

Received: 15.10.1982 (13)

Cytological effects of dimethylformamide,  
dimethylacetamide and dimethylsulphoxide  
on root tips of Allium cepa

By

A . S . Shehab

Botany Department, Faculty of Girls

Ain - Shams University, Cairo  
=====

Introduction

Dimethylformamide (DMF), dimethylacetamide (DMAC) and dimethylsulphoxide (DMSO) are used as common solvents for industrial organic chemicals such as polymers and dye stuffs. They are extremely powerful solvents; DMSO being the most powerful. They are aprotic solvents being capable also of certain kinds of chelation. They are totally miscible with water; DMSO being even hygroscopic. Moreover, they are fat soluble.

The aim of this investigation was to study the mitotic effect of DMF, DMAC and DMSO on root tips of Allium cepa as a test plant.

Material and Methods

Allium cepa bulbs were grown in tap water, in the dark and at room temperature. When the roots were 2-3 cm in length, water was replaced by the experimental solutions.

The different concentrations used from DMF, and DMSO were 1,3,5 and 7 %. The time of treatment was 3 hours. After each treatment, the roots were cut, fixed in carnoy's fixative (1 : 3 acetic-alcohol) for 24 hours, then stored in 70% alcohol under refrigeration.

Observations were made from leuco-basic fuchsin stained slides.

Mitotic index was calculated as the average number of dividing cells from 10 different root tips, for each treatment 10,000 cells were counted.

#### Results and Discussion

The three chemicals used have a mild effect on mitosis of Allium cepa, the inhibition of mitotic index was obvious in the higher concentrations (Table I). They also affected the mitotic phases. A slight increase in the number of prophase was noted in 1 and 5% DMAC. While slight increase in metaphases was observed in 3 and 5% DMSO. It is also apparent from Table I that the number of ana-telophases was higher than the other phases in 1 and 5% DMF and 7% DMSO.

The percentage of aberrant cells was proportional to the concentration of the chemicals (Table 2).

Most of the abnormalities scored were in the metaphase stage, Table 2. This means that the three chemicals used act as stathmokinetic agents. Accumulation of prophase and metaphases may refer to a delay in the spindle formation and not to the blocking of mitosis at metaphase.

The presence of multipolar spindles indicate that the chemicals used were mero-stathmokinetic agents.

The most dominant abnormality is the disturbed type (Table 3). Disturbed prophase (Fig 1) were observed in nearly all treatments but in small percentages. Fig 2 show prophase metaphase which is a sign of stathmokinesis. This abnormality was dominant in 5% DMAC. While figs 3,4,5 show different forms of disturbed metaphases. Figs 6 show a somatic reduction of chromosomes, in which the metaphase chromosomes were separated into two unequal groups. Disturbed ana-telophases and multi-polar spindles (Figs 7,8 and 9) were also observed.

Agents such as acetone (Kaharity 1966), folidol (Ravindran 1971), Sevin (Amer et al 1971) and Rogar (Amer and Farah 1974) were also known to produce disturbed meta and ana-telophases.

Polyploidy (Fig. 10) was noted in I and 3% DMAC only ~~and~~  
~~in a~~ (Table 3). Ennis et al. (1948) attributed polyploidy to  
the impairment of the action of the spindle.

Surpassing chromosomes (Fig. 11), lagging chromosomes  
(Fig. 12), anaphase bridges (Fig. 13), c-metaphase (Fig. 14)  
and c-anaphase (Fig. 15) were less dominant abnormalities.  
Micronucleated (Fig. 17) and binucleate of interphase cells  
(Fig. 18) were also observed in small percentages.

Super contraction of metaphase chromosomes (Fig. 6 and 16)  
was an abnormality observed after treatment with the three  
chemicals. This abnormality was also seen by Reib (1975) after  
treating Allium Cepa roots with the mycotoxin diacetoxyscirpenol

SUMMARY

The effect of dimethylformamide, dimethylacetamide and dimethylsulphoxide on root mitosis of Allium Cepa was studied.

The three chemicals had mild effect on the mitotic index. They also affected the mitotic phases. Their effect was on the spindle. The observed abnormalities were : disturbed metaphases and ana-telophases, lagging chromosome, bridges, c-metaphase, c-anaphase and polyploidy. Super contracted chromosomes were prominent after treatment with the chemicals used.



