EFFECTS OF DIFFERENT ROOTSTOCKS ON GROWTH, BIOCHEMICAL AND MOLECULAR CHANGES IN GRAFTED CUCUMBER (*CUCUMIS SATIVUS L.*)

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ABSTRACT:

The experiments was carried out in greenhouse during seasons 2017 and 2018 to study the vegetative growth, physiological, chemical and molecular changes of grafted cucumber cv Gianco RZ f1hybridon different rootstocks. Various 6 genotypes of rootstocks from cucurbitaceae family were used for grafting such as Gordal, Bottle gourd, Luffa, Pumpkin, Star and Hersh in additional to Control plant which self-grafted. The obtained results exhibited that Hersh rootstock gave the longest and largest diameter of grafted cucumber plant in comparison to the control plants. However, the highest leaves number was revealed from Star rootstock compared to the control plants, while the biggest leaf area was obtained from Botle gourd rootstock compared to Luffa rootstock which gave smallest leaf area in both seasons. Grafted cucumber on Hersh rootstock exhibit the earliest of flowering and harvesting time compared with luffa rootstock which was the latest. On the other side the highest fruit total yield was obtained from Star rootstock in comparison to Luffa rootstock during both seasons. The physical and chemical traits of grafted cucumber fruits were tabulated to study the interaction between cucumber scions- rootstocks. Molecular analysis via ISSR using five primers was done to identify the variation of heritability in grafted cucumber induced phenotypic. These results exhibited that the used rootstocks effected significantly on the changes of scion product after grafting. Overall, its recommended that the use of Hersh and Star rootstocks could be provide a useful tool to improve vegetative growth, earliness of flowering, yield and fruits nutritional values of grafted cucumber.

Keywords: Rootstock, scion, cucumber, ISSR, grafting, polymorphism, carbohydrates

INTRODUCTION:

Cucumber (*Cucumissativus L.*) is the first most important crop in greenhouse production in Egypt. And one of the most popular vegetable crops which grown in greenhouses in several countries and annually produced about 71.4 million tons in the world (Fao 2015). Grafting is a tool and very important technique to improve vegetable growth, yield production and fruit quality (Marsic and Jakse 2010, Schwartz *et al.,* 2010, and Farhadi*et al,* 2016). Grafting is an ancient, vegetative, asexual plant propagation technique. It is accomplished most commonly by connecting two plant segments, the shoot piece known as'scion' and the root piece called 'rootstock'(stock)(Goldschmidt 2014, Garner 2013 and Koepke and Dhingra 2013).

Grafting is applied in the agricultural practice for protection of plants against environmental adverse and plant disease in cucurbitaceae family. Grafting also combines desirable roots and shoots to generate chimeras that are more vigorous, more pathogen resistant and more abiotic stress resistant (Melnyk 2017). Grafting within a genus is often successful, but within a family success is unusual. Exceptional instances include the Solanaceae (tomatoes, potatoes, and tobacco), cacti families and cucurbitaceae family (grafted cucumber on most of cucurbits genus), which often graft successfully within their respective families and become a common practice (Lewis and Alexander, 2008 and El-Syed*et al.,* 2014).

The growth, yield productivity and quality of vegetables being affected by grafting on Honey Dew' (*Cucumismelo var. inodorus*) as rootstock (Davis at al., 2008). Cucumber can be grafted on various rootstocks from cucurbitaceae family such as Cucurbita maxima, C. moschata, C. ficifilia, Lagenaria spp., Luffa spp. (Oda, 2002 and Sakata *et al.,* 2008). The positive effect of grafting depends mostly on the genotype of rootstocks by increasing of vegetative growth, earliness of flowering and yield production (Huang *et al.,* 2009; Cansev and Ozgur 2010 and Uysal*et al.,* 2012). Numerous studies have reported that different rootstock genotypes could have variable effects on yield and quality of the grafted vegetable, and the overall performance largely depends on the specificity of the rootstock-scion combination (Edelstein *et al.,* 2004, Cohen *et al.,* 2007 and Davis et al., 2008).
Generally, rootstocks are powerful of supply water and nutrient uptake by the soil, or to distribute growth regulators to the grafted part (Helaly, 2017). As in watermelon production, using grafted plants is becoming an important production type in melon and cucumber production (Yarsi*et al,* 2017 and Usanmaz*et al.,* 2018). Grafting cucumber has improved growth and yield with their quality which was a rapid alternative tool to the relatively breeding program in vegetable crops (Flores *et al.,* 2010 and Al-Harbia*et al.,* 2018).

