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TECHNOLOGIES OF GRAFTING IN VEGETABLE CROPS (REVIEW)

Kamal Benyamin Esho(1) Esraa Abd. Al- huseein Jasim(2)

Horticulture and Landscape Design, College of Agriculture and Forestry University of Mosul

ABSTRACT

Through this information, it became clear that grafting is the installation of a variety of vegetable crops desirable for its characteristics on another variety rootstock (root origin), from the same plant family (in order to make a good fit between them), with characteristics that are more resistant and capable of facing environmental conditions, life and germination. Seedlings on the origins by eliminating pathological and insect pests such as fusarium and bacterial wilt and nematodes that are endemic to the soil, thus reducing production costs, and vaccination technology in vegetables by producing a healthy and good crop as well as a type that has no negative impact on the environment and human health, and generates good profit for producers and Mahs manufacturers Yell vegetables. And it has a great role in supplying foreign exchange to the country. And through this technology, it is possible to provide good assets for grafted seedlings from the nightshade (Solanaceae) family and pumpkin plants (Cucurbitaceae).

Introduction

The countries of the world differ among themselves in the extent of their needs for grafted seedlings according to the agricultural area available in these countries, with the increase in the intensity of agricultural crops production, especially vegetables, and the urgent need to increase the productivity of its unit area, as a result of the increase in demand for it due to the large increase in the population, so the sterilization process Agricultural soils are necessary before planting in order to get rid of endemic diseases in them in general. Many solutions have been used to eliminate these inhabitants, including the use of some chemical compounds such as methyl bromide gas, appropriate agricultural rotations, genetic modification of crops, thermal sterilization...etc. However, the great negative effects of these solutions on human health and the environment have prompted a trend to search for new alternatives to sterilize agricultural soils. Thus, many developed countries are moving in steady steps to reduce the residual impact of these pesticides that affect public health and human beings by specifying the number of days after treatment with pesticides on crops (crops) to avoid negative health effects. Annually, many pesticides and compounds that have a long-lasting effect on fruits, leaves or soil are excluded, and all these measures aim first at producing vegetable crops that do not have negative effects when consumed. Intensive agriculture results in many problems, the most important of which is the spread of pathogens in the soil that affect the quantity and quality of production (Kacjan and Osvald, 2004 and Besri, 2008).

Among these alternatives is the technology of grafting in vegetable crops, which contributed to increasing productivity within a unit area and continuing production processes under different conditions, including weather, nature of soil and soil diseases. Therefore, vaccination has an effective and active role in this area, and through it, many of these problems can be overcome. Grafting is an ancient technique that has been used in fruit trees for hundreds of years, and this is very similar to what happens in vegetable crops . Grafting means the composition of a variety of vegetable crops that are desirable for its characteristics on another variety (rootstock), of the same plant family (in order to reconcile them well), with more resistant qualities and the ability to cope with environmental, biological and germination conditions, so we get a new plant with a root system. Strong capable of transferring nutrients from the soil to the shoot system with high efficiency while bearing the problems of stress in the soil and its satisfactory revival, thus improving the productivity of the shoot, as well as the quality and goodness of fruits and the healthy appearance of the shoot. The rootstock used is a hybrid root obtained from several parents, which are often wild stock. Resistance inherent in origin and its ability to increase and absorb nutrients from the soil and provide them with flavor is one of the most important technologies that help grafted plants resist soil diseases (Guan et al., 2012).

The interest in the grafting process in vegetable crops in the world began to the year 1920 in both Korea and Japan, and interest in the technology of grafting in vegetable crops increased in 1927 when watermelon was grafted onto some varieties of the Gourd vegetable group in mainly East Asian countries (Ashita, 1927).And in some European countries with limited areas due to the lack of the possibility of following agricultural rotations, which in turn causes the concentration of many soil diseases that affect the root system of vegetable crops, unlike what is found in countries with large agricultural areas such as the United States of America, which follow a cycle system. Therefore, the method of producing vegetables with grafting technology is not widespread. It has been found that more than 92% of watermelon and melon production in Japan and Korea are grafted before seedlings, and the total grafted seedlings in Korea are about 540 million seedlings, and Japan with about 750 million seedlings (Oda, 1999).

