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PLANT, FLOWER, FRUIT AND SEED CHARACTERISTICS OF FIVE GENERATION INBRED SUMMER SQUASH LINES (*CUCURBITA PEPO* L.)

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Abstract

In this study five generation inbred lines of summer squashes (*Cucurbita pepo* L.) were developed through inbreeding by using earliness as the selection criteria where plant, flower, fruit and seed charecteristics were investigated. Plants were grown in two seasons in a year. In 1999, six inbred lines [Safir 1(8), Safir 1(9), Gieda 11(38), Gieda 7(20), Atlanta 7(23), Atlanta 7(24)] and four hybrid lines [GiedaxSafir 6 (15), GiedaxSafir 6 (23), Gieda xAtlanta 12 (16) , Gieda xAtlanta 12 (18)] in F_5 generation were grown in randomized block design with three replications. Data related to plant, flower, fruit and seed characteristics of these 10 lines are presented.

Introduction

Summer squashes with monoecious flowers are formed singly in the axils of the leaves. Pistillate and staminate flowers are big and easy to distinguish. Breeding summer squashes is relatively an easy process. Generally the cucurbits are considered to be naturally cross-pollinated. Pistillate flowers occur a few days after staminate ones and remain receptive for 24 hours. Fertilization occurs in the early morning according to environmental factors. Bees and other insect species act as the pollinators (Whitaker & Robinson, 1986).

As hybrids have the capacity for higher yield and earliness over open-pollinated squash cultivars, there is need to develop new hybrid squash cultivars. This breeding method is based on the principle of crossing two inbred lines. The first step is to obtain the homozygous lines by using inbreeding.

Inbreeding is the mating of closely related individuals which results in a large number of weak types with a general decline in their vigor, fertility and fecundity. Recessive, lethal and deleterious genes are usually concealed in a heterozygous system which are increased in the homozygous balance after inbreeding. Inbreeding increases homozygosity and reduces the proportion of heterozygosity in the population thus reducing the vigor of plants. For inbreeding, usually selfing and sib mating are practised (Kalloo, 1988).

The generation of selfing depends upon the degree of inbreeding depression in the crop. After four generations of selfing, most plants still gave good seed yield which indicates a low degree of inbreeding depression (Nieuwhof, 1985). Experimental results have demonstrated that cucurbits exhibit no inbreeding depression. In *Cucurbita maxima* and *C. pepo* only some degree of inbreeding depression was observed in I_2 (Abdel-al *et al*., 1973, Borghi, 1976). However some researchers have found clear evidence of inbreeding depression in *C. pepo*, particularly in seed yield. This difference might be the response of different species of *Cucurbita* to inbreeding (Whitaker & Robinson, 1986).

In this study, some plant, flower, fruit and seed characteristics of five generations of inbred lines of *Cucurbita pepo* L., in terms of their response to inbreeding depression is reported.

Materials and Methods

Experiments were conducted at the Agricultural Faculty of Akdeniz University in 1996-1999. Atlanta, Safir and Gieda cultivars were grown and made selfing and crossing to get segregration in 1996. Plants were grown in both spring and fall so that two generations of improvements could be done in a year. As pesticide was not applied, natural selection for resistance to disease was obtained. Inbreedings were continued during 1997 and 1998. At the end of the 1998, twelve inbred lines (Atlanta 2, 5, 6, 7; Safir 1, 2, 3, 4; Gieda 7, 11, 15, 14) and eight hybrid lines (Gieda x Safir 1,6,7,9; GiedaxAtlanta 2,11, 12, 20) were obtained in F_4 generation. Seeds of F_4 generation sown on 9 August, 1998 and seedlings were planted in field on 20 August 1998 in rows. Inbreedings were done in early and late flowering plants. Pistillate and staminate flowers that were to be used in pollination the following morning were tagged in the afternoon prior to anthesis by the appearance of a slight touch of yellow at the apex of the corolla tube. They were prevented from opening by using pens at the tips of the corolla tube. The following day early in the morning, soon after dehiscence the pollen sacs, transfer of the pollen from anther to stigma were commenced. After selfing, the pistillate flowers were labelled and tied to prevent uncontrolled pollination. In this research, the first pistillate flower of the plants were used for pollination since the fruit set was usually better, that is the plant did not produce any fruit previously. If open pollinated fruits were already formed, they were picked to improve the fruit set of the controlled pollinations.

