SQUASH HYBRID PRODUCTION AND GENETIC STUDIES ON SOME IMPORTANT CHARACTERS

By

MOHAMED ISMAIL ABDALLH MOHAMED

B.Sc. Agric. Sci. (Vegetable Crops), Fac. Agric., Cairo Univ., 2007
M.Sc. Agric. Sci. (Vegetable Crops), Fac. Agric., Cairo Univ., 2012

THESIS

Submitted in Partial Fulfillment of the Requirements for the Degree of

DOCTOR OF PHILOSOPHY

In

Agricultural Sciences
(Vegetable Crops)

Department of Vegetable Crops
Faculty of Agriculture
Cairo University
EGYPT

2016

APPROVAL SHEET

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APPROVAL COMMITTEE

Dr. MOHAMED EL-SAID AHMED.....
Professor of Vegetable Crops, Fac. Agric., Banha University

Dr. SAID ABDALLA SHEHATA .....
Professor of Vegetable Crops, Fac. Agric., Cairo University

Dr. KHALED EL-SAYED ALI ABDEL-ATI .....
Professor of Vegetable Crops, Fac. Agric., Cairo University

Dr. AHMED ABDEL-MONEIM HASSAN .....
Professor of Vegetable Crops, Fac. Agric., Cairo University

Date: 29/6 /2016

SUPERVISION SHEET

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Dr. AHMED ABDEL-MONEIM HASSAN
Professor of Vegetable Crops, Fac. Agric., Cairo University

Dr. KHALED EL-SAYED ALI ABDEL-ATI
Professor of Vegetable Crops, Fac. Agric., Cairo University

Name of Candidate: Mohamed Ismail Abdallh Mohamed **Degree:** Ph.D.

Title of Thesis: Squash Hybrid Production and Genetic Studies on Some Important Characters

Supervisors: Dr. Ahmed Abdel-Moneim Hassan
Dr. Khaled El-Sayed Ali Abdel-Ati

Department: Vegetable Crops **Approval:** 29 / 6 / 2016

ABSTRACT

This study was carried out during the period from 2013 to 2015 at the Agricultural Experiment Station of the Faculty of Agriculture, University of Cairo, Giza, Egypt. The first experiment aimed at evaluating 23 genotypes of summer squash (*Cucurbita pepo*), viz., PEP 11 (P_1), PEP 17 (P_2), PEP 238 (P_3), PEP 263 (P_4), PEP 281 (P_5), PEP 286 (P_6), PEP 317 (P_7), PEP 529 (P_8), PEP 530 (P_9), PEP 610 (P_{10}), PEP 1635 (P_{11}), PEP 1636 (P_{12}), PEP 1641 (P_{13}), PEP 1642 (P_{14}), PEP 1651 (P_{15}), PEP 1661 (P_{16}), PEP 1672 (P_{17}), PEP 1684 (P_{18}), PEP 1687 (P_{19}), PEP 1688 (P_{20}), PEP 1692 (P_{21}), PEP 1763 (P_{22}) and cv. Eskandarani (P_{23}) and 21 of their hybrids for some vegetative, flowering and yield characters during the 2014 and 2015 summer seasons under open field conditions. The highest significant values for plant length and number of branches / plant were in P_{17}; for sex ratio was in P_1, P_2 and P_{21}; for fruit length was in P_7; for fruit diameter, flesh thickness and flesh thickness / fruit diameter was in P_{21}; for average fruit weight was in P_{12}; for yield was in P_7, P_{11}, P_{14}, P_{16} and P_{23}; while the least significant number of nodes to the first female flower was in P_1 and P_2. The highest significant values for plant length were in the hybrids $P_{12} \times P_3$, $P_2 \times P_{12}$, $P_5 \times P_6$, $P_5 \times P_{13}$, $P_9 \times P_{11}$ and $P_{16} \times P_2$; for number of branches / plant was in hybrid $P_{12} \times P_3$; for sex ratio was in hybrids $P_{23} \times P_{13}$ and $P_7 \times P_{23}$; for fruit length was in hybrid $P_{14} \times P_2$; for fruit diameter was in the check hybrid Sama; for fruit weight was in hybrid Sama, $P_2 \times P_{11}$, $P_2 \times P_{12}$ and $P_{16} \times P_{11}$; for yield was in hybrid Sama, $P_2 \times P_{12}$, $P_5 \times P_2$, $P_{13} \times P_2$ and $P_{23} \times P_{13}$; for flesh thickness was in hybrid $P_2 \times P_{12}$, $P_2 \times P_{11}$, $P_{11} \times P_5$ and $P_{14} \times P_2$; for flesh thickness / fruit diameter was in the hybrid $P_{11} \times P_5$; while the lowest significant number of nodes to the first female flower was in hybrids $P_{23} \times P_{13}$, $P_7 \times P_{23}$, $P_{13} \times P_4$ and $P_{15} \times P_{23}$. Significant heterobeltiosis and standard heterosis were found in some hybrids for all studied traits, except fruit diameter, fruit weight and yield for standard heterosis and, except flesh thickness / fruit diameter for heterobeltiosis.

