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Determination of the best rootstock(s) for grafting in important greenhouse cucumber varieties of IRAN

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Abstract: *This research was done on determining the best rootstock(s) on two varieties of greenhouse cucumbers in Vegetable Research Center in Karaj [Iran]. The research trial plan was factorial based on CRD in three replications. Ten days after the planting, 11 varieties of squash seeds rootstocks and two varieties of greenhouse cucumber seeds named "Soltan and Extreme" were planted as scions, then the scions varieties were grafted on the mentioned rootstocks by approach method. Two days after grafting and recording the jointing percentage, grafted transplant was planted in greenhouse. About 40 days after planting and at the time of maximum plant growth, the growth traits such as plant height, stem diameter and the number of nodes were recorded for each plant, then in beginning of flowering and fruit set, the fruit traits including quantity, diameter, fruit length, and weight were recorded in a forty days period. In four harvesting periods. The result showed that in respect to jointing the rootstock Tian No.4 was the best, but in respect to the amount of fruit and total weight in a grafted plant, Ardabil skinless cucurbit rootstocks and ES 113 were respectively the best. Among the cucumber varieties, the percentage of jointing of Soltan variety was superior to Exterem, but in respect to fruit weight of the produced fruit in a grafted plant, no differences were observed.*

Keywords: *Greenhouse cucumber, Scions, Rootstock, Growth trait, Fruit*.

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I. Introduction

Grafting is done on some vegetables especially fruit vegetables including cucumber, Eggplant, Tomato mainly to reduce chemicals, Soil antiseptic, and more yield, to produce stronger root and lead to better absorption of water and food elements. According to King et al., 2008, vegetable drafting is aimed at disease management and to control, vegetable nematodes on farm and greenhouse.

Furthermore, grafted plant will house a better performance and tolerable to environmental stresses such as Salinity and Soil coldness (Edelstein, 2004) Hence, greenhouse Soil antiseptic is not completely done and it is not economical, grafting is regarded an important substitute technic especially in producing greenhouse vegetables. Despite the widespread application of grafting, the scientific information on rootstock and scion is very limited.

Vegetable grafting was done for the first time water melon and squash to reduce fusarium soil inhabitant in Japan and Korea in 1920 (Lee et al., 1998).

Greenhouse cultivated areas were estimated to be 1000 hectares in Iran in 1909, out of which 93% is credited to greenhouse cucumber (Anonymous, 2012). Grafting technic for cucumber is to enerease the yield and also to enhance its resistance to soil inhabitant and soil streses such as soil coldness that is a common issue in the world. The Researchers in Japan studied the possibility of resistant transfer of white powder to grifted cucumber by grafting on highly resistant rootstocks including (White powder, tokiwa powder) and the result showed the lack of transferring resistance to grafting on related and mentioned rootstocks. (Sakata et al., 2006)

The findings of some executed research on the importance and function of using proper rootstock in grafting showed that grafted water melons by gourd rootstock and grafted Tomato on Tomato variety of Tmknvf2 have had more power in absorbing water and mineral food materials and elements. (Khan et al., 2006; Lam et al., 2006)

Lam and colleagues in a comparison of grafting plants on Two varieties of seed lees water melons on Shintooza squash and non-grafted plants found out that the number of fruit in grafted plants was significantly more than non-grafted ones. But the fruit average weight was more in non-grafted plants.

Pavlou and his colleagues examined the compatibility of greenhouse cucumber on different rootstocks of squash and also the resistance of the grafted plants on different aspects of Fusarium and reported that all rootstocks of squash had partial resistance to Fusarium pollution and the least Fusarium contamination was noticed on grafted plants based on hybrid rootstock TS-B 58 which shows the higher resistance of this rootstock

to Fusarium. The various rootstocks also affected to the number of the leaves and fruit Total performance. Grafted Plants in contaminated situation compared to check have had more number in leaves and better performance. (Miguel et al., 2004)

Miguel and his colleagues examined the performance and qualitative traits of grafted water melons on resistant rootstocks in the soil contaminated to Fusarium and reported that grafted plant performance was higher than the check (non-grafted) and using the rootstock had no effect on the watermelon quality and using a resistant rootstocks were proper replacement for Metilbromide.

