J. Agric. Sci. Mansoura Univ., 33(11): 8071 - 8090, 2008

NEW GRAFTING METHOD FOR SEEDLESS WATERMELON PLANTS PROPAGATION

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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 its very expensive seed price, triploid seeds do not germinate well and the less homogenous germination and growth. For this reason, this study aimed to propagate seedless watermelon by developing new pattern of grafting technique for watermelon plants 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.

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, vegetable crops are often grafted including tomato, pepper, eggplant, cucumber, melon and watermelon. The main advantage of grafting in this case is for diseases resistant rootstocks. The new method of grafting in this study is the first method for using the grafting as a propagation method in vegetable crops. Grafting did not use before this method 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 (Chiffon F1) and seeded watermelon (Aswan F1 hybrid) plants which grown in the plastic house conditions after 75 days from transplanting. Three types of cuttings were used as a scions. The first type is the cutting from terminal growing point of the main stem and lateral branches 6-10cm in length 0.45-0.6 cm in diameter, the second type is cutting included two nodes, buds and leaves and the third type is cuttings included one node, bud and leaf for using its as scions and grafting them onto four rootstocks i.e., *Lagenaria siceraria*, Bottle and Calabash gourd, Pumpkin *Cucurbita moschata* and Ercole *Cucurbita maxima* × *Cucurbita moschata* by using the hole insertion method.

The experiment was conducted in randomized complete blocks design with three replicates during the season of 2007/2008 including twelve grafting treatments and the control seedless watermelon hybrids were sown without grafting. The obtained results showed that, the *Cucurbita* rootstocks had a lower survival rate than *Lagenaria* rootstocks with all types of cuttings. The grafted plants by 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 the seedless watermelon without grafting as a control.

Keywords: Watermelon, Rootstock, Grafting, Seedless, Gourd, Propagation, Triploid, *Legenaria*, *Cucurbita*,

INTRODUCTION

Watermelon *Citrullus lanatus* is an important crop cultivated in Egypt. Watermelon is now considered one of the cash crops besides being a favorable 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 (seedless) hybrids, first reported in Japan in 1947 (Kihara, 1951), have gradually found their way onto the market. The 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 (Garret, *et al.*, 1995 and Zhang, *et al.*, 1995).

Seedless watermelons, which are highly prized by consumers (Marr and Gust 1991), are produced from triploid plants that arise from seed obtained by cross-pollination of the female flower of a tetraploid plant (4X=44) inbred line as the female parent with pollen from a diploid plant (2X=22) inbred line as the male parent of the hybrid (Adelberg, *et al.*, 1997). Highest yields of pure triploid seed are obtained by labor-intensive hand pollination of each tetraploid flower and preventing self-pollination by tetraploid pollen. This also requires trained workers (Kihara, 1951).

Tetraploid lines have conventionally been produced from inbred diploid lines by colchicine treatment of seedling shoot tips, doubling the chromosome number. Chemical ploidy, mutation, and low fertility are routine problems of primary tetraploids (Adelberg, *et al.*, 1997).

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. Many watermelon growers pay specialty nurseries to grow transplants from seed, raising the cost by another $50 per 1000 transplants. The 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).

Despite costly inputs, triploid seed do not germinate well. Triploid seeds have small, triploid embryos encased in a thick tetraploid seed coat. 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 transplanting to the field. Triploid seed can be germinated under field conditions if carefully pregerminated (Adelberg, *et al.*, 1997).

Seedless watermelon hybrids are highly sterile that develop fruits, but no seeds (Kihara, 1951). The seeds for growing them are produced by crossing a normal watermelon with one that has been changed genetically by treatment with a chemical called colchicine. The seeds from this cross produce plants that, when pollinated with pollen from normal plants, produce seedless watermelon (Fiacchino and Walters 2000).

The growing costs of seedless watermelon (triploid hybrid watermelon) in Egypt is very expensive due to introducing the seeds, its price is about (2.0 L.E /seed) moreover the maximum percent of germination is 70% (according to Syngenta Company).

Grafting is a method of asexual plant propagation widely used in horticulture where the tissues of one plant are encouraged to fuse with those of another. It is most commonly used for the propagation of trees and shrubs grown commercially. It is most commonly used for the propagation of trees and shrubs grown commercially. Fruit tree propagation is usually carried out through asexual reproduction by grafting the desired variety onto a suitable rootstock.

In most cases, one plant is selected for its roots, and this is called the stock or rootstock. The other plant is selected for its stems, leaves, flowers, or fruits and is called the scion. While, nonwoody plants and vegetable crops are often grafted including tomato, cucumber, eggplant and watermelon. The main advantage of grafting in this case is for disease-resistant rootstocks.

Since the beginning of civilization, fruit and nut trees have been grafted because of the difficulty in propagating by cuttings, and the superiority and high value of the grafted crop. Grafting is among the most expensive propagation techniques, surpassing even micropropagation. Budding, which is a form of grafting, is three times more costly than cuttings, and 14 times more expensive than seedling propagation (Maynard and Bassuk, 1990). The horticulture and forestry industries have sought to develop clonal propagation systems that avoid labor-intensive graftage. Yet, traditional and highly efficient grafting and budding systems are essential for the propagation of many woody plant species. New markets continue to require grafted and budded plants for improved plant quality, fruit yield, superior forms, and better adaptation to greater ecological ranges. In the southeastern United States, where high temperatures and periodic flooding of soils (low soil oxygen) are the norm, cultivars of birch, fir, and oak are grafted onto adapted rootstock (Raulston, 1995).

Chua and Teoh, (1973) indicated that, grafting approach, as used for propagating durian, rambutan, *Averrhoa carambola* and mango is described and its advantages are discussed. The propagation techniques described were used for apples and peaches in Colombia, where temperatures are higher than optimum for deciduous fruit. Clear polyethylene strips about 2 - 3.5 cm wide were wrapped above and below T- or inverted T-buds; with cleft and bark grafts strips 6 - 10 cm wide were wrapped tightly around the stub of the rootstock and the scion base to retain moisture (Larsen, 1976).

In forestry, grafting is used almost exclusively for the clonal production of genetically improved seed orchards of Monterey pine (*Pinus radiata*), hoop pine (*Araucaria cunninghamii*), slash pine (*P. elliottii*), Caribbean pine (*P. caribaea*), eucalyptus (*Eucalyptus nitens*), Douglas Fir (*Pseudotsuga menziesii*), and others (Porada, 1993). The major advantage of using grafts is that superior germplasm from older, elite trees can be clonally regenerated as parent trees for seed orchards. Frequently, trees selected for breeding or seed orchard purposes are so old (often greater than 15 or 20 years) that clonal production by rooted cuttings is either impossible or far more costly than grafting. Where graft incompatibility is not a serious problem, grafting scions of elite trees onto established seedling rootstock is a quick, straightforward, and cost effective way of developing seed orchards (Hartmann, *et al.*, 2002).