Many researchers have used grafting to study the molecular mechanisms of grafted plants induced phenotypic variation in anatomy, morphology and production (Wang *et al* 2017). By grafting different genotypes to each other and looking for the movement of molecules from one genotype to another, researchers have identified the transport of proteins, hormones, RNAs, and secondary metabolites over long distances (Turnbull 2010; Goldschmidt, 2014 and Melnyk 2017).

The heritability of graft-induced phenotypic changes suggests that regulatory processes underlying the scion–rootstock communication also involve a genetic component (Tsaballa*et al.,* 2013 and Wang *et al.,* 2017). In addition, a study by Taller *et al.,* (1998) detected several RAPD markers analysis in the grafted plants induced variants and found the same fragments in the rootstock genotypes but not in the scion. They suggested that the genetic changes caused by grafting were attributable to direct DNA uptake through the vascular bundles (Wang *et al.,* 2017).The detection of variants DNA in the grafted plants indicates that the direct transfer of DNA from the rootstocks to the scion's, and was the cause of the changes in pepper plants (Taller *et al.,* 1999). Analyses of molecular markers by ISSR offered some indications for the extent of genetic changes occurred in the scion during grafting (Tsaballa*et al.,* 2013).

The major areas of the application of ISSR are in genomic fingerprinting, genetic diversity and phylogenetic analysis, genome mapping, gene tagging and marker assisted selection, determining SSR motif frequency and studies of natural population/ speciation (Singh *et al.,* 2016).Molecular mechanisms are probably confirming graft-induced changes via rootstock-scion interactions, and improve the quantity and quality of grafted plants.Graft-induced variant traits and can be utilized as a novel source of new generation in pepper breeding program. Principally, graft-induced genetic changes can also be attributed to direct DNA uptake through the vascular system. A detailed molecular analysis of graft-induced genetic changes in pepper will be presented in the near futureTsaballa*et al.,* 2013 and Singh et al., 2016).Among the several DNA based techniques, Random Amplified Polymorphic DNA (RAPD) is simple, less technology intensive, cheap and does not require pre-sequencing for designing primers. RAPD markers have been extensively used as a tool to estimate genetic diversity to determine intraspecific variations in different plant species (Mady*et al.,* 2013, Mady*et al.,* 2014, Helaly*et al.,* 2014, and Helaly*et al.,* 2017).

The aim of this study was to evaluate plant growth and productivity, and quality of grafted cucumber on different rootstocks in order to establish the most useful scion/rootstock combinations. Also, to study ascertain the genetic nature of several graft-induced variant traits and to understand the long standing grafting mysteries.

MATERIALS AND METHODS:

The experiments were conducted in greenhouse during the two successive summer seasons in 2017 and 2018. They were performed in a private farm in Sarawa, Ashmoun, El-menofea governorate, Egypt). The nutritional values analysis was done in the laboratory of horticulture departments (Vegetable lab), faculty of Agriculture, Al-Azhar University, Cairo, Egypt, while the molecular analysis for ISSR was done in the biotechnology department, International Research Center, Giza, Egypt.

First Experiment: Effect of rootstocks on grafted cucumber.

This experiment was done to study the effect of grafting scion of cucumber on different rootstocks to achievehigh productivity and quality of cucumber (*cucumissativus* L.), Gianco RZ hybrid f1 was obtained from RijkZwaan – Holland (Imported by: RZ Egypt for importing(393 the fourth tourist area, 6th October City, Giza, Egypt). Cucumber plants were grafted onto various rootstocks such as: 1) Control plants was grafted onto themselves. 2) Gordal (*Cucurbita maxima* × *cucurbitamoschata*)from Growtch Company. 3) Bottle Gourd (*Lagenariasiceraria*)Local variety. 4)Luffa (*Luffaaegyptiaca*)Local variety. 5) Pumpkin (*Cucurbitamoschata*)Local variety. 6)Star (*C.maxima* × *C.moschata*)fromNew star company. 7) Hersh (*Cucumismelovar. inodorus*L.) Local variety was obtained from Almenshaa - Sohagcovernorate.The experiment was conducted randomly in greenhouse(wide range 6m and length 10m contain 5 lines) with three replicate, each contain 7 plants with distance among cucumber plants 30 cm. Grafting method was used according, to the methods described by Kawaide (1985) and El-Sayed*et al.,*(2014).