Fig 1 abnormal prophase

(3% D M F)

Fig 2 prophase metaphase

(5% D M A C)

Fig 3,4 and 5 Disturbed metaphase

(3% DMSO nad DMAC)

Fig 6 Somatic reducion

(5 and 7% D M F)

Fig 7,8 and 9 multipolar spindles

(5 and 7% D M F)

Fig 10 polyploid metaphase

(3% D M A C)

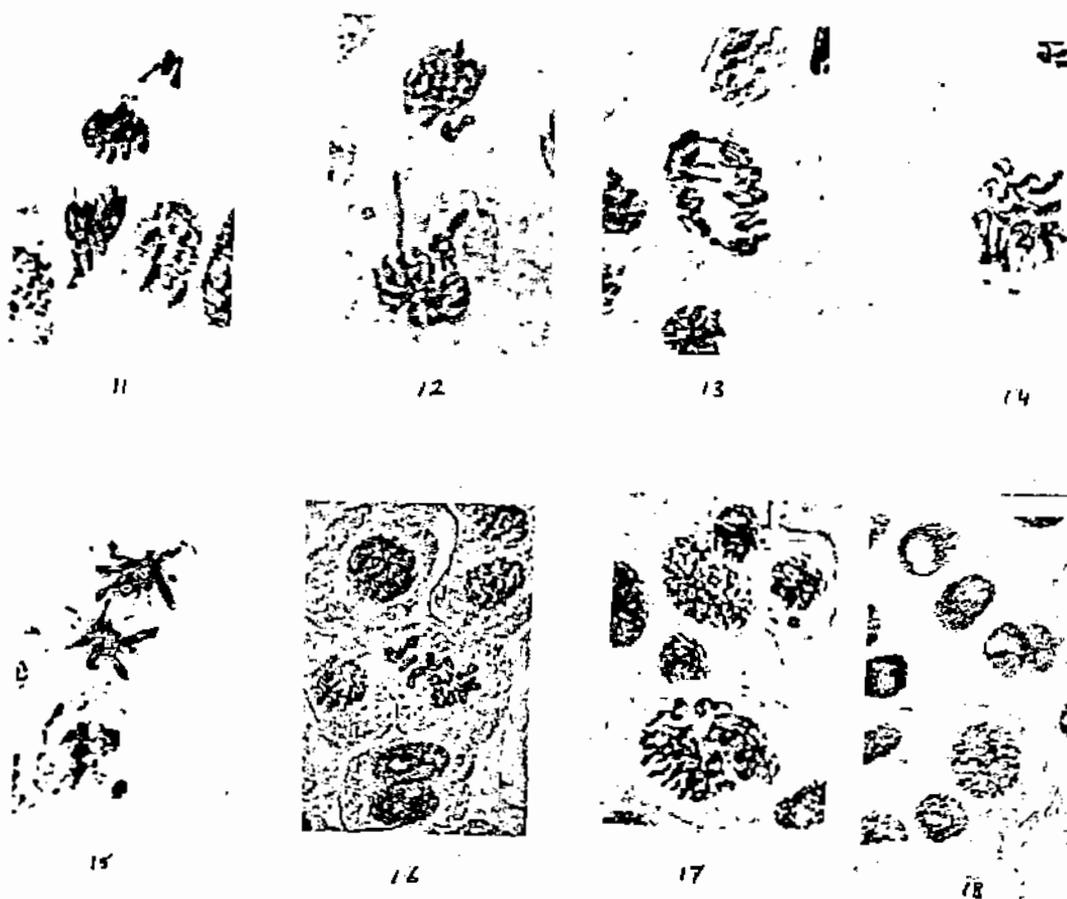


Fig 11	Surpassing chromosomes	50 D M F
12	Lagging chromosome and bridge	58 D M F
13	Multibridged anaphase.	50 D M S O
14	C-metaphase	18 D M S O
15	C-anaphase	38 D M F
16	Contracted metaphase chromosomes	(30 D M S)
17	Micro-nuclei.	(10 D M S)
18	Binucleate cell	(50 D M F)

Mitotic Index and Percentage of mitotic phases in treated Allium cepa roots

Agents	Total No of Div. cells	Prophase		Metaphase		Ana-telophase		M.I. %/100
		No	%	No	%	No	%	
Control	650	302	46.46	126	19.38	222	34.15	65
<u>D M F</u>								
18	570	132	23.16	154	27.01	284	49.82	57
38	518	206	39.76	106	20.46	206	39.76	51.8
58	580	218	37.58	110	18.96	252	43.44	58
78	490	208	42.44	112	22.85	170	34.69	49
<u>D M A C</u>								
18	564	296	52.48	128	24.82	140	24.82	56.4
38	434	184	42.39	98	22.58	152	35.02	43.4
58	424	250	58.96	70	16.5	104	24.5	42.4
78	420	206	49.04	74	17.61	140	33.33	42
<u>D M S O</u>								
18	680	280	41.17	76	11.17	234	34.41	68
38	604	208	34.43	168	27.81	228	37.74	60.4
58	462	170	36.79	120	25.92	178	37.22	46.2
78	430	184	42.79	70	16.27	176	40.93	43

