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CHROMOSOME NUMBER AND CYTOLOGICAL OBSERVATIONS OF SELECTED *Xanthomonas* AND THEIR POSSIBLE IMPORTANCE IN BREEDING FOR DRY ROOT-ROT RESISTANCE

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ABSTRACT

A significant decrease in yield of taniers (*Xanthosoma* Spp.) during the last decades has been attributed to many factors, among the most important is the dry root-rot syndrome. Reported throughout the Caribbean as «Burning», in Africa as «Apollo» disease. *Pythium, Rhizoctonia* and *Fusarium* have been associated with this. Improvement of taniers has been traditionally made by clonal selection and no reports are availble on genetic gains obtained through breeding. This study presents preliminary data on 17 *Xanthosomas*. Cultivar Venezolana and two introductions are pentaploid (2nd=65) ; Palma is tetraploid (2n=52) while the remaining 13 studied are diploids (2n=26). Pentaploids with their 13 extra chromosomes could present problems in a breeding program. Of two hybrids of Vinola x Kelly, C1-21 is more stable (microspores and pollen) than C1-27 and should be more fertile and easier to use in a breeding program. The pentaploids (65) could have resulted from natural union of an unreduced tetraploid egg (52) with a reduced pollen grain (13) from a diploid. If the pentaploids have resistance to the dry-root-rot syndrome it might have come from either a diploid or tetraploid. This particular genotype with resistance to this syndrome might prove to be a key factor in a breeding program.

RESUME

NOMBRE DE CHROMOSOMES ET OBSERVATIONS CYTOLOGIQUES DE *XanthosomaS* SELECTIONNES ET LEUR IMPORTANCE POSSIBLE DANS LA SELECTION POUR LA RESISTANCE A LA POURRITURE SECHE DES RACINES

Une réduction significative du rendement des *Xanthosomas* spp. au cours des dernières décennies a été attribué à divers facteurs, dont le plus important est le syndrome de la pourriture sèche des racines, signalée dans toute la Caraïbe comme «brûlure», en Afrique comme «maladie» d'Apollo». Des *Pythium, Rhyzoctonia* et *Fusarium* y ont été associés. L'amélioration des *Xanthosoma* a été traditionnellement faite par sélection clonale et on ne dispose pas d'information sur des gains génétiques obtenus par croisement. Cette étude présente des données préliminaires chez 17 *Xanthosoma*. Le cultivar Venezolane et deux introductions sont pentaploïdes (2n=65) ; Palma est tétraploïde (2=52), tandis que les 13 extra chromosomes pourraient présenter des problèmes dans un programme de croisement. De deux hybrides de Vinola x Kelly, C1-21 est plus stable (microspores et pollen) que C1-27 et devrait être plus fertile et facile à utiliser dans un programme de croisement. Les pentaploïdes (65) pourraient provenir de l'union naturelle d'un ovule non réduit de tétraploïde (52) avec un pollen réduit (13) de diploïde. Si les pentaploïdes ont la résistance au syndrome de la pourriture sèche de la racine, elle pourrait provenir soit d'un diploïde soit d'un tétraploïde. Ce génotype particulier, résistant à ce syndrome, pourrait se révéler un facteur clé dans un programme de croisement.

INTRODUCTION

Taniers, or new cocoyams (*Xanthosoma* spp.) are important root crops in the tropics. During 1986-87, 15,327 m tons worth $8.37 million were consumed making it the second most important root crop in Puerto Rico. Production of taniers in Puerto Rico reached a peak in 1955 ; since then, yields have declined sharply making importation necessary in order to meet the local demand. According to Vicente-Chandler (1985), about 23,000 m tons will be needed to supply the local demand in the year 2000.

The yield reduction of taniers has been the subject of study by researchers

in the tropics and has been attributed to a condition called «mal seco» or dry-root-rot syndrome in Puerto Rico. This condition has been reported throughout the Caribbean, where it is known as «burning», and in Africa where it is referred to as «Apoll» disease. Four- or five-month-old plants affected with the dry-root-rot syndrome stop growing, show reduced foliage, and present symptoms of premature senescence and the one-time profuse root system suddenly becomes a fiber-like mass of dry roots. Plants are easily pulled out of the soil as a result of the deterioration of the root system. Fungal pathogens such as *Pythium, Rhizoctonia* , and *Fusarium* have been associated with this condition although research on this aspect appears to be inconclusive. Since fungicide treatments have not been effective in controlling the syndrome, it appears that development of resistant germplasm is the most effective approach.

