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SEED GERMINATION, LEAF COLOR, AND PLANT SEX AS MARKER TRAITS IN POLYPLOID BREEDING OF WATERMEION

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INTRODUCTION

Triploid or seedless watermelon is a true F 1 hybrid. A triploid embryo results from crossing a tetraploid female parent with a diploid male parent. Gene markers are useful tools for ready identification of hybrid plants, and thus would facilitate the production of triploid watermelon. The present investigation was conducted to reveal differences in percent seed germination, and to evaluate the inherent differences in seed germination, and the mode of inheritance of leaf color and plant sex as possible marker characteristics.

REVIEW OF LITERATURE

Bianchi and Marchesi (1964) found that triploid seeds obtained from a cross between a tetraploid hybrid and diploid Charlesten Gray were of poor germination. Sanz-De Cortager (1965) stated that low germination charcterized the tetraploid forms of Chilefen variety of watermelon. Filov (1939) used yellow leaves as a gene marker. The cultivars Zelo-Koryi with yellow leaves and Krasaveik with green leaves were used. He concluded that green was dominant over yellow. Barham (1956) experimented with the cultivar Royal Golden. Before the first fruits start ripening the foliage and stems become chlorotic near the base. This condition progresses from the base toward the growing points of the vines and may extend throughout the plant, affecting both stems and leaves. The chlorotic condition was controlled by a single recessive gene pair.

The watermelon plant is either monoecious or andromonoecious. The monoecious plant produces male and female flowers whereas the andromonoecious plant produces male and perfect flowers. Rosa (1928) stated that the monoecious condition was dependent on a single dominant gene for expression. He observed the stability of plant sex type.

MATERIALS AND METHODS

A totai of 38 diploid, triploid, and tetraploid progenies was used throughout this investigation. This plant material included six diploid varieties, namely, Chilean Black, Congo, Shipper, Yellow Skin, and Yellow Elongate, and five tetraploid varieties, namely, Asahi-Chilean, Fumin, F-4, Ogon, and Takii's Earliest Gem. The triploids were 27, and were obtained from crossing tetraploid female-with diploid male-parents. Chilean Black, Congo, and Shipper were introduced from U.S.A. Kaho, Fumin, F-4. and Ogon were introductions from Japan. The other four Varieties, viz. Asahi-Chilean, Takii's Ealiest Gem 4x, Yellow Elongate, and Yellow Skin were originated in U.A.R. according to procedures mentioned by Abd El-Hafez in 1963, and 1969.

Table 1 gives the pedigree of triploids made to study the percentage of seed germination, leaf color, and sex in the triploid progeny and its parents. Seeds were germinated in sterilized sand in Petridishes at 30° C in an oven. A sample of 75 seeds represented each entry, and replicated three times. The germinated seeds were counted after five days and the percentage of germination was determined and statistically analyzed. All tetraploid varieties possessed green leaves. Yellow Skin and Yellow Elongate had yellow leaves. All varieties were monoecious except Chilean Black that was andromonoecious.

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Table 1. DIPLOID, TRIPLOID, AND TETRAPLOID WATERMELON MATERIAL USED FOR SEED GERMINATION, LEAF COLOR, AND PLANT SEX STUDIES

Pedigree of Triploid		Character studied (+)		
Female 4x Parent	Male 2x Partent	Seed germination	Leaf color	Plant sex
Asahi-Chilean	Chilean Black	+	—	+
" "	Congo	+	—	—
" "	Kaho	+	—	—
" "	Shipper	+	—	—
" "	Yellow Skin	+	+	—
" "	Yellow Elongate	+	—	—
Fumin	Chilean Black	+	—	+
"	Congo	+	—	—
"	Kaho	+	—	—
"	Shipper	+	—	—
"	Yellow Skin	+	+	—
"	Yellow Elongate	+	+	—
F-4	Chilean Black	+	—	+
"	Congo	+	—	—
"	Kaho	+	—	—
"	Shipper	+	—	—
"	Yellow Skin	+	+	—
"	Yellow Elongate	+	—	—
Ogon	Chilean Black	+	—	—
"	Congo	+	—	—
"	Kaho	+	—	—
"	Shipper	+	—	—
"	Yellow Skin	+	+	—
"	Yellow Elongate	+	+	—
Takii's E. Gem 4x	Chilean Black	—	—	+
" "	Yellow Skin	—	+	—
" "	Yellow Elongate	—	+	—

RESULTS

Percentage of Seed Germination

The percentage of seed germination in the parental and 3x offspring populations is shown in Table 2, and illustrated in Figure 1.

(1) Triploids from the maternal parent Asahi-Chilean . —

There were highly significant differences in percent seed germination among diploids, triploids, and tetraploids. The triploid had the same percentage of seed germination as that of 2x and 4x when the diploid paternal parent was Congo, Shipper, or Yellow Skin. The average percent germination in these populations ranged from 66.0 to 85.7. However, germination percentage was lower in the triploid than either 4x or the diploid parent Chilean Black. When Kaho or Yellow Elongate was the diploid parent, the triploid was equal to each in percent germination. But, both triploids and diploids were lower than the tetraploid Asahi-Chilean in germination percentage.

