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INFLUENCE OF SALINITY ON MITOTIC DIVISION AND CHROMOSOMAL BEHAVIOUR OF SOME TAXA OF ZYGOPHYLLUM

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The present investigation deals with the effect of salinity (NaCl) on seed germination, mitotic division and chromosomal behaviour of some taxa of *Zygophyllum* naturally growing in the Egyptian deserts. These species are *Z. simplex, Z. decumbens Z. coccineum, Z. aegyptium, Z. album, Z. berenicense and Z. propinquum.* The applied concentrations of NaCl were 31, 62, 125, 250, 350, and 500 mM. The results indicated that the seeds of different taxa showed different percentages of germination under normal conditions. The highest percentages were recorded with *Z. simplex* and *Z. coccineum*, whereas, the lowest percentages of germination were recorded with seeds of both varieties of *Z. decumbens*. For all studied species, the germination percentage decreased with increasing the NaCl concentration. Moreover, no germinated seeds were recorded at 350 mM and 500 mM for all the studied taxa. The results also revealed that all the studied taxa have Mitotic index (MI) values less than 6 %, where the MI values ranged from 5.93 to 4.20 and which recorded in *Z. album* and *Z. berenicense,* respectively. Under salt stress, the mitotic values sharply decreased with the increase of NaCl concentration and the lowest value of 0.04% was recorded following treating the root tip cell of *Z. coccineum* with 250 mM. In the treated roots, the inhibition of the mitotic division was accompanied with imbalance in the frequencies of the mitotic stages. At higher concentrations of NaCl, the decreases in MI value are associated with the induction of chromosomal abnormalities in all studied taxa of *Zygophyllum*. The percentage of the total abnormalities was increased with the increase of NaCl concentrations. The treatment induced different types of chromosomal aberrations and the chromosomal stickiness was the most common type of abnormality in all taxa.

Keywords: salinity, germination, mitotic division, chromosomal aberrations, *zygophyllum.*

The sensitivity of plant to salinity may depend on their developmental stages (Adam, 1990) and may be greater during germination than during seedling growth and development (Bewley and Black, 1982). The salinity is known to affect many aspects of the plant metabolism and to induce changes in their anatomical and morphological characters. Salinity caused a loss in plant growth and productivity in most treatments. Poljakoff-Mayber (1975) and Mayer and Poljakoff-Mayber (1978) reported that different responses to salinity have been found between germinating and growing seedlings of a number of halophytes and the first author found that a little changes in volume of the nuclei and an increase in the amount of DNA per cell in root tips of pea plants growing under salinity conditions. Also, the changes in the amount of plant cell ultra-structure and/or inhibition of the cell division in *Vigna sinensis* (Cathey, 1964), *Zea mays* (Nir *et al.*, 1970) and *Atriplex halimus* (Badawy, 1984) root tips were induced by the addition of NaCl to the growing medium and become more distinctive with increasing the salinity and prolongation of the exposure period. The reduction in the rate of seed germination was reported in some halophytic and non-halophytic plants following the treatment with different concentrations of NaCl (Farghal, 1990; Gonzales and Prado, 1992; Noor and Khan, 1995; Ungar, 1996 and Prado *et al.*, 2000). Moreover, Mansour (1994) found that the cessation of germination of *Inula crithmoides* seeds at higher concentrations of salinity and the mitotic index values decreased with the increasing of the osmotic agent concentrations. *Zygophyllum* is a dicotyledoneous genus native to the Egyptian desert where it is used as a very important medicinal plant and it is represented by different taxa grown as halophyte plants in salty soils. In halophytes, adaptation to salinity is associated with metabolic adjustment that led to the accumulation of several organic solutes (Briens and Larher, 1982).

Several investigators studied the effect of salinity as an ecological factor on the germination of seeds of different *Zygophyllum* species (Agami, 1986; Ismail, 1990; Khan and Ungar, 1996 and 1997). So, it is important to investigate the influence of salt stress on the seed germination with its relationship with the cell division and chromosomal behaviour of these taxa where less is known about the response of cell division in meristematic cells when they are subjected to salt stress.

MATERIALS AND METHODS

Seeds of nine taxa of genus *Zygophyllum* (7 species and 2 varieties) were collected from the plants grown in their natural habitats in the Egyptian deserts (Table 1) and their latitude and longitude were determined by using GPS apparatus.

TABLE (1). List of the studied species of *Zygophyllum* and their collection sites.