Plant growth parameters:-

A - Vegetative growth:-Vegetative growth characters, were recorded after 60 days after transplanting in samples of four plants randomly chosen from each replicate as follows: 1) Plant length (cm): It was measured as the average length of four plants. The measurement started from cotyledonary leaves to the terminal bud. 2) Stem diameter (cm): It was measured by using a caliper above grafting zone. 3) Number of leaves per plant: Fully expanded leaves were counted and recorded. 4) Leaf area cm^2: The leaf area was estimated by using a digital leaf area meter (LI 300 portable area meter produced by LI-COR, lincolin, Nebraska, USA).

B - **Earliness of flowering and Earliness of harvesting:-** 1) The earliness of flowering was counted the number of days from transplanting day to the appearance the first flower.2)Earliness of harvestingwas counted the number of days from transplanting day to the appearance the first fruit harvest.

C – Yield Characteristics:- 1) Early yield was counted bases on the total numbers of cucumber fruits during the first three harvests. 2) Total weight of fruits /plant it represents the total weight of the harvested fruits throughout the entire season in kg per plant. 3) Total number of fruits/plant: It recorded as the total number of the harvested fruits per plant throughout the entire season. 4) Fruit length (cm): The average fruit length was measured by rular. 5) Fruit diameter (cm): The average fruit diameter was measured by venir caliper. 6) Fruit firmness was measured by using Magness and Ballauf pressure tester in kg/cm^2.

C – Chemical characteristics:-1)Dry matter % of the fruits was recorded from 100 g fruits, the fresh fruits were oven dried at 70˚c for two days and dry weight of fruit was determined by electronic balance.2) Ascorbic acid (Vitamin C mg/100 g Fr. Wt.) was determined using 2, 6- dichloroendophenol method as described in A.O.A.C. (2000). 3) Total soluble solids (T.S.S. %)was measured in fruit juice by using a hand refractmeter and estimated according to the methods of A.O.A.C. (2000).4) Total carbohydrates of cucumber fruits juice were determined as according in A.O.A.C (2000).

Second experiment: Molecular studies on grafted cucumber.

DNA of 7 samples was extracted from the forth leaf of the apical meristem and purified from all samples using QiagenDNeasy™ Plant Minikit following the protocol of the manufacturer (QiagenInc, Valencia, CA) according to Doyle and Doyle 1990; Mady et al 2013 and Helaly et al 2014. Five primers were used for inter simple sequence repeat (ISSR) - polymerase chain reactions (PCR) analysis [1) SR1, AGAGAGAGAGAGAGAGC; 2) SR-6, GAGAGAGAGAGAGAGAT; 3) SR-7, ACACACACACACACACC, 4) SR-12, GAGGAGAGAGAGAGAGG and 5)SR-64, ATGATGATGATGATG].The PCR were completed according to instructions included with the primers until reproducible bands were obtained. PCR components, reactions and running agarose gel were done according toHelaly et al.,(2014).The products were visualized under UV light to observe the banding patterns for each amplicon and determine the level of polymorphism. The banding profile of ISSR were scored using Labimage program. The polymorphism was estimated as follow: polymorphism % = (Number of polymorphic bands/Total Number of Bands) ×100. The cluster tree analysis was done using SYSTAT program.

Statisyical analysis: All experiments were statistically analyzed in a complete randomized design with three replicates. Obtained data were subjected to the analysis of variance procedure and means were compared by L.S.D. method at 5% level of significant according to (Snedecor and Cochran, 1980).

Results:

First Experiment: Effect of rootstocks on grafted cucumber.

A – Vegetative growth.

