# STUDIES ON PROPAGATION OF WATERMELON PLANTS

**By**

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B.Sc. Agric. Sci. (Horticulture), Fac. Agric., Cairo Univ., Egypt, 1996
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APPROVAL SHEET

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SUPERVISION SHEET

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## ABSTRACT

Watermelon (*Citrullus lanatus)* is an important vegetable crop grown in Egypt. Seedless watermelon cultivars are preferred by most consumers because of their sweeter taste and lack of hard seeds. The growing costs of seedless watermelon (triploid hybrid watermelon) in Egypt is very expensive because of its very expensive seed price, triploid seeds do not germinate well and the show least homogenous germination and growth. For this reason, the present study aimed to propagate seedless watermelon by developing new pattern of grafting technique for propagation to minimize the amounts of imported watermelon hybrids seeds in general and seedless watermelon in particular and decreasing the cost of seedling production and producing homogenous plants characteristics.

Now a days grafting is a method of asexual plant propagation widely used in horticulture. It is most commonly used for the propagation of trees and shrubs grown commercially. While, grafted vegetable crops are often including tomato, pepper, eggplant, cucumber, melon and watermelon. The main advantage of grafting in this case is for diseases resistant rootstocks. whereas of grafting in this study was used in the first time as a propagation method in vegetable crops. Grafting did not use before that as a method of propagation in the vegetables and non-woody plants.

The new approach of grafting technique is depending on dividing the mother plants from seedless cv. (Chiffon $F_1$ (yellow flesh) and ZG 8825 $F_1$ hybrid (red flesh)) and seeded watermelon cv. (Aswan $F_1$ hybrid) this plants were grown in the plastic house conditions for 75 days from transplanting. Three types of cuttings were used as scions. The first type is the cuttings from terminal growing point of the main stem and lateral branches 6-10cm in length 0.4 and 0.6 cm in diameter, the second type is cuttings included one node, bud and leaf and the third type is cuttings included two nodes, buds and leaves for using its as scions and grafting them onto four rootstocks *i.e.,( Lagenaria siceraria,) ie.,* bottle gourd and calabash gourd, Pumpkin *(Cucurbita moschata)* and Ercole (*Cucurbita maxima* × *Cucurbita moschata*) by using the hole insertion method.

The studies were conducted in three experiments by randomized complete blocks design with three replicates during the seasons of 2007/2008 at Kaha Horticultural Farm while, in 2008/2009 at a farm in Badrashein City. Each hybrid was conducted in single experiment. Each experiment included different parts of one scionsof watermelon hybrid seedless or seeded which grafted in different rootstocks gaving twelve grafting treatments beside the control watermelon hybrids which were sown without grafting. The obtained results showed that, the *Cucurbita* rootstocks gave a lower survival rate than *Lagenaria* rootstocks with all types of scions cuttings. The grafted plants onto calabash gourd and Ercole rootstocks with any types of scions using this technique showed significant increment in most characteristics such as vegetative growth, early and total yield, fruit characteristics, total sugars and reducing or non-reducing sugars as compared with nongrafting watermelon (control).

Mean while treatments which inculude calabash gourd and Ercole rootstocks with all types of cuttings as scions showed a best resuilts than bottle gourd and pumpkin with any types of scions and the control (nongrafting).

**Kay words:** Watermelon, Rootstock, Grafting, Seedless, Bottle gourd, Calabash gourd, Propagation, Triploid, *Legenaria*, *Cucurbita*.

# *DEDICATION*

*I dedicate this work to whom my heart felt thanks; to my Friends for their patience and help, as well as to my parents ,brothers and sister for all supporting lovely offered along the period of my post graduation.*

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*As I began this work in the name of* ***ALLAH.*** *I would like to end it also by thanking* ***ALLAH*** *who gives me the power, sufferance and help to finish it.*

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# CONTENTS

# INTRODUCTION

Watermelon(*Citrullus lanatus*) is an important crop cultivated in Egypt. Watermelon is grown worldwide and ranks sixth (28 405 000 mt) in world production of fruit crops (Allred and Lucier, 1990). China occupied the first rank in producer of watermelon since 1986. Turkey and the former USSR are second and third, respectively, and Egypt is a distant fourth in production. The top four exporters are Mexico, Spain, Italy and Greece (Allred and Lucier, 1990).

Watermelon now is considered one of the cash crops besides being a lovely summer fruit. In 2006, acreage planted with watermelon was 164, 529 feddans with an average yield of 12.31 ton/fed, according to statistical data of Ministry of Agriculture.