NO.	Species	collection site		Latitude: Longitude N	E
1.	*Z. simplex* L.	Attaqa	Red sea	29°53'	32°26'
2.	*Z. decumbens* Del. var. *decumbens*.	Suez gulf k30 South	Red sea	29°44'	32°23'
3.	*Z. decumbens* Del. var. *megacarpum* A. Hosny	Suez gulf k30 South	Red sea	29°44'	32°23'
4.	*Z. coccineum* L.	Suez gulf k30 South	Red sea	29°44'	32°23'
5.	*Z. album* var. *album*.	Suez gulf k30 South	Red sea	29°44'	32°23'
6.	*Z. album* var. *amylocarpum*.	Suez gulf k30 South	Red sea	29°44'	32°23'
7.	*Z. berenicense* (Muschler) Hadidi.	Suez gulf k30 South	Red sea	29°44'	32°23'
8.	*Z. aegyptium* A. Hosny	Damietta – Sidi Shata	Mediterranean sea	31°25'	31°52'
9.	*Z. propinquum* Decne.	Suez gulf k30 South	Red sea	29°44'	32°23'

Seeds were selected for uniformity of size and mass. Seeds were sterilized by immersing in 2% sodium hypochloride for 3 minutes and rinsed repeatedly with distilled water. One hundred seeds from each species (Four replicates of 25 seeds each) were placed in 7 cm Petri- dishes containing a sheet of Whatmann No.1 filter paper moistened with distilled water at $25 \pm 1^{0}C$ under dark conditions, then allowed to germinate. The number of the germinated seeds (radical protrusion as a criterion) was counted and the germination percentages were estimated (Ramiro *et al.*, 1995). The germinated seeds were removed and fixed in 3:1 ethanol: glacial acetic acid solution overnight and stored in 70% ethanol in refrigerator until use for cytological preparations. To study the effect of salt stress, 100 seeds of each species were germinated in the same manner with replacing the distilled water with required NaCl solution. The different applied concentrations were 0.0, 31, 62, 125, 250, 350 and 500 mM. The germinated seeds were counted and after immersion in different concentrations of NaCl, the percentage of the germination was estimated under the salt stress conditions.

For cytological preparation, the treated and untreated meristematic root tips were removed from the fixed germinated seed, washed several times, blotted on filter paper, hydrolyzed in 1N HCl for 8 minutes at 60^0C and stained in Feulgen reagent for 2 hours. At least 3 stained meristematic root tips were squashed for each treatment and the control. In each preparation the number of the dividing cells in each stage were scored. The mitotic index and mitotic phases frequencies were calculated for each species. Also, the total number of abnormal cells and the number of each type of abnormality in each mitotic stage with the different treatments for each species were estimated.

RESULTS

Under Normal Conditions

Seed germination

From the results given in table (2), it was found high variations in the germination percentages of seeds of the different taxa of *Zygophyllum* germinated in distilled water. These variation range from 88% to 13.8%. The highest germination percentage of 88% was found in *Z. simplex* and *Z. coccineum*. The lowest one was found in both varieties of *Z. decumbens* (13.8% in *Z. decumbens* var. *decumbens* and 16.6% in Z. *decumbens* var. *megacarpum*). There is a remarkable variation in the germination percentages in both varieties of *Z. album*, where the germination percentage in *Z. album* var. album was 61.7% and was 82% in *Z. album* var. *amylocarpum*. Also, it was found that *Z. berenicense* and *Z. aegyptium* had germination percentages of 84% and 67.6%, respectively.

Mitotic index

The results in table (2) show that the mitotic index of the root tip cells of the different studied species of *Zygophyllum* was in variable values. The values range from 5.93% to 4.20%. The highest mitotic index value was recorded in *Z. berenicense* of 5.93% but the lowest mitotic index were scored in both varieties of *Z. album* (5.00% in *Z. decumbens* var. *decumbens* and 5.10% in *Z. decumbens* var. *megacarpum*). In both varieties of *Z. decumbens*, the calculated mitotic index values were almost in equal value. The values were 4.25% in *Z. album* var. *album* and 4.90% in *Z. album* var. *amylocarpum*, respectively.