Early ripening of greenhouse cucumber is reported by cheshmehmanesh et al., 2003 in which two varieties of greenhouse cucumbers were grafted on Fig shaped squash.

Farhadi and Nematollahi evaluated and studied the grafting effects on hybrid greenhouse quality named "Soltan". They examined the grafted Fruit on five rootstocks including fig leaf squash, marrow, serpent gourd, native Dastgerdi and cantaloupe along with two check treatments of Soltan cucumber and hybrid cucumber named RZ 2279, in which grafted Soltan cucumber had a superior quality in respect to fruit tissue fragility, and the other traits were mediem and were generally accepted on a fig leaf squash rootstock. Bekhradi and his colleague in their study, on the effects of various squash rootstocks on Charleston grey's watermelon performance and growth and its effect on rottening disease, found out that grafting and using different rootstocks were effective mostly on growth traits and had no significant effect on fruit quality. The highest yield was on watermelon performance on Ferro root

Hybrid pumpkin and large gourd, and the least performance was related to marrow in 2005. Moradipoor and Colleagues in 2006 evaluated the effects of different squash rootstocks on the period of seedling durability and some growing traits of two varieties of greenhouse cucumbers entitled Roberto and Danito, grafted on squash rootstocks by besicle method.

In a comparison, the rootstocks used, had higher percentage of durability in Shintoza grafted rootstock (hybrid pumpkin and large gourd was more than gourd bottle gourd rootstock (lagenaria siceraria). Ahrar and Colleagues in 2009 have reported the possibility of water absorption and nutrients by grafting greenhouse cucumber on marrow in hydroponic cultivation system.

Therefore, in respect to the offered research findings it can be said that the aim to use grafting method in vegetables like greenhouse cucumber was mainly higher yield and deprive Soil stress especially fungi diseases such as Fusarium, Pythium and a like. The important point in using and applying grafting is the applicability of proper rootstocks to get the best result due to get to a specific purpose for each product. In respect to genetic excess and availability of some native squash and muskmelon, these genetic resources can be used to identify the proper rootstocks along with other received resources from companies and international centers. So this research has been done to show various applications effects of native and exotic squash rootstock in grafting two varieties of greenhouse cucumber to introduce and release superior rootstocks.

II. Materials & Methods

This research was carried out in semi-controlled Plastic covered greenhouse in vegetable research Unit related to SPII in 5 km, Mohammadshahr, Karaj in 2013 and 2014. All research precedures were done in controlled greenhouse on 25 degree C° and with a mean moisture of 75 percent. The soil in this greenhouse is contaminated to fungi especially different races of Fusarium. The first step in implementing this research has focused on collecting rootstocks seeds and scions varieties from domestic companies and some squash plantation areas in Ardabil Province, To plant the rootstocks and scions varieties, plastic pots were used respectively in two big size (30 × 30 cm) and small size (10 × 10 cm). In this research two factors were examined. The scion variety in two levels included "Soltan" and "Extreme" varieties. The second factor included squash rootstock in eleven levels of which these rootstocks were local domestic squash and the squash related to private sectors company. The rootstocks varieties include; TIAN No.2, TIAN No.1, Ardabil skinless squash, Ardabil cucurbit, Moghan cucurbit, Behta 1, Variety 2 Beh 2, Hybrid squash variety ES 113, ES 152, ES 30900.

In this research vincinity close grafting method way applied. In this research factorial experiment was carried out randomly.

Planting rootstocks seeds were planted 10 days earlier than scions varieties seeds. All the rootstocks were planted in the first 10 days of (Aban): November. Two seeds were planted in each pot. The scions seed varieties planting were done respectinely in the first year and second year in (21/8/1391 and 22/8/1392) (10/11/2012-2013) [Iranian solar years].

