Cytogenetics of Euploids and Aneuploids of *Solanum viarum* Dunal

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The cytomorphic evaluation of C_3 generation autotetraploids of *Solanum viarum*, a steroid bearing species used by industries led to the detection of aneuploids in the autotetraploid progeny. Aneuploids which commonly occur in induced autotetraploid population contribute to poor yield performance. Khush (1973) has reported wide variation in frequency of aneuploids in induced autotetraploids of number of crop plants. In induced autotetraploids of *Solanum viarum*, eventhough cytomorphic studies have been carried out upto C_3 generation (Bhatt 1977) aneuploids have not been reported, however comprehensive meiotic studies in our laboratory revealed the occurrence of a low frequency of daughter nuclei carrying aneuploid chromosome number.

In the present study, the fate of gametes with aneuploid chromosome number was investigated in the C_3 generation, which led to the detection of aneuploids. The present communication for the first time presents comparative data on meiosis in aneuploids and euploids and evaluates their significance as autotetraploid breeding programme in *Solanum viarum*.

Materials and methods

C_3 generation autotetraploids of the diploid commercial variety 'Glaxo' were used in the present study. These tetraploids were induced in this laboratory by Nandakumar (1983). C_3 plants were screened and could be visually distinguished based on differences in berry size into two types. Meiotic studies were carried out adopting procedure outlined by Krishnan (1983). Pollen size (μ) and pollen fertility (%) were assayed in acetocarmine.

Results and discussion

A knowledge on frequency of aneuploids in autotetraploid progeny will be valuable adjunction in autotetraploid breeding programme. Such data will facilitate prediction of chromosomal stability in the generations and prospects of maintaining autotetraploid cultivar. To this end, the present investigation has few interesting information to offer. The choice of the 26 plants examined in the present study is only a biased sample of the population and as such cannot be used in predicting the frequency of autotetraploids and aneuploids in the population sampled. But, on the other hand, the aneuploid samples can be considered as an unbiased sample. The 16 plants sampled consisted predominantly of $2n=47$ (Fig. 1) chromosome number plants i.e., 11 out of 16. Of the remaining five, three plants had $2n=49$ (Fig. 2) and one each with $2n=46$ (Fig. 3) and $2n=50$ (Fig. 4). The projected frequency of gametes with 23 and 25 chromosomes, as per Maheswar (1983) observation is expected to be equal as they are the product of the same nuclear division. Since the determination of chromosome distribution was made at metaphase II, if we assumed further changes in the chromosome constitution in the gametes, the frequency of 47 chromosome plants must be equal, as also of plants

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with 46 and 50 chromosome numbers. The latter was found to be true in the present study but not the former. The deficiency in $2n=49$ chromosome number plants as compared to those with $2n=47$ may be attributable to more efficient transmission of gametes bearing 23 chromosomes through male or female lines (Table 1) in preference to those with 25 chromosomes or

Figs. 1-6. 1, metaphase II ($2n=47$) showing 23+24 chromosome distribution. $\times 2500$. 2, anaphase I ($2n=49$) showing 49 chromosomes. $\times 2500$. 3, metaphase II ($2n=46$) showing 22+24 chromosome distribution. $\times 2500$. 4, anaphase I ($2n=50$) showing 25+25 chromosome distribution. $\times 2500$. 5, anaphase I ($2n=48$) showing 24+24 chromosome distribution. $\times 2500$. 6, metaphase I in plant No. 23 ($2n=48$) showing $1^{VI}+4^{IV}+2^{III}+8^{II}+4^I$ chromosome distribution. $\times 2500$.

Table 1. Chromosome number in daughter nuclei at the end of first division

Chromosome no.	No. of plants scored	Chromosome number in daughter nuclei											No. of PMCs scored
		14	19	20	21	22	23	24	25	26	28	29	33
48	10	—	1 (0.79)	1 (0.79)	—	—	25 (19.69)	100 (78.74)	25 (19.69)	—	1 (0.79)	1 (9.79)	—
Hypoploids 46	1	—	—	—	4 (80)	1 (20)	—	1 (20)	4 (80)	1	—	—	—
47	11	1 (1.15)	—	—	1 (1.15)	10 (11.49)	75 (86.2)	75 (86.2)	10 (11.5)	1 (1.15)	—	—	1 (1.15)
Hyperploids 49	3	—	—	—	—	—	1 (2.94)	33 (97.06)	33 (97.06)	1 (2.94)	—	—	—
50	1	—	—	—	—	—	—	3 (16.67)	15 (83.3)	3 (16.69)	—	—	—

Figures in parentheses refer to x2 percentage values.

higher survival rate of zygotes/embryos with $2n=47$ chromosome number. Preferential transmission among aneuploid gametes is well documented in literature (cf. Khush 1973).