Mitotic phases frequencies

The frequencies of the different mitotic phases in root tip cells of the different taxa of *Zygophyllum* are given in table (2). From these results, it is obvious that a remarkable variation was observed in the percentage of each phase in the different studied species of *Zygophyllum*. The results showed that the prophase frequency ranges from 35.76% to 5.3%. The highest percentage was recorded in *Z. album* var. *album* (35.76%) and the lowest percentage was recorded in *Z. simplex* (5. 37%). It was notable that, the little in the prophase percentages between the two varieties of each of *Z. decumbens* and *Z. album* .The prophase percentages for *Z. decumbens* var. *decumbens* and *Z. decumbens* var. *megacarpum* were 29.52% and 25.09%, respectively, and in *Z. album* var. *album* and *Z. album* var. *amylocarpum*, were 35.76% and 23.78%, respectively. The metaphase frequency ranges from 36.99% to 9.95%. The highest metaphase percentage was found in *Z. berenicense* (36.99%) and the lowest one was in *Z. simplex* (9.96%). While the two varieties *Z. decumbens* had a closely related values (34.90% for *Z. decumbens* var. *megacarpum* and 31.43% for *Z. decumbens* var. *decumbens*). The two varieties of *Z. albums* showed differences in their metaphase values where the value of 32.72% was recorded in *Z. album* var. *amylocarpum* and the value of 22.59% in *Z. album* var. *album*. The anaphase frequency ranges from 24.09% to 9.77%. The highest anaphase percentage was found in *Z. coccineum* (24.09%), and the lowest one was in *Z. simplex* (9.77%). The two varieties of *Z. decumbens* had anaphase percentages of 23.81% for *Z. decumbens* var. *decumbens* and 22.35% for *Z. decumbens* var. *megacarpum*. Although the two varieties of *Z. album* had different anaphase percentages of 16.97% in *Z. album* var. *album* and 18.91% in *Z. album* var. *amylocarpum*. The telophase frequency ranges from 74.90% to 15.24%. The highest anaphase percentage was found in Z. simplex (74.90%) and the lowest one was recorded in Z. *decumbens* var. *decumbens* (15.24%). The telophase percentages for other species were ranged from 19.16% (in *Z. coccineum*) to 24.88% (in *Z. propinquum*) and the telophase percentages of *Z. album* var. *album* and that of *Z. album* var. *amylocarpum* were 24.71% and 24.59%, respectively.

Under NaCl Stress

Seed germination

From the results in Table (2), it was obvious that the increase in the concentration of NaCl decreased the germination percentage values for each species less than their respective control values. At the NaCl concentration of 31 mM, the germination percentage of all tested species was slightly different from those of the control values.

At higher NaCl concentrations of 62 mM and 125 mM, germination percentages for all taxa were gradually decreased when compared with their control values. At NaCl concentrations of 250 mM, a sharp drop in the germination percentage values than their control values was observed in all species (except those of *Z. album* var. *amylocarpum*, *Z. berenicense* and *Z. aegyptium* where the germination percentages were relatively high), whereas at the same concentration no seeds of *Z. propinquum* germinated. Under saline condition of concentration 350 mM and 500 mM, no germination was recorded in all tested species.

TABLE (2). The germination percentages, mitotic index values and frequencies of the different mitotic phases in root tip cells of the different species of *Zygophyllum* tested under different concentrations of NaCl.

Species	NaCl (mM)	Germ. (%)	% of Mitotic Phases P	M	A	T	MI ± SE
Z. simplex	0.0	88.0	5.36	9.96	9.77	74.90	5.25±0.02
	31	86.7	57.40	30.83	9.33	2.43	4.93±0.04
	62	73.3	23.71	38.79	21.12	16.38	2.23±0.03
	125	66.6	19.86	48.63	17.12	14.38	1.46±0.01
	250	10.0	44.83	24.14	12.64	18.93	0.87±0.01
Z. decumbens var. *decumbens*	0.0	13.8	29.52	31.43	23.81	15.24	3.15±0.02
	31	20.5	34.65	28.01	20.75	16.60	2.82±0.03
	62	06.0	36.21	11.52	17.28	34.80	2.43±0.04
	125	04.0	44.44	18.52	23.15	13.89	1.08±0.03
	250	06.0	61.90	0.0	0.00	38.10	0.42±0.02
Z. decumbens var. *megacarpum*	0.0	16.6	25.10	34.90	22.35	17.65	3.10±0.02
	31	08.0	24.85	27.01	16.63	31.51	3.00±0.01
	62	13.0	68.67	9.05	11.45	10.84	2.32±0.02
	125	04.0	28.19	43.62	18.78	9.40	1.49±0.02
	250	1.70	100	0.00	0.00	0.00	0.10±0.01
Z. coccineum	0.0	88.8	27.01	29.74	24.09	18.01	5.48±0.02
	31	71.0	38.05	30.41	20.95	10.59	4.44±0.01
	62	50.0	41.21	27.47	13.19	17.53	1.82±0.03
	125	34.0	38.87	22.23	14.18	24.07	0.54±0.02
	250	04.0	100	0.00	0.00	0.00	0.04±0.05
Z. album var. *album*	0.0	61.7	35.76	22.59	26.94	14.71	4.25±0.01
	31	53.1	36.76	21.79	15.37	25.18	4.13±0.02
	62	43.0	36.88	21.67	16.73	24.71	2.63±0.03
	125	40.6	39.51	20.54	21.95	18.90	1.64±0.02
	250	04.6	60.00	20.00	20.00	0.00	0.50±0.02
Z. album var. *amylocarpum*	0.0	82.0	23.78	32.72	18.90	24.60	4.92±0.02
	31	81.0	25.74	24.56	20.72	29.43	4.13±0.01
	62	78.5	26.27	38.56	10.17	25.00	2.36±0.01
	125	75.0	33.02	26.98	14.86	25.14	2.15±0.03
	250	28.0	38.21	21.14	14.63	26.02	1.25±0.03
Z. berenicense	0.0	84.0	30.19	36.93	12.65	20.58	5.93±0.01
	31	80.0	30.37	35.98	17.45	16.20	5.42±0.03
	62	72.7	34.30	46.80	6.40	15.50	3.44±0.02
	125	46.6	56.67	30.15	9.56	3.62	1.36±0.01
	250	23.7	37.78	33.33	11.11	17.78	0.45±0.04
Z. aegyptium	0.0	67.6	33.66	24.76	17.60	23.98	5.13±0.03
	31	65.0	30.30	26.67	17.17	25.86	4.95±0.01
	62	52.6	34.90	28.28	15.52	21.30	2.77±0.02
	125	45.0	38.68	22.07	15.50	23.75	2.13±0.02
	250	39.0	42.86	22.86	20.00	14.28	0.70±0.01