Data presented in Table (1) clearly indicated that grafting cucumber scion on Hersh rootstock showed significant increase in plant length (3.43m and 3.44m) during first season, but the result didn't reach the significant level in the second season in comparison to the control plants (2.57m and 2.95m) in both seasons respectively.The largest stem diameter was obtained from Hersh rootstock (10.70 mm and 11.37 mm)compared with self-grafted plants (9.20 mm and 10.13 mm) in the two seasons respectively. Star rootstock gave the highest counted leaves number per plantwhich recorded 43.00 and 40.66 compared with the lowest number (35.00 and 31.66) obtained from self-grafted control in both season respectively. Referencing to the biggest leaf area was achieved from Botle gourd rootstock and significantly increased with register values 80.53 and 80.22 cm2 in compared with the lowest values (95.37 and 131.30 cm2) was obtained from Luffa rootstock during both seasons respectively.

Table 1: Effect of rootstocks on vegetative growth of grafted cucumber plants during two seasons 2017 and 2018.

Characters	Plant length (m)		Stem diameter (mm)		Number of leaves / plant		Leaf area (cm^2)	
Treatments	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Control	2.57	2.95	9.20	10.13	35.00	31.66	84.48	102.00
Gordal	3.25	3.38	10.65	11.20	41.00	38.33	85.42	123.89
Bottle Gourd	3.11	3.27	10.08	10.95	38.00	37.33	95.37	131.30
Luffa	2.75	3.11	9. 55	10.54	37.00	30.00	80.53	80.22
Pumpkin	2.74	3.06	9.43	10.66	37.00	31.66	82.64	95.49
Star	3.05	3.15	10.56	11.13	43. 00	40.66	85.67	110.94
Hersh	3.43	3.44	10.70	11.37	42.33	39.33	86.52	104.36
L.S.D at 0.05	0.36	N.S	0.30	0.09	1.94	1.98	0. 98	3.40

B- Earliness of flowering and harvesting.

Earliness of flowering and Earliness of harvesting are presented in Table (2) which has significant differences between the grafted rootstocks-scion genotypes. The rootstock Hersh was earlier flowers with least days number (35.84 and 36.33 days) followed by Star rootstock which recorded 37.53 and 36.56 days in both seasons respectively. In contrast, Luffa rootstock delays the grafted cucumber flowering with register days 56.54 and 55.31 in both seasons respectively. Concerning the earliness of harvesting typical results was found from Hersh rootstock with revealed days number 46.81 and 47.25 followed by Star rootstock with recorded days 47.44 and 47.59 in both seasons respectively. The delayed harvest of grafted cucumber was obtained from Luffa rootstock with exhibited days 63.40 and 62.70 in both seasons respectively.

Table 2: Effect of rootstocks on the earliness of flowering and earliness of harvesting in grafted cucumber during two seasons 2017 and 2018.

Characters	Earliness of flowering (days)		Earliness of harvesting (days)	
Treatments	**2017**	**2018**	**2017**	**2018**
Control	45.53	43.48	58.50	55.14
Gordal	39.56	36.69	51.51	48.33
Bottle Gourd	40.43	40.32	53.53	52.13
Luffa	56.54	55.31	63.40	62.70
Pumpkin	49.26	45.79	60.51	55.89
Star	37.53	36.56	47.44	47.59
Hersh	35.84	36.33	46.81	47.25
L.S.D at 0.05	2.09	1.89	1.92	2.46

C – Yield characteristics of cucumber fruits

The obtained results in Table (3) showed the effect of different rootstocks on early yield/ plant, commercial yield/ plant and total yield/ plant in grafted cucumber during both seasons of 2017 and 2018.

Table 3: Effect of grafting on early yield, commercial yield and total yield of cucumber fruits per plant during two seasons 2017 and 2018.

Characters	**Early yield/ plant (fruit number)**		**Commercial plant (kg/plant)**		**Total yield (kg/plant)**	
Treatments	2017	2018	2017	2018	2017	2018
C Control	5.40	6.40	3.03	2.98	3.66	4.07
Gordal	21.20	8.60	3.45	3.72	4.12	4.60
Bottle Gourd	11.20	7.00	3.36	3.20	3.83	4.44
Luffa	5.00	5.20	2.94	2.54	3.11	4.16
Pumpkin	8.40	6.20	2.97	2.82	3.62	3.82
Star	31.20	15.60	4.04	3.93	4.90	5.17
Hersh	27.40	11.40	3.91	3.44	4.43	4.51
L.S.D at 0.05	0.4	0.3	٠.80	٠.36	٠.13	0.23

Early yield was significantly increased from Star rootstock with recorded fruit number 31.20 and 15.60 in comparison to the lowest number obtained from Luffa rootstock with register fruit number 5 and 5.20 in both seasons respectively. The highest commercial yield (4.04 and 3.93 kg /plant) and total yield (4.90 and 5.17 kg/plant) was revealed from Star rootstock in both seasons respectively. Luffa rootstock exhibit significant decreased with lowest value in commercial yield (2.94 and 2.54 kg/plant) and total yield (3.11 and 3.82 kg/plant) in both seasons respectively.