Rootstock and Scions seeds germination began right 10 days after planting and plants were ready to be grafted after a month, Grafting operations were carried out on 18 and 19 of Azar (on December 8 and 9 th) in 2003.

The used rootstock, included a 10 centimeter stem with at least one leaf. in approach grafting in the middle of rootstock and scion scraching was done and Two parts were attached and grafted area was tied by a

proper cellophane. Grafting operation was done at the prime of the day. Post grafting control and supervisions included proper irrigation of the grafted plants, temperature control on 22C˚ and avaroge moisture of 75%. The grafted spot anastomosis (pustule) lasted for Two weeks. Due to the shortness of the day, greenhouse lights were on at least four hours in a day. The trial greenhouse floor way irrigated to adjust and balance the moisture content astomosis part, was transplanted and planted in greenhouse soil and these plants were planted based on Trial planting plan in 2012 and 2013. The roots were transplanted to greenhouse by the earlier soil of the pot to prevent any damage to the root.

Irrigation operation was done by installing and applying. To nutrition, complete fertilizers sprayings, were carried out in a Ten days period and 30 days period after the transplant.

The plant spraying was done by the use of Metasistox Poison (Toxin) with the concentration of 2 in every 1000 to control and manage white fly.

Meanwhile, the cucumber plants were fixed by thread (string) after the growth increase and stability, and were checked regularly.

The plant growth traits were recorderd at the prime or harvested Jan 20: (Bahman) and fruit harvest was after the first 10 days of Feb, once in every 10 days and all together, havesting was done in four cuttings. In this research, the following traits were recorded.

2.1: Jointing Percentage:In respect to the number of in pot plants fully were recorded in percentage.

2.2: Plant height: 25 days after the grafted transplant.

2.3: Plant height: 25 days after the plants were grafted and transplanted, the traits were recorded by the use of cloth measuring tape.

2.4: Stem diameter: This trait was done by measuring stem diameter which was about 20 centimeter above the soil by the use of slide-callipers in millimeter.

2.5: The numbers of nodes in plant: This trait was measured by counting, the numbers of nodes in plant along with other growth traits.

2.6: Fruit number in each plant:The number of fruit was counted in each cutting and the Total amount in four cuttings were reported.

2.7: Fruit weight:The harvested plants were weighed after each cutting and the Total weight for the four cuttings were recorded.

2.8: Fruit DM Percentage: In the lase cutting from each fruit, a fruit was randomly chosen and 50 grams of its fresh fruit (material) was transferred to oven by the temperature of 70C˚ for 48 hours, after being crushed. It was weighed again after the mentioned period, the percentage of dried matter portion was calculated in treatments.

The research statistical analysis was done by SAS software. A comparison of the mean examined traits was carried out by Dun can 5% by the same software.

III. Results And Discussion

The results of the traits variance analysis and mean comparison are offered in Tables 1, 2-3-4. In this research, there is a significant difference in a 1 percent level in all the traits, among the trail rootstocks, scions varieties, and rootstock and scions reactions. (Table 1) In respect to the execution of this research in controlled research greenhouse in a period of Two years it can be concluded that this project was carried out in two experiments and the issue of year wasn't a significant and meaningful difference in variance analysis of the Table.

The results of mean traits comparison in 11 root stocks studied in Table 2 showed that:

The Plant height in rootstock number 5 (Ardabil Skinless cucurbit was 113.58 centimeter which had the highest rank (A) and Moghan cucurbit root stocks, Beh 1 and ES 30900, in respect to this trait, was at the lowest rank (e). The Tallest and lowest stem diameter in root stocks (TIAN No.1) was 8.52 millimeters and ES 30900 was 3.13 millimeters.

The numbers of the nodes in each plant were the same as stem diameter and the maximum mean of this trait to root stocks TIAN 1 No.1 and TIAN No.2) were in A rank and it's least was related to root stock 11 (ES 30900) was in grade E.