The high seed production capability of $2n=48$ (Fig. 5) plants is one of the major advantages in autotetraploid breeding programme in this crop. The numerical parity in chromosome number does not vouchsafe similarity in chromosomal make up as unbalanced chromosomal combination can also find their place among euploid and aneuploid types. Evidences for occurrence of unbalanced chromosomal combination among $2n=48$ plants have not so far been

Table 2. Chromosomal association at metaphase I in $2n=47$, $2n=48$ and $2n=49$ plants of *S. viarum*

Plant number		Chromosomal association						Frequency of PMCs	Total no. of PMCs examined
		IV	V	IV	III	II	I		
Chromosome No. 2n=47									
2	a	—	—	7	1	7	2	1	=2
	b	—	—	8	1	5	2	1	
26	a	1	—	7	1	4	2	1	=3
	b	1	—	5	1	9	—	1	
	c	—	1	5	1	9	1		
Chromosome No. 2n=48									
10	a	—	—	8	6	1	1	1	=3
	b	—	—	5	—	14	—	1	
	c	—	—	8	—	8	—	1	
15	a	—	—	4	1	14	1	1	=3
	b	—	—	6	—	12	—	1	
	c	—	—	9	—	6	—	1	
23	a	1	—	4	2	8	4	1	=2
	b	—	—	6	1	10	1		
Chromosome No. 2n=49									
18	a	—	—	9	—	6	1	1	=2
	b	—	—	9	1	5	—	1	
14	a	—	—	4	1	15	—	1	=1

Table 3. Seed fertility characters in $2n=46$, 47, 48, 49 and 50 chromosomal plants

Characters	Hypoploids		Hyperploids		$2n=48$
	$2n=46$	$2n=47$	$2n=49$	$2n=50$	
Pollen size (μ)	32.46	32.84 (30.80–36.96)	34.04 (33.72–34.44)	33.20	32.92 (32.24–34.40)
Pollen fertility (%)	18.63	38.96 (11.58–77.66)	47.47 (9.73–71.78)	40.25	61.41 (43.86–79.56)
No. of seeds/berry	5.70	23.05 (8.21–65.00)	70.63 (60.07–82.42)	48.83	102.41 (83.15–173.16)
No. of seeds/plant	832.00	5375.00 (611–12063)	28384.67 (4926–44209)	1709.00	48150.80 (10215–124113)

Numbers in parentheses refer to range.

reported in this crop. The present study, however, provides preliminary but direct cytological proof for existence of such types among $2n=48$ plants. Among the four plants with $2n=48$ which were examined for chromosomeal association at metaphase I in plant number 23, an hexavalent was observed (Table 2, Fig. 6). Since multivalents other than quadrivalents and trivalents have not been reported in autotetraploids of this species (vide Bhatt 1977 and Maheswar 1983), the occurrence of hexavalent can be considered as a direct proof for the occurrence of unbalanced chromosomal types in autotetraploid progeny. Hexavalent/pentavalent were

also found in one of the two $2n=47$ plants screened for metaphase I stage. In this plants a pentavalent was also detected. The presence of such unbalanced types in $2n=48$ offer a ready source of variability on which selection can act successfully. It is imperative that further studies are carried out to estimate the frequency of such unbalanced chromosomal types.

In the present study pollen sterility in the $2n=48$ plants ranged from 21 to 37 per cent with a mean of 38.6 per cent (Table 3). The values for C_2 (46%) and C_3 (38.6%) generations do show agreement. The extent of chromosomal abnormalities in C_3 generation plants consisting of precocious movement of chromosome at metaphase I (0.0 to 52.94 cells), laggards at anaphase I (in 0.0 to 84.0% cells), and extra nuclei at telophase I and II (in 0.0 to 100% cells in telophase I and 0.0 to 9.60% in telophase II cells) can not explain the observed sterility in C_3 generation autotetraploids. Here again, the possible role of unbalanced chromosomal distribution has to be accounted for the observed sterility. According to Stebbins (1950) irregular chromosomal distribution is only one of the three possible causes of sterility in autotetraploids. The other two being irregular distribution caused by meiotic abnormalities of physiological nature presumably controlled genetically and genetic-physiological sterility of unexplained nature but not associated with meiotic irregularity. The results of the present study provide direct proof of occurrence of unbalanced chromosomal distribution and in view of the near normal meiotic behaviour of autotetraploids of *Solanum viarum* appear to have an important role in reduction of fertility.

Summary

Comprehensive cytomorphic evaluation of C_3 generation autotetraploids of *Solanum viarum*, a steroid bearing species used by industries, led to the detection of aneuploids in the population. These aneuploids included both hypoploids and hyperploids differing from eu-tetraploids by one or two chromosomes. In morphological characters aneuploids and eu-tetraploids were more or less similar but differences for berry yield and component characters were evident. Cytological studies revealed several interesting features that have bearing on the causes underlying lowered fertility in eu-tetraploids, production of new cytotypes and chromosomal stability of eu-tetraploid population. These are discussed in the context of promoting eu-tetraploids as commercial crop varieties and the enhanced role of eu-tetraploidy in genetic amelioration of this South American introduction.

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