When looking at the importance of vaccination in East Asia, such as Japan and Korea, we find that the areas that are grown with vegetables, which are planted with grafted plants, have increased in recent periods, reaching 35.1 thousand hectares in Japan for cultivation in open fields and 15.7 thousand hectares in greenhouses cultivated with crops Various vegetables, and this technology has spread in many countries of the world, including the countries of the Mediterranean basin, and Japan relies heavily on vaccination in the production of vegetables, vaccination technology is considered one of the most effective ways to combat root diseases in addition to other benefits in increasing productivity, increasing farmers' income and reducing the need. To use chemical compounds for sterilization, which are of high cost (Al-Arousi and others, 1996).

This technology is of great importance in controlling soil pathogens, and as a result, it increases the efficiency of plants in absorbing water and nutrients, improving the quantity and quality of the crop, and also extending the production season (Oda, 2002, Hang et al., 2005). Most of the continuous agricultural losses in the production of vegetable crops in greenhouses are due to soil diseases and nematodes. As an anti-measure against such damages such as fusarium wilt and bacterial wilt, seedlings are grafted into different types and varieties of origins (Bakr, 2008). This technology has evolved into equipping large fields with grafted seedlings and for various crops (Kubota et al., 2008).

There is a great need to increase the area of cultivation with vegetable crops and also to increase the productivity per unit area in order to supplement the local market with the vegetable yield for

Vol. 5, No. 05; 2020

ISSN: 2456-3676

human consumption, thus the need arises to get rid of the diseases (bacterial, fungal, and nematodes) that are endemic in the soil and that cause a lack of production and the death of plants. One of the most important global common methods for eliminating these endemic diseases is the use of methods of sterilizing the soil with chemical compounds, including methyl bromide, but then it was found that these compounds have significant negative effects on human health and the environment, thus prompting researchers to study new alternatives to soil sterilization, including sterilization based on Sun heat (solar sterilization), heat sterilization, evaporation, and use of resistant varieties (Edelstein and Ben-Hur, 2006 and Ellis et al., 2008).

Grafting technology is a quick way to take advantage of disease-resistant genotypes resulting from plant breeding programs while minimizing the use of chemicals and using high-yielding varieties sensitive to soil diseases to contribute to integrated disease management programs and help achieve alternative cultivation (Leonardi and Romano, 2004, Mudge et al., 2009).

Uysal et al. (2010) indicate that grafting improves plant growth and production depending on the inherent genotype used. Sawalha (2012) also found that the production of a dunum of uplifting in Palestine in the Sanur Plain was 2.7 tons for uplifting grafted on the origin of pumpkins and 2.4 tons for uplifting grafted on the origin of gourds. Grafting also had a significant effect in reducing the number of damaged fruits and dead plants due to soil fungi compared to the control.

Ibrahim et al. (2016) indicated that the grafting of cucumber hybrids (Emir F1) on five origins of RS 841 F1, large honey squash, musk squash, pumpkin, and fiber in addition to unvaccinated plants (comparison) for Fusarium wilt disease. The results showed poor plant growth. The treatment of vaccination on the pumpkin was significant compared to the rest of the treatments. No significant differences were found between the comparison treatment and the vaccination treatments on pumpkin origins in growth traits.

Table (1) The aim of vaccinating seedlings of vegetable crops.

Type of plant	**Goal of grafting**
Watermelon	Resistance to fourosy wilt, and drought resistance
Cucumber	Fusarium Wilt Resistance, and Wilt Resistance (Phytophthora melonis)
Muskmelon	Resistance to fusarium wilt and Phytophthora melonis diseases.
Tomato	resistance to bacterial wilt, nematodes, and disease resistance (Fusarium oxysporum, Pyrenochacta lycopersici, and Verticillum dahliae)
Eggplant	resistance to bacterial wilt, nematodes, and disease resistance (Fusarium oxyporum and Verticillium albo-atrum)

The aims of vegetable grafting

1)Resistance to soil diseases, especially with fusarium in the family Cucurbitaceae.

