combination and the alteration of restriction patterns. It has also been suggested that the inverted repeat found in most plastomes may suppress recombinations or that plastome mutations may be corrected by gene conversions (for review see Palmer, 1985).

The large amounts of variation observed in the mtDNA of *Vaccinium* indicate that breeders fortuitously selected variable cytoplasms in creating highbush cultivars. This is not surprising, since three divergent species at two ploidy levels are represented. It is not known if these DNA variations translate into functional differences, but the high degree of mtDNA variability among the different cytoplasmic sources suggest that RFLPs should provide useful information on the evolution and taxonomy of the group. Nuclear RFLPs should also aid in locating economically important traits through the development of linkage maps.

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Spontaneous Tetraploid Melons

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Abstract. **Since 1968, three spontaneous 4x melons *(Cucumis melo* L.) plants were discovered in our field or greenhouse plantings. Two were found in the cultivar Planters Jumbo and one in the virescent marker C879-52. Each of these 4x plants had rounded cotyledons, shorter internodes, thicker stems and leaves, more hairs, and smaller fruits, with larger stem and blossom scars, than their 2x counterparts. Also, their flowers, pollen grains, stomates, and seeds were larger. The discovery of a 4x virescent plant in 1987 allows easier germplasm transfer between ploidy levels. Morphological characteristics of 2x and 4x melons will allow identification without need for chromosome counts.**

Interest in tetraploid (4x = 48 chromosomes) melons began in the 1930s with the discovery that colchicine produced polyploid plants. Shifriss (1942) began developing tetraploids of *Cucumis sativus* L. with colchicine in 1939 and then produced tetraploids of *C. melo* L. Batra (1952) developed six 4x melon cultivars with colchicine. Fruit quality in these tetraploids was superior to diploids (2x = 24 chromosomes); however, yields were lower in five of the six 4x lines. The 4x plants had larger flowers, pollen grains, and stomates in addition to thicker stems and lower fertility than the 2x plants. Tetraploid fruit were smaller and rounder than diploid fruit. Kubicki (1962) developed 4x cucumbers and melons and stated that spontaneous 4x types were lacking in the genus *Cucumis.* Dumas de Vaulx (1974) induced 4x with colchicine, studied fertility, and confirmed the morphological characteristics described by previous workers. He found that pollen tube growth was normal and did not cause poor seed set in self-pollinated 4x or crosses between 2x and 4x plants. A few viable seeds were obtained when the 4x parent was female and none when it was male. Ervin (1941) studied polysomaty in *C. melo.* He found that 4x cells occur regularly in root and stem tips of most plants. This finding suggested that polysomaty may also occur in gametes and that spontaneous 4x plants might be

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Table 1. Ploidy of plants with easily recognizable 2x or 4x visual traits.

Line	No. plants	External visual traits						Confirmed ploidy
		Seed	Cotyledon	Stem	Flower	Stem scar	Blossom scar	
Diploids								
C879-J2	6	Long	Long	Thin	Small	Small	Small	2x
Planters Jumbo	14	Long	Long	Thin	Small	Small	Small	2x
Putative tetraploids								
C883-m6	4	Plump	Round	Thick	Large	Large	Large	4x
67-1-100	8	Plump	Round	Thick	Large	Large	Large	4x
C879-J2-H10	8	Plump	Round	Thick	Large	Large	Large	4x

found. Love et al. (1986) reported that ≈ 0.02% doubled gametes occur in watermelon. These gametes occasionally result in the development of spontaneous 4x plants. A similar percentage of doubled gametes may occur in other melons.

C.F. Andrus (unpublished, 1961), U.S. Vegetable Lab., Charleston, S.C., found that 4x melons had better flesh quality and higher levels of resistance than 2x melons. He also believed that they had many shortcomings and were not very useful (personal communication). During his study, he developed several colchicine-derived 4x plants. He also found a few spontaneous 4x melon plants in field plots. One spontaneous 4x plant from 'Planters Jumbo', designated C883-m6, was saved for further study. In 1969, P.E.N. found another 4x 'Planters Jumbo' plant in a greenhouse planting of 67-l-m6. This 4x selection was designated 67-l-m6-100. After considerable study, we concluded that 4x melons were no better than current 2x cultivars and discontinued the project.