* P = prophase, M = Metaphase, A = Anaphase, T= Telophase, MI = Mitotic index, Germ = Germination.

Mitotic index

The results in table (2) showed that the mitotic index values of the root tip cells of the different studied species of *Zygophyllum* is affected by the different NaCl concentration treatments comparing with their respective control values. At the lowest NaCl concentration of 31 mM, mitotic index values slightly decreased in their values (Except those of *Z. decumbens* var. *decumbens*, *Z. album* var. *album* and *Z. berenicense*). At higher concentrations, the decrease in the mitotic index values accompanied by the appearance of chromosomal aberrations which were ranged from 13.79% to 100% in accordance to the species and the NaCl concentrations.

Mitotic phases frequencies

The results in table (2) showed that a remarkable variation in the percentage of each mitotic phase in the root tip cells of different studied species of *Zygophyllum* with different NaCl concentrations. From these results, it was found that the percentages of prophase, metaphase, anaphase in *Z. simplex* increased on the expense of the telophase percentage, but in *Z. berenicense* and *Z. coccineum*, the prophase percentage values were increased on the expense of the other mitotic phases percentage values in compared with their respective control values. But in the varieties of *Z. decumbens*, the increase of the applied NaCl concentration solution increased the prophase and the telophase percentage values comparing with their respective control values and the metaphase and anaphase percentages values were decreased in regard to their control values .In both varieties of *Z. album*, a gradual increase in prophase percentage values was recorded by increasing the NaCl concentration but the other percentages of the other mitotic phases have unclear relation by increasing the NaCl concentration.

Types of abnormalities

The results given in table (3) showed that the treatments with different concentrations of NaCl induced a different number of abnormal cells in the different stages of mitosis in root tip cells of different studied taxa of *Zygophyllum*. In each taxon, the total percentage of abnormalities increased with the increase of NaCl concentration. For each applied concentration of the lowest percentage range of 13.8% to 58.6% of abnormalities was recorded in root tip cells of *Z. simplex* but the highest percentage range of 59% to 100% was scored in root tip cells of both varieties *Z. decumbens* var. *decumbens*, where all the divided cells were abnormal with the NaCl concentrations of 125 mM and 250 mM. Also following the treatment with the 250 mM concentration of NaCl all divided cells in root tips of *Z. coccineum*, *Z. album* var. *album*, *Z. berenicense* and *Z. aegyptium* were abnormal. In different species of *Zygophyllum* the treatments induced a different types of abnormalities. These types were stickiness, disturbed chromosomes, lagging chromosomes, vacuolated nucleus at prophase and diagonal at anaphase. The sticky chromosomes was the most dominant type of abnormalities and was observed with all treatments of NaCl. The other types were recorded in different frequencies with the most treatments. Different types of chromosomal aberrations are given in fig. (1).

TABLE (3). Total abnormal cells, the total percentage and types of abnormalities in the different mitotic cell stages following the treatments with different concentrations of NaCl.