The second experiment aimed at determining the genetic basis of the inheritance of some vegetative, flowering and fruit characters of summer squash. The first cross was accession PEP 1672 × accession PEP 1692 and the second cross was PEP 11× PEP 1763. Genetic populations of the two crosses, viz., P_1, P_2, F_1, F_2, BCP_1 and BCP_2, were evaluated during the 2015 winter season under greenhouse conditions. Results indicated that in the first cross partial dominance controlled the inheritance of low levels of plant length, internode length, number of branches/plant, stem thickness and fruit peduncle and also controlled high levels of number of nodes to the first female flower and days to the first female flower anthesis. Complete dominance controlled the inheritance of short internode length in the second cross. The minimum number of genes controlling various characters was 2 or 6 for plant length, 5 for number of branches/plant, 1 or 3 for internode length, 5 for number of nodes to the first female flower, 2 for days to the first female flower anthesis, 2 for stem thickness and 3 for fruit peduncle. Broad sense heritability estimates for the previously mentioned traits were, respectively 80.47 % or 90.36 %, 66.84 %, 84.11 % or 89.18 %, 71.68 %, 85.57 %, 69.77 % and 61.76 % for fruit peduncle. Narrow sense heritability estimates were from 39.77 % or 77.39 % for plant length, 80.34 % for internode length, 48.16 % for stem thickness and 22.29 % for days to the first female flower anthesis.

Key words: Squash, *Cucurbita pepo*, evaluation, heterosis, potence ratio, heritability

ACKNOWLEDGEMENT

All thanks and praises to thank ***ALMIGHTY ALLAH (GOD)****, the most merciful and beneficent, who gave me the ability and knowledge to complete this study. Thanks for all people who taught and sustained me throughout my life.*

I would like to express my sincere thanks and appreciation to ***Dr. Ahmed Abdel-Moneim Hassan****, Professor of Vegetable Crops, Faculty of Agriculture, Cairo University for his supervision, ingenious and kind guidance, encouragement, and positive criticism during the course of this investigation and writing of the manuscript.*

The author wishes to express his sincere gratitude and appreciations to Dr. ***Khaled El-Sayed Ali Abdel-Ati****, Professor of Vegetable Crops, Faculty of Agriculture, Cairo University for his supervision, motivation, valuable guidance, continuous advice, friendly attitude and helping during the course of this work and writing of the manuscript.*

Thanks are also extended to the staff members of the Vegetable Crops Department, Faculty of Agriculture, Cairo University for their help, encouragement, and the facilities provided during the work of this thesis.

Also, my deep grateful thanks to all members of my family my father, my mother, my wife, my son, my sister and my brother.