(2) Triploids from the maternal parent Fumin : —

Highly significant differences in percent seed germination existed among 2x, and 4x populations. The triploid had a similar germination percentage as that of diploid and tetraploid parents when Congo and Yellow Skin were the diploids. The percentage of germination averaged 67.3-86.7. On the other hand, percent germination was in 3x similar to 4x when Shipper or Yellow Elongate was the paternal parent. Both 3x and 4x had a higher germination percentage than that of both diploid parents. The triploid having Chilean Black as the diploid parent showed a lower percent germination than this parent but was equal to the tetraploid parent. The Fumin-Kaho triploid had a higher germination percentage than Kaho but was equal to Fumin. It should be pointed out that the percentage of seed germination in all triploids having Fumin as their maternal parent was of the same magnitude as that of the tetraploid. This percentage averged 67.3-85.3, and 76.3 in the triploids and tetraploid, respectively.

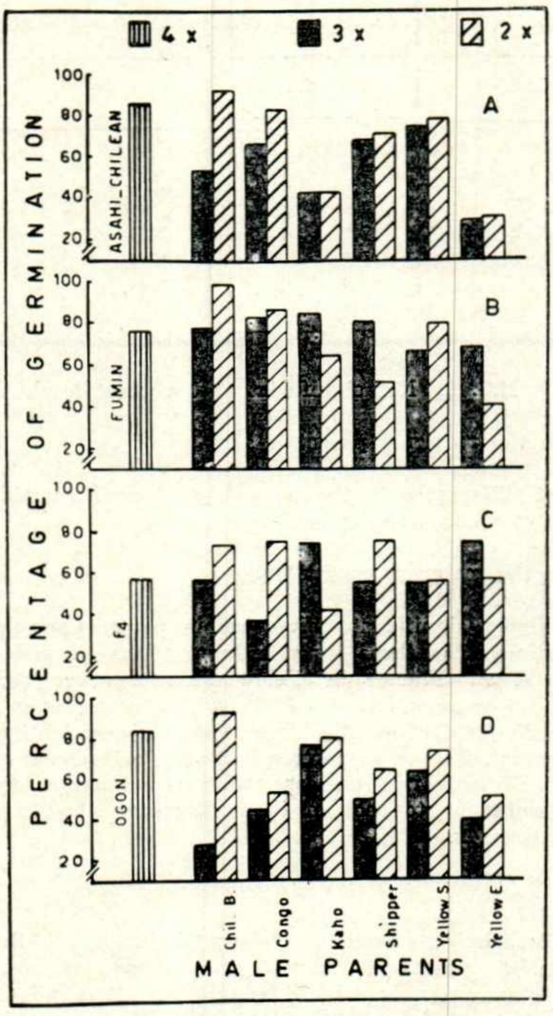

Figure 1. AVERAGE PERCENTAGE OF SEED GERMINATION IN TRIPLOIDS OF WATERMELON DERIVED FROM VARIOUS DIPLOID AND TETRAPLOID PARENTS.

Table 2. THE AVERAGE PERCENTAGE OF SEED GERMINATION IN FOUR TETRAPLOIDS, SIX DIPLOIDS, AND THEIR TRIPLOIDS IN WATERMELON.

Diploid	ASahi -Chilean		Fumin		F-4		Ogon	
	2x	3x	2x	3x	2x	3x	2x	3x
Chilean B.	92.0	53.3	98.7	77.7	73.3	57.3	93.3	26.7
Congo	82.7	66.0	86.7	82.7	74.7	37.3	52.7	44.0
Kaho	43.3	43.0	65.3	85.3	42.0	74.0	80.0	76.3
Shipper	70.7	68.0	52.0	80.7	74.7	55.3	64.0	59.3
Yellow S.	77.7	74.0	80.0	67.3	56.0	55.0	72.7	62.7
Yellow E.	40.0	39.3	41.3	69.0	57.3	75.0	51.3	38.7
X	67.7	57.3	70.7	77.1	63.0	59.0	69.0	51.3
X 4x	85.7		76.3		57.0		84.0	
L.S.D. (0.05) for : —								
13 Lots	26.3		18.2		N.S.		25.6	
2x, 3x, 4x	20.7, 10.7		N.S.		N.S.		20.1, 10.4	
2x	26.3		18.2		N.S.		25.6	
3x	N.S.		N.S.		N.S.		25.6	

N.S. = Not significant at 5 percent level.

(3) Triploids from the maternal parent F-4 : -

No significant differences in the percenage of seed germination were found among populations of various ploidy levels.