Species	Conc. NaCl (mM)	% Total abn.	% of abn. at different mitotic stages				Percentages and types of abnormalities				
			P	M	A	T	Stick.	Dist.	Lag.	Vac.	Diag.
Z. simplex	62	13.8	40.6	59.4	--	--	43.75	34.38	--	21.78	--
	125	30.8	22.3	53.3	13.3	11.1	51.10	26.67	4.44	11.11	6.66
	250	56.6	49	21.6	13.7	15.7	50.98	19.60	7.84	9.80	11.76
Z. decumbens var. *decumbens*	62	60	73	--	--	--	47.61	--	--	35.71	29.16
	125	100	46.6	14.6	24.2	14.6	46.15	26.92	3.84	7.68	15.36
	250	100	61.9	--	--	38.1	36.36	18.18	13.63	13.63	18.18
Z. decumbens var. *megacarpum*	62	59	100	--	--	--	58.06	22.58	--	19.35	--
	125	100	28.2	43.6	18.8	9.4	32.00	28.00	8.00	16.20	16.00
	250	100	100	--	--	--	1.00	--	--	--	--
Z. coccenium	62	36.3	31.8	36.4	13.6	18.2	42.43	18.18	9.09	21.22	9.09
	125	74	37.5	25	15	22.5	46.00	25.00	10.00	10.00	10.00
	250	100	100	--	--	--	1.00	--	--	--	--
Z. album var. *album*	62	39.9	50.5	12.1	12.4	16.1	48.00	20.00	20.0	12.00	--
	125	48.2	26.6	31.7	26.6	15.1	48.68	22.58	14.91	14.91	3.22
	250	100	60	20	20	--	41.68	20.83	20.83	8.33	8.33
Z. album var. *amylocarpum*	62	28.81	27.9	47.1	8.8	16.2	31.25	31.25	21.87	9.38	6.25
	125	17.21	21.6	32.4	21.6	24.4	44.05	29.41	5.88	17.66	--
	250	60.16	25.7	23	19	32.3	50.00	25.00	25.00	--	--
Z. berenicense	62	37.2	40.6	42.2	3.90	13.3	53.12	25.00	9.38	9.38	3.12
	125	56.6	59.7	24.7	9.1	6.5	45.42	36.36	18.19	--	--
	250	100	48.9	33.3	11.1	6.7	60.00	40.00	--	--	--
Z. aegyptium	62	40.80	56	16	16	14	39.29	28.57	10.71	14.28	7.14
	125	56.8	25.6	20.7	20.7	13.2	47.62	28.57	14.28	4.76	4.76
	250	100	42.9	20	20	14.2	50.00	25.00	16.67	3.33	--
Z. propinquum	62	18.9	--	--	--	--	47.62	23.81	28.57	--	--
	125	65.6	38.7	12.5	12.5	22.5	40.00	30.00	20.00	10.00	--
	250	0.00	--	--	--	--	--	--	--	--	--

• No abnormalities were recorded at both the control (0.00 mM) and at 31mM

•• P = Prophase, M = Metaphase, A = Anaphase, T = Telophase, Stick = Sticky chromosomes, Dist = Disturbed chromosomes, Lag = Lagging, Vac. = Vacuolated, Diag = Diagonal anaphase.