Vegetative propagation techniques commonly employed for *Juglans nigra* include rooting, grafting and budding. Predictable propagation rates are difficult to determine, regardless of technique. Reports of successful rooting trials indicate the importance of utilizing axillary bud-origin shoots. Grafting and budding success is dependent upon proper scion wood collection and handling, in addition to a knowledge of the effects of callusing temperature and the physiological condition of the rootstock (Coggeshall, *et al*,. 1997). Vegetative propagation of major tree spices grown in India, including *Myristica fragrans, Syzygium aromaticum, Cinnamomum verum [C. zeylanicum], C. aromaticum, Pimenta dioica, Garcinia gummigutta (syn. G. cambogia), G. indica, Tamarindus indica* and *Punica granatum*, is described. Propagation methods including cuttings, air layering, budding, grafting and micropropagation are discussed (Rema, *et al.*, 1997).

Cultivar stability in fruit tree species is ensured by grafting on particular rootstocks and a fruit tree can be considered as a symbiosis between scion and rootstock (Errea, 1998). Hua-Biao, *et al.*, (1999) recorded that *C. praecox* is a popular ornamental shrub which must be propagated vegetatively as seeds do not come true to type. The traditional methods of side, top and bud grafting and of taking cuttings have low success rates, so an alternative method was developed. A success rate of 90% has been achieved and 150-200 grafts can be done per person per day.

The demand for *Carabao mangoes* which are true-to-type and precocious is high in the Philippines. True-to-type propagation and nursery practices of *Carabao mangoes* for large scale production of quality planting materials were investigated. The processes involved are described and included sourcing for quality seeds during the season, proper handling of seeds and preparation, sowing, transplanting, growing Carabao seedlings for rootstocks in organically enhanced soil media for 6-8 months, proper selection of scions, grafting and further seedling growth and hardening. One production cycle took about one year (Javier, *et al.*, 1997).

Mohamed, (2000) recorded that; in Egypt tree fruits (except Figs) are usually propagated by grafting.

The production of grafted plants first began in Japan and Korea in the late 1920s with watermelon *Citrullus lanatus* grafted onto gourd rootstock (Lee, 1994).

The grafting was used in vegetables production for resistant the soil problems and 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 and development; (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).

The traditional methods such as tongue approach grafting, one cotyledon graft, side grafting, hole insertion grafting (Oda, 1995), stem grafting and hypocotyl graft. All of this methods were used the rootstock and the scion in seedling stage, when the scions and rootstocks having one or two true leaves, while, the new method was depending on mother plants grown in the nursery greenhouse and collected the shoot tip and cuttings for using as a scion and grafted it on the different rootstock.

This study aim to use the grafting for propagation of seedless watermelon to produce many grafting seedlings from one triploid seed and to control many problems such as, decreasing the cost of triploid seedless watermelons seeds, solving the problem of low germination and in addition to the many benefits when planted the grafted plants in the field or greenhouse. This technique is perfectly compatible method with sustainable agriculture and eco production system especially when we use resistant rootstock. Grafting provide increasing tolerance to diseases and vigor to crops and should be considered a low-input, sustainable horticulture practice for the future.

The study aims to develop new pattern of grafting technique for watermelon plants propagation to minimize the amounts of imported watermelon hybrids, in general, and seedless watermelon in particular. Also, this technique decreased the cost of seedless watermelon seedling production and producing homogenous plants characteristics.

MATERIALS AND METHODS

Grafting is one of the methods for plant propagation widely used in horticulture. This is often done to produce a hardier or more disease resistant plant or to propagate desirable cultivars or forms selected for their stems, leaves or flowers. It is most commonly used for the propagation of trees and shrubs grown commercially. In most cases, one plant is selected for its use as a root and this is called the stock or rootstock. The other plant is selected for its desirable vegetative stems, leaves, flowers, or fruits and is called the scion.

The aim of the present study was suggested as a new method for seedless watermelon hybrid plants propagation by new approach of grafting technique which depending on dividing the mother plants to cuttings for using as scions and grafting them onto other rootstock which should be equal in diameters comparably.

Three types of cuttings were taken from mother plants, which were planted in the plastic house conditions after 75 days from transplanting for grafting. The scions used in these studies were as follows

(A)- Cutting from terminal growing point of the main stem and lateral branches 6-10cm in length 0.45-0.6 cm in diameter.

(B)- Cutting included two nodes, buds and leaves.

(C)- Cuttings included one node, bud and leaf.

The experiment was conducted during 2007/2008 season.

1. Plant materials

1.1. Watermelon cultivars

The seedless watermelon cultivar (Chiffon F1 as yellow flesh from Syngenta seed Company) and seeded watermelon commercial F1 hybrid Aswan (Sakata Seed Company) was used as pollinator. Seedless and seeded watermelon were grafted onto four rootstocks, i.e., Bottle gourd *Lagenaria siceraria*, Balabash gourd *Lagenaria siceraria*, Pumpkin *Cucurbita moschata* and Ercole *Cucurbita maxima* × *Cucurbita moschata* (hybrid Nun 6001F1 Holland Nunhems). Watermelon hybrids without grafting Chiffon as a seedless hybrid and seeded hybrid Aswan were used as a control. This experiment included seedless watermelon hybrid, which grafted into different rootstock by different scion parts and the control.

Triploid and diploid watermelon seeds were sown in the plastic house at Dokki on 13th November in 2007 in the foam seedling trays with 84 cells filled with mixture of peat-moss and vermiculite at the ratio (1:1 v/v), 300 gm ammonium sulphate, 400 gm calcium superphosphate, 150 gm potassium sulphate, 50 ml. nutrient solution and 50 gm of a fungicide were added for each 50 kg of the peat moss. Seedless and seeded watermelon seedlings transplanted on 22nd December, 2007, in plastic house in El-Dokki location as a mother plants.

Mother plants were subjected to the conventional agricultural practices i.e., irrigation, fertilization, pests and diseases management as commonly followed by the Ministry of Agriculture in Egypt, for producing good watermelon vegetative growth.

In this respect all female flowers or any fruit set were removed. After 75 days from transplanting the good and healthy mother plants free of pests and diseases especially virus diseases were selected for obtaining different types of scions. Suitable branches were chosen for scions from the shoot tip, upper, middle and bottom nodal segments from the all primary or secondary branches, nodal cuttings included one or two buds.

