CHROMOSOME STUDIES IN GENUS ALSTROEMERIA[1)]

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Abstract

Chromosomes of 9 species and 25 cultivars from different sources were studied in somatic cells and microsporocytes in the genus Alstroemeria. All 9 species had 2n=2x=16 chromosomes with different karyotypes. Chromosome numbers of four cultivars were 2n=2x=16 chromosomes, 12 were 2n=3x=24, 1 was 2n=3x+1=25, and 8 were tetraploid with 4x-1=31, 4x=32, 4x+1=33, with 6 plants having 2n=32. Meiotic behavior of chromosomes was normal in some species. However, meiosis was abnormal in all cultivars even in diploids. Pollen fertility was high in all species, but was very low in most cultivars with the exception of Orange Beauty (2n=25) and most of the tetraploids which had some good pollen grains.

1. Introduction

Alstroemeria has become a popular cut flower in the floriculture industry in recent years. Most of the cultivars of Alstroemeria seem to have been originated from polyploidization and hybridization of various parental species and cultivars and/or from mutagen treatment (Broertjes and Verboom, 1974; Verboom, 1980). It is known that most of the species in Alstroemeria assumed to be used for breeding program were diploid with 2n=2x=16 (Darlington and Wylie, 1955).

Chromosomes of Alstroemeria cultivars have been reported only in a few cases. Some cultivars were suspected to be triploid without cytological study. Chromosome numbers of cv. Orchid, cv. Beauty, cv. Edison and cv. Starosa were diploid (2n=16) and cv. Regina was triploid (2n=24) (Broertjes and Verboom, 1974).

In this paper some results of chromosome studies in 9 species and 25 cultivars are briefly reported.

2. Materials and Methods

Nine species used in this study were collected from various sources. They are: A. aurantiaca, A. psittacina, A. pulchella (=A. psittacina), A. pelegrina, A. versicolor, A. haemantha, A. chilensis, A. caryophyllaea and A. hookeri.

A total of 25 cultivars were also collected from various sources. These materials were grown in the greenhouse in the Department of Agronomy, Colorado State University. Root tips were collected, pretreated with ice cold water (1°C) for 16 hours and directly transferred to 0.8% aceto-carmine solution. After 3 to 5 days in the aceto-carmine, squash preparations were made in 45% acetic acid or

lactopropionic aceto-orcein.

Meiosis was studied in some materials using young flower buds that were collected, fixed in 3:1 mixture of alcohol and glacial acetic acid, and stained in 0.8% acetocarmine or lacto-propionic aceto-orcein. Squash preparations were made in a way similar to that used for somatic cells.

Pollen fertility was studied in most of the species and cultivars. Photomicrographs of pollen grains were taken with lower magnification. Viable and abortive pollen grains were evaluated in the photos.

3. Results

3.1. Somatic chromosomes

Chromosome numbers in the 9 species were all 2n=16, indicating their diploid nature. However, there was a considerable difference in their karyotypes. Some species showed heterozygous nature with one or more non-homologous pairs.

Chromosome numbers of 25 cultivars were studied with the results shown in Table 1. Only four (16%) of 25 cultivars were diploid with 2n=16 chromosomes. Eight cultivars (32%) were tetraploid (2n=32, 6 cultivars) or near tetraploid, one each with 2n=31 and 2n=33. Twelve cultivars were triploid (2n=24) and one cultivar was hypertriploid with 2n=3x+1=25 chromosomes.

Most of the tetraploid cultivars showed gigas-type characteristics with thick stems, thick and dark green leaves, thick flower petals and overall stunted appearance.

3.2. Meiotic chromosomes

Meiosis was studied in the species A. psittacina that showed normal 8 bivalents at metaphase I (Fig.2a). Chromosome behavior in the later meiotic stages was usually normal.

In contrast, meiotic chromosome behavior was highly abnormal in most of the cultivars including the diploids. For example in the diploid cultivar Canaria (Fig. 2b), meiotic chromosome pairing varied from cell to cell with varying number of bivalents and univalents.