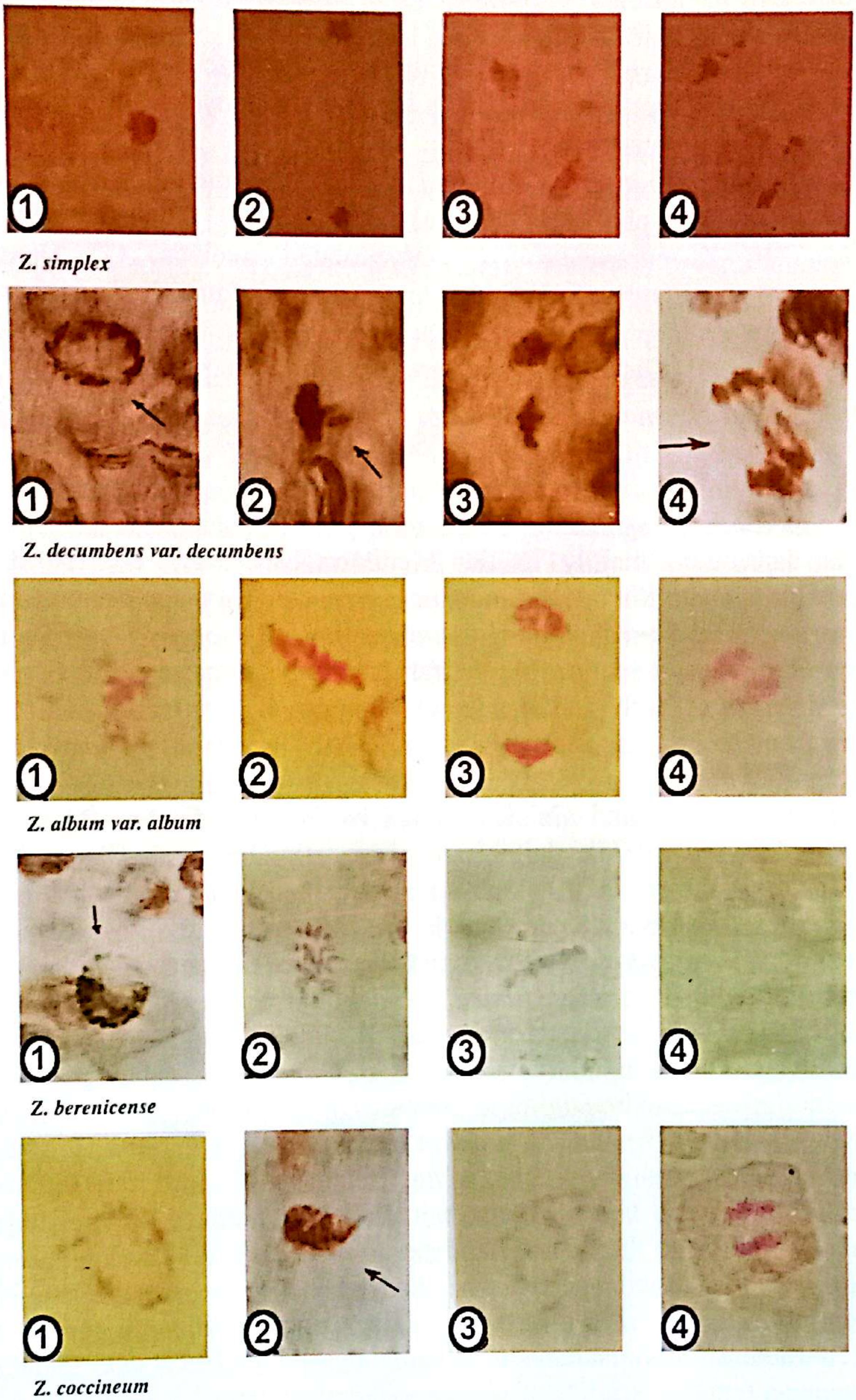

Fig. (1). **Different types of mitotic abnormalities induced in some taxa of *zygophyllum* root tip cells following the treatment with different concentrations of NaCI**

In *Z. simplex*: (1) Sticky prophase, (2) Sticky anaphase, (3) Diagonal at anaphase, (4) Sticky metaphase with lagging chromosomes.

In *Z. decumbens* var. decumbens: (1) Vacuolated nucleus, (2) Sticky metaphase with lagging chromosome, (3) Diagonal at anaphase, (4) Bridges.

In *Z. album* var. album: (1) Disturbed metaphase, (2) Sticky metaphase, (3) Unequal distribution, (4) Double bridges.

In *Z. berenicense*: (1) Vacuolated nucleus, (2) Disturbed metaphase, (3) Sticky metaphase, (4) Disturbed anaphase.

In *Z. coccineum* : (1) Vacuolated nucleus, (2) Sticky prophase, (3) Disturbed metaphase, (4) Sticky anaphase.