Triploid hybrids, first reported in Japan in 1947 (Kihara, 1951). In Cairo, tetraploid and triploid watermelon were produced by Abd El-Hafez (1963) and he used the gene markers in the development of the production of seedless watermelon in 1969, have gradually found their way onto the market in the United States, triploid production became significant only in the 1980s. Triploid watermelons are smaller, have a tougher rind and a much longer shelf life than diploids. Triploid watermelon fruits have considerably more resistance to fruit blotch than diploid watermelon fruits (Garret *et al.,*1995). Consumers in the USA have accepted the so-called seedless watermelon despite the higher price. Despite the more exacting requirements of triploid production, growers have begun to culture the triploid watermelon to gain the higher return.

Triploid seeds resulted from cross-pollination of the female flower of a tetraploid plant with pollen from a diploid plant. The highest yields of pure triploid seed are obtained by labor-intensive hand pollination of each tetraploid flower and preventing self-pollination by tetraploid pollen (Kihara, 1951).

Triploid seed production areas are primarily located in developing countries because of lower labor costs. Andrus (1971) proposed low-cost production of triploid seed by tetraploid plants interspersed in rows of diploid pollinators. Cross-pollination will predominate because diploid pollen is more abundant and competitive. Mixtures of triploids and a few tetraploid seed are sold, tetraploid watermelons are later separated by hand at harvest, based on fruit shape and color. This also requires trained workers.

In 1995 in the United States, commercial growers were paying \$140-\$180per 1000 seed; several fold the price of diploid hybrid seed. These prices are offset in the market, where triploid fruit can bring significantly higher prices than diploid fruit (Adelberg *et al.,* 1997).

Despite costly inputs, triploid seed do not germinate well. Having small, triploid embryos encased in a thick tetraploid seed coat. During germination, numerous air spaces can fill with water, inhibiting the respiration of the expanding embryo. The seed coat sticks tightly to the cotyledons and frequently keeps the emerging cotyledons from expanding and photosynthesizing. To optimize emergence, triploid seed should be scarified, planted flat and germinated at temperatures above 27 °C with careful moisture control and then drenched with warm water just after emergence to remove the still pliable seed coat. Four weeks after planting, the seedlings are ready for transplant to the field. Triploid seed can be germinated under field conditions if carefully pregerminated (Adelberg *et al.,* 1997).

Many watermelon growers pay specialty nurseries to grow transplants from seed, raising the cost by another $50 per 1000 transplants. High cost of seed production and difficulty in germination make triploid watermelon a choice candidate for commercial micropropagation to provide transplants directly to the grower. Increasing the number and diversity of tetraploid parents for triploid hybrids will increase the number of triploid varieties available (Adelberg *et al.,* 1997).

Tetraploid lines have conventionally been produced from inbred diploid lines by colchicine treatment of seedling shoot tips, doubling the chromosome number. Chimecal ploidy, mutation, and low fertility are routine problems of primary tetraploids. It is possible to obtain a large number of tetraploids from tissue culture. This alternative may rapidly increase the number of suitable tetraploid parents (Zhang *et al.,* 1995 and Rhodes and Zhang, 2000).

Seedless watermelons are sterile hybrids that develop fruits, but no seeds. The seeds for growing them are produced by crossing a normal watermelon diploid (2X=22 chromosomes) with one that has been changed genetically by the treatment with colchicine (tetraploid (4X=44 chromosomes) which were used as a female parent. The seeds from this cross produce plants that, when pollinated with pollen from normal plants, produce seedless watermelons fruits (Zhang *et al.,* 1995 and Rhodes and Zhang, 2000).

Use of triploid hybrids has provided a method for production of seedless fruit. Kihara began working on seedless watermelons in 1939, and had commercial triploid hybrids available 12 years later. The development of triploid cultivars add several problems to the process of watermelon breeding: extra time for the development of tetraploids; additional selection against sterility and fruit abnormalities; choice of parents for reduced seed coat production; the reduction in seed yield per acre obtained by seed companies; reduced seed vigor for the grower; and the necessity for diploid pollenizer taking one-third of the grower's production field (Adelberg *et al.,* 1997).

The growing costs of seedless watermelon (triploid hybrid watermelon) in Egypt is very expensive due to introducing the seeds, its price is about 1.75 -2.00 L.E /seed. Moreover the maximum percent of germination is 70% (according to Syngenta Company). So the cultivated area of seedless watermelon is about 100 feddans comparing with the 164, 529 feddans for seeded watermelon according to statistical data of Ministry of Agriculture (2006). In this connection, the fruit price of seedless fruit is about five times the price of seeded watermelon fruits. So, an efficient method for developing tetraploids is needed.

