7. Polyploidy and nuclear cycle in Zea mays L. root-tips.

In MGCNL 44:192-195 (1970), we reported the duration of the nuclear cycle in diploid root tips of Seneca 60 and of a chromosome 9 tester at 25°C. These studies have been extended to undertake an examination of some of the factors which might influence the duration of the various components of the cycle. In the present study we report on the duration of the nuclear cycle as a function of genotype and polyploidy.

We obtained seeds of diploid and tetraploid stocks of inbred W23 from the Maize Genetics Coop., Urbana, Illinois, courtesy of Dr. R. J. Lambert. Triploid seeds were obtained after crossing diploid (W23) and tetraploid (W23) stocks. We chose 25°C for the study inasmuch as our previous work indicated that 25°C provided for good resolution of the cycle, i.e., it was neither telescoped nor elongated. Likewise, experimental error appeared to be minimal at 25°C.

The experimental procedures for the pulse labeling and autoradiography were those outlined in MGCNL 43:186-190 (1969) and MGCNL 44:192-195 (1970). All slides from each experiment were coded and scored blindly.

At 25°C, the labelled prophase frequency curves (as well as the metaphase and anaphase curves) were identical for all three stocks; therefore, it is clear that the cycle duration is similar in diploid, triploid and tetraploid material. The classification data are presented in Table 1. Employing the proportion method, the nuclear cycle duration and its components were estimated and are presented in Table 2.

The results presented indicate that the duration of the nuclear cycle and in particular the S and M periods in diploid, triploid and tetraploid stocks are similar. The slight differences are due undoubtedly to the experimental variation attributable to the plotting of the ascending and descending slopes of the curves. Inasmuch as we are dealing with percentage data, we used a probit regression analysis to obtain weighted mean values and standard deviations appropriate to these means (see Table 3).

Table 1

Frequency of labelled and unlabelled nuclei from primary root-tips following pulse labelling (^{3}H-TdR, 30 min) at 25° in W23 inbreds

Stock	Interphase		Prophase		Metaphase		Anaphase		Telophase	
	Lab	Unlab	Lab	Unlab	Lab	Unlab	Lab	Unlab	Lab	Unlab
Diploid	10409	19209	679	647	210	236	56	71	260	377
Triploid	9641	21747	563	518	242	306	48	84	153	236
Tetraploid	10639	22150	709	736	294	287	71	75	274	377
Total	30689	63106	1951	1901	746	829	175	230	687	990

Table 2

Estimates (from the data in Table 1) of the duration of the nuclear cycle in primary root-tips of inbred W23 stocks at 25°C

Phase	Mean Duration					
	Diploid		Triploid		Tetraploid	
	Hrs.	% of total	Hrs.	% of total	Hrs.	% of total
Interphase:						
G_1	2.10	18.8	2.89	25.1	2.65	23.1
S	5.50	49.1	5.00	43.5	5.20	45.2
G_2	2.31	20.6	2.50	21.7	2.31	20.1
sub-total	9.91	88.5	10.39	90.4	10.16	88.4
Mitosis:						
Prophase	0.68	6.1	0.56	4.9	0.68	5.9
Metaphase	0.23	2.1	0.28	2.4	0.28	2.4
Anaphase	0.06	0.5	0.06	0.5	0.07	0.6
Telophase	0.32	2.9	0.21	1.8	0.31	2.7
sub-total	1.29	11.5	1.11	9.7	1.34	11.7
Total	11.20		11.50		11.50	

Table 3

Standard deviations of the nuclear cycle component estimates in the primary root tips of Zea mays L. (inbred W23) at 25°C.

Phase	Hours		
	Diploid	Triploid	Tetraploid
G_1 + M	0.21	0.14	0.24
S	0.16	0.15	0.04
G_2 + P	0.18	0.18	0.12
Total Nuclear Cycle	0.26	0.18	0.28

M = Prophase + Metaphase + Anaphase + Telophase

P = Prophase

It is generally recognized that homologous chromosomes may synthesize their DNA at the same time and in a similar manner, although differences in the S period timing pattern have been reported within certain homologous pairs in mammalian tissues (e.g., X-chromosomes). From this point of view, one would predict that the addition of complete sets of chromosomes might not alter markedly the time required for DNA synthesis, provided that sufficient precursors and enzymes were present so as not to limit the rate of synthesis. As long as the genes are equally active in 2n, 3n, and 4n nuclei, then the triploid or tetraploid states should have little or no effect on the time needed for certain synthesis events. From our data, it is clear that there is not an increase in the duration of the S phase or of the entire nuclear cycle. These results agree with the conclusion of several other workers that the duration of the DNA synthesis period is independent of DNA content in diploid, triploid and tetraploid nuclei, although this study is the only report in which autotetraploids were examined.

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