The improvement of taniers has been traditionally done by the introduction of germplasm, clonal selection and pre-breeding. No report is available in the literature indicating any specific breeding system which should be followed. There exists considerable variability within *Xanthosoma* , some edible, others ornamental and some for other uses, and numerous species have been described (Gooding and Campbell, 1961). The basic chromosome number for *X. sagittifolium, violaceum, atrovirens* , and others has been reported to be n=13.

This paper will present information on chromosome number and cytological and morphological observations as part of a breeding program for the development of *Xanthosoma* with resistance to the dry-root-rot syndrome.

MATERIALS AND METHODS

The members of the genus *Xanthosoma* studied, except hybrids C1-21 and C1-27 were selected from 74 cultivars under field evaluation at the ARS Isabela experiment farm. Hybrids C1-21 and C1-27 (Vinola x Kelly) were developed by Angel Bosques-Vega of the Isabela Agricultural Experiment Substation of the University of Puerto Rico, College of Agricultural Sciences, Mayaguez, Puerto Rico. The selections are commercial varieties or introductions with apparent resistance to the dry-root-rot syndrome. A description of each of the cultivars by flesh color (corm and/or cormel) is as follows :

Cultivar	Flesh color
Kelly, Palma, Venezolana Amarilla del Pais, Corozal 1, Corozal 2	Yellow

Blanca del Pais, Rascana Blanca Dominica, Alela	White
Vinola, C1-21, C1-27	Purple

Root-tip chromosome number determinations and microsporocyte analyses were made at the ARS USDA College Station laboratory, Texas. Root tips of one two cm length were collected at 9:00 PM and placed in a saturated aqueous solution of 1-bromonaphtalene at room temperatures for 15-20 hours. They were then fixed with 3 parts absolute ethyl alcohol to 1 part glacial acetic acid. Root tips were hydrolysed in 1N HCL for 8 minutes and stained in Fuelgen's solution for 3 to 5 hours. Slides were made by squashing the root tips in aceto-carmine at one-half strength.

Spadexes were fixed in 3 parts absolute ethyl alcohol to 1 part glacial acetic acid for microsporocyte and pollen observations. After 24 hours, they were tranferred to 70 % ethyl alcohol. slides of microsporocytes were prepared by staining the contents of anthers in aceto-carmine. Pollen was observed on slides after staining with I2KI solution in 50 % ethyl alcohol.

RESULTS AND DISCUSSION

A morphological description based on three important plant characters, namely leaf blade, petiole and above ground stem for the *Xanthosoma*s studied follows :

Leaf Blade

The leaf sinus of cultivars Kelly, Blanca Dominica, Palma, Amarilla and Blanca del Pais, Corozal 1 and 2 and Adela is not denuded. Vinola and Rascana leaf sinus is denuded. The length of the basal rib ranges from 76 cm (Palma and Vinola) to 28 cm (Rasacana). Width of leaf blade ranges from 86 (Palma) to 28 cm (Kelly). The blades of cultivars Kelly, Blanca, Dominicana, Vinola, Rascana and Alela have rough texture, while Palma, Amarilla and Blanca del Pais, Corozal 1, 2 have soft texture. All cultivars exhibit an entire smooth leaf margin and non peltate sagittate blade. Plants were not available for C1-21
and C1-27. We found that cultivar Venezolana and Corozal 1 are identical.

Petiole

The length (cm) of the periole ranges from 147 (Palma) to 53 cm (Amarilla del Pais) while the ratio of the sheath to the total petiole length ranged from

0.74 (Kelly) to 0.38 cm (Amarilla del Pais). The petiole color varied from light green (Alela) to purple (Kelly). The cross section of the petiole's sheath varied from 3.8 cm (Kelly) to 8.9 (Corozal 1).