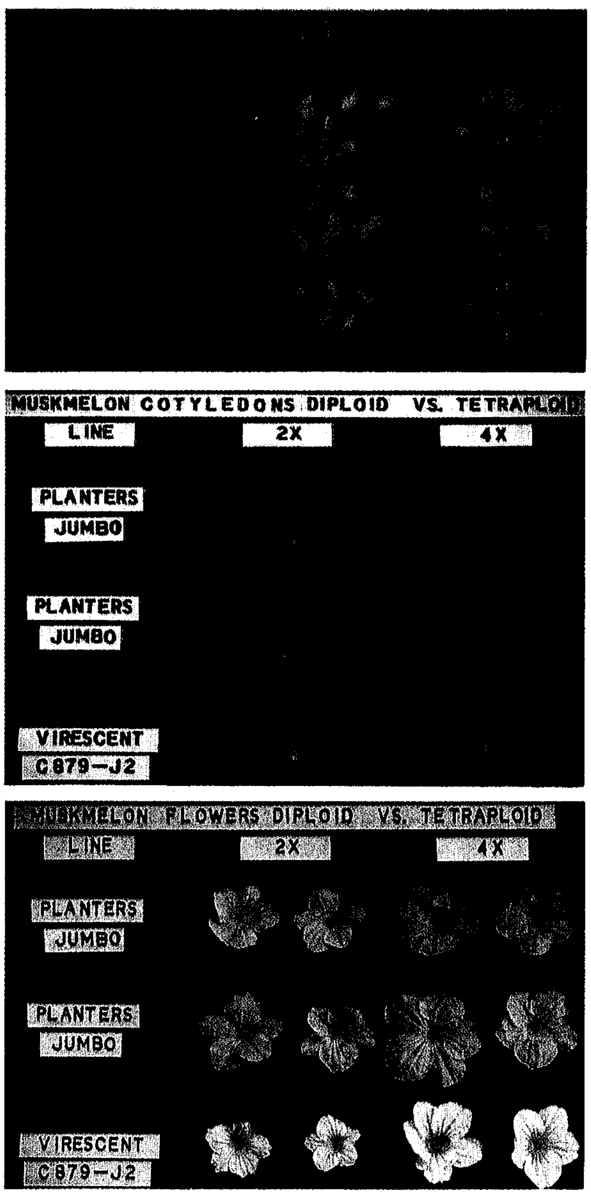

Fig. 1. A comparison of 2x and 4x melon seed (**top**), cotyledons (**center**), and flowers (**bottom**).

The project was revived in 1983 in response to requests from industry for information and photographs of 4x melons. They also asked about the availability of 4x germplasm and the possibility of producing seedless melons. We increased the 1969 seed lots and re-examined plant and fruit characteristics. Our objectives were to 1) document the occurrence of two spontaneous 4x lines in our collection; 2) compare their distinguishing characteristics with those of artificially produced 4x lines; 3) devise techniques for developing 4x virescent marker plants to use in the production of more diverse 4x melon germplasm; and 4) present photographs that will make it easier to recognize tetraploid melons in the future.

The plant materials for this study included 'Planters Jumbo' and its two 4x progeny mentioned above. Also included were C879-52 (Nugent, 1987) plus a spontaneous 4x plant (C879-J2-H10) discovered in a 1987 field planting of this virescent *(vv)* marker. This plant had thick leaves, short internodes, and four small, round to oblate fruit with large stem and blossom scars. Because of its 4x characteristics, the fruit were harvested. These fruit contained many hollow and 35 large, thick, plump seed. Twenty of these seeds were planted in the greenhouse to study the morphology of the resulting plants and to pollinate some of them. Self-pollinations were successfully made on eight of 10 plants. Seven of these selfed plants had 4x characteristics, but one appeared to be 2x. The two remaining plants did not set fruit. One of these two plants had typical 4x characteristics. The other was smaller with short internodes, thick and curled leaves, and flowers with leafy sepals but no petals. Its male flowers had no anthers and aborted at opening. This plant, which did not survive, resembled the octaploid (8x) described by Kubicki (1962).