Meiotic chromosome behavior in triploid cultivars was extremely abnormal with complicated chromosome associations with many univalents at metaphase I (Fig. 2c) and abnormal separation at anaphase I and later stages.

Meiotic chromosome behavior in tetraploid cultivars was fairly normal with a good number of bivalents and some univalents (Fig.2d), although chromosome configurations varied from one cell to another.

3.3. Pollen Fertility

Pollen fertility was very good in most of the species studied with 80% or higher percentages of well developed pollens. An exception was A. chilensis which was completely male sterile. However, most of the cultivars showed extremely low pollen fertility or almost complete sterility even in diploid cultivars. Some tetraploid cultivars however, showed fairly good pollen fertility. A triploid cultivar that showed some pollen fertility with 40% apparently good pollen grains was a hypertriploid cultivar, Orange Beauty, (2n=25) .

4. Discussion

Chromosome numbers of some wild species of Alstroemeria were studied at an early stage of cytological studies. Darlington and Wylie (1955) listed chromosome numbers of 8 species in Alstroemeria, all of which showed diploid number of 2n=2x=16 with the exception of apparent A. ligtu having 2n=32 (Goodspeed, 1940).

In agreement with most of the previous work, all 9 species showed diploid number (2n=2x=16). However, there were some variations in karyotypes in different species, though karyotype analysis was conducted only briefly (Sato, 1938; Taylor, 1926; Whyte, 1929).

Another finding from the brief karyotype analysis was the heterozygous nature of the chromosome complement. Some species definitely showed one or more non-homologous pairs in their somatic cells.

It was a surprise to find so many cultivars were polyploid with the highest percentage of triploids followed by tetraploid, the lowest being diploid. It was difficult to explain the origin of high percentage of polyploid cultivars since all putative parental species have diploid chromosome number of 2n=16. However, informal information suggest that polyploidization was made at one time or another during the breeding period. Whatever the origin of polyploid cultivars may be, it is obvious that polyploid cultivars have high market value in Alstroemeria. One more aspect is the finding of aneuploids in both triploid and tetraploid cultivars (Table 1). It is interesting to note that a hypertriploid cultivar, Orange Beauty (2n=3x+1=25) showed fairly good pollen fertility and was used for the development of a Canadian cultivar Alsaan (Lin and Molnar, 1983).

Meiosis was studied in only a limited number of species and showed rather normal chromosome behavior. It is interesting to study detailed meiotic behavior in some species with heterozygous chromosome complement.

Meiosis was briefly studied in many cultivars. Generally, meiotic irregularities at various stages were caused by abnormal pairing behaviors at prophase I through metaphase I. Varying numbers of univalents were observed in all cultivars including diploids. Multivalents were seldom recorded in both triploid and tetraploid cultivars.

Corresponding to the fairly normal meiotic behavior most of the species showed relatively high pollen fertility. However, most of the cultivars including diploids showed no or extremely low pollen fertility. Definitely some cases were ascribed to irradiation treatment together with triploidy. The main cause of pollen sterility is extremely irregular meiotic chromosome behaviors in all cultivars even in diploids.

The fairly good pollen fertility in many tetraploid cultivars may be, at least, partly ascribed to the relatively high degree of bivalent formation at meiotic metaphase I (Fig. 2d). The relatively high fertility of Orange Beauty ($2n = 3x + 1 = 25$) is not well understood at present. The cause(s) of male sterility in a species, A. chilense is not known.

Cytological study in the genus Alstroemeria has been rather limited in the past. The present studies provide some information on the chromosome constitutions of some species and a good number of cultivars. However, it is important to study detailed karyotypes in each species, since previous work conducted with the paraffinsection method (Taylor, 1926; Whyte, 1929; Sato, 1938) does not provide accurate information on chromosome constitutions. Karyotype analysis in many cultivars is very important to determine the parental species involved in the breeding program.

Meiotic analysis will also shed some light on the chromosome constitutions, particularly the presence or absence of structural changes and the nature of changes in some species.