Plant breeders will not be required to produce grand numbers of hybrid seeds from seedless plants (triploid) or seeded plants (diploid) from some vegetable crops specially melon, cucumber, squash and watermelon after the discovery of this method of grafting which will lead to decreasing the costs of production to a great limit.

The production of grafted plants first began in Japan and Korea in the late of 1920s with watermelon grafted onto gourd rootstock (Lee, 1994). In Egypt, Mounir (1965) produced grafted watermelon plants on many rootstocks for protection from fusarium wilt.

The grafting was used in vegetables production for solving soil problems, controlling soil borne diseases, increasing tolerance to low and high temperature and for growth activation. In general the aims also expanded until today when grafting serves a spectrum of purposes: (1) to boost plant growth; (2) to control wilt caused by pathogens; (3) to reduce viral, fungal and bacterial infection; (4) to strengthen tolerance to thermal or saline stress; (5) to increase nutrient and mineral uptake to the shoot (Rivero *et al*., 2003). This study aims to using grafting for a new goal as a plant propagation method specially for seedless watermelon propagation to produce many grafted seedlings from one seed and to control many problems such as, the cost of triploid seedless watermelons is too high for seed production, decrease the seed germination and do not homogenous germinate additional to the many benefits when planted the grafted plants in the field and good characteristics of grafted plants and this technique is perfectly compatible method with sustainable agriculture and eco production system especially when we use resistant rootstock.

The study aims to develop new pattern of grafting technique for watermelon plants propagation to minimize the amounts of imported watermelon seeds in general and seedless watermelon in particular. Also this technique decreased the cost of seedless or seeded watermelon seedling production and producing homgenous plants characteristics and to obtain many benefits from grafted plants in the field such as, resistance to diseases, good mineral uptake, increasing the growth rate, yield productivity, quality and earlier productivity.

# REVIEW OF LITERATURE

## 1. The history of grafting

The origins of grafting can be traced to ancient times. There is evidence that the art of grafting was known to the Chinese at least as early as 1560 b.c. as recorded by Hartmann and Kester (1975) and Hartmann *et al*. ( 2002)

The cultivation of grafted vegetable plants began in Korea and Japan at the end of the 1920's when watermelon plants were grafted onto squash rootstock, (Rivero *et al*., 2003 and 2004). Since then, grafting has been widely used in many parts of Korea and Japan, and throughout Asia and Europe for intensive crop systems (Hartmann and Kester, 1975). Currently, 81% and 54% of vegetable cultivation in Korea and Japan, respectively, uses grafting (Lee, 2003). This cultural technique is mainly utilized in intensive cropping systems like greenhouse and tunnel production.

In the last 20 years, grafted plant cultivation has largely increased for both *Solanaceace* and *Cucurbitaceae*, especially when adequate disease resistance is not available in commercial hybrids (Lee, 1994). Cultivation of grafted vegetables has been done mostly in Korea, Japan and some Asian and European countries where land use is very intensive and continuous cropping is common (Lee, 1994 and Oda, 1995). After methyl bromide was banned in many countries, the use of grafted seedlings was introduced in Turkey. Seedling companies started to produce tomato and cucumber grafted seedlings. Research has continued on watermelon, melon and cucumber grafting. It is believed that use of grafted plants in fruit-bearing vegetables may help to reduce the need for soil fumigation with methyl bromide for many crops(Miguel, 2004a and b ).

In Greece, grafting is highly popular, especially in southern areas, where the ratio of the production area using grafted plants to the total production area, amounts to 90-100% for early cropping of watermelon and 40-50% for melons under low tunnels, 2-3% for tomato and egg plants, and 5-10% for cucumbers (Traka-Mavrona *et al.,* 2000)

This cultural technique is mainly utilized in intensive cropping systems like greenhouse and tunnel production. Grafting is especially popular for tomato, eggplant and *Cucurbita* production in Asia, and in 1998, 540 million transplants were grafted in Korea and 750 million in Japan (Lee *et al.,* 1998). This technique has been adopted in the Mediterranean region as well, where the use of grafting has been proposed as a major component of an integrated management strategy for managing soilborne disease and increasing crop productivity.

Rivero *et al*. (2003) indicated that, the advantages of grafting plants for current agriculture, these being: resistance to evermore frequent soil diseases; tolerance of low temperatures characteristic of many latitudes of the world where intensive cultivation is economically important; tolerance to the growing problem of salinity from abuse of chemical fertilizers and desertification in many agricultural zones; and enhanced water and inorganic-nutrient uptake. All these advantages provide motivation for grafting in present-day world agriculture.