (mg)
			MALATHION		
IR64	0.1	0.159±0.01	0.046±0.002	0.0282±0.022	0.0226±0.0007
	0.5	0.144±0.01	0.040±0.007	0.0239±0.001	0.019±0.0009
	0.75	0.133±0.03	0.039±0.003	0.0222±0.001	0.017±0.0012
	1	0.090±0.004	0.0376±0.002	0.0185±0.005	0.015±0.0007
Sahbhagi	Control	0.2822±0.001	0.066±0.0020	0.11983±0.0036	0.0183±0.0021
	0.1	0.2645±0.010	0.0496±0.0026	0.0839±0.0091	0.018±0.0021
	0.5	0.2546±0.0246	0.0453±0.0017	0.0546±0.0194	0.0136±0.002
	0.75	0.2207±0.0089	0.04±0.002	0.0335±0.0053	0.0093±0.005
	1	0.213±0.0811	0.0396±0.003	0.0176±0.0028	0.012±0.0014
			FURADAN		
IR 64	control	0.042±0.0026	0.0156±0.001	0.0146±0	0.007±0.002
	50	0.0416±0.0005	0.013±0.00	0.0133±0.000	0.006±0.000
	100	0.032±0.001	0.0113±0.00	0.0096±0.001	0.005±0.001
Sahbhagi	Control	0.0438±0.001	0.0098±0.002	0.017±0.001	0.0073±0.001
	50	0.042±0.000	0.013±0.000	0.0146±0.001	0.0062±0.000
	100	0.0276±0.005	0.01±0.000	0.0126±0.000	0.0046±0.000

Table 5 Effects of malathion and furadan on relative water content (RWC) of shoot.

Pedticides	Conc.(µg/ml)	Rice variety	Relative Water Content of shoot (%)
Malathion	Control	IR64	86.99
	0.1		86
	0.5		84.88
	0.75		80.30
	1		76.335
	Control	Sahbhagi	82.67
	0.1		81.89
	0.5		79.23
	0.75		73.11
	1		53.49
Furadan	50	IR64	83.94
	100		80.21
	50	Sahbhagi	82.01
	100		79.66

Table: 6 Effect of furadan on total chlorophyll content of rice

Rice variety	Chemical conc.(µg/ml)	Chlorophyll content(mg/ml)
IR64	Control	16.883
	50	13.454
	100	12.578
Sahbhagi	Control	12.86
	50	10.898
	100	10.83

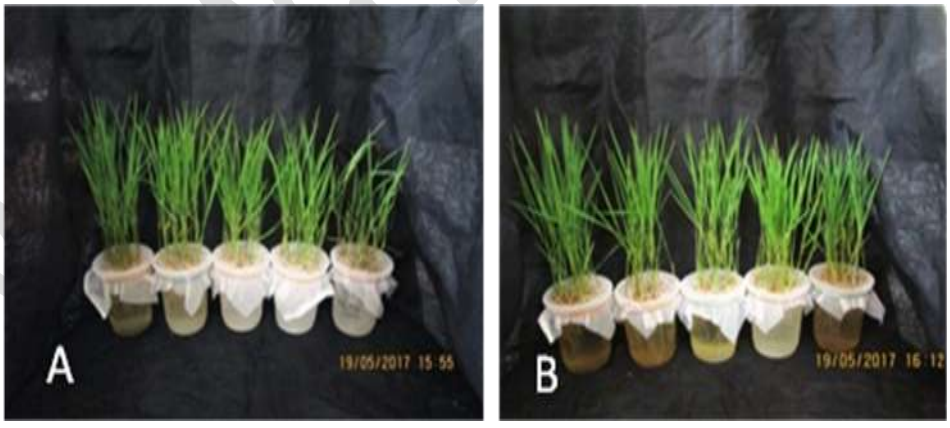

Fig. 2 Effect of 0.1, 0.5, 0.75 and 1µg/ml malathion on shoot length and the control. A. IR64, B. Sabhagi.

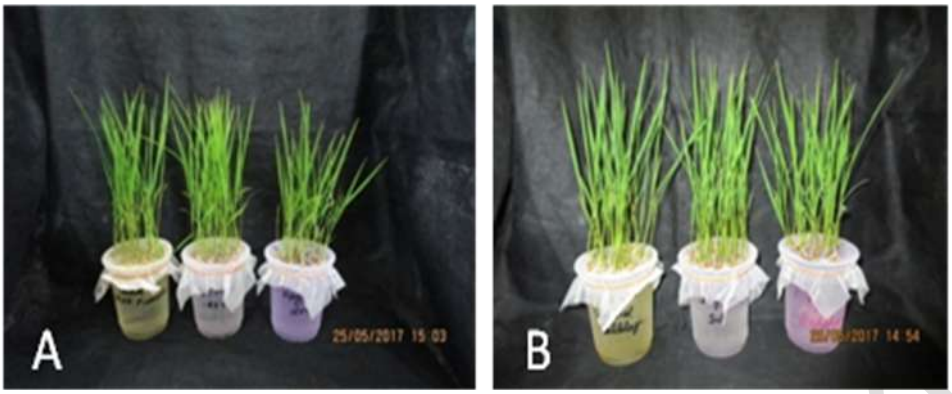

Fig. 3 Effect of 50 and 100µg/ml furadan on shoot length in comparison to control, A. IR64 B. Sabhagi

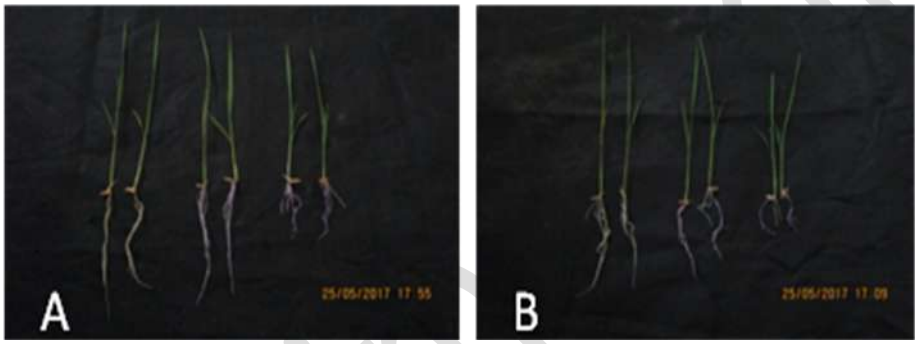

Fig. 4 Effect of 50 and 100µg/ml furadan on the root length in comparison to the control. (A) IR64 (B) Sabhagi.

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