D – Physical characteristics of cucumber fruits:-

The results for the fruit number per plants, fruit length, fruit diameter and fruit firmness showed significant differences between investigated treatments (Table 4). The highest fruit number per plant was recorded in cucumber grafted on Star rootstock (56 and 64) followed by Gordal rootstock (50.66 and 62) in both seasons respectively. Self-grafted plants (control) showed the significant decrease in fruit number per plant (26 and 43.32) in both seasons respectively. The longest fruit length (14.07 and 14 cm) and greatest fruit diameter (3.77 and 3.76 cm) was established in cucumber grafted on star rootstock during both seasons respectively.

Table 4: Effect of rootstock on the physical characteristics of grafted cucumber fruits during seasons 2017 and 2018.

Characters	Number fruit per plant		Fruit length (cm)		Fruit diameter (cm)		Fruit firmness kg/cm^2	
Treatments	2017	2018	2017	2018	2017	2018	2017	2018
Control	26.00	43.32	12.31	12.01	3.28	3.31	7.00	5.33
Gordal	50.66	62.00	13.45	13.45	3.52	3.50	7.20	6.33
Bottle Gourd	41.32	52.00	13.68	13.37	3.57	3.40	6.86	6.16
Luffa	36.00	44.66	13.24	13.09	3.56	3.51	5.16	5.33
Pumpkin	30.66	46.66	13.05	12.89	3.35	3.37	5.50	5.50
Star	56.00	64.00	14.07	14.00	3.77	3.76	7.33	6.50
Hersh	48.00	55.32	14.05	13.88	3.56	3.41	7.43	7.23
L.S.D at 0.05	2.32	1.32	0.371	0.41	0.08	0.14	0.72	0.60

In the contrary, the smallest fruits (12.31 and 12.01cm) and lowest fruits diameter (3.28 and 3.31cm) were obtained from self-grafted cucumber plants during both seasons. Regarding to the effect of different rootstocks on fruit firmness kg/cm^2 in grafted cucumber comparing to the control plants, data exhibited the highest firmness was obtained from Hersh rootstock (7.43 and 7.23 kg/cm^2) followed by Star rootstock which revealed 7.33 and 6.50 kg/cm^2 in both seasons respectively. Luffa rootstock gave lowest value and differed significantly in fruit firmness with recorded number 5.16 and 5.33 kg/cm^2 in both seasons respectively.

E - Chemical characteristics.

The results for the fruits dry matter %, T.S.S %, Ascorbic acid and total carbohydrate showed significant differences between investigated treatments (Table 5). Grafted cucumber scion on Star rootstock gave the highest fruits chemical contents in fruit dry matter % (9.92 and10.08 %), T.S.S (5.11 and 4.26 %) and ascorbic acid (3.60 and 3.45 mg/100 g fw) in both seasons respectively. In contrast the lowest value of fruit dry matter % (8.15 and8.79 %), T.S.S (2.96 and 2.84 %) and ascorbic acid (2.23 and 2.62 mg/100 g fw) were obtained from Luffa rootstock in both seasons respectively. Hersh rootstock reacted specifically to the total carbohydrates % with the highest recorded value in comparison to all treatments in both experimental seasons. Significant differences of the total carbohydrates were obtained from grafted cucumber scion onto Hersh rootstock with recorded percentage 3.13 and 3.06% during the studied seasons. In contrary, the lowest total carbohydrates was found from grafted cucumber scion on Luffa (2.44 and 2.55 %) followed by self-grafting cucumber (2.55 and 2.77 %) in both seasons respectively.

Table 5: Effect of rootstock on the chemical contents of grafted cucumber fruits during seasons 2017 and 2018.

