Karyomorphology of *Vitis vinifera*, *V. rotundifolia* and Their Hybrid

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Grapes being an important fruit crop, voluminous information is available on various aspects such as morphology, physiology, breeding, pathology and horticultural and agronomic practices. The grape cultivars grown in the country belong to *Vitis vinifera* and are susceptible to the major fungal pathogens. This led the breeders to introduce disease resistance in the grape cultivars by hybridization. With this objective, this Institute has undertaken the hybridization of *V. vinifera* cv. Gulabi (susceptible) with *V. rotundifolia* cv. James (resistant). The hybrid thus raised is resistant to the major fungal pathogens.

Cytological work on grapes is mostly restricted to detection of chromosome numbers as the chromosomes are very small (Hirayanagi 1929, Kobel 1929, Nebel 1929, Sax 1929, Olmo 1937) and very few reports on chromosome morphology are available. Detailed karyomorphology of prominent grape varieties has been reported by Murin (1964), Sudharsan Raj and Seethaiah (1969, 1973) and Patil and Jadhav (1985). Thus, the information available on detailed karyomorphology is very meagre. Hence, an attempt has been made to study the chromosome morphology in detail for the above parents and their F_1 hybrid.

Materials and methods

Root tips of Gulabi, James and F_1 hybrid were collected from potted plants at 9.30 to 10.00 a.m. and exposed to α -bromonaphthalene for 1.30 hr at 4°C. After thorough washing in tap water these tips were fixed in Carnoy's fluid for 24 hr and stored in 70% alcohol. Root-tip smears were taken by adopting the procedure of Sharma and Sharma (1980). Cells with well separated metaphase plates were marked and ten such plates from 4-5 slides were sketched at bench level.

Data recorded on chromosome arm-length, SAT-chromosomes were used to prepare idiograms by adopting the criteria suggested by Sears (1958) and Riley (1963). Karyotype symmetry is expressed as per Stebbins' (1958) notations based on relative lengths and arm-ratios.

Results

In *V. vinifera* cv. Gulabi, *V. rotundifolia* cv. James and their F_1 hybrid-Gulabi $\times$ James, the somatic numbers observed were $2n=38$, 40 and 39 respectively. Details regarding mean lengths in the haploid chromosome complement and arm-ratios (short arm/long arm) are given in Table 1. Idiograms and metaphase diagrams are presented in Fig. 1. It will be seen from Table 1, that total chromosome length of the haploid complements are 26.39 μm in James, 24.65 μm in Gulabi and 26.21 μm in their hybrid. In each of the three karyotypes, there are six to seven chromosomes with sub-median constrictions and rest have median or near median constrictions. Only one pair of SAT-chromosomes in these karyotypes was observed, which

was invariably the longest chromosome in the karyotype. Further details on longest and shortest chromosomes, their ratios, differences and number of chromosomes with arm-ratios are given in Table 2.

Table 1. Chromosome morphology in parents and hybrid

Chromosome No.	<i>V. vinifera</i> cv. Gulabi (n=19)		<i>V. rotundifolia</i> cv. James (n=20)		F ₁ hybrid Gulabi × James (n=19+1)	
	Total length	S/L ratio	Total length	S/L ratio	Total length	S/L ratio
I	1.80**	0.84	1.67**	0.93	1.77**	0.93
II	1.61	0.87	1.62	0.72*	1.60	0.93
III	1.54	0.77*	1.57	0.78*	1.54	0.79*
IV	1.42	0.71*	1.53	0.82	1.51	0.86
V	1.42	0.92	1.46	0.70*	1.40	0.75*
VI	1.36	0.97	1.42	0.82	1.38	0.97
VII	1.31	0.68*	1.38	0.77*	1.36	0.94
VIII	1.29	0.90	1.34	0.91	1.35	0.69*
IX	1.28	0.71*	1.33	0.77*	1.34	0.68*
X	1.26	0.94	1.32	0.89	1.32	0.89
XI	1.24	0.91	1.31	0.77*	1.30	0.86
XII	1.23	0.76*	1.30	0.91	1.28	0.88
XIII	1.22	0.69*	1.27	0.92	1.24	0.82
XIV	1.19	0.89	1.23	0.89	1.21	0.70*
XV	1.17	0.92	1.20	0.88	1.18	0.97
XVI	1.16	0.93	1.18	0.84	1.16	0.76*
XVII	1.10	0.83	1.16	0.70*	1.15	0.92
XVIII	1.04	0.82	1.11	0.85	1.13	0.95
XIX	1.00	0.82	1.05	0.81	1.03	0.94
XX	—	—	0.94	0.96	—	—
Total n=	24.65 μ m	—	26.39 μ m	—	25.25 μ m	—
n+1=	—	—	—	—	+0.96 μ m	0.80*

* Sub-median chromosomes

** SAT-chromosome

Table 2. Variations in the chromosome complements of parents and hybrid

Characters	<i>V. vinifera</i> cv. Gulabi P ₁	<i>V. rotundifolia</i> cv. James P ₂	Gulabi × James F ₁
Diploid chromosome number	2n=38	2n=40	2n=39
Total chromosome length of diploid complements in (μ m)			
Range	43.00–53.20	45.87–58.33	46.20–54.20
Mean	49.30±3.10	52.78±4.30	51.16±3.10
Longest chromosome length (μ m)	1.80	1.67	1.77
Shortest chromosome length (μ m)	1.00	0.94	0.96
Longest/shortest (μ)	1.80	1.78	1.84
Longest-shortest differences (μ m)	0.80	0.73	0.81
Chromosome diameter (mean μ m)	0.51±0.13	0.67±0.15	0.59±0.14
No. of chromosomes with arm ratio			
0.61–0.80 (Sub-median)	6 × 2 = 12	7 × 2 = 14	6 × 2 = 12 + 1
0.81–1.00 (Median)	13 × 2 = 26	13 × 2 = 26	13 × 2 = 26
No. of SAT chromosomes	2	2	2
Stebbins' notations	1a	1a	1a

Total length of the diploid complement revealed James to have maximum length ($52.78 \mu\text{m}$) than Gulabi ($49.30 \mu\text{m}$). F_1 hybrid was intermediate in position.