In regard to the number of fruit in Ardabil skinless cucurbit with having 12.16 Fruits hold the top rank and the minimum fruit number was credited to the root stock 11 (ES 30900) having 1.95 fruit and ranked J.

In regard to fruit weight trait for squash plant ES 113 (Rootstock 9) with 2191.6 milligram was the top grade "a" and the variant 11 (ES 30900) with 170.83 grams and "i" rank had the minimum mean.

The percentage of fruit dried ingredient (matter) for rootstock 8 (Beh 2 varient) with 7.40% had the superior rank "a" and the minimum rank was credited to rootstock No.3; (Tian No.3) having rank "h" the jointing percentage for rootstock No.4 (Tian No.4) having 90.75% had the highest rank (a) and root 11 (ES 30900) having the mean of 41.75% had the lowest rank (i).

To sum up, it seems that in respect to fruit traits and rootstocks jointing 4 (Tian No.4) Ardabil 5 skinless cucurbits and (ES 113) were the best.

The result of comparing average traits for scions variant (greenhouse cucumber variants) in Table 3 shows that "Extreme" variant was superior (a) in most traits. Compared with "Soltan", but in respect to fruit dried ingredients and jointing, Soltan was superior (a). it was expected to be superior in respect to the newness of "Exterem" which was also called "Super Soltan".

In Table 4: The result of comparing trial trait average in the reaction of rootstock to scions is offered and portays that:

Plant height in combination of Exterem Ardabil cucurbit having 136.91 centimeters had the highest rank and the least rank (h) was for ES 30900 Soltan, ES 30900 having 36.58 and 35.83 centimeters.

Stem diameter in combination of (interaction with) of Tian No.1 Soltan , Tian No.1 Extreme, Tian No 2 Exterem, had the highest rank (a), these traits in combination Exterem having 3.11 millimeter was in the lowest rank (k).

The node numbers in plant just like stem diameter in combination of Tian No.1 Soltan, Tian No.1 Exterem, Tian No.2 Exterem had the highest rank and with the combination of ES 30900 Soltan, ES 30900 Exterem with having I rank were in minimum rank with J nodes.

In regard with the number of fruit in each plant Exterem combination (interaction) and Ardabil cucurbit with having 12.58 fruit placed in rank "a" but the combination of (interaction with) Moghan Soltan cucurbit, Moghan Exterem cucurbit ES 30900 Soltan and ES 30900 Exterem placed in the least rank of "k" in this trait.

Fruit weight in plant in the interaction with ES 113 Soltan having 2533 grams which had the highest rank but this trait in the interaction with ES 30900 having 156.67 grams showed the lowest rank (l).

Root stock & especially in scions variant Exterem was the best in respect to fruit dried matter having 7.54% in rank "A" in combination (interaction) with TIAN No.3 Soltan, this in the lowest rank was "h" having 6.86%.

In regard with jointing interaction TIAN No.4 Soltan, TIAN No.4 Exterem, ES 113 Soltan were higher in rank "a" and the least trait was in the interaction of Exterem, Moghan cucurbit having 35.58% with the least rank of "f".

Once again, in this research the necessity and superiorty of using grafting method on greenhouse cucumber is proven and due to the fungi contamination of greenhouse soil to Fusarum fungi the ideas of Ahrar et al., 2009 were approved, which meant using grafting with superior rootstocks such as Ardabil skinless cucurbit and ES 113 could have a superior application while being tolerant to soil contamination.

As mentioned in the earlier history of this research, rootstocks are in fluential in the growth and production of cucumber. In this research, some rootstocks such as (Tian No.1) and (Tian No.2) had higher vegetative growth and were superior in respect to plant height traits and stem diameter. But couldn't be superior in fruit production and fruit weight.

Variations like Ardabil skinless cucurbit or hybrid cucurbit ES 113 showed it's superiority with having enough proper leaves and branches.