Characters	Fruits dry matter %		T.S.S %		Ascorbic acid mg/100 g fw		Total Carbohydrates %	
Treatments	2017	2018	2017	2018	2017	201	201	2018
Control	8.26	9.44	3.08	3.01	2.72	2.85	2.55	2.77
Gordal	8.70	10.07	4.19	3.87	3.17	3.06	2.93	2.82
Bottle Gourd	8.56	9.73	3.77	3.72	2.69	3.08	2.72	2.84
Luffa	8.15	8.79	2.96	2.84	2.23	2.62	2.44	2.55
Pumpkin	8.54	9.01	3.77	3.13	2.53	2.91	2.84	2.73
Star	9.92	10.08	5.11	4.26	3.60	3.45	3.10	2.90
Hersh	9.68	9.78	4.95	3.97	3.42	3.23	3.13	3.06
L.S.D at 0.05	0.35	0.42	0.49	0.14	0.10	0.16	0.22	0.18

Second experiment: Molecular studies on grafted cucumber.

DNA analysis demonstrated the minor genetic variability among the investigated grafted cucumber (rootstock-scion) in this study. The amplification of ISSR –PCR was done by using five primers revealed a total of 46 bands which exhibited 33.32% polymorphism (Table 6 and Figure 1). The obtained bands varied with the selection of primers and counted 30 monomorphic bands beside 16 polymorphic bands (Table 6).The number of polymorphic fragments per primer ranged 42.86% from primer SR-64, 14.29% from primer SR-1, 33.33% from primer SR-6, 30% from primer SR-7 and 46.15% from primer SR-12. The highest number of polymorphic bands (6) was obtained with primers SR-12. The lowest number of polymorphic bands (1) was observed with primers SR-1 as shown in Table (4). The level of polymorphism was found to be in between 14.29 % to 46.15%. The highest percentage of polymorphism (46.15 %) was observed with primer SR-12 while the lowest percentage of polymorphism (14.29 %) was noticed with primer SR-1.

Table 6:ISSR-PCR amplification products of DNA extracted from leaves of grafted cucumberusing five primers.

Primers Code	Primer sequences (5'→3')	Total amplified fragments	Monomorphic fragments	Polymorphic fragments	Polymorphism %
SR-1	AGAGAGAGAGAGAGAGC	7	6	1	14.29
SR-6	GAGAGAGAGAGAGAGAT	9	6	3	33.33
SR-7	ACACACACACACACACC	10	7	3	30
SR-12	GAGGAGAGAGAGAGAGG	13	7	6	46.15
SR-64	ATGATGATGATGATG	7	4	3	42.86
Total		46	30	16	33.32

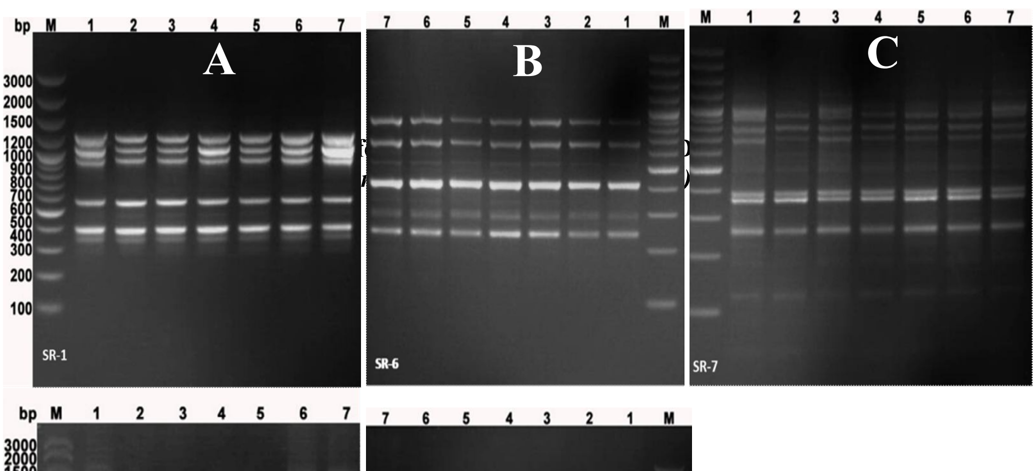

Figure 1: ISSR-PCR product of genomic DNA of the seven grafted cucumber (rootstock-scions)
[M: molecular marker, self-grafted (1), Gordal (2), Bottle gourd (3), Luffa (4), Pumpkin (5) Star (6) and Hersh (7). ISSR profile of used five primers as SR-1 (A), SR-6 (B), SR-7 (C), SR-12 (D), SR-64 (E) and diagram of cluster tree from DNA matrix of the various grafted cucumber genotypes by unweighted pair group mathematic average (F).