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INTRODUCTION

Summer squash, which is a member of the Cucurbitaceae, is one of the most important vegetable crops. There are two local cultivars of summer squash in Egypt. They are Balady, which is inferior due to its prostrate growth habit and low yield, and Eskandarani, which is high yielding and preferred by both the producer and consumer and is considered the main zucchini-type summer squash cultivar grown in Egypt (Hassan, 2001; El-Adl *et al.*, 2012).

Zucchini is the most widely-grown and economically important summer squash varietal groups in comparison with all other members of *Cucurbita* (Paris, 2001).

Squash hybrids have the capacity for high yield and earliness over open-pollinated cultivars. Therefore, it is essential to develop new squash hybrids. The breeding method is based on the principle of crossing two inbred lines. The first step is to obtain the homozygous parental lines by inbreeding (Kalloo, 1988).

Fruit shape can vary from round to disc shaped to very long. The fruits can be smooth or warted, with or without longitudinal ribs, longitudinal grooves, furrows, or wavy lobes. Exterior color can be green, orange, or yellow, but range in shading and intensity from almost black to almost white and can appear in patterns of longitudinal striping, which can be broad and contiguous, narrow and noncontiguous, irregular, and/or in latitudinal bicolour patterns, all superimposed on barely discernable to obvious light-colored speckling. The color of the mature fruit flesh is most often light yellow-orange,

but can range from greenish white to intense orange; it can be relatively thick or thin, and coarsely fibrous and tough to finely fibrous and tender (Paris, 2008).

Therefore, this study aimed at:

1. Evaluation of some imported genotypes of summer squash (*Cucurbita pepo* L.) and some of the hybrids produced among them for some vegetative, flowering and yield characters.
2. Determining the genetic basis of the inheritance of some vegetative and flowering characters.

REVIEW OF LITERATURE

1. Botany

Summer squash is the edible immature fruits of *Cucurbita pepo* L., which belongs to the economically important family Cucurbitaceae. It is a short-season crop adapted to tropical and subtropical regions. Some *C. moschata* Duchesne varieties are grown for their edible immature fruits. Some *C. maxima* Duchesne varieties are grown for this purpose in South America. Summer squash fruits are harvested when they are shiny. Preferred size ranges from 100 to 200 g, which is usually harvested two and five days past anthesis, depending on growing conditions. If the fruits are not harvested on time, they continue to grow and begin to lose their shininess. Oversize fruits are generally unsaleable (Whitaker and Robinson, 1986; Paris, 1996 and 2008).

Cucurbita pepo is native to North America and can be found growing wild in northeastern Mexico and southern, southeastern, and central USA. As yet undiscovered wild populations might still exist in central or southern Mexico and the wild range might have extended to what is now the northeastern USA (Paris, 2008).

Eight cultivar groups of summer squash are designated, viz., scallop, crookneck, straightneck, vegetable marrow, cocozelle, zucchini, acorn, and pumpkin. In the scallop group, fruit shape is flattened, with scalloped margins. The crookneck group fruit shape is long, peduncular half with narrow, slightly to very curved neck, and a broad stylar half, convex at stylar end. The straightneck group fruit

shape is cylindrical with short neck or constriction near the peduncle with broad stylar half. The vegetable marrow group fruit shape is short with length-to-broadest width ratio of 1.5-3.0, tapered cylindrical, narrow at peduncle end, and broad at stylar end. The cocozelle group fruit shape is long to extremely long with length-to-broadest width ratio at least 3.5, cylindrical but bulbous at stylar end. The zucchini group fruit shape is uniformly cylindrical, length-to-width ratio 3.5-4.5. The acorn group fruit shape is turbinate, broad at peduncle end, convex at stylar end, and furrowed ;while pumpkin group fruit shape is round to spherical, globular, oblate, ovate or obovate (Paris, 1986; 2000 and 2008).