Therefore, it can be concluded that the effects of the kind of rootstock plays an important part in grafting Soltan greenhouse cucumber. As Farhadi and Nematollahi 2005 had reported Soltan variety of fig shaped leaf rootstock as the best one, and Salehi Mohammadi in 2002 had reported the marrow rootstock as the best one.

In a research done by Masiha, et al., 1997 reported that fig shaped leaf cucurbit was the most suitable rootstock for greenhouse cucumber especially to overcome the coldness of the soil in greenhouse. Basically, there was a significant difference among the scions in respect to jointing and fruit production (The number and weight of the fruit in each plant) in which Soltan variety had the most jointing but the most advanced and newer variety of "Exterem or Super Soltan" had a higher fruit performance as expected.

Table 1: Results of traits combined analysis variance

jointing	fruit DM	fruit weight/plant	fruit No/plant	node No/plant	stem diameter	plant height	df	{tc "Type III Model ANOVA " \f C \l 4}SOV
13.63636	0.61094697	154.56	0.060606	0.094697	0.1012458	39.4091	1	yr
0.95455	0.00003788	417.56	0.094697	1.257576	0.1275038	1322.0189	4	rp (yr)
7699.62348**	0.54928030**	9461531.42**	289.695455**	154.560606**	53.6917842**	16307.2689**	10	RootStocK
2.07803	0.00078030	8109.56**	0.110606	0.119697	0.0321517	40.1674	10	yr*RS
210.96970**	0.93367424**	7151.05**	2.560606**	59.185606**	55.7612458**	16896.0000**	1	Scion
2.56061	0.00094697	4272.14	0.060606	0.003788	0.0585034	99.4091	1	yr*Scion
663.99470**	0.06750758	794060.98**	18.277273**	21.210606**	15.0257717**	3123.2750**	10	RS*Sc
2.58561	0.00028030	3344.47	0.077273	0.045455	0.0269076	20.1341**	10	yr*RS*Sc
1.2530	0.00096811	341.7	0.067565	1.645173	0.1819925	348.1120	82	Error
1.8	0.43	1.7	3.6	18.1	8.2	14.7		cv (%)

* and ** respectively significantly difference at %5 and %1 levels

Table 2: Results of traits mean comparisons in studing rootstocks (Duncan 5%)

rootstocks	plant height (cm)	stem diameter (mm)	node No/plant	fruit No/plant	fruit weight/plant (g)	fruit DM (%)	Jointing (%)
TIAN No.1	99.87 b	8.52 a	10.87 a	11.04 c	1542.91 c	7.00 f	75.20 c
TIAN No.2	98.45 b	6.41 b	10.25 a	7.25 e	1073.33 e	7.02 e	70.00 d
TIAN No.3	72.45 cd	5.23 d	8.75 b	7.25 e	1235.41 d	6.91 h	60.20 e
TIAN No.4	90.33 b	4.62 f	6.91 c	7.50 d	1075.00 e	7.17 c	90.75 a
Ardabil skinless squash	113.58 a	5.94 c	9.04 b	12.16 a	1889.58 b	7.21 b	58.08 f
Moghan Boorani squash	43.75 e	5.75 c	4.50 d	2.45 i	339.08 h	6.95 g	40.37 j
Beh.1	43.20 e	4.53 f	4.66 d	3.75 h	435.00 g	7.20 b	47.95 g
Beh.2	75.83 c	4.88 e	7.04 c	6.91 f	977.25 f	7.40 a	47.79 g
ES113	91.54 b	3.63 h	7.50 c	11.37 b	2191.66 a	6.95 g	86.41 b
ES 152	63.58 d	4.00 g	5.08 d	5.75 g	977.50 f	6.95 g	45.20 h
ES 30900	36.20 e	3.13 i	3.00 e	1.95 j	170.83 i	7.10 d	41.75 i

Means followed by similar letters in each column are not significantly different at %5 level

Table 3: Results of traits mean comparisons in studing scions (Duncan 5%)