Aboveground Stems

The main corm is ocassionally utilized for propagation purposes and in some instances for feed. The cultivars studied are acaulescent except Vinola and Adela which develop short aboveground stems when grown over one year. The presence, abundance and color of latex varied. Rascana latex is light purple while that of the remaining cultivars is cream-colored. In Blanca Dominica, Kelly, Rascana, Corozal 1 and Alela the latex is especially abundant.

Cytological Observations

The chromosome number (2n=26) for *Xanthosoma sagittifolium, X. violaceum* and *X. atrovirens* was reported by Marchant (1971). Darlington and While (1955) referenced 2n=24 for *X. violaceum* and 2n=26 for X. *sagittifolium* . No other reports are available which might provide additional information on the chromosome number and other cytological studies on members of the genus. The local commercial varieties (Kelly, Alela, Amarilla and Blanca del Pais, Rascana, Vinola and Blanca Dominicana) are all diploids (2n=26). On the other hand, Palma, a non-commercial cultivar is a tetraploid (2n=4x=52). Cultivars Venezolana, Corozal 1 and 2 are pentaploids (2n=5x=65). The results for the chromosome number determinations and observations on microspore tetrads are summarized in Table 1.

With some exceptions diploid tanier cultivars were found to be completely fertile. Fig. 1 shows the chromosomes of cultivar Alela which is probably fertile. In our study this cultivar did not show irregularities in microspore development. Microspore tetrads of hybrid C1-21 (Vinola x Kelly) are apparently fertile (Fig. 2). On the other hand, another hybrid, C1-27 developed utilizing the same parents, shows irregularities and is probably not very fertile (Fig. 3). Cultivar Kelly shows irregularities in the microspore which might limit its use in a breeding program.

The chromosome number of a non-commercial cultivar, Palma is shown in Fig. 4. This cultivar is highly resistant to the dry-root-rot syndrome and could be a potential parent in a breeding program. Microsporocyte analyses of this cultivar were not carried out since flowers were not available at the time this study was conducted.

Non-commercial cultivars such as Corozal 1 and 2 and Venezolana are

pentaploids but are highly resistant to the dry-root rot syndrome. The chromosome number of Corozal 1 as well as that for Corozal 2 and Venezolana is 65 (Fig. 5). Tetrads of microspores, many with more than four are commonly observed in these cultivars. The extra small microspores are probably due irregular distribution of the 13 extra chromosomes. Fertility in these pentaploids might be very low or non-existant.

CONCLUSIONS

This study presents preliminary data on chromosome number and microsporocyte and pollen observations of selected numbers of the genus *Xanthosoma* . Cultivars Venezolana and two introductions are pentaploids (2n=5x=65) ; Palma is a tetraploid (2n=4x=52) while the remaining *Xanthosomas* are diploids (2n=2x=26). It appears that pentaploids with their 13 extra chromosomes could present problems in a breeding program. Two hybrids of Vinola x Kelly were studied ; C1-21 is more stable (microspores and pollen) than hybrid C1-27 and should be more fertile and easier to use in a breeding program. The pentaploids (65) could have resulted from natural crosses of tetraploids with the union of an unreduced egg (52) with a reduced pollen grain (13) from a diploid. If the pentaploids have resistance to the dry root-rot syndrome it might have come from either the diploid or tetraploid. A search for this particular genotype with resistance to the dry root-rot sundrome in taniers might prove to be a key factor in a breeding improvement program for *Xanthosomas*.

ACKNOWLEDGMENT

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REFERENCES

DARLINGTON, C.D. and WYLIE, A.P. (1955). Chromosome Atlas of Flowering Plants, Second Edition, London. 519 pp.

GOODING, H.J. and CAMPBELL, J.S. (1961). Preliminary trials of West Indian *Xanthosoma* cultivars. Trop. Agri. Trinidad 38 : 145-152.

MARCHANT, C.J. (1971). Chromosome variation in Araceae. II Richardae to Colacasieae. Knew Bull. 25, pp. 47-56.