These three 4x lines (C883-m6, 67-l-m6, C 879-J2-H10) were identified as tetraploids based on descriptions by Batra (1952) and Kubicki (1962) and phenotypic similarity to colchicine-produced tetraploids developed at this laboratory in the late 1960s. We now present observations on the morphology and cytology of these three spontaneous 4x C. *melo* plants, document the occurrence of spontaneous tetraploid melons, and provide a visual guide simplifying the identification of 4x melon plants and fruit.

Table 2. Fruit diameter and weight of confirmed 2x and 4x melons.

Line	Ploidy	No. plants	No. fruit	Diam (cm)		Wt (g)	
				Range	Mean	Range	Mean
C879-J2	2x	6	9	12.6–18.3	14.1	1045–1852	1499
C879-J2-H10	4x	8	26	10.1–14.6	12.6	610–1490	995
Planters Jumbo	2x	14	14	14.0–20.3	15.4	1575–3240	2383
C883-m6	4x	4	18	8.9–15.5	14.1	460–1953	1485
67-1-100	4x	8	8	13.3–15.2	14.5	960–1850	1303

Seeds were started in sand beds or peat pellets. Pollinations were made on plants grown to maturity in 370-cm^3 pots or soil benches in the greenhouse. Standard hand-pollination procedures were used. Photographs of fruit were from plants grown on raised, paper-mulch-covered beds. These beds, fertilized at a rate of 454 kg of 5N-4.4P-8.3K/ha, were 200 cm apart in field plots isolated at least 150 m from other melons. No irrigation or pesticides were used on these plants.