(4) Tripolids from the maternal parent Ogon :-

There were highly significant differences in percent germination among 2x, 3x, and 4x populations. The three types of populations showed a similar percent germination when Kaho, Shipper, or Yelow Skin was the diploid parent. The average percentage of germinotion was 59.3 - 84.0. On the other hand, the triploid resulting form the dipolid Chilean Black was lower in germination than the diploid or the tetraploid parent. These two parents had an equal percent germination. When Congo or Yellow Elongate was used as the paternal parent the triploid had a similar percent germination to each of them. However, the 3x and 2x showed a lower germination than 4x.

Color of Leaves

Two diploid varieties, namely, Yellow Skin and Yellow Elongate were used. Both varieties possessed leaves and stems of yellow color. The tetraploid parents were green in color. The triploids, from all combinations. were of light, yellow color especially the mid-ribs and the terminal lobes or leaves. However. this color was not intermediate between parents but the triploid plants had a greenish cast rather than yellow. Thus, incomplete dominance of the color genes was evident. The intensity of yellow color grade of the triploid plant became greater as the plant approached the flowering stage.

Obviously, this leaf character can be used as a genetic marker. The vine of the triploid plant would have a faint yellow color, in contrast to the normal green vine of the tetraploid.

Plant Sex

The tetraploid varieties were monoecious, i.e. the plant produces male and female flowers. The diploid Chilean Black parent was andromonocious, that is, having male and perfect flowers on the same plant. The triploid plants, resultant from each cross, were monoecious. This would indicate that the monoecious character was dominant over andromonocious.

The use of this characteristic as a genetic marker is rather limited since the triploid plant would produce flowers similar in sex to those of the tetraploid parent. However, it has its value in distinguishing 3x from 2x plants. The former would be monoecious, whereas the latter would be andromonocious.

DISCUSSION

Results on the percentage of seed germination revealed the fact that seeds with triploid embryo are not necessarily inferior in germination as commonly believed in watermelon. There were no differences in percent germination among seeds of various ploidy levels when F-4 was used as the tetraploid female parent. Seeds with 3x emrvo resultant from the tetraploid Fumin had the same magnitude of germination as that of the tetraploid. In some crosses having either Asahi-Chilean or Ogon as the tetraploid parent, the triploid had a similar percent germination as that of 2x and 4x when the diploid paternal parent was Shipper or Yellow Skin. However, germination was lower in the triploid than either 4x or the diploid Chilean Black. Other triploid strains varied in percent germination according to various diploids and tetraploids used as parentage. The low germination of triploids was reported by Bianchi and Marchesi (1964), and Saz-De Cortager (1965 There was no mention of the similarity of percent germination of 2x, 3x, and 4x seeds in the available literature.

The normal green color of leaves distinguished the tetraploid varieties from two diploids, namely, Yellow Skin and Yellow Elongate, the leaves of which were of yellow color. The resultant triploids were faint yellow, indicating incomplete dominance of gene or genes responsible for the expression of this trait. This conclusion does not agree with that reported by Filov (1939) and Barham (1956) who stated that green was dominant over yellow. Such discrepancy could be attributed to the different plant material used. The leaves of Royal Golden variety used by Barham (1956) turned yellow at fruit maturity. The foliage of Yellow Skin and Yellow Elongate handled in the present studies was of a conspicuous yellow color since the early stages of plant growth.

As to plant sex, triploids resulting from various tetraploid monoecious parents and a diploid andromonoecious parent were monoecious. This would indicate that the monoecious type was dominant over andromonoecious. These data are in accordance with those reported by Rosa (1928). Obviously, a high percentage of seed germination can be secured in seeds having triploid embryo by the use of specific parents that contribute to high capability of germination. The color of leaf can be utilized as a distinguishing feature of 2x, 3x, and 4x populations. The triploid plant produced foliage with a faint yellow color when the tetraploid parent was normal green and the diploid parent of yellow color. Plant sex can be applied to distinguish between 3x and 2x when a monoecious tetraploid is crossed with an andromonoecious diploid. The triploid would be monoecious.

SUMMARY

Six diploid varieties of watermelon and five tetraploid varieties were crossed to produce 27 triploid progenies. The diploids were Chilean Black, Congo, Kaho, Shipper, Yellow Skin, and Yellow Elongate. The tetraploids were Asahi-Chilean, Fumin, Ogon, and Takii's Earliest Gem.

The percentage of seed germination, leaf color, and plant sex were studied in the triploid progeny and its parents. There were no differences in percent germination among 2x, 3x, and 4x seeds of populations having F-4 as the tetraploid parent. Triploid-embryo seeds from the tetraploid Fumin had the same magnitude of germination as that of the tetraploid. Triploids originated from other tetraploids varied in percent germination. The average percentage of germination was from 40.0 to 93.3 in 2x, from 36.7 to 85.3 in 3x, and from 57.0 to 85.7 in 4x. As to color of leaves, the diploids Yellow Skin and Yellow Elongate possessed leaves of yellow color. The tetraploid parents were green. The resultant triploids were light yellow, especially the mid-ribs and terminal lobes of leaves. Incomplete dominance of color genes was evident. Concerning the type of plant sex, the tetraploid varieties were monoecious. The monoecious type was dominant over andromonoecious.

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