

Cytology of *Solanum nigrum* L., *S. retroflexum* Dunn. and their hybrids

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Abstract. Cytomorphological characters of *Solanum retroflexum* and tetraploid *S. nigrum*, and their F_1 hybrids were studied. The hybrids were fertile with highly regular meiosis. It is concluded that the species are differentiated primarily by genetic factors. The origin of the two species from the same or identical ancestors is discussed.

Keywords. *Solanum retroflexum*; *S. nigrum* (4x); interspecific hybrids; cytology; interrelationship.

1. Introduction

Solanum nigrum is a polyploid complex based on $x = 12$ chromosomes (see Bhaduri 1933; Stebbins and Paddock 1949; Schilling and Heiser 1979). The species of the complex are annual herbaceous weeds with variable morphological characters. In the present paper an attempt has been made to reveal the interrelationship and mechanism of evolution of some species of *S. nigrum* complex based on meiotic behaviour of chromosomes of species-hybrids.

2. Materials and methods

The material was obtained from *Solanum retroflexum* Dunn. and natural tetraploid *S. nigrum* L. The seeds of the former were obtained from Dr W G D'Arcy, Research Botanist, Missouri Botanical Garden, USA, and the seeds of the latter were collected from local populations growing at Delhi. The data on morphological characters were collected from mature plants of same age. Meiosis was studied in squashes of pollen mother cells fixed in Carnoy's fluid and made permanent with butyl alcohol. The fertility of the plants is estimated by stainability of pollen in acetocarmine. Several reciprocal cross-pollinations were made between the two species.

3. Observations

3.1. Morphology of the parents and hybrids

S. retroflexum is a semi-erect herb with long lateral branches. The leaves are ovate with highly dentate margin. Mature fruits are globose and dull purplish black. Tetraploid *S. nigrum* is an erect herb bearing several thick, ovate leaves with dentate margin. Mature fruits are globose and orange red.

Reciprocal cross-pollinations were successful and the reciprocal hybrids were morphologically alike. One hundred flowers of *S. retroflexum* were pollinated with pollen of tetraploid *S. nigrum*. Twenty three mature fruits were obtained with a total number of 250 seeds and the percentage of germination was 76.

The hybrids were erect, vigorous in growth and profusely branched bearing several flowers. The fruits were globose and purplish red with several well-filled seeds. The hybrids were late in flowering and continued to grow for longer period than the parents. The pollen fertility of the hybrids was 78.50%. A comparative account of morphological features of the parents and hybrids is given in table 1.

3.2. Cytology of the parents and hybrids

Meiosis in *S. retroflexum* and tetraploid *S. nigrum* was normal with 24 bivalents at diakinesis and metaphase I. Some of the bivalents were of ring type with chiasmata at both the arms. In *S. retroflexum* the frequency of chiasmata, per bivalent, at diakinesis and metaphase I was 1.77 and 1.25, respectively. In tetraploid *S. nigrum*, the frequency of chiasmata at diakinesis was 1.79 while at metaphase I it was 1.21. In both the species the subsequent stages of meiosis were normal.

In most of the pollen mother cells of the hybrids, the chromosomes were associated in pairs. At diakinesis, the hybrids showed 21–24 bivalents with a mean value of 23.37 and univalents 0–6 with a mean value of 1.25. Multivalents were absent. The frequency of chiasmata, per bivalent, was 1.75. Metaphase I was found to be normal in as many as 86% of the cells with 24 bivalents. Most of the bivalents were rod type. The mean pairing of chromosomes, per cell, was 22.58 II + 2.83 I. The frequency of chiasmata, per bivalent, was 1.14. In about 14% of the cells a few univalents, ranging from 0–10, were observed. At anaphase I, the disjunction of chromosomes of bivalents was normal. The univalents remained stranded at equator, but subsequently moved towards the poles. Chromosome bridges and fragments were not observed. Micronuclei were absent at telophase I and II. The products of meiosis were tetrads and the size of pollen was uniform.