Cluster analysis was done on the basis of similarity coefficients which ranged from 0.0 - 0.4 among the 7 tested samples (Figure 1 F). The dendrogram constructed from UPGMA cluster analysis of the Dice similarity coefficients calculated from ISSR data. The dendrogram based on genetic similarities separated the seven samples of cucumber into two main groups. It could be observed that sample (1) was grouped in the first cluster alone (cucumber self-grafted), and all other samples (2, 3, 4, 5, 6 and 7) were grouped in the second cluster, which was separated into three sub-clusters, the first sub-cluster included sample (2) and the second included samples 3, 4 and 5, the third included samples 6 and 7.

DISCUSSIONS:

Cucumber (*Cucumissativus* L., 2n=2x=14) is one of the most important member of the cucurbitaceae family including several crops of economic importance (Singh *et al.,* 2016).

A - Effect of rootstocks on grafted cucumber.

The highest vegetative growth and earliness of flowering in this study were obtainedfrom grafted cucumber scion on Hersh and Star rootstocks. These results may be due tothe different grafting compatibility among rootstocks and cucumber scion which improve the water and elements absorption. Grafting improved nutrient uptake in grafted plants increases photosynthesis, which is particularly noticeable under less than optimal growing conditions such as weak sun light and low CO2 content in solar greenhouses during winter condition. It has been suggested that these conditions allow grafted plants to produce higher yields, sometimes with improved fruit quality (Pulgar*et al.,* 2000; Xu*et al.,* 2006; Zhu *et al.,* 2006 and Hu *et al.,* 2006).

Earliness of flowering and harvesting was obtained from Hersh and Star rootstocks compared to self-grafted and others root stock, may be due to huge growth of plant, increasing photosynthesis assimilation and hormonal balance synthesis. Aloni*et al.,* (2010) reported that the hormones in plants are regulated by root–shoot interactions, including graft-union formation, rootstock -scion communication, and plant growth and development. Sakata *et al.,*(2008) investigated the formation of female flowers in watermelon grafted onto squash 'bottle gourd' was significantly earlier compared to other rootstocks. Flowering date affects fruit harvest time, which can have a direct impact on productivity and quality.We can only suggest that certain introduced factors of the stock combined in an exceptional way with genes of the scion that control shoots differentiation or the hormonal balance, giving rise to this character (Taller *et al.,* 1998 and wang*et al.,* 2016).

Grafting cucumber scion on Star and Hersh rootstocks were revealed the highest yield productivity and quality includingfruit physical and chemical characteristics. These results indicate that scion cultivars react specifically to individual rootstocks. Higher yield, greater earliness, large fruits or great fruit number could be obtained by appropriate scion and rootstock combinations. Clearly, the cucumber scion affects final growth, yield, and quality of fruit in grafted cucumber, but rootstock effects can drastically alter these characteristics. There are many conflicting reports on changes in fruit quality resulting from grafting (Salam *et al.,* 2002, Yetisir*et al.,* 2003 and Davis *et al.,* 2008).Our results exhibited significant increment of dry matter, TSS, ascorbic acid and total carbohydrates in grafted cucumber under the control of Hersh and Star rootstocks. These results may be due to the high compatibility in the vascular bundle of grafting union between rootstock and scion and could be due to vigorous root system which is often capable of absorbing water and nutrients more efficiency than scion roots(Miguel et al., 2004, Davis and Perkins-Veazie, 2005, Davis *et al.,* 2008 and Uzal*et al.,* 2012).