DISCUSSION

In the Egyptian flora, the genus *Zygophyllum* is represented by 10 species distributed mainly in the Mediterranean coast, Eastern desert, Western desert and Sinai. Of which, seven species were represented in this study; these species are belonging to two sections of subgenus Agrophyllum, section Bipartia and section Mediterranea. The germination of seeds is an important process, each plant has its own manner of germination which may be governed by many aspects concerning the seed or the surrounding environments and the requirement of these conditions vary according to species and variety, and are determined by heredity factors (Mayer and Poljakoff-Mayber, 1978). In this concern, Bewley and Black (1982) concluded that the seeds of halophytes are adapted to a saline environment, those of non-halophytes have variable salt-tolerance limits with respect to germination. *Z. simplex* has the highest germination percentage of these species belonging to section *Bipartia*, but both varieties of *Z. decumbens* have the lowest calculated percentages of all studied taxa (13.8% and 16.7%, respectively). This variation may be due to that *Z. simplex* as being an annual herb. In the species belonging to section Mediterranea, the germination percentages ranged from 62% to 88% indicating high variability of these species. Under stress conditions, it was found that the different culture of sodium chloride lead to delay the germination and to reduce its percentage in all taxa according to the tolerance of the taxa and to NaCl concentration. In general, all the tested species can withstand the stress until the NaCl concentration reaches 250 mM but at higher concentrations no germination was recorded. Similar results were obtained by Koller (1955) who found that *Z. dumosum* (another species of section Altae of subgenus Agrophyllum, can withstand NaCl concentration of 300 mM, but Agami (1986) found that *Z. dumosum* seeds may germinate at soil salinity of 500 mM with special soil regimes, reached to the same results . It is assumed that the decrease in the percentages of germination of salt stressed *Zygophyllum* seeds is either due to a low water entry into seeds or to metabolic alteration or due to both of them. In this concern, Greenway and Munns (1980) found that salinity could inhibit germination or plant growth by lowering external water potential affecting ion toxicity and ion imbalance and also Bewley and Black (1982) reported that salinity may affect the germination of seeds in two ways (a) by creating an osmotic potential to prevent water uptake and/or (b) by providing conditions for the entry of ions which may be toxic to the embryo or developing seedling. When the water supply decreases several changes take place while plant growth is inhibited. A decrease in the water potential of the environmental effects of water potential of plant tissues which is supported to act as driving force to more water into the cell, turger is lost, depriving the cells of the force needed to extend the cell walls, consequently the growth ceases immediately. This observation complements that radicle growth can proceed at a lower potential than the initiation of radicle elongation. During germination the seeds are more susceptible to damage by salt water than is the established seedlings (Bewley and Black, 1982). On the other hand, the decrease in germination percentage under stress condition could be attributed to a general decrease in total metabolic activity caused by salt stress where Prado *et al.*, (2000) found that, the decrease in glucose and fructose in the embryonic axis in the seeds of *Chenopodium quinoa* treated with NaCl whereas a high level of hexose was observed in embryonic axis in distilled water and could also be related to NaCl inhibition of α amylase (Lin and Kao, 1995) and because carbohydrates, especially starch, represent the major reserve substances in most seeds. According to Gill and Singh (1985) germination, growth and other related processes can be affected in seeds that are subjected to salt stress changes in any one of these processes can affect other metabolic activities, particularly the carbohydrates metabolism that plays an important role in germination. During early germination, mobilization of storage carbohydrates occurs and mobilizes into soluble forms such as glucose fructose and sucrose before germination is completed (Bewley and Black, 1994), that are readily transportable to site where they are required for growth (Mayer and Poljakoff-Mayber, 1978).

The mitotic index values of the different species of *Zygophyllum* under normal germination conditions using distilled water were generally dependent on the germination percentage values. The mitotic phase percentages of the different studied taxa vary from species to species and even within the varieties of the same species. From these values, we can conclude that *Z. simplex* has the highest telophase percentages in all tested taxa (74.9%). For the other species, the prophase percentages and the metaphase percentages have higher values over those values of anaphase and telophase in both varieties of *Z. decumbens* and *Z. coccineum*, while in both varieties of *Z. album*, *Z. berenicense* and *Z. aegyptium*, the anaphase percentage have lower percentages than those of the other mitotic phases percentages, the metaphase percentages value in *Z. propinquum* has the highest percentage. The mitotic index values in the root tip cells of the different *Zygophyllum* species generally decreased by increased osmotic potential indicating the mitotic division is favored under non- saline conditions. Bernstein and Hayward (1958) attributed the reduction in growth due to inhibition of cell division by sodium chloride. On the other hand, the decrease in the rate of cell division by using salinity could be attributed either to the reduction of the moisture requirements of the tissue or due to inadequate moisture supply. Moreover, the inhibition of cell division by increased osmotic potential may be caused by micro tubule depolymerization which may be affect all the event which are involved with the spindle functionality (Seijo *et al.*, 1997).

Also, the results showed that, the treatment with NaCl altered the frequencies of different mitotic phases. So, this effect could be due to the action of salinity condition on the nuclear metabolism (Mansour, 1989) or by lowering the DNA content (Barakat, 1966; Badr and El-Sheikh, 1980; Zeinab and Sallam, 1996). Moreover, the disturbances in the mitotic activity and alterations in the frequency of the mitotic phases may be ascribed to the effect of the osmotic agent (NaCl) on the spindle formation (Mansour, 1994). The failure of the mitotic index to reach the control level seemed to be due to retardation of cell division (Kulieva *et al.*, 1975 and Mansour, 1994). In general, a decrease in the telophases frequencies among the treated plants compared with the controls indicated that NaCl prevented most of the cell from passing into mitosis by accumulating them in the prophase and metaphase. The increase in the prophase percentage might indicate a delay in the spindle formation and the accumulation of metaphase suggests disorder of the mitotic spindle. In addition, the steep reduction of anaphase frequency in almost all treatment was also to some extent a valuable indicator of the inhibition of mitotic mechanisms. In this study, chromosomal aberration were recorded in the studied species with the applied NaCl concentrations more than 31mM. These aberrations ranged from 13.79% to 100% in accordance to the species and the NaCl concentrations. Cathey (1964), Hussein *et al.* (1988), Mansour (1994) and Galal and Abd-Alla (1996) observed similar results by using other salts. In this respect, Matsuura and Iwabuchi (1962) concluded that salts such as sodium chloride or potassium chloride induced an alteration of ionic environment in the cells, which indirectly resulting chromosomal aberrations.