Selections of six inbred lines [Safir 1(8), Safir 1(9), Gieda 11(38), Gieda 7(20), Atlanta 7(23), Atlanta 7(24)] and four hybrid lines [GiedaxSafir 6 (15), GiedaxSafir 6 (23), Gieda xAtlanta 12 (16), Gieda xAtlanta 12 (18)] were considered as F5 generation. Seeds of these lines were sown on 04 March 1999 and the seedlings were planted on 22 March 1999 under randomised block design with three replicates. Plants of this generation were evaluated for the criteria of plant habit, number of male and female flowers per plant, fruit colour, fruit length, fruit width, fruit weight, number of fruit per plant, seed length and width, number of seed per fruit, and 1000 seed weight. The data on the number of female and male flowers and fruit per plant, and the number of seed per fruit were applied for $\sqrt{}$ transformation since this variable did not show a continuous normal distribution. Analysis of variance was conducted according to the Randomized Block Design. Then Least Significant Difference Test was carried out at 0.05 level.

Results and Discussion

All lines, except Gieda 7(20), had bush habit. Where the branching charecteristics were taken into consideration, it was found that only lines Gieda 11(38) and Atlanta 7(23) had many branches, while the others had no branches. Plant habit and branching are important for the plant properties. Bush habit has been considered to be conditioned by a single incompletely dominant gene in *C. pepo* and the symbol 'Bu' has been assigned to this gene (Edelstein *et al*., 1989). Edelstein *et al*., (1989) reported that the bush growth habit is advantageous not only to home gardeners but also to commercial growers, as various cultural and harvesting operations are facilitated by compact growth. According to Paris *et al*., (1984) tidy habit in *C. pepo* and *C. maxima* was managed with absence of dominant gene. Edelstein *et al*., (1989) found that tidy habit is dominant to branching.

According to the flower properties, there were differences among number of female and male flower per plant (Table 1). Atlanta 7 (23) had the highest number of female flower per plant and the lowest number of the male flower per plant among lines in this experiment.

Table 1. Properties on flower of 10 hybrid lines.

Lines	female flower no/plant	male flower no/plant
Safir 1(8)	4.67 a	6.13 ab
Gieda* Atlanta12 (16)	3.53 ab	6.33 ab
Safir 1 (9)	3.21 ab	7.54 a
Gieda* Atlanta12 (18)	4.21 ab	6.07 ab
Gieda 7(20)	3.10 b	5.80 ab
Gieda 11(38)	3.62 ab	6.00 ab
Atlanta 7 (23)	3.61 ab	6.35 ab
Atlanta 7 (24)	3.47 ab	6.67 a
Gieda* Safir 6 (23)	4.71 a	5.93 ab
Gieda* Safir 6 (15)	2.80 b	5.33 b

There was a difference among lines for fruit width (Table 2). GiedaxAtlanta 12 (18) had the widest of 4.55 cm; Atlanta 7(23) had the shortest of 4.12 cm. There was no statistical difference among lines for fruit length and number of fruit per plant. When the fruit weight taken into consideration, lines Atlanta 7(23) and Atlanta 7(24) has the heaviest fruit,Gieda 11(38) and GiedaxSafir6(23) has the lightest fruit among the lines in the experiment.

Table 2. Fruit width, length and weight and number of fruits plant of ten inbred lines fruits.