B - Molecular studies on grafted cucumber:

It's interesting to answer the question was asked by Tallrer*et al.,* (1998) and Helaly, (2017) of how genetic changes can occur in grafts. This study was carried out to ascertain the genetic nature of several graft-induced variant traits. However, molecular analysis will be necessary in order to understand the mechanisms of the graft-induced changes. Several RAPD-PCR markers were detected using a limited number of primers (Taller *et al., 1998). Our results indicated that minor genetic variability among the rootstock-scion* induced new plants which detected by ISSR-PCR.Molecular markers (ISSR) are more reliable and accurate method for diversity assessment. The information obtained from this study may be useful for further identification of promising cucumber genotypes for understanding the grafting mechanism of genetic diversity present in new cucumber generation (Singh *et al., 2016).*

On the other hand, Stegemann and Bock, (2009) suggested that gene transfer is restricted to the contact zone between scion and stock indicates that the changes can become heritable only via lateral shoot formation from the graft site.Results of present study are in conjunction with the previous studies reported by Taller *et al.,*(1998), Taller *et al.,*(1999) and Wang *et al.,*(2017). Our discovery suggests that grafting provides an avenue for genes to cross species barriers. Phylogenetic evidence suggests that DNA can be transferred horizontally between reproductively isolated species (Keeling and Palmer 2008 and Stegemann and Bock 2009). Instead, our finding that gene transfer is restricted to the contact zone between scion and stock indicates that the changes can become heritable only via lateral shoot formation from the graft site. Previous studies have shown that graft-induced phenotypic changes may be due to the exchange of genetic materials between different tissues (Taller et al., 1998; Stegemann and Bock, 2009; Tsaballa*et al.,* 2013, Melnyk*et al.,* 2015 and Wang *et al.,* 2017). Finally, we still need to know and understand more about the grafting mechanismbetween rootstock and scion to confirm the grafted induced changes genetically in long distance by using homogenousplants. The currently available molecular tools are expected to advance our understanding and eventually resolve the long standing grafting mysteries.

CONCLUSIONS:

The use of local landraces as rootstocks could help to decrease the cost of grafted plants. However, our results using local landraces highlighted the importance of checking the grafting compatibility with the most important hybrid used. This investigation illustrated how grafting affects cucumber fruit productivity and quality and what quality traits were affected. It is intended to show the importance of careful selection of rootstock/scion combinations to ensure high quality grafted cucumber fruit. The Hersh genotypes proved the best local rootstock used in grafted cucumber for growth and yield production which leads to reduce the imported rootstocks genotypes seedsfrom outside Egypt to save the foreign currencies (US Dollar, GBP and Euro) for other future needs.

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تاثير الاصول المختلفة على النمو والتغيرات البيوكيميائية والوراثية للخيار المطعوم

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أجريت التجارب فى الصوبة خلال موسمى ٢٠١٧/٢٠١٨ لدراسة النمو الخضرى والتغيرات البيوكيميائية والوراثية للخيار المطعوم صنف جيانكوF1 على الاصول المختلفة. أستخدمت ٦ اصول متنوعة من العائلة القرعية فى التطعيم مثل Gordal, Bottle gourd, Luffa, Pumpkin, Star and Hershبالاضافة الى الكنترول (خيار مطعوم على نفسة). أظهرت النتائج المتحصل عليها ان اصل الـ Hersh اعطى اطول النباتات واكبر قطر لساق الخيار المطعوم مقارنة بالكنترول. علاوة على ذلك أعلى عدد اوراق تم الحصول علية من التطعيم على اصل Star مقارنة بالخيار المطعوم على نفسة (الكنترول)، بينما اكبر مساحة ورقه تم الحصول عليها من اصل Botle gourd مقارنة باصل الـ Luffa الذى اعطى اصغر مساحة ورقة خلال الموسمين. التبكير فى الازهار والحصاد تم الحصول عليه من اصل الـ Hersh مقارنة بالـ Luffa الاكثر تاخيرا. ومن جهة اخرى اعلى محصول ثمار تم الحصول عليه من الاصل Star مقارنة باصلLuffa الذى اعطى اقل محصول خلال الموسمين. الصفات الطبيعية والكيميائية لثمارالخيار المطعوم جدولت لدراسة التفاعل بين الطعم والاصول.كما أجرى التحليل الوراثى للنباتات المطعومه عن طريق تقنية الـ ISSR باستخدام ٥ بادئات لتمييز الاختلافات الوراثية للخيار المطعوم. هذه النتائج اوضحت ان الاصول المستخدمة اثرت معنويا على التغيرات للنباتات الناتجة من التطعيم. اجمالا، اوصت الدراسة بان استخدام اصول الـ Hersh and Star يمكن ان تكون اداة مفيدة لتحسين النمو الخضرى والتبكير فى الازهار والمحصول والقيمة الغذائية لثمار الخيارالمطعوم.