Table 2

Total percentage of abnormalities and percentage of abnormalities in each phase

Agents	NO of abn. cells	% of abn. cells	Prophase		Metaphase		Anatelelophase		
			NO abn. cells	% abn. cells	NO abn. cells	% abn. cells	NO abn. cells	% abn. cells	
Control	20	3.07							
<b>D.M.F</b>									
1%	52	9.12	-	-	38	73.07	14	26.92	
3%	76	13.51	104	14.29	40	57.14	20	28.57	
5%	186	32.06	4	2.15	90	48.38	92	49.46	
7%	192	39.18	18	9.37	100	52.06	74	38.54	
<b>D.L.A.C</b>									
1%	72	12.76	8	11.11	<b>46</b>	63.88	18	25	
3%	66	15.2	2	3.03	52	78.78	12	18.18	
5%	118	27.63	52	44.06	62	52.54	4	3.38	
7%	106	25.23	18	16.98	58	54.71	30	28.30	
<b>D.N.S.O</b>									
1%	66	6.47	-	-	28	63.6	16	36.39	
3%	86	14.23	12	13.95	52	60.45	22	25.58	
5%	86	18.61	20	23.25	38	44.18	28	32.42	
7%	120	27.90	6	5.0	50	41.66	54	45.0	

Percentages of the different abnormalities in treated  
Allium cepa roots

Agents	Dist.	Lag.	Brid.	C.m.	C. anap	Polyploidy
<u>D M F</u>						
18	26.92	19.23	11.53	42.3	-	-
38	88.57	2.85	-	-	8.57	-
58	87.09	7.52	1.07	-	4.3	-
78	82.29	9.34	-	-	8.33	-
<u>D M A C</u>						
18	83.33	-	-	5.55	-	11.11
38	86.11	2.7	-	-	-	2.7
58	98.36	1.69	-	-	-	-
78	92.45	7.5	-	-	-	-
<u>D M S O</u>						
18	68.18	9.09	9.09	13.63	-	-
38	81.39	4.65	2.32	11.62	-	-
58	81.39	6.97	11.62	-	-	-
78	78.33	13.33	8.33	-	-	-

References

- Amer, S., Hammouda, M.A., and Farah, O.R. 1971  
Cytological and morphological effects of the  
insecticide N-methyl-1-naphthyl carbamate "Sevin"  
Flora 160, 433 -439.
- Amer, S. and Farah, O.R. 1974.  
Cytological effects of pesticides.  
VI Effect of the insecticide "Roger" on the  
mitosis of Vicia faba and Gossypium barbadense  
Cytologia 39 (3) : 507 - 514.
- Ennis, W.B. Jr., Fish, El. and Graber, L.F. 1948  
Nuclear and cellular responses of certain plants  
to iso-propyl -N- phenyl carbamate.  
Amer. J. Bot. 35 :208.
- Kabority, A. 1966.  
Induction of multipolar spindles in the meiosis  
of Triticum aestivum as affected by acetone.  
Cytologia 31 : 457 - 460
- Ravindran, P.N. 1971 Cytological effects of folidol.  
Cytologia 36 : 504.
- Reib, J. 1975 Mycotoxin poisoning of Allium cepa root  
tips. II Reduction of mitotic index and  
cytological abnormalities by patulin, rubratoxin  
and diacetoxyscirpenol.  
Cytologia 40 : 700 - 708.

التأثيرات السيتولوجية لثنائي ميثيل فورماميد  
وثنائي ميثيل اسيتاميد وثنائي ميثيل سلفوكسيد  
على جذور نبات البصل

### أمال شهاب

قسم النبات - كلية البنات - جامعة عين شمس

درس تأثير ثنائي ميثيل فورماميد وثنائي ميثيل اسيتاميد وثنائي ميثيل سلفوكسيد على الانقسام  
الغير مباشر لجذر البصل .

وجد ان الثلاث مواد المستعملة لها تأثير بسيط على معدل الانقسام وكذلك تؤثر على معدل  
الاطسوار . وقد وجد ان تأثيرها يكون على المغزل . وأنواع الشذوذ المختلفة هي اضطراب المغزل  
في الطور الاستوائي والانفصالي والكروموسوم المتلكى . والمقناطر والاستوائي الكولشييني والانفصالي  
الكولشييني والتضاعف . وقد وجدت الكروموسومات القصيرة جدا في جميع المعاملات بالثلاث  
كيمياويات المستعملة .