Lagenaria rootstock seeds were sown in seedling trays for a period of 10 days while Cucurbit rootstocks as local Pumpkin cultivar and Ercole *Cucurbita maxima* × *Cucurbita moschata* were sown in seedling trays for a period of 7 days before there transferred into plastic pots of 10 cm diameter, containing the same volume from the mixture of peat moss and vermiculite. Grafting process was performed after 20 and 25 days from their transplanting in *Lagenaria siceraria* rootstock and Cucurbit rootstocks as local pumpkin cultivar and Ercole *Cucurbita maxima* × *Cucurbita moschata* respectively or when the stem diameter reached 6-8 mm in *Lagenaria* rootstocks and 6 mm in *Cucurbita* rootstocks. Rootstock seedlings were subjected to acclimatization before and after grafting to increase the percentage of survival rate. Before grafting, the rootstock were put under sunlight condition for 2-3 days and the soil should be kept dry to avoid spindly or elongation growth as mentioned by (Oda, 1995)

The grafting method used the hole insertion by removing all the growing points by sharp stainless razor blades to prevent future shoot growth of the rootstock. This is one of the advantages of this type of graft. A specialized tool, such as a bamboo stick or small drill bit or piercing the center of the rootstock by a hedge-shape stick, is used to remove all of the meristem from the rootstock leaving a small hole with a small splice along both sides. The sticks pierce must inter the stock at a depth of 1cm. The chosen scion is then slant cut in a similar shape as the piercing stick and placed within the hole. After grafting the plastic grafting clip was used at the place of grafting to keep the scion and rootstock together during healing.

Grafted seedlings were removed immediately into the shaded plastic low tunnel for healing and hardening which these are a key factors for the survival of grafted plants as mentioned by (Oda, 2007). Recommended temperatures for this process are 25–32°C. A layer of water were kept in the polyethylene floor liner and the doors were kept closed to maintain high humidity over 85% RH. The pots including the grafted plants were put on bricks to support the plants above the water level. The grafted seedlings should wilt initially but were recovered within three days. Four to five days after grafting, the hardening process was began by peeling away the top (silver) layer of shade net of 60-mesh nylon netting to exclude virus-transmitting insects. The double door reduces the chance for entry of insects with workers. The water of the floor pan was drained. The chamber's plastic-covered door was opened; the screen door was kept closed to prevent insect infestation. These conditions were maintained for four to five days.

Grafted plants were moved out of the tunnel and placed into a screen house, nine days after grafting. The plants were stayed in the screen house for seven to eight days for further development and hardening. The entire process takes 30 to 33 days from sowing.

Grafted watermelon seedlings were transplanted on May 13 to the open field. Each experiment included thirteen treatments. Twelve from these were grafting treatments all of rootstock with different segments plant parts (shoot tip, nodal cuttings included one bud and nodal cuttings included two buds) and one treatment was ungrafted watermelon plants. Each plots consisted of two rows each row was 5m. length and 2m width, plants were spaced at 1m interval on one side of the row. Grafted seedlings from Aswan cultivar on all rootstock was used as a pollinator and planted in every third row. Each treatment included 10 plants in each replicate.

Grafted plants were transplanted to the field in Kaha experimental, Kalubia Governorate at a density of 2200 plants per feddan 70% seedless and 30% seeded as a pollinator. The grafted seedlings were planted above the soil level to avoid any infection and avoid any adventitious roots from the scion which can develop and grow into the soil. If this occurs, disease can bypass the resistant rootstock and may lead to infection and death of the entire plant. The conventional agricultural practices i.e., irrigation, fertilization, and weeding and pest control followed standard commercial practices, were done as recommended by the Ministry of the Agriculture in Egypt, for watermelon production. Plots were harvested on 26 July, 12 and 28 August 2008.

2. Experimental design and statistical analysis

A randomized complete blocks design with three replicates was used in the experiment. Data were statistically analyzed using analyses of variance by the technique of analysis of variance ANOVA, with the Stat soft statistical package MSTATC software program (Michigan State University,. East Lansing, MI, USA). Probabilities of significance among treatments and Means were compared with least significant difference L.S.D. ($P \leq 0.05$) were used to compare means within and among treatments according to Gomez and Gomez (1984).

3. Studied characteristics:-

3.1. Survival rates:-

Survive rates were measured after 12 days from the grafting by account the success seedlings and dividing it on the total number of the grafting seedlings

The following data were recorded during growth period until the end of harvesting.

3.2. Vegetative growth characteristics:

Vegetative growth characters were measured after harvesting in samples of four plants randomly chosen from each plot.

***- Plant length (cm):**

It was measured as the average length, in centimeters, of four random plants. The measurement started from the surface of the ground to plant stem apex.

***- Leaves area (cm^2):**

It was expressed as the mean leaf area in cm^2 using the dry weight method. The leaves were cleaned from dust and then weighted to nearest 0.001 g. Previously determined were 20 disks of known area.

$$\text{Leaves area } \left(cm^2\right) = \frac{\text{Dry weight of plant leaves}}{\text{Dry weight of 20 disks}} \times 20 \times \text{the area of disk}$$

Where, the area of a disk is about 1.0 cm

***- Plant fresh weight (gm):**

It was measured as the total weight of three plants from each plot without roots.

3.3. Yield and its components:

The fruits were harvested at two times 80 and 100 days from planting. The following traits were evaluated:

***- Total weight of fruits /plant:**

It represents the total weight of the harvested fruits throughout the entire season in kg per plant.

***- Early yield:**

It was estimated as the weight of fruits/fed of all harvested fruits during the first 3 weeks from the starting harvest.

***- Total yield (ton/fed.):**

The yield of all fruits harvested throughout the entire season. This was calculated by transferring the total yield per plot to ton per feddan.

3.4. Fruit characteristics:

Fruit characteristics were determined by measuring the following measurements:

***- Fruit length (cm).**
***- Fruit diameter (cm).**
***- Fruit shape index:**

It was calculated by dividing fruit length on fruit diameter.

- Fruit size (cm^3):

It was measured by using water displacement technique by displacement the same size from water in normative beaker and estimated the same size from water. This was done in a special container which was filled with water until overflows form the spout. Fresh fruits were immersed and the overflow water volume was measured in a graduated cylinder.

3.5. Chemical determinations:-

*- Total soluble solids (T.S.S. %):

It was estimated in fruit juice by using a hand refractometer. Three fruits were taken at random from each treatment for this test. This was estimated according to the methods of A.0.A.C. (1975).

*- Total, reducing and non-reducing sugars:

They were determined of each fruit samples according to Malik and Singh (1980) method, since sugars were extracted from 0.5-gram ground dried material by distilled water, then determined by phenol sulfuric method and Nelson arsenate-molibdate colorimeteric method for total and reducing sugars, respectively. The non-reducing sugars were calculated by the difference between total and reducing sugars

RESULTS AND DISCUSSION

1. Survival rates

The survival rates of plants grafted onto different rootstocks by different parts from mother plants as scions are presented in (Table1). Data in the table indicated that significant differences were observed between the different rootstock and different parts from mother plants on survival rates, the lowest survival rate was found 66,66% when used the pumpkin as rootstock with cutting included two nodes, leaves and bud as scions, while pumpkin as rootstock and used cutting included one node, leaf and bud showed 68,89.