Lines	Fruit width	Fruit length	Fruit weight	Fruit no/plant
Safir 1(8)	4.18 ab	13.64	127.8 cd	4.00
Gieda* Atlanta12 (16)	4.37 a	13.98	125.6 cd	2.43
Safir 1 (9)	4.33 a	15.24	150.8 ab	2.91
Gieda* Atlanta12 (18)	4.17 ab	14.08	124.3 cd	4.21
Gieda 7(20)	4.13 ab	15.32	129.7 cd	2.53
Gieda 11(38)	4.12 ab	14.05	112.6 d	2.62
Atlanta 7 (23)	4.44 a	15.18	157.2 a	2.93
Atlanta 7 (24)	4.55 a	14.91	162.4 a	2.47
Gieda* Safir 6 (23)	3.70 b	14.89	118.3 d	4.21
Gieda* Safir 6 (15)	4.44 a	14.25	140.3 bc	2.43

When the fruit colour is taken into consideration, Atlanta line 7(23) has light green and sandy dark green (data are not shown). Similarly Safir 1(8) and GiedaxSafir 6(23) also have sandy fruit colour yellow with white. GiedaxAtlanta 12(16) has yellow to sandy dark. Similar to Safir1(8) line GiedaXAtlanta 12(18) line has green and sandy light green similar to GiedaXAtlanta 12(18) line and Safir1(8) line. According to Schaffer *et al*., (1986) Shifriss found out that the skin color for summer squash was different from each other and the fruit skin colours varied from green yellow to orange.

Table 3. Seed size (length & width), seed number and seed weight in 10 inbred lines.

Lines	Seed width (mm)	Seed length (mm)	Seedno/ fruit	Seed weight (g)
Safir 1(8)	8.8 abc	14.3 a	64 f	104.4 b
Gieda* Atlanta12 (16)	8.4 abcd	13.4 ab	64 f	66.1 de
Safir 1 (9)	9.6 a	14.6 a	171 c	119.3 a
Gieda* Atlanta12 (18)	7.8 bcde	12.4 ab	117.5 d	63.1 e
Gieda 7(20)	8.5 abcd	13.9 ab	101 e	90.7 c
Gieda 11(38)	8.3 abcd	11.9 ab	44.5 g	64.7 de
Atlanta 7 (23)	9.3 ab	14.8 a	318 a	110.1 ab
Atlanta 7 (24)	6.9 de	14.1 ab	307 b	77.1 d
Gieda* Safir 6 (23)	6.6 e	11.1 b	22 h	35.5 f
Gieda* Safir 6 (15)	7.5 cde	13.3 ab	124 d	63.3 e

Atlanta line 7(23) showed maximum seed number of 318 and this line was found to be the best producing line (Table 3) as compared to Gieda XSafir 6(23) line which had the lowest seed number of 22. It is well known that the number of developing seeds can influence the size and shape of the mature fruit (Stephenson *et al*., 1988). Fruits with a below-average number of seeds are most likely to abort (Bertin, 1982; Lee & Bazzaz, 1982; Galen *et al*., 1985). In grape which has a double sigmoidal growth curve like *Cucurbita pepo*, fruits with fewer seeds tend to grow more rapidly even though the final volume is less than fruits with greater seed numbers (Staudt *et al*., 1986). Stephenson *et al*., (1988) reported that fruits with low seed numbers would be about 17% smaller than fruits with high seed numbers, the increase in fruit number would override this drawback. In this present study, it was observed that differences in the number of seeds influence the size of the fruit. In Safir 1(9) 1000 seeds weighed 119.33 g as compared to GiedaxSafir 6(23) with 35.45 g seed weight. Similarly Safir 1 (9) had highest of 9.6 mm seed width as compared to GiedaxSafir line 6(23) with 6.6 mm seed width. Atlanta 7(23), Safir 1(9) and Safir 1 (8) showed maximum seed length of 14.8, 14.6 and 14.3 mm, respectively.

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