

NUCLEAR FACTORS AND DIFFERENTIAL RADIO-SENSITIVITY OF *SECALE* SPP.

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(Accepted : 11-xii-1966)

A COMPARISON was made of the radio-sensitivity to X-rays of four species of *Secale*, namely *cereal* L., *vavilovii* Grossh., *silvestre* Host., and *anatolicum* Boiss. All the four species were also studied for their DNA content, nuclear volume, distribution of heterochromatin at the early prophase, total chromatin length at somatic metaphase and the degree of karyotype symmetry.

The DNA content was estimated using a microspectrophotometer constructed on the two-wavelength principle of Ornstine (1952) and Patau (1952). The prophase nuclei were measured in preference to interphase nuclei since inter-slide differences were less in the former. The prophase nuclei were also studied for the distribution of heterochromatin along the length of the chromosomes. The heterochromatin was always observed as terminal knobs at the end of either one or both arms of the chromosomes. The mean nuclear volume was calculated from the mean diameters of three readings of each of the selected spherical nuclei.

The karyotype and the measurement of the chromatin length were made from ten well spread somatic metaphases selected from the root-tip squashes made following the schedule of Upadhyya (1963). The karyotype symmetry was determined following Stebbin's (1958) classification.

The data on the DNA content, total chromatin length, nuclear volume, distribution of heterochromatin and the karyotype symmetry are given in Table 1. *S. silvestre* showed about 9 percent higher DNA content than rest of the species which had similar amounts of DNA. There were no appreciable differences among the four species of *Secale* with regard to chromatin length, nuclear volume or karyotype symmetry. However, differences were observed in the degree of heterochromatinization. *S. cereale* and *vavilovii* carried distinct terminal heterochromatic knobs on all the chromosomes, whereas *silvestre* and *anatolicum* did not have such knobs.

The dry seeds of all the four species were irradiated with X-rays (50 kV, unfiltered, doserate 2.4 kr/min.) for the study of differential radiosensitivity. For the study of the effect on the seedling height the seeds were treated with

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TABLE 1
Nuclear characteristics of secale species

Species	DNA content of 4c nuclei (in arbitrary units)	Total chromatin length in μ	Nuclear volume in μ^3	Heterochromatin	Karyotype classification according to Stebbins (1958)
	Mean \pm S.E.	Mean \pm S.E.	Mean \pm S.E.		
<i>S. cereale</i> L.	35.98 \pm 0.87	173.77 \pm 5.76	344.28 \pm 4.85	Terminal knobs on all chromosomes	2a
<i>S. vavilovii</i> Grossh.	36.48 \pm 0.95	184.12 \pm 5.87	334.58 \pm 4.52	same	2a
<i>S. silvestre</i> Host.	39.24 \pm 0.79	177.62 \pm 5.37	351.44 \pm 4.28	absent	2a
<i>S. anatolicum</i> Boiss.	35.21 \pm 0.53	184.58 \pm 7.45	332.18 \pm 6.01	absent	2a

15, 20 and 25 kr. The seeds were germinated in petridishes and the seedling height measured after 15 days of growth. The data on the seedling heights are expressed as the percentages of control in Table 2. However, for the study of the effect on the chromosomes, the seeds were irradiated with only one dose of 11 kr. The roots were fixed after 20 hours of soaking of the irradiated seeds in petridishes. The percentage of the cells showing chromosome breaks at the metaphase and dicentric bridges and fragments at anaphase, as well as the mean number of breaks per cell are given in Table 3. The data in Tables 2 and 3 are the averages of two replications.

TABLE 2
Average seedling heights of Secale species following irradiation with X-rays (Expressed as percentage of control)

Species	Dose of X-rays		
	15 kr	20 kr	25 kr
<i>S. cereale</i>	98.1	87.05	87.10
<i>S. silvestre</i>	75.0	47.9	45.8
<i>S. vavilovii</i>	67.8	61.55	41.95
<i>S. anatolicum</i>	33.15	0.0	0.0

The data given in Table 2 and 3 bring out the differences among the four species. *S. anatolicum* was found to be most radiosensitive, since even the lowest

TABLE 3

(Chromosome aberration Frequencies following 11 kr. of X-rays)

Species	No. of cells studied	Percentage of cells showing breaks	Mean no. of breaks per cell
<i>S. cereale</i>	131	35.87	0.81
<i>S. silvestre</i>	116	41.38	0.95
<i>S. vavilovii</i>	120	43.67	0.86
<i>S. anatolicum</i>	104	60.57	1.89

dose of 15 kr reduced the seedling height by about 67 per cent., where as the next higher dose of 20 kr completely killed the seeds. Similarly, at 11 kr the mean number of chromosome breaks per cell were 1.89, and 60.57 per cent of the cells showed one or more chromosome breaks. In contrast, *S. cereale* was most resistant to X-rays. Although the degree of chromosomal damage to *cereale*, *silvestre*, and *vavilovii* by 11 kr of X-rays was of similar magnitude, the data on the seedling height bring out the differences. The seedling height for *cereale* show a maximum reduction of only about 13.0 per cent. at the highest dose of 25 kr, where as *silvestre* and *vavilovii* show more than 50.0 per cent. reduction at the same dose.

The following conclusions are drawn from this study :

(i) *S. anatolicum* proved to be most radiosensitive to X-rays among the four species studied.

(ii) *S. cereale*, *silvestre* and *vavilovii* showed similar degree of initial damage to the chromosomes as indicated by the aberration frequencies.

(iii) *S. cereale* was, however, able to recover to a great extent showing the least reduction in seedling height as compared to *silvestre* and *vavilovii* which showed a much higher degree of reduction in seedling height.

(iv) No correlation could be found between various nuclear factors studied and the degree of radiosensitivity.

(v) *S. cereale* and *vavilovii* were found to be carrying terminal heterochromatin as knobs on the early prophase chromosomes, whereas *silvestre* and *anatolicum* were found to be lacking such heterochromatin on the prophase chromosomes.

ACKNOWLEDGEMENTS

We are indebted to Dr. M. S. Swaminathan, Director, Indian Agricultural Research Institute, New Delhi for his interest and suggestions during the course of this study. One of us (M.D.U.) is also grateful to the Council of Scientific and Industrial Research for the award of Senior fellowship during which this study was made.

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