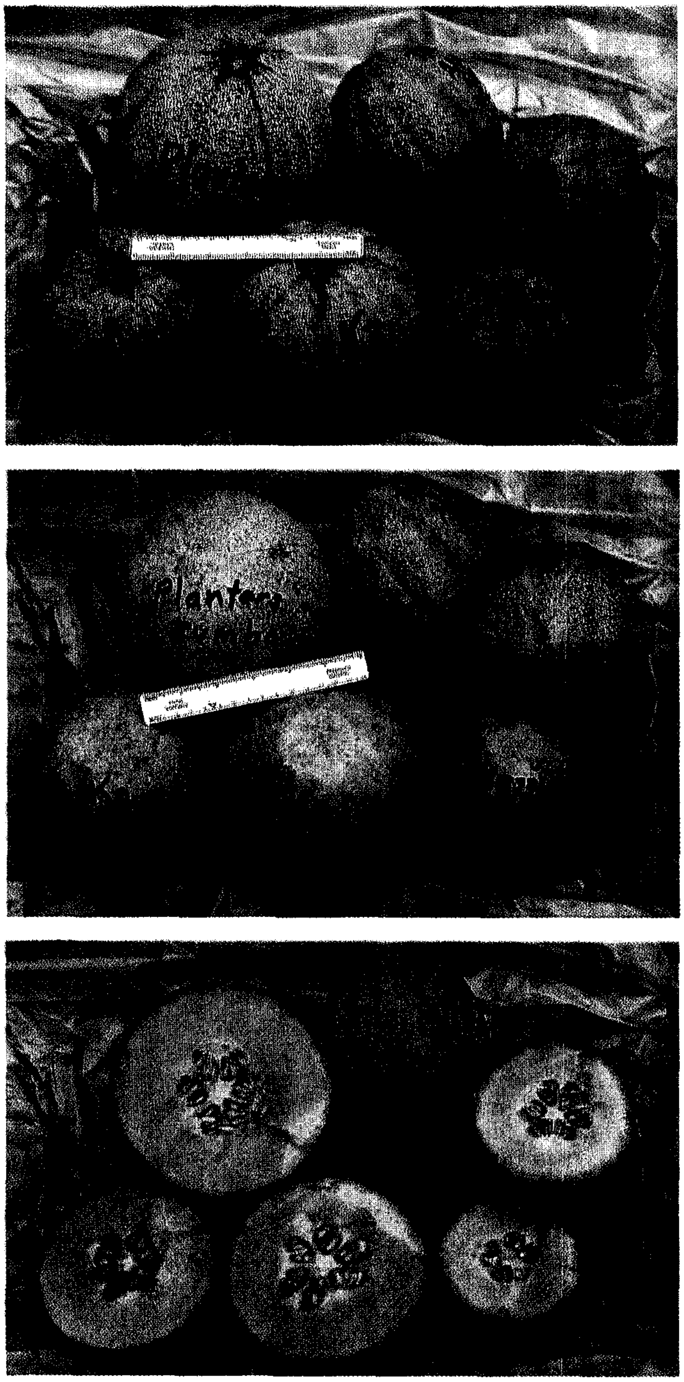

Fig. 2. Stem (**top**) and blossom (**center**) scars and cross-sections (**bottom**) of 2x 'Planters Jumbo' and C879-J2 (**top row**) and 4x melons (**bottom row**) C883-m6 (K2), 67-1-m6-100 (K3), and C879-J2-H10.

Ploidy of all plants in this study, determined by visual morphological traits, was confirmed by chromosome counts. This demonstrated that visual traits are useful in identifying various ploidy levels (Table 1). A single descriptive term was used instead of measurements to simplify recognition of plants at each ploidy level. Flower buds for cytological ploidy level confirmation were fixed in Carnoy's solution (6 ethyl alcohol : 3 chloroform : 1 glacial acetic acid) or a modification (4 chloroform : 3 ethyl alcohol : 1 glacial acetic acid), refrigerated at 4C for 24 to 48 h, and then placed in 70% alcohol. Anthers from squashes of fixed buds were prepared in acetocarmine for chromosome counts.

The spontaneous 4x plants had more rounded cotyledons, shorter internodes, thicker leaves, more trichomes, and smaller fruits with larger stem and blossom scars than their 2x counterparts (Figs. 1 and 2). Also, their flowers, pollen grains, stomates, and seeds were larger. Many of the characteristics of these spontaneous 4x plants were similar to colchicine-produced lines. For example, all 4x plants in this experiment had smaller fruit, set fewer seed, and seemed less fertile than their 2x parents (Tables 2 and 3). Several colchicine-induced 4x plants from C.F. Andrus were similar in many ways to the three spontaneous lines described in this paper, but their quality was not as good. Illustrations of these tetraploids are provided to guide breeders in identifying 4x plants during early growth and at harvest (Figs. 1 and 2). Chromosome counts of 'Planters Jumbo' and its 4x progeny illustrate confirmed ploidy levels (Fig. 3).

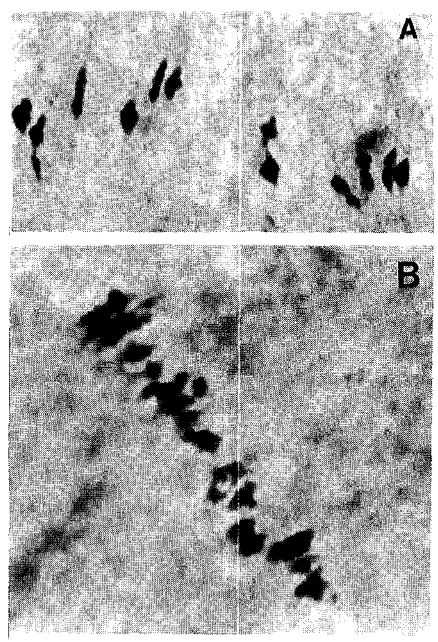

Fig. 3. Chromosomes of 2x (**A**) and 4x (**B**) 'Planters Jumbo'.

Table 3. Seed counts and weights of confirmed 2x and 4x melons.