The highest rate was 94,44% with *Lagenaria* (2) as rootstock and shoot tip as scions. Data in this table indicated that in general, *Cucurbita* type rootstocks had a lower survival rate than *Lagenaria* type rootstocks.

Lagenaria (2) with shoot tip gave the best results followed by Ercole (*C. maxima* × *C. moschata*) rootstocks with all parts from mother plants as scions. Pumpkin rootstocks had a lower survival rate than the other treatments. On the other hand, no significant differences among pumpkin with other parts as a scions was noticed. While Ercole with shoot tip showed significant increment compared with Ercole with cutting included one node or two nodes, whereas, no significant differences between them. No significant differences between *Lagenaria* (1) and *Lagenaria* (2) with all cuttings as scions. These results were agreement with (Oda *et al.*, 1993). *Cucurbita* type rootstocks had a lower survival rate than *Lagenaria* type rootstocks. Yetisir and Sari (2003b) reported that survival rate was low (65%) in *Cucurbita* type rootstocks, it was high (95%) in *Lagenaria* type rootstocks.

Table 1: Effect of grafting seedless watermelon on several rootstocks by different cuttings from mother plants as scions on survival rate percentage of seedlings in 2007/2008 season.

Rootstocks	Scions		Survive rate %
Lagenaria (1)	Cuttings	Shoot tip	85.55
		One node	92.22
		Two nodes	89.99
Lagenaria (2)	Cuttings	Shoot tip	94.44
		One node	89.10
		Two nodes	92.22
Pumpkin	Cuttings	Shoot tip	74.44
		One node	68.89
		Two nodes	66.66
Ercole	Cuttings	Shoot tip	88.89
		One node	74.46
		Two nodes	73.33
L.S.D. 0.05			10.80

2. - Vegetative growth characteristics:

The growth performances of plants grafted onto different rootstocks were compared with control. Grafted plants in all rootstocks with all parts from mother plant as scions showed significant increment compared with control as shown in table 2.

Table 2: Effect of grafting seedless watermelon on several rootstocks by different cuttings from mother plants as scions on plant length (cm), leaves area (cm²) and plant fresh weight (kg) compared with the control in 2007/2008 season.

Rootstocks	Scions		Vegetative characters		
			Plant length (cm)	Leaves area (cm^2)	Plant fresh weight(Kg)
Lagenaria (1)	Cuttings	Shoot tip	341.8	47399	2.100
		One node	382.7	45537	2.155
		Two nodes	367.4	44786	2.230
Lagenaria (2)	Cuttings	Shoot tip	437.8	53475	2.713
		One node	401.3	52070	2.650
		Two nodes	404.3	52887	2.590
Pumpkin	Cuttings	Shoot tip	367.8	53606	2.410
		One node	398.8	53900	2.312
		Two nodes	399.8	49196	2.190
Ercole	Cuttings	Shoot tip	415.5	55925	2.640
		One node	434.5	55043	2.710
		Two nodes	432.0	55696	2.750
Control			310.4	38252	2.110
L.S.D. 0.05			58.6	8123	0.360

Data in Table (2) indicate that there was a significant effect between different grafting treatments and control on plant length leaves area and plant fresh weight. Dearly indicate that plant length, leaves area and plant fresh weight were significantly increased with most grafting treatment especially when grafting on *Lagenaria* (2) by shoot tip scions and Ercole rootstocks by all type of cuttings whereas these pattem of grafting technique produced the highest values from these characteristics. Grafting watermelon significantly affected plant growth. Control plants had short plant length, less leaves area and low plant fresh weight. Vegetative growth characteristics was positively influenced by grafting when compared with the control. The root system of *Lagenaria* (2) and Ercole rootstocks were much pronounced than that of watermelon, which might facilitate the uptake of more nutrient resulting better growth of the grafted plant. The results showed that the increasing in watermelon vegetative growth through the use of grafted plants can be attributed mainly to disease control and secondly to better plant growth. Increased plant growth responses, not related to the control of a major pathogen, are a well-known phenomenon in grafted plants (Lee,. 1994). The rootstock's vigorous root system is often capable of absorbing water and nutrients more efficiently than scion roots, and may serve as a supplier of additional endogenous plant hormones (Lee,. 1994 and Pulgar *et al.*, 2000). Cucurbits usually show a significant amount of xylem sap after vine cut, greatly influenced by the rootstock and containing high concentrations of minerals, organic substances, and plant hormones (cytokinins and gibberellins) (Kato and Lou, 1989, Masuda and Gomi,. 1982). These results were agreement with those of Alan *et al.*, (2007) and Bletsos (2005) they found that, grafting due to positively affected on plant vigour and height, fruit yield and quality, marketable yield, fruit size in early production and total soluble solids. Salam *et al.*, (2002) reported also, that both the length of vine and number of lateral branches produced in the grafted plants were higher than those of the nongrafts.

3. Yield and its components:-

Results in Table (3) show that there were significant differences between the grafted and ungrafted plants in early yield and total yield (kg/plant and ton/feddan). *Lagenaria* (2) and Ercole rootstocks showed a significant increment compared with *Lagenaria* (1), pumpkin, and control.

Grafted plants flowered about 20 days earlier and showed more vigorous vegetative growth than the control plants. Grafted plants by shoot tip on *Lagenaria*(2) gave 66.8% higher in total yield (kg/plant) than the control plants. Similarly, grafted plants showed 101–284% higher in early yield compared with control plants. In total yield, *Lagenaria* type rootstocks produced a higher yield than *Cucurbita* type and the control, while control plants had 12.93 kg/plant. In total yield (ton/fed.) *Lagenaria* (2) rootstocks with shoot tip as scion produced 71.96%higher yield than the control. In contrast, *Lagenaria*(1) rootstocks with cutting included two nodes as scion had 0.56% higher yield than the control, while pumpkin rootstocks with shoot tip as scions had 4.64% less yield than the control. The study showed that rootstock choices influence plant growth as well as yield and quality of scion fruit, suggesting an important consideration in the potential use of grafting applications in watermelon.

Early yield was significantly lower in the control than the other grafting treatments, the highest early and total yield was observed in the grafted plants on *Lagenaria* (2) by shoot tip as a scion. The early production of the grafted plants by shoot tip on *Lagenaria* (2) was increased by 262.56%, as compared to the control, while, early production of the grafted plants by cutting included one node as scion on Ercole was increased by 284.03%, as compared to the control. This might be due to the higher vegetative growth of the grafting plants. Research has shown that possible mechanisms for increased yield are likely due to increased water and nutrient uptake among vigorous rootstock genotypes. Stomatal conductance was improved in tomato when grafted onto vigorous rootstock (Fernandez- Garcia *et al.*, 2002). Nutrient uptake for macronutrients such as phosphorus and calcium were enhanced by grafting (Leonardi and Giuffrida 2006 and Ruiz, *et al.,* 1996)

Table 3: Effect of grafting seedless watermelon on several rootstocks by different cuttings from mother plants as scions on total yield (kg/plant), early yield (ton/fed.) and total yield (ton/fed.) compared with control in 2007/2008 season.