Pollen fertility in cultivars may provide an indication of the female fertility of the cultivars which might be used for further crossing program for breeding new cultivars.

Coordinated, systematic cytological and cytogenetic studies may eventually help the Alstroemeria industry to develop breeding programs within the USA.

References

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Table 1. Chromosome numbers in 25 cultivars in Alstroemeria.

Chromosome Number	Cultivars
2n = 2x = 16	Orchid, Canaria, Zebra, Eureka
2n = 3x = 24	Pink Perfection, Regina, Carmen, Marina, Campfire, Red Surprise, King Cardinal, Apple Blossom, Pink Triumph, Mona Lisa, Yellow King, Rosita
2n = 3x+1 = 25	Orange Beauty
2n = 4x-1 = 31	Luciana
2n = 4x = 32	Jubilee, Arizo, Orego, Alnba, Texas, Neva
2n = 4x + 1 = 33	Rosario

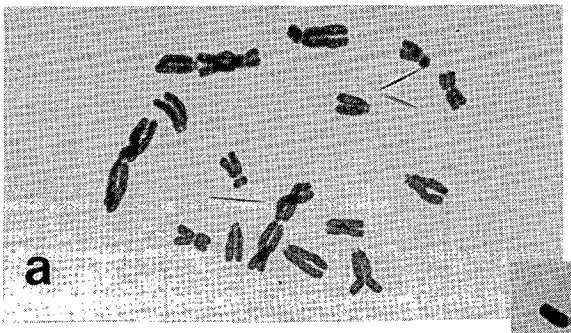
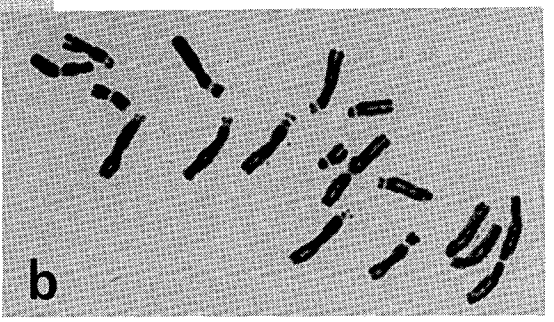


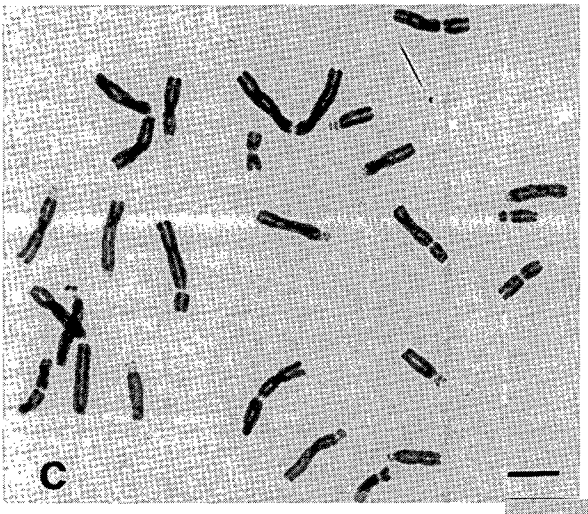
Fig. 1. Somatic chromosomes in one species and three cultivars in Alstroemeria

(Bar, 10)