2. Economical and health benefits

Egypt is one of the major summer squash producing countries. According to FAO statistics, Egypt ranked as the eighth largest producing country in the world for pumpkins, squash and gourds (http://faostat.fao.org). Egypt's production of summer squash in 2012 was 310,058 tons, area cultivated was 39,783 feddans, and average production was 7.79 tons / feddan in summer season, while Egypt's production in fall season was 48,816 tons, area cultivated was 7,730 feddans, and average production was 6.31 tons / feddan (Agriculture Directorates of Governorates, Ministry of Agriculture and Land Reclamation, Egypt, 2013).

Summer squash is rich with niacin and contains medium amounts of riboflavin and vitamin C. In addition to fruit nutritional value, squash is used for many other purposes, for example, some European countries grow squash as oil seed crop, and in Egypt it is

grown for both immature fruit and its edible seeds (Whitaker and Robinson, 1986 and Hassan, 2001).

1. Evaluation of squash genotypes for vegetative, flowering and yield characters

Elmstrom (1978) evaluated 20 cultivars of yellow squash and 14 cultivars of green squash in two separated experiments for early and total yield. Yellow straightneck varieties had higher marketable yields than the yellow crookneck varieties. Cvs Goldzini, Gold Slice, Golden Girl and Seneca Butterbar had the highest early and total yields of the straightneck varieties, while cvs Slendergold and Dixie were the highest yielding crookneck varieties. Cvs Ambassador, Elite, Castle Verde and Hyzini were the highest yielding in green varieties. Differences in color intensity and plant growth were found among the green summer squash varieties.

Alsadon *et al.* (1994) evaluated 9 squash cultivars for number of fruits / plot, fruit weight, early and total yield. Significant differences were found among the evaluated cultivars for all studied traits except fruit weight trait. The cultivars Karama, Encore and Opaline produced the highest early yield in the first season, while cvs Rama, Opaline and Bonita produced the highest early yield in the second one. Cvs Gada, Encore, Karama and Opaline produced the highest number of fruits and total yield in both seasons.

Kasrawi (1995) evaluated 41 landraces of summer squash for some vegetative (plant length, stem color and leaf area), flowering (number of male and female flowers, number of nodes to first female flower and percent of female flowers), fruit (fruit color, fruit shape and

fruit bulb color) and yield (fruit number per plant) characters. Significant differences in these traits were found among the evaluated landraces. Yield, number of female flowers and percent of female flower were lower in landraces than in check cultivars.

Khalil *et al*. (1996) evaluated 3 cultivars of summer squash, namely, Scarla, Arab Marrow and Claritta for growth (plant length, number of leaves / plant, leaf area, fresh weight and dry weight / plant), yield and seed production. No differences were found in the first season in yield, while cv. Scarla had the highest significant yield in the second season. Cv. Scarla had the highest fruit number / plant. The three cultivars had similar vegetative growth characters.

Khalf-Allah *et al.* (2001) evaluated seven inbred lines (designated L_1 to L_7) of cv. Eskandrani and their hybrids for some vegetative (plant length, leaf area and number of leaves), flowering (sex ratio, date to 1st female flower, number of male flowers and number of female flowers), fruit (fruit length, fruit shape index and average fruit weight) and yield (number of fruits, and early and total yield) characters.Significant differences were found among the evaluated genotypes in all studied traits. The highest genotypes were $L_1 \times L_5$ in fruit weight, $L_3 \times L_6$ in number of fruits / plant, $L_2 \times L_6$ in early yield / plant and $L_4 \times L_6$ in total yield / plant.

Ercan and Kurum (2003) developed and evaluated 6 inbred lines of summer squash, viz., Safir 1 (8), Safir 1 (9), Gieda 11 (38), Gieda 7 (20), Atlanta 7 (23), Atlanta 7 (24) and four of their hybrids for plant habit, number of male and female flowers per plant, fruit color, fruit length, fruit diameter, fruit weight, number of fruits per plant, seed