	Scions		Yield		
			Early yield (ton/fed.)	Total yield (kg/plant)	Total yield (ton/fed.)
Lagenaria (1)	Cuttings	Shoot tip	3.8525	13.36	22.05
		One node	4.4920	14.50	23.93
		Two nodes	3.9833	13.00	21.45
Lagenaria (2)	Cuttings	Shoot tip	6.8068	22.23	36.68
		One node	5.8131	18.00	29.70
		Two nodes	6.2928	18.56	30.62
Pumpkin	Cuttings	Shoot tip	3.7915	12.33	20.34
		One node	4.8826	14.74	24.31
		Two nodes	4.2039	13.28	21.91
Ercole	Cuttings	Shoot tip	6.4016	20.30	33.49
		One node	7.2099	19.24	31.75
		Two nodes	6.5539	18.22	30.06
Control			1.8774	12.93	21.33
L.S.D. 0.05			1.0068	1.40	2.31

Many authors have stated that a rootstock promoted higher yields in grafted plants (Chouka and Jebari (1999) and Ruiz and Romero (1999)). These increases can be explained by an interaction of some or all of the following phenomena: increased water and plant nutrient absorption (Kato and Lou (1989), augmented endogenous hormone production (Zijlstra, *et al.,* (1994), and enhanced scion vigor (Leoni, *et al.*, (1990), resistance to soil pathogens (Edelstein, *et al.,* (1999) and Lee (1994)).

Salam *et al.*, (2002) studied the effect of grafting on the growth and yield of watermelon. They showed that grafting also produced higher number of fruits per plant (5.25) and larger fruit (30.30 cm) which ultimately produced higher yield (56.92 t/ha) than non grafted plants. The grafts produced 3.5 times higher yield than non grafts.

Yield was increased by grafting in watermelon (Ruiz and Romero 1999; Yetisir and Sari 2003a), and similar results have been found in cucumber (Pavlou, *et al.,* 2002). Yields can be increased in watermelon production even under optimum growing conditions (Yetisir and Sari 2003a). Furthermore, fruit quality, as indicated by fruit firmness, can be increased in watermelon by grafting onto certain rootstock (Roberts *et al.*, 2005 and Rivard 2006).

Maroto, 2002 mentioned that average yield of the main cultivar (without considering the yield of the pollenizers) in the grafted plots reached 89 ton per hectare for the eight years of experimentation. This was a remarkably high yield for an early cycle watermelon production. Grafted watermelons with saline-tolerant rootstocks showed yield increase up to 81% under greenhouse production (Colla *et al.*, 2006).

4. Fruit characteristics:-

Fruit characteristics of watermelon grafted onto different rootstocks are presented in (Table 4). The biggest fruit was obtained from the *Lagenaria* (2) rootstock with shoot tip scions reached to 7100cm^3 whereas fruits from the control plants reached to 4416 cm^3.

These results showed that grafted plants improved plant growth and yield without any harmful effects on fruit quality. The positive effects of grafting can change according to the rootstock being used.

Table 4. Effect of grafting seedless watermelon on several rootstocks by different cuttings from mother plants as scions on fruit length (cm), fruit diameter (cm), fruit shape index and fruit size (cm^3) compared with control in 2007/2008 season.

Rootstocks	Scions		Fruit characters			
			Fruit length (cm)	Fruit diameter (cm)	Fruit shape index	Fruit size (cm^3)
Lagenaria (1)	Cuttings	Shoot tip	23.1	21.6	1.069	4616.7
		One node	22.4	20.7	1.082	5050.0
		Two nodes	23.8	22.4	1.062	4508.3
Lagenaria (2)	Cuttings	Shoot tip	28.3	26.4	1.072	7100.0
		One node	27.4	26.1	1.050	5766.7
		Two nodes	26.9	25.2	1.067	5825.0
Pumpkin	Cuttings	Shoot tip	22.6	21.7	1.041	4291.7
		One node	22.5	21.3	1.056	5133.3
		Two nodes	23.6	22.4	1.053	4500.0
Ercole	Cuttings	Shoot tip	27.8	26.0	1.070	6416.7
		One node	27.6	26.1	1.057	6016.7
		Two nodes	27.3	25.3	1.079	5691.7
Control			24.6	22.3	1.103	4416.7
L.S.D. 0.05			1.9	1.7	N.S	477.4

It is obvious from Table (4) that there was a significant increment in fruit size, length and diameter without any significant effect on fruit shape index. Fruit yield was positively influenced by grafting versus control. It is evident from the data, in the same table, that the *Lagenaria* (2) rootstock with shoot tip scion produced larger fruits. No significant effect on fruit shape index which may be due to this parameter was genetic characteristics not changed by environmental condition. These results agree with that obtained by (Miguel *et al.*. 2004) they observed that grafting watermelon on 'Shintoza' rootstock increased both fruit set and fruit size compared to the non-grafted plants. Bletsos (2005) recorded that, grafting positively affected plant vigour and height, fruit yield, quality, marketable yield and fruit size in early production.

5. Chemical analysis

Results detected in Table (5) show that there were significant differences between the watermelon fruits produced from grafted and ungrafted plants in total soluble solids. The soluble solids contents were significantly affected by grafting. All combination from rootstocks with all type of scions gave similar results concerning soluble solids, the total soluble solid percent (TSS %) of fruits produced in grafted plants were significantly higher than that of non grafts. In this connection, Georgiev (1972) and Ahmed *et al.*, (1987) also reported that brix percent of watermelon was higher when grafted on squash and bottle gourd, respectively, than the control (non-graft). Lo'Pez-Galarza *et. al.*, (2004) in all samplings, total sugar concentrations and soluble solids contents were smaller ($P \leq 0.01$) in fruit from grafted than from non-grafted plants. Bletsos (2005) recorded that, grafting positively affecting on melon plant vigour and height, fruit yield and quality, marketable yield, fruit size in early production and total soluble solids (^{o}Brix). In these respect, several investigators obtained similar results e.g., Salam et. al. (2002), Yetısır *et al.*, (2003) Yetisir and Sari, 2003a, Alan *et al.*, 2007 in watermelon. Huitron *et al.*, (2007) on watermelon recorded that, none of these rootstocks significantly affected the quantity of total soluble solids, presenting values above 11.17 degrees Brix. Fruits from grafted plants had a thicker rind and slightly lower total soluble solids content than the fruit from non-grafted plants as recorded (Alexopoulos *et al.*, 2007).