a. A. psittacina, 2n=2x=16

b. A. cv. Canaria, 2n=2x=16

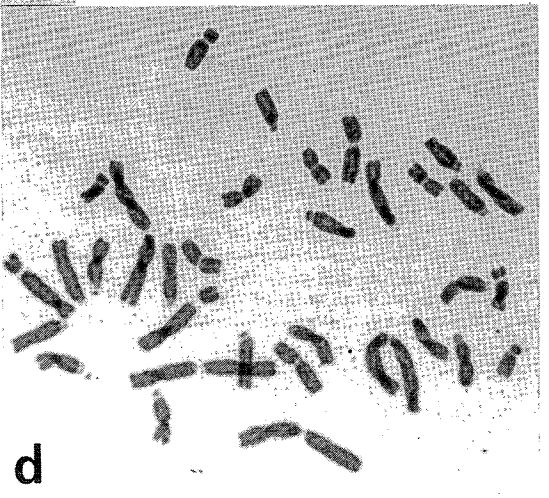


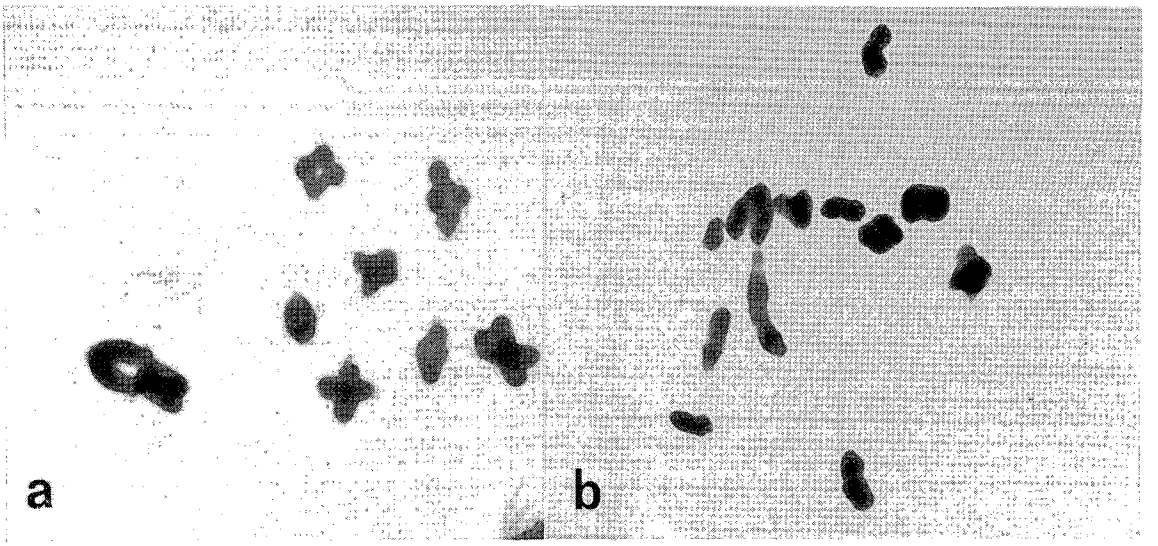


c. A. cv. Marina, 2n=3x=24

d. A. cv. Rosario, 2n=4x+1=33

Bar represents 10μm





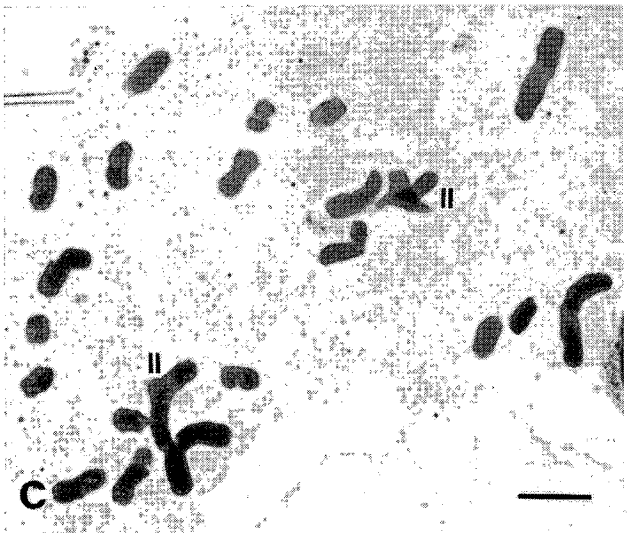


Fig. 2. Meiotic chromosome configurations at metaphase I in the same four materials as figure 1.

a. A. psittacina, 8II

b. A. cv. Canaria, 5 II+6I

c. A. cv. Marina, 2II+20I

d. A. cv. Rosario, 1III+14II+2I

Bar represents 10µm