VICENTE-CHANDLER, J. 1985, Una nueva agricultura para Puerto Rico-Ano 2,000, uSDA, ARS, Agric. Exp. Stn., Univ. P.R.

table 1 : Chromosone number and microscope observations of selected Xanthosomas

Identity	Chrom. no.	Sporocyte*
Palma	52	
Amarilla del Pais	26	
46-PR14808, Vinola	26	
Blanca	26	
44-PR14806, Rascana	26	
36-PR14796, Blanca del Pais	26	
43-PR14804, Kelly	26	Tetrad-many shriveled
76-Santo Domingo White	26	
Xanthosoma sp. Sel #1	65	
Xanthosoma sp. Sel #2	65	
Alela	26	Tetrad-normal
Vinola	26	
Venezolana	65	Tetrad-very irregular
Hyb. C-1-21 Vinola x Kelly		Tetrad-normal
Hyb. C-1-27 Vinola x Kelly		Tetrad-many shriveled

* Tetrad observations are preliminary and frequencies of irregularities need to be determined

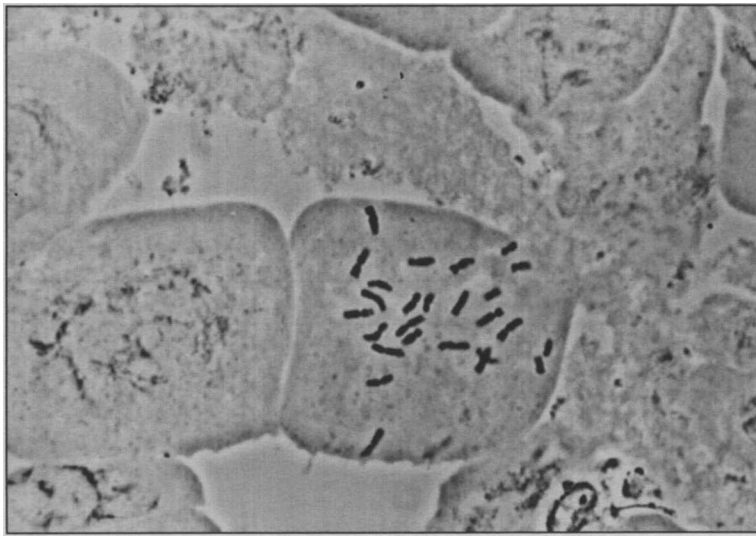

Figure 1 : A smeared root-tip cell of cultivar Alela with 26 chromossomes

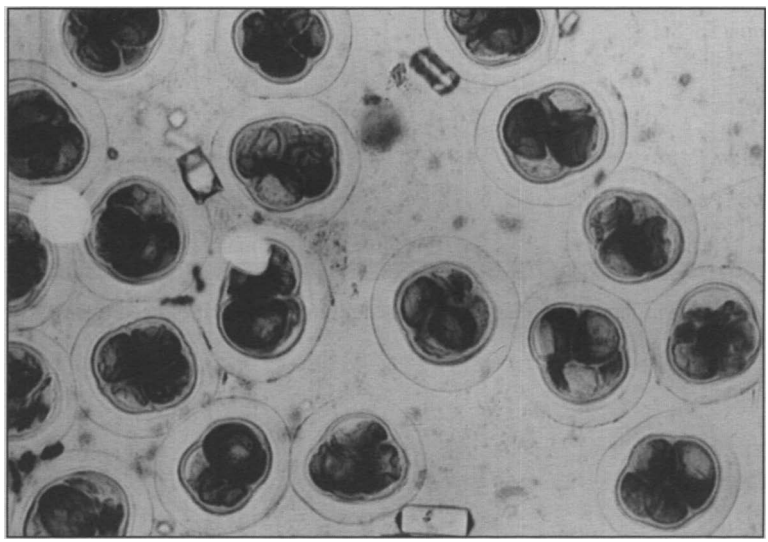

Figure 2 : Smeared root-tip cell of hybrid C1-21, tetrads of microspores

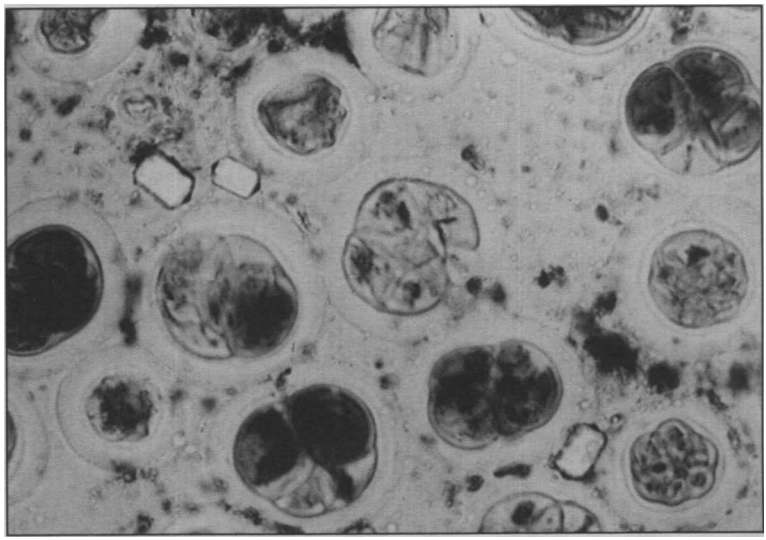

Figure 3 : Smeared root-tip cell of hybrid C1-27, showing tetrads of microspores, many empty and shriveled

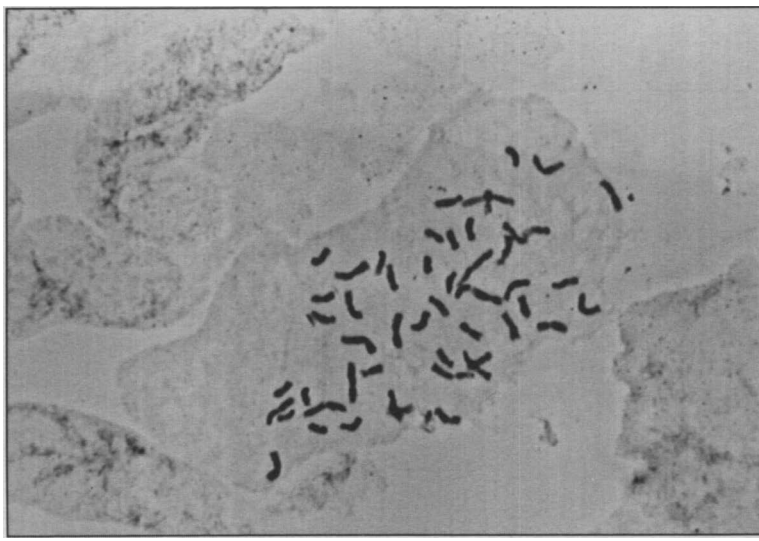

Figure 4 : Smeared root-tip cell of non-commercial cultivar Palma with 52 chromosomes

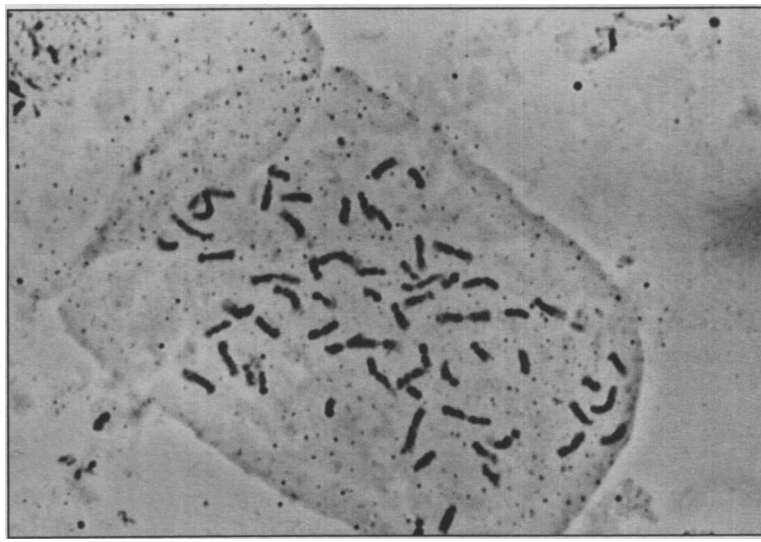

Figure 5 : Smeared root-tip cell of non-commercial cultivar Corozal 1 with 65 chromosomes