Table 5. Effect of grafting seedless watermelon on several rootstocks by different parts from mother plants as scions on T.S.S, reducing and non reducing sugars (g/100g) fresh weight and total sugar compared with control in 2007/2008 season.

Rootstocks	Scions		Chemical analysis			
			T.S.S	Sugars % (g/100g) fresh weight		Total Sugar
				R	NR	
Lagenaria (1)	Cuttings	Shoot tip	12.3	4.978	3.568	8.547
		One node	12.7	5.328	3.421	8.749
		Two nodes	12.8	5.218	3.591	8.809
Lagenaria (2)	Cuttings	Shoot tip	12.7	4.945	3.642	8.587
		One node	13.2	5.574	3.649	9.224
		Two nodes	13.3	4.945	3.503	8.448
Pumpkin	Cuttings	Shoot tip	12.6	5.497	3.356	8.853
		One node	12.8	5.046	3.532	8.578
		Two nodes	12.5	4.738	3.679	8.416
Ercole	Cuttings	Shoot tip	12.8	4.770	3.685	8.456
		One node	13.2	4.925	3.727	8.652
		Two nodes	12.7	5.049	3.934	8.984
Control			11.3	4.097	2.950	7.047
L.S.D. 0.05			0.8	0.735	0.453	0.955

Reducing, nonreducing and total sugars contents of watermelon juice are presented in the same table demonstrate significant increment in reducing, nonreducing and total sugar compared with control except pumpkin rootstocks with cutting included two nodes and Ercole rootstock with shoot tip scions in reducing sugar and pumpkin rootstocks with shoot tip scions in non reducing sugar while total sugar showed significant differences between the fruit produced from grafting and ungrafting plants.

These results may be due to as recorded by Ying *et al.*, 2004 sugar accumulation correlated with sugar metabolism and their related enzyme activities during fruit development.

CONCLUSION

This study has developed a new method of propagation and easy produce many seedless watermelon seedlings by grafting. This method has shown a remarkable success and can be used in many vegetable crops such as cucurbits and Solanaceae.

The method has succeeded in propagating seedless watermelon through out obtaining several plants from one plant, homogenous plants and reducing the amount of seeds are usually used in cultivation.

The results show that using *Lagenaria* (2) with the three kinds of cuttings is the best treatment and the second best is Ercoli rootstock with all kinds of cuttings as scions. Grafting seedless watermelon using these rootstocks by this method produced high early and total yield with the best fruit characters compared with ungrafted plants.

REFERENCES

Adelberg, J. W.; X. P. Zhang and B. B. Rhodes (1997). Biotechnology in Agriculture and Forestry, High-Tech Micropropagation V (ed. Bajaj, Y. P. S.), Springer-Verlag, Berlin Heidelerg vol. 39, pp. 60–76.

Ahmed, M. S.; M. S. Liamsombat and M. S. Z. Ren (1987). Effect of rootstock on watermelon. Report On Field Trial. No-30. Vegetable Crop Production Course, Tusukuba International Agricultural Training Centre. Jica., Pp: 23-37.(Cited by Salam, M. A.; A. S. M. H. Masum; S. S. Chowdhury; M. A. Monoranjan Dhar Saddeque and M. R. Islam (2002). Growth and yield of watermelon as influenced by grafting. On Line Journal of Biological Sciences, 2 (5): 298-299,

Alan, O.; N. Ozdemir and Y. Gunen (2007). Effect of grafting on watermelon plant growth, yield and quality. Journal of Agronomy, 6(2): 362-365.

Alexopoulos, A.A; A. Kondylis and H.C. Passam (2007). Fruit yield and quality of watermelon in relation to grafting. Journal of Food, Agriculture and Environment., 5(1): 178-179

Association of Official Analytical Chemists (1975). Official Methods of Analysis of the Association of Official Agriculture Chemists. 12th Ed. Published By the A.O.A.C., Washington, D.C., U.S.A.

Bletsos, F. A. (2005). Use of grafting and calcium cyanamide as alternatives to methyl bromide soil fumigation and their effects on growth, yield, quality and fusarium wilt control in melon. Journal of Phytopathology, 153:155-161.

Chouka, A.S. and H. Jebari (1999). Effect of grafting on watermelon on vegetative and root development, production and fruit quality. Acta Horticulturae, 492: 85-93. Proceedings Of The First International Symposium On Cucurbits, Adana, Turkey, 20-23 May 1997.

Chua, S. E. and T. S. Teoh (1973). Propagation by approach grafting and woody cutting of some tropical fruit and ornamental trees. Singapore-Journal-of-Primary-Industries. 1973, 1: 2, 87-95. (Cited from Horticultural-Abstracts 1974 044-07130)

Coggeshall, M. V.; W. F. Beineke and J. W. Van-Sambeek (1997). Black walnut vegetative propagation: the challenge continues. Knowledge for the future of black walnut. Proceedings of the Fifth Black Walnut Symposium, Stockton, Missouri, USA, 28-31 July 1996. General-Technical-Report-North-Central-Forest-Experiment-Station,-USDA-Forest-Service., No. NC-191, 70-77(Cited from CAB Abstracts and Plant-Propagation Abstracts 1997)

Colla, G.; Y. Roupahel; M. Cardarelli and E. Rea (2006). Effect of salinity on yield, fruit quality, leaf gas exchange, and mineral composition of grafted watermelon plants. Hortscience 41:622-627.

Edelstein, M.; R. Cohen; Y. Burger and S. Shriber (1999). Integrated management of sudden wilt in melons, caused by *Monosporascus cannonballus,* using grafting and reduced rates of methybromide. Plant Disease, 83: 1442-1445.

Errea, P. (1998) Implications of phenolic compounds in graft incompatibility in fruit tree species. Scientia Horticulturae Volume 74, Issue 3, 15 May 1998, Pages 195-205

Fernandez-Garcia N.; A. Cerda and M. Carvajal (2003). Grafting a useful technique for improving tolerance of tomato. Acta Hort. 609, 251–256.

Fiacchino, D. C. and S. A.Walters (2000). Influence of diploid pollenizers on seedless watermelon yield and quality. HortScience. 35(3):430 (Abstr.).

Garret, J. J.; B. B. Rhodes and X. Zhang (1995). Triploid watermelons resist fruit blotch organism. Cucurbits Genet Coop Rep, 18: 56–57.

Georgiev, D. (1972). Studies on the water absorption and sap exudation in melons grafted on squash. Rasteniev" Dni-Nauki., 9:10, 31-36 (Cited from Horticultural Abstracts, 043-05960, (1973) Cab Abstracts)

Gomez, K. A. and A. A. Gomez (1984). Statistical procedures for agricultural research. International Rice Research Institute, 2nd Ed. Joho Wiley and Sons. Inc. New- York: 680 P.