In all the three karyotypes, Gulabi had the longest chromosome ($1.80 \mu\text{m}$) and James had the shortest chromosome ($0.94 \mu\text{m}$). Conversely, Gulabi had minimum chromosome diameter ($0.51 \mu\text{m}$) and James had maximum diameter ($0.67 \mu\text{m}$). SAT-knob in all these karyotypes was attached to the long arm of the chromosome. (See idiogram).

Figs. 1-3. 1. Karyotypic and idiogram of Gulabi $\times 1,026$, 2. Karyotypic and idiogram of James $\times 1,023$, 3. Karyotypic and idiogram of (Gulabi $\times$ James) $F_1 \times 985$.

Discussion

Karyomorphology as also chromosome number of a variety or species are useful in its identification as also in establishing the relationships among related species. In the present studies, the chromosome number of *V. vinifera* (Gulabi) is $2n=38$ and of *V. rotundifolia* (James) is $2n=40$, thus, confirming the earlier reports (Patel and Olmo 1955, Shetty 1959, Vatsala 1960, Hazra and Sharma 1970, Nagare 1982, Patil and Jadhav 1985). Similarly, in F_1 hybrid the chromosome number, $2n=39$, is as normally expected and reported earlier by Patel and Olmo (1955). Smaller size of chromosomes has placed limitations on further detailed studies on chromosome morphology. In spite of small chromosome size Sudharshan Raj and Seethaiah (1969, 1973) and Patil and Jadhav (1985) have reported karyomorphology of nine grape varieties, viz., Alamwick, Gros Colman, Mission, Muscat of Alexandria, Selection-7, Selection-94, Thompson seedless, Kalisahebi and Anab-e-shahi.

Earlier reports suggest mean length of chromosomes to be 0.5 microns by Ghimpu (1929), 0.855 to 1.014 microns by Shetty (1959) and 0.590 to 2.163 microns by Sudharsan Raj and Seethaiah (1969, 1973). Later, Patil and Jadhav (1985) reported chromosome lengths in the range of 0.975 to 2.450 microns. All the 19 chromosomes were either median or sub-median. Present studies revealed the chromosome lengths in the range of 0.94 to 1.80 microns with

median or sub-median centromeres. Thus, the karyotypes in Gulabi, James and the hybrid appear to be symmetrical. According to Stebbins (1950), such symmetrical karyotypes are considered as unspecialized karyotypes.

Total length of the chromosome complement is more in James than that of Gulabi as normally expected due to the presence of one additional pair of chromosomes in the former. In addition, other factors such as (i) differential rate of condensation, (ii) possible role of various structural changes, (iii) selection of non-comparable cells and (iv) observational errors might have affected the chromosome lengths in the complements. Gulabi has relatively the longest chromosomes ($1.80\ \mu\text{m}$) and minimum chromosome diameter ($0.51\ \mu\text{m}$), thus supporting the role of these factors.

It is interesting to note that in all the three karyotypes there are 13 chromosomes with median constrictions and 6 or 7 chromosomes with sub-median constrictions. Such situation may not have any relation with the basic chromosome number though in a way it supports the suggestion of the basic chromosome number in *Vitis* as $x=13$ by Patel and Olmo (1955) and Iyer (1960). Present observations revealed the chromosome size to be rather small in grapes which is a perennial shrubby-woody plant. Stebbins (1938) has attributed small size of chromosomes to such shrubby-woody plants.

Stebbins (1950) has stated that usually the satellite is borne on the short arm of the chromosome with subterminal centromere or on one of the arms of the V shaped chromosome and usually a single pair SAT-chromosomes is present in the diploid plants. Present observations on parents and hybrid differ from the above suggestions of Stebbins (1950) as the SAT-knob is attached to the long arm of the chromosome. Such situations have been reported by AL-Fakhry *et al.* (1964) in *Pennisetum typhoides* and by Sharma and Mukhopadhyay (1965) in *Arisaema tortuosum* and *A. sanguineum*.

The above observations suggest the variations in the karyotypes of Gulabi, James and their F_1 hybrid to be not conspicuous though in morphological and fruit characters as also disease resistance there are marked variations. Such situations imply these variations might have been due to intra-chromosomal variations by way of accumulation of genic differences.

Summary

Karyomorphology of *V. vinifera* cv. Gulabi, *V. rotundifolia* cv. James and their hybrid, revealed the somatic chromosome numbers as $2n=38$, 40 and 39 respectively. In these karyotypes, 13 chromosomes pairs were median and 6 or 7 were sub-median. Total lengths of the complements were $52.78\ \mu\text{m}$ in James, $49.30\ \mu\text{m}$ in Gulabi and $51.16\ \mu\text{m}$ in hybrid. Gulabi had the largest chromosome ($1.80\ \mu\text{m}$) and James had the shortest chromosome ($0.94\ \mu\text{m}$). Chromosome diameter was inversely proportional to the length. All the karyotypes had only one pair of SAT-chromosomes, SAT-knob being attached to the long-arm of the chromosome. On the whole, karyotypes appeared to be symmetrical, though there are vast variations in morphology and disease resistance, suggesting the inter-chromosomal variations by way of accumulation of genic differences.

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