Isozyme Analysis of Hybrids and Their Parents of Watermelon [Citrullus lanatus (Thunb.) Matsum. & Nakai]

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Abstract

Ten F_1 hybrids and their 16 parents of watermelon [Citrullus lanatus (Thunb.) Matsum. & Nakai] were used for isozyme analysis of peroxidase (POD) and esterase (EST) of dry seeds, germinating seeds, cotyledons and roots at the cotyledonary stage. The results obtained indicated that zymograms of POD and EST varied at different stages and different parts of the plant. Isozyme variation between hybrids and their parents was found at the seed germination stage and cotyledonary stage of POD, as well as cotyledonary stage of EST. The following cases were observed in our study: F_1 hybrids had the same zymogram as their two parents, or maternal parents, or paternal parents, or had 'hybrid enzyme' or lacked some zymographic bands of their parents. High heterosis was generally found in the hybrids with the same isozyme zymograms of POD as their paternal parents, and EST as their maternal parents.

Evidence for a Tetrasomic Line in Watermelon

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A tetrasomic genotype has 2n + 2 chromosomes. If the chromosomes are simply duplicates of a given pair of homologues and segregation of this extra pair is normal, genes on these chromosomes should behave as expected for a tetraploid. Phenotypic differences between a tetrasomic and tetraploid should be a distinguishing feature. Also, a tetraploid x diploid cross will produce sterile triploids. However, a tetrasomic x disomic cross will produce trisomic progeny which should be much more fertile than triploids.

A glabrous, male sterile tetraploid watermelon line has been described (1). This line has been hybridized with diploid lines to produce triploid seedless progeny. We reported a related line that generally segregated as expected for a tetraploid line (2). The + + gms gms genotype generally produced progeny

segregating 35:1 hairy:glabrous. Crossing the genotypes gms gms gms gms x + + gms gms generally produced progeny segregating 5:1 hairy:glabrous. These crosses distinguished the tetrasomic from the disomic condition. Cytological examination of microsporocytes from male fertile plants from this line suggested high fertility and a haploid chromosome number nearer 1 than 22.

Glabrous plants from this line were crossed with three diploid genotypes: 'Crimson Sweet', LA 390 and SC 7. Germination of the hybrid seed in the greenhouse averaged 95% compared with 51% for the triploid cultivar 'Triple Sweet'. Seed number in F_1 hybrid fruit growing in the field was high. Seed morphology was similar to that of diploid rather than tetraploid seed.

Segregation ratios were re-examined in nearly 100 self- and sib-pollinations among glabrous, male sterile and hairy, male fertile plants. First, the progeny of a single plant was examined. This plant, when selfed, produced progeny segregating 39:7 hairy:glabrous. Forty-five of the plants were selfed and/or sib-pollinated to determine their genotype (Table 1).

Second, plants determined to be + gms gms gms among the F_1 progeny of the single + gms gms gms parent were testcrossed to gms gms gms gms sister plants. Hairy, male fertile plants from these testcrosses were selfed. All progeny from the single parent are grouped in Table 1. The tetrasomic nature of the line is indicated by segregation ratios of 35:1 and 5:1 in the F_2 progeny. Trisomy, rather than triploidy, was indicated by the high germination rate of seed from crosses with the three diploid lines noted earlier and by the presence of several hundred seed per melon produced on the hybrid plants. Progeny from the open-pollinated trisomic plants are being evaluated.

Seed of the putative tetrasomic line, segregating 1:1 for hairy, male fertile: glabrous, male sterile are available from the senior author.

Literature Cited

1. Love, S.L., B.B. Rhodes and P.E. Nugent. 1986. Controlled pollination transfer of nuclear male-sterile gene from a diploid to a tetraploid watermelon line. Euphytica 35:633-638.

2. Rhodes, B.B. and L.G. Blue. 1986. Segregation of glabrous, male-sterile in an autotetraploid line of Citrullus lanatus. Cucurbit Gen. Coop. 9:84-86.

Table 1. Distribution of genotypes from a single self-pollinated plant determined to be of the genotype ± gms gms gms.

Putative genotype[z]		Fraction of 46 F_1 progeny		F_2 segregation	
	ID	Theoretical	Actually[Y]	Selfed	sibbed
+ + gms gms	(1)	11.5	15	35:1	5:1
+ gms gms gms	(2)	23.0	23	3:1	1:1
gms gms gms gms	(3)	11.5	7	male sterile	

Crosses	Progeny			
	Hairy	Glabrous	Expected	Chi-Square
(3) x (2)	29	18	1:1	2.57
F_2 selfed	36	7	3:1	1.74
	40	7	3:1	2.56
(3) x (2)	29	21	1:1	1.28
F_2 selfed	37	13	3:1	0.03
	37	9	3:1	0.72
	40	10	3:1	0.67
(3) x (2)	9	11	1:1	0.05
F_2 selfed	33	7	3:1	1.20
	41	5	3:1	4.90
	40	9	3:1	1.15
(3) x (2)	11	6	1:1	1.47
F_2 selfed	34	11	3:1	0.01

[z]Determined by self and sib pollinations and Chi-Square analysis.
[Y]One hairy, male fertile plant lost after count of F_1 progeny.