Hartmann, H.T.; D.E. Kester; F.T. Davies and R.L Geneve (2002). Hartmann and Kester's , Plant Propagation; Principles and Practices. Seven Edition. New Jersey: Regent-Prentice Hall, 07458. 873p.

Hua-Biao, Hu-YiMin, Hua-B and Hu-YM (1999) Propagation of Chimonanthus praecox by a new grafting method. Journal-of-Jiangsu-Forestry-Science-and-Technology, 26: 1, 55-56 (Cited from CAB Abstracts).

Huitron, M. V.; M Diaz; F. Dianez and F. Camacho (2007). The effect of various rootstocks on triploid watermelon yield and quality. Journal of Food, Agriculture and Environment, 5 (3/4): 344-348.

Javier, F. B.; U. Lavi; C. Degani; S. Gazit; E. Lahav; E. Pesis; D. Prusky; E. Tomer and M. Wysoki (1997). True-to-type propagation and nursery management of 'Carabao' mango. Proceedings of the 5th international

Kato, T. and H. Lou (1989). Effects of rootstock on the yield, mineral nutrition and hormone [cytokinins, gibberellins and auxins] level in xylem sap in eggplant. Journal of The Japanese Society For Horticultural Science, 58:(2) 345-352.

Kihara, H. (1951). Triploid watermelon. Proceeding of the American Society for Horticultural Science, 58:217-230

Larsen, F. E. (1976) Budding and grafting with polyethylene strips. Plant-Propagator., 22: 3, 10-11(Cited from. Horticultural-Abstracts 1977 047-03237).

Lee, J. M. (1994). Cultivation of grafted vegetables: current status, grafting methods, and benefits. Hortscience 29:235-239.

Leonardi, C. and F. Giuffrida (2006). Variation of plant growth and macronutrient uptake in grafted tomatoes and eggplants on three different rootstocks. European Journal of Horticultural Science 71:97-101.

Leoni, S.; R. Grudina; M. Cadinu; B. Madeddu and M. G. Carletti (1990). The influence of four rootstocks on some melon hybrids and a cultivar in greenhouse. Acta Horticulturae, 287: 127-134. 2nd International Symposium On Protected Cultivation Of Vegetables In Mild Winter Climates, Iraklion, Crete, Greece, 29 Oct.-3 Nov., 1989.

Lo´Pez-Galarza, S.; A. San Bautista; M. Perez; A. Miguel; C. Baixauli; B. Pascual; J. V. Maroto and J. L. Guardiola (2004). Effects of grafting and cytokinin-induced fruit setting on colour and sugar-content traits in glasshouse grown triploid watermelon. Journal of Horticultural Science and Biotechnology, 79(6): 971–976.

Malik, C. P. and M. B. Singh (1980). Plant enzymology and histoenzymology. A Text. Manual. Kalyani Publishers, New Delhi.

Maroto, J. V. (2002). Horticultura herbácea especial. Mundi-Prensa, 5th Ed. Madrid, Pp. 553–564 (Cited by. Miguel, A.; J. V. Maroto; A. San Bautista; C. Baixauli; V. Cebolla; B. Pascual; S. López, and J. L. Guardiola (2004). The grafting of triploid watermelon is an advantageous alternative to soil fumigation by methyl bromide for control of fusarium wilt. Scientia Horticulturae,103 (1) 9-17).

Marr, C. and K.L.B. Gast (1991). Reaction of consumers in a farmers market to prices for seedless watermelon and ratings of eating quality. Horttechnology, 1: 105–106.

Masuda, M. and K. Gomi (1982). Diurnal changes of the exudation rate and the mineral concentration in xylem sap after decapitation of grafted and non-grafted cucumber (in Japanese with English summary). J. Jpn. Soc. Hort. Sci. 51: 293-298.

Maynard, B.k. and N.L. Bassuk (1990). Comparisons of stock plant etiolation with traditional propagation methods. Comb. Proc. Intl. Plant Prop.Soc. 40:517-523 (C. A. Hartmann, H.T.; D.E. Kester; F.T. Davies and R.L Geneve (2002). Hartmann and Kester's, Plant Propagation; Principles and Practices. Seven Edition. New Jersey: Regent-Prentice Hall, 07458. 873p.

Miguel, A.; J. V. Maroto; A. San Bautista; C. Baixauli; V. Cebolla; B. Pascual; S. López and J. L.Guardiola (2004). The grafting of triploid watermelon is an advantageous alternative to soil fumigation by methyl bromide for control of fusarium wilt. Scientia Horticulturae,103 (1) 9-17.

Mohamed N. F. (2000). Studies on grafting and micrografting of some fruit trees. Ph.d Faculty of Agriculture, Cairo University Egypt.

Oda, M. (1995). New grafting methods for fruit-bearing vegetables in japan. Japan Agricultural Research Quarterly, 29:187-194.

Oda, M. (2007). Vegetable seedling grafting in japan. Acta-Horticulturae, 759: 175-180. Proceedings of the Xxvii International Horticultural Congress on Global Horticulture: Diversity and Harmony. Introduction, Ihc 2006, Seoul, Korea, 13-19 August 2006.

Oda, M.; K. Tsuji and H. Sasaki (1993). Effect of hypocotyl morphology on survival rate and growth of cucumber seedling grafted on *Cucurbita spp.* Jarq, 26: 259-263.

Pavlou, G. C.; D. J. Vakalounakis and E. K. Ligoxigakis (2002). Control of root and stem rot of cucumber, caused by *fusarium oxysporum* f. Sp radicis-cucumerinum, by grafting onto resistant rootstocks. Plant Disease 86:379-382.

Porada, H (1993). Timber species propagation. Comb. Proc. Intl. Plant Prop.Soc. 43:80-85 (C. A. Hartmann, H.T.; D.E. Kester; F.T. Davies and R.L Geneve (2002). Hartmann and Kester's , Plant Propagation; Principles and Practices. Seven Edition. New Jersey: Regent-Prentice Hall, 07458. 873p.

Pulgar, G.; D. A. Villora; D. A. Moreno and L. Romero (2000). Improving the mineral nutrition in grafted watermelon plants: nitrogen metabolism. Biol. Plant. 43:607-609.

Raulston, J.C. (1995). New concepts in improving ornamental plant adaptability with stress tolerant rootstocks. Comb. Proc. Intl. Plant Prop.Soc. 45:566-569 (C. A. Hartmann, H.T.; D.E. Kester; F.T. Davies and R.L Geneve (2002). Hartmann and Kester's, Plant Propagation; Principles and Practices. Seven Edition. New Jersey: Regent-Prentice Hall, 07458. 873p.

Rema, J.; B. Krishnamoorthy and P. A. Mathew (1997). Vegetative propagation of major tree spices - A Review Journal-of-Spices-and-Aromatic-Crops. 1997, 6: 2, 87-105; 7 pp .