Line	Ploidy	No. plants	No. fruit	No. seed/fruit		Total seed wt (g)	
				Range	Mean	Range	Mean
C879-J2	2x	6	9	279–571	417.6	8.3–16.3	12.7
C879-J2-H10	4x	8	26	15–305	94.5	0.5–4.4	2.0
Planters Jumbo	2x	14	14	338–716	496.9	6.6–21.4	14.5
C883-m6	4x	4	18	45–229	116.5	0.9–5.5	2.9
67-1-100	4x	8	8	24–179	89.1	0.5–5.3	2.3

Fast and accurate visual identification of 4x plants, without measurements, is essential to the development of commercially useful lines. By using characteristics such as those described and illustrated, accurate identification of 4x melons is possible. This procedure reduces the need for more difficult and time-consuming chromosome counts. Ail three 4x lines reported will be useful in improving this germplasm and the development of new germplasm sets. As new lines are identified, they can be tested for potential use in the development of inbred lines, hybrids, or parents for the production of triploid (3x) hybrids.

The recently discovered 4x virescent line likely will be especially useful as a female for production of 3x and 4x germplasm. It will be particularly helpful in large, field-scale research and commercial seed production without hand pollination. With this technique, all hybrid seedlings from 4x virescent plants will be normal green, in contrast to parental-type yellow seedlings having the recessive virescent trait. Initial attempts to cross 4x melon plants with 2x plants have thus far resulted in fruit with hollow seedcoats in the first generation and no 3x plants.

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Field Reaction of Landrace Components of Red Mottled Beans to Common Bacterial Blight

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Abstract. **Field reaction of 25 red mottled bean (*Phaseolus vulgaris* L.) genotypes to common bacterial blight *[Xanthomonas campestris* pv. *phaseoli* (Smith) Dye] was evaluated in Puerto Rico over 2 years. The average disease severity (percent leaf area with symptoms) was similar over years. The determinate red mottled genotypes had almost twice as much disease as indeterminate genotypes. Eight of the indeterminate genotypes had significantly less disease than the mean of the field experiments. These genotypes may serve as useful sources of resistance to common bacterial blight. The size of the chlorotic zone around necrotic lesions varied between growing seasons, showing that environment can influence the expression of common bacterial blight symptoms.**

Common bacterial blight (Cbb) is a serious disease in tropical and temperate bean growing regions (Beaver et al., 1985; Coyne and Schuster, 1974; Schieber, 1970). Most red mottled beans grown in the Dominican Republic are susceptible to common bacterial blight, but the characteristic chlorotic border around the necrotic leaf lesions often has not been observed on certain 'Pompadour'-type red mottled genotypes. The red mottled landrace cultivars, mostly grown by small-scale farmers, have been found to vary for several important traits, including growth habit, leaf pubescence, and biological N fixation capacity (Catano, 1990; Oviedo et al., 1990). The possibility that disease reaction could also vary led to the objective of this research: to evaluate a group of selections from the Dominican red mottled bean landrace for necrotic and chlorotic field reaction to common bacterial blight.

Twenty-five determinate and indeterminate red mottled bean genotypes were evaluated in Puerto Rico for field reaction to common bacterial blight in 1988 and 1989. Two red kidney genotypes, 27R and 3M-152, were also planted as susceptible controls. The experiments were planted at the Isabela Substation on 31 Oct. 1988 and 11 Oct. 1989. A randomized complete block design with five replications was used. Experimental units consisted of one 1.5-m row planted with 15 seed. Plots were evaluated for disease severity 46 days after planting in 1988 and 58 days after planting in 1989. All genotypes were at the early to mid-pod-fill stage of development when visually evaluated for percentage of leaf area showing necrosis and water-soaking due to Cbb. In addition, the size of the chlorotic zones surrounding the Cbb lesions was rated using a scale where 1 = no chlorotic zone and 5 = a chlorotic zone surrounding and nearly as large as the necrotic lesion. Rainfall and temperatures were normal and, therefore, favorable for disease development. Natural infection on the susceptible genotypes became prominent shortly after flowering. The average disease severity was similar between years. The disease severity on the susceptible controls ranged from 24% to 34% (Table 1). The small plots with five replications provided an adequate level of precision to detect significant disease severity differences among genotypes. Moreover, the disease se-

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