Different types of chromosomal abnormalities were observed as a result of the treatments (Table 2), among which were the following: stickiness, vacuolated nucleus, lagging chromosomes, disturbed metaphase and diagonal anaphase. The occurrence of lagging chromosomes could be due to a hindrance of the pro-metaphase movement of the chromosomes to the adjacent inner surface of the phases (Amer, 1973). Lagging chromosomes were also referred to a chromosome with inactivated centromere (Tomkins and Grant, 1972), this inactivation prevents the chromosome from inserting into the spindle fibers and continuation of the normal kinetics of the cellular division. This type was observed by other inorganic salts (Misra, 1982 and Mansour, 1994). Sticky chromosomes were the most frequent types are induced by all the treatments of NaCl. The occurrence of this type could be explained on the physiological bases where the stress may lead to liberation of enzymes from lysosome which affect nucleic acid or nucleoprotein altering their properties (Mertz, 1969), while the induction of spindle disturbance may be due to an influence of the osmotic agents on microtubules formation and/or orientation (Mansour, 1994). Vacuolated nucleus was observed with some treatment. In this type, the chromatin lost its staining ability or appeared as dense granulated and nuclei become vacuolated.

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تأثير الملوحة على الانقسام الميتوزي والسلوك الكروموسومي لبعض الوحدات التصنيفية للزيجوفيللم

عباس الغمري ، محمود منصور ، عصام عبد العظيم ، أحمد قاسم
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يختص هذا البحث بدراسة تأثير الملوحة (كلوريد الصوديوم) على إنبات البذور والانقسام الميتوزي والسلوك الكروموسومي لبعض الوحدات التصنيفية لنبات الزيجوفيللم (الرطريط) الذي ينمو بريا في الصحاري المصرية. وهذه الوحدات التصنيفية هي: زيجوفيللم سمبلكس، ز. كوكسينم، ز. ديكمبنس ديكمبنس، ز. ديكمبنس ميجا كاربم، ز. البم البم، ز. البم اميليكاربم، ز. بيرينسنس، ز. ايجبتم و ز. بروبنكم. والتركيزات المستخدمة من كلوريد الصوديوم هي ٣١، ٦٢، ١٢٥، ٢٥٠، ٣٥٠ و ٥٠٠ مللي مول.

أوضحت النتائج أن بذور الأنواع المختلفة من نبات الزيجوفيللم أظهرت نسب مختلفة للإنبات تحت الظروف العادية حيث سجلت أعلى نسبة إنبات لبذور الزيجوفيللم سمبلكس وزيجوفيلم كوكسينم بينما أقل نسبة إنبات للبذور قد سجلت في سلالتي زيجوفيللم ديكمبنس. تقل نسبة إنبات البذور لجميع الأنواع المدروسة بزيادة تركيز كلوريد الصوديوم من ٣١- ٢٥٠ مللي مول. أما عند تركيز ٣٥٠ و ٥٠٠ مللي مول لم يحدث إنبات لجميع بذور النباتات المستخدمة.

أظهرت النتائج أن معدل الانقسام الميتوزي لجميع الأنواع المدروسة تقل عن ٦٪ حيث تتراوح بين ٤،٢٪ و٥،٩٣٪ وسجلت في ز. البم و ز. بيرنيسنس على الترتيب تحت الظروف الطبيعية. أما تحت تأثير المعاملة بكلوريد الصوديوم فإن معدل الانقسام يقل بشدة مع زيادة التركيز في جميع الأنواع وكانت نسبة ٠،٠٠٤٪ هي أقل قيمة لمعدل الانقسام الميتوزي وسجلت في خلايا القمم النامية لجذور نبات زيجوفيللم كوكسينم عند تركيز ٢٥٠ مللي مول من كلوريد الصوديوم. صاحب النقص في معدل الانقسام تغيير في نسب مراحل الانقسام الميتوزي لجميع الأنواع المدروسة تحت ظروف الملوحة. عند التركيزات العالية من كلوريد الصوديوم أيضا صاحب التناقص في معدل الانقسام إحداث شذوذ كروموسومي في جميع الأنواع المدروسة وتزداد نسبة الشذوذ بزيادة تركيز كلوريد الصوديوم. أحدثت المعاملة عدة أنواع من الشذوذ الكروموسومي وكانت الكروموسومات اللزجة هي أكثر الأنواع شيوعا في كل الأنواع المدروسة من نبات الزيجوفيللم.