Rivard, C. L. (2006). Grafting tomato to manage soilborne diseases and improve yield in organic production systems. M. Sc. Thesis, Plant Pathology, Faculty of Agriculture and Life Sciences, North Carolina State University, USA.

Rivero, R. M.; J. M. Ruiz and L. Romero (2003). Role of grafting in horticultural plants under stress conditions. Journal of Food, Agriculture and Environment Vol. 1 (1): 70-74. 2003

Roberts, B. W.; W. W. Fish; B. D. Bruton; T. W. Popham and M. J. Taylor (2005). Effects of watermelon grafting on fruit yield and quality. Hortscience 40 (3):871 (Cited F rom Rivard, C. L. (2006). Grafting tomato to manage soilbome diseases and improve yield in organic production systems. M. Sc. Thesis, Plant Pathology, Faculty of Agriculture and Life Sciences, North Carolina State University, USA.

Ruiz, J. M.; A. Belakbir and L. Romero (1996). Foliar level of phosphorus and its bioindicators in cucumis melo grafted plants. A possible effect of rootstocks. Journal of Plant Physiology 149:400-404.

Ruiz, J. M. and L. Romero (1999). Nitrogen efficiency and metabolism in grafted melon plants. Scientia Horticulturae, 81:113-123.

Salam, M. A.; A. S. M. H. Masum; S. S. Chowdhury; M. A. Monoranjan Dhar Saddeque and M. R. Islam (2002). Growth and yield of watermelon as influenced by grafting. On Line Journal of Biological Sciences, 2 (5): 298-299,

Yetisir, H. and N. Sari (2003A). Effect of different rootstock on plant growth, yield and quality of watermelon. Australian Journal of Experimental Agriculture, 43: 1269-1274.

Yetisir, H. and N. Sari (2003B). Effect of hypocotyl morphology on survival rate and growth of watermelon seedlings grafted on rootstocks with different emergence performance at various temperatures. Turkish Journal of Agriculture and Forestry, 28 (4): 231-237.

Yetisir, H.; N. Sari and S. Yücel (2003) Rootstock resistance to fusarium wilt and effect on watermelon fruit yield and quality. Phytoparasitica, 31 (2): 163–169.

Ying, L. H.; Z. Z. Jun; Q. Q. Qiu and G. Z. Ping (2004). The effects of different rootstocks on the sugar metabolism and related enzyme activities in small and early-maturing watermelon during fruit development. Acta Horticulturae Sinica. 31(1): 47-52 (Cited from Horticultural Crops Abstract, International Standard Serial Number: 0513-353x)

Zhang X.P.; B.B. Rhods; H.T. Skorupska and W.C. Bridges (1995).Generating tetraploid watermelon using colchicine in vitro. In Dunlap JR (ed) Proc Cucurbitaceae 94: evaluation and enhancement of cucurbit germplasm. Texas A &M University, USDA/ARS/SARL, pp 134-139.

Zijlstra, S.; S. P. C. Groot and J. Jansen (1994). Genotypic variation of rootstocks for growth and production in cucumber: possibilities for improving the root system by plant breeding. Scientia Horticulturae, 56: 185-196.

طريقة جديدة للتطعيم لإكثار نباتات البطيخ عديم البذور

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البطيخ من محاصيل الخضر الهامة في مصر. يفضل عديد من المستهلكين البطيخ عديم البذور حيث انه أكثر حلاوة في الطعم كما انه لا يحتوي علي بذور صلبة. تكاليف زراعة البطيخ عديم البذور مرتفعة في مصر نظرا لارتفاع أسعار البذور واستيرادها من الخارج وانخفاض نسبة الإنبات و عدم تجانس الإنبات الذي يترتب عليه عدم تجانس النمو في الحقل. ولذلك هدفت تلك الدراسة إلي إكثار البطيخ عديم البذور بواسطة طريقة جديدة للتطعيم بهدف تقليل كمية البذور المستوردة المطلوبة للزراعة من هجن البطيخ بصورة عامة و هجن البطيخ عديم البذور بصفة خاصة وكذا تقليل تكاليف إنتاج الشتلات و الوصول إلي شتلات متجانسة في النمو.

التطعيم طريقة لإكثار النباتات لاجنسيا و هي تستخدم علي نطاق واسع في البساتين وتستخدم بالأخص في إكثار الأشجار و الشجيرات بصورة تجارية بينما في محاصيل الخضر تستخدم في كل من الطماطم و الفلفل و الباذنجان و الخيار و الشمام و البطيخ ولكن الهدف الرئيسي في تلك الحالة هو مقاومة أمراض ومشاكل التربة. الطريقة الجديدة للتطعيم في هذه الدراسة هي أول طريقة تسمح باستخدام التطعيم كطريقة للإكثار في محاصيل الخضر.

الطريقة الجديدة للتطعيم اعتمدت علي تقسيم نباتات من البطيخ عديم البذور من الهجين شيفون و نباتات البطيخ البذري الهجين أسوان والتي زرعت في الصوب البلاستيكية كنباتات أمهات إلي ثلاث أنواع من العقل بعد ٧٥ يوم من الزراعة. النوع الأول عقل طرفية من القمة النامية أو الفروع الجانبية بطول من ٦-١٠ سم و قطر ٠,٤٥ – ٠,٦ سم و النوع الثاني من العقل يحتوي عقدتين و برعمين وورقتين والنوع الثالث من العقل يتضمن علي ورقة واحدة وبرعم إبطي واحد وعقدة واحدة استخدمت كطعوم ويتم تطعيم تلك العقل المذكورة علي أربعة أصول هي يقطين (١) *Lagenaria siceraria* و اليقطين (٢) *Lagenaria siceraria* و القرع العسلي *Cucurbita moschata* و الهجين النوعي ايركولي *Cucurbita maxima* × *Cucurbita moschata* باستخدام طريقة الإيلاج في ثقب hole insertion.

صممت التجربة بطريقة القطاعات الكاملة العشوائية في ثلاث مكررات في الموسم ٢٠٠٧-٢٠٠٨ شملت ١٢ معاملة تطعيم ومعاملة الكنترول بزراعة هجين البطيخ عديم البذور شيفون بدون تطعيم.

الأصول من النوع *Cucurbita* أعطت اقل معدل بقاء بالمقارنة بالأصول من اليقطين *Lagenaria* مع جميع أنواع العقل المستخدمة كطعوم. النباتات المطعومة بهذه الطريقة أظهرت زيادة كبيرة في معظم الصفات الخضرية المدروسة و المحصول المبكر والمحصول الكلي و صفات الثمار و السكريات الكلية و السكريات المختزلة و غير المختزلة بالمقارنة الكنترول (بدون تطعيم).