Scion	plant height (cm)	stem diameter (mm)	node No/plant	fruit No/plant	fruit weight/plant (g)	fruit DM (%)	Jointing (%)
Soltan	67.34 b	4.69 b	6.58 b	6.93 b	1077.30 b	7.14 a	61.23 a
Exterem	83.34 a	5.61 a	7.53 a	7.13 a	1087.71 a	7.02 b	59.44 b

Means followed by similar letters in each column are not significantly different at %5 level

Table 4: Results of traits mean comparisons in reciprocal effects of factors (Duncan 5%)

RS * Scion	plant height (cm)	stem diameter (mm)	node No/plant	fruit No/plant	fruit weight/plant (g)	fruit DM (%)	Jointing (%)
TIAN No.1*Soltan	94.33 c	8.48 a	10.83 a	11.66 b	1694.17 d	6.90 gh	70.75 c
TIAN No.1*Exterem	105.41 bc	8.56 a	10.91 a	10.41 c	1391.67 e	7.09 ef	79.67 b
TIAN No.2*Soltan	92.50 cd	4.08 ghi	9.50 bc	7.50 e	1150.00 fg	6.95 g	69.83 c
TIAN No.2*Exterem	104.41 bc	8.74 a	11.00 a	7.00 ef	996.67 gh	7.10 ef	70.17 c
TIAN No.3*Soltan	69.83 ef	4.89 defg	9.00 cd	7.50 e	1270.83 ef	6.86 h	70.00 c
TIAN No.3*Exterem	75.08 de	5.57 cd	8.50 cde	7.00 ef	1200.00 f	6.96 g	50.42 d
TIAN No.4*Soltan	90.00 cd	4.53 fghi	6.33 fg	6.50 fg	950.00 h	7.05 f	92.00 a
TIAN No.4*Exterem	90.66 cd	4.71 efgh	7.50 ef	8.50 d	1200.00 f	7.30 cd	89.50 a
Soltan *Ardabil skinless squash	90.25 cd	4.94 def	7.75 de	11.75 b	1608. 33 d	7.05 f	51.17 d
Exterem * Ardabil skinless squash	136.91 a	6.94 b	10.33 ab	12.58 a	2170.83 b	7.38 b	65.00 c
Soltan Moghan* Boorani squash	38.00 h	6.05 c	4.00 hi	2.33 k	329.17 jk	6.95 g	45.17 de
Exterem Moghan *Boorani squash	49.50 gh	5.45 cde	6.16 h	2.58 k	349.00 j	6.95 g	35.58 f
Soltan* Beh.1	43.17 gh	4.67 efgh	4.83 h	3.50 j	450.00 j	7.15 e	50.92 d
Exterem* Beh.1	43.25 gh	4.39 fghi	4.50 h	4.00 j	420.00 j	7.25 d	45.00 de
Soltan *Beh.2	48.33 gh	3.94 hi	4.58 h	4.91 i	679.50 i	7.35 bc	45.33 de
Exterem * Beh.2	103.33 bc	5.82 c	9.50 bc	8.92 d	1275.00 ef	7.45 a	50.25 d
ES113* Soltan	67.92 ef	3.87 ij	6.41 fg	12.75 a	2533.33 a	6.95 g	94.83 a
ES113* Exterem	115.17 b	4.63 efgh	8.58 cde	10.00 c	1850.00 c	6.95 g	78.00 b
ES152* Soltan	69.92 ef	4.22 fghi	6.16 g	6.00 gh	1000.00 gh	6.95 g	45.25 de
ES152* Exterem	57.25fg	3.78 ij	4.00 hi	5.50 hi	955.00 h	6.95 g	45.17 de
ES 30900* Soltan	36.58 h	3.15 jk	3.00 i	1.92 k	185.00 kl	7.05 f	38.33 e
ES 30900* Exterem	37.10 h	3.11 k	3.00 i	2.00 k	156.67 l	7.15 e	45.17 de

Means followed by similar letters in each column are not significantly different at %5 level

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