4. Discussion

Valuable information can be obtained from the meiotic behaviour of chromosomes of the hybrids regarding the degree of genetic relationship of the parents in spite of the instances where synapsis and asynapsis are controlled by genetic and environmental factors. In the present study, the pairing of chromosomes of the hybrids into as many as 24 bivalents at metaphase I followed by high percentage of stainable

Table 1. Comparison of morphological characters of *S. retroflexum*, *S. nigrum* (4x) and their hybrids

Character	<i>S. retroflexum</i>	<i>S. nigrum</i> (4x)	hybrid (F ₁)
Habit	Semi-erect but lateral branches becoming long and decumbent	Erect and branched	Erect and branched
Height (cm)	65.0 (50.00-76.00)	68.20 (49.50-81.00)	82.00 (62.00-96.00)
Stem	Angular, dark green with smooth ridges	Slender and green without prominent ridges	Slender and dark green without prominent ridges
Leaf	Thin and ovate with highly dentate margin	Thick and ovate with dentate margin	Thin and ovate with dentate margin
Petiole length (cm)	2.90 (1.20-3.20)	3.00 (1.20-3.90)	3.50 (2.20-4.20)
Lamina length (cm)	7.80 (4.60-10.00)	7.20 (4.30-8.70)	7.40 (5.00-9.60)
Lamina breadth (cm)	4.40 (2.50-4.60)	3.90 (3.50-5.10)	4.00 (2.80-5.20)
Flowers/inflorescence	5 (3-7)	5 (2-6)	4 (2-5)
Corolla diameter (mm)	8.00 (6.00-10.00)	6.00 (5.00-10.00)	7.00 (6.00-9.00)
Fruits/inflorescence	4 (3-7)	5 (2-6)	4 (3-5)
Fruits diameter (mm)	7.00 (6.00-9.00)	5.00 (4.00-9.00)	6.00 (5.00-7.00)
Fruit colour	Dull purplish black	Orange red	Purplish red
Seeds/fruit	62 (11-67)	38 (9-48)	32 (17-50)
Pollen grain diameter (μ)	24.00 (18.60-27.90)	25.12 (15.50-31.00)	25.47 (12.40-31.00)
Pollen fertility (%)	91.00 (89.00-98.00)	83.46 (85.00-92.12)	78.50 (68.12-81.46)
Chromosome number (n)	24	24	24

N.B. : The range of values is given in parentheses

pollen and seed set indicates that the genomes of the parents, *S. retroflexum* and tetraploid *S. nigrum* are largely homologous and the species are differentiated primarily by genetic factors. At metaphase I the increase in mean number of univalents, per cell, than at diakinesis seems to be due to precocious separation of chromosomes of the bivalents. If this is so they may not affect the normal segregation.

In hybrids, at metaphase I, the reduction in frequency of chiasmata, per bivalent, as compared to those of the parents may suggest the existence of small structural differences which are too small to be detected cytologically. Stebbins (1947) emphasised that small structural differences between chromosomes could conceivably co-exist with a high degree of regular meiotic pairing.

It may be noted that marked evidence of structural differentiation is not to be expected in species with small chromosomes and few chiasmata, and moreover, there is a good deal of evidence now available that a large proportion of structural differences between genomes involve segments which are so small that they do not give the typical meiotic figurations such as multivalents and bridge-fragments in structural hybrids. In such cases it may be desirable to seek the differences between the parents at genic level (see Stephens 1950).

It is suggested by considering all the aforesaid facts that the parents, *S. retroflexum* and tetraploid *S. nigrum* are differentiated primarily by genetic factors and probably the two species might have been derived from the same or identical ancestors. The presence of indistinguishable structural differences of chromosomes of the parents which are not capable of affecting the pollen fertility and pairing of chromosomes of the hybrids, supports the view that the genomes of the species are in 'initial stages of species divergence'.

References

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