2) Fig-leaf gourd Use the pumpkin plant or any other cucurbit family plant.

3) Increased tensile strength of plants due to changes in the environment, such as temperature and humidity.

4) Increasing the plants' tolerance to salt stress.

5) Top / Root ratio: Adjustment of the ratio of shoots to roots.

Vol. 5, No. 05; 2020

ISSN: 2456-3676

6) Increase the period of germination of the plant.
7) Reducing the need to sterilize the soil with methyl bromide.
8) Saving the production requirements of irrigation water and used fertilizers.
9) Ease of inclusion in integrated pest management programs.
10) Increase the productivity of varieties and improve the quality of fruits, especially stunted vegetables.

As it found from the strength of the assets used in the grafted seedlings, the post-harvest characteristics are improved through grafting, i.e. the effect of the origin on the taste, but the common mistake is that grafting affects the taste of the crop, which has not been proven by evidence and research that vaccination causes a change in the taste of the crop except in cases of harvest In a stage not suitable for actual ripening of fruiting vegetables. And scientific experiments have shown an increase in the yield of grafted plants by about 20% over the regular seedlings not grafted in virgin lands by about 60-70% over the normal seedlings grown in the old infested lands.

11) Reduction in production expenses.
12) Reducing the number of seedlings per unit area.

Where it was found that in the watermelon plant, the number of seedlings per acre decreased from 2,200 seedlings (regular, un-grafted seedlings) to 900 - 1100 seedlings per acre when planting with grafted seedlings.

13) Resistance to cold soil conditions or high soil temperature during winter and summer.

Common problems of grafting technology in vegetable crops.

1) Choose the appropriate assets in order to vaccinate them.
2) The method of conducting the vaccination.
3) The availability of technical manpower with experience in vaccination technology.
4) The right time for vaccination.
5) The high financial cost of seed assets used in vaccination.
6) Agricultural service operations (follow-up) after the vaccination procedure.
7) The bad effects of the assets on the quality and the quality of the taste fruits.
8) There are two types of incompatibility between taste and original

A) Mechanical rejection, due to the failure to complete the fusion process well, completely or relatively, that is, the phenomenon of swelling in the vaccination area.

B) Physiological rejection, which is that both the taste and the origin secrete substances that may affect the natural growth of each on the other side, which affects the success of the vaccination process or the effect on showing the bad characteristics of the taste (spoiling the taste characteristics).

9) The parent's intolerance to the temperatures prevailing in the region.
10) The root does not tolerate soil pH, soil salinity, or soil moisture.

Vol. 5, No. 05; 2020

ISSN: 2456-3676

The plant family used in grafting
1) Cucurbit family (watermelon, cucumber, and cantaloupe)
2) The nightshade family (tomato, pepper, eggplant)
Rootstocks using in grafting
The success rate of the vaccination process varies according to several factors, including
First: The extent of plant kinship and genetic variances between both origin and taste, so when choosing the origin and taste, the following things must be taken into account
* Origin is a botanical strain.
* The origin is within the same plant species.
* The origin is within the same gender.
* The origin falls within the same plant family.
* The origin belongs to another botanical family (the vaccination is between the plant families).

Table (2) shows the assets used in these two families.

Scion	Rootstock
Watermelon	*Lagenaria sicenaria*
Cucumber	Cucurbita spp.
Melon for greenhouse	*Cucumis melo*
Melon for open field	*Cucurbita moschata* , *Cucurbita maxima*
Cantaloupe	hybride or cantaloupe variety with best production traits *C. maxima x C. moschata* *C. ficifolia* *L. siceraria*
Tomato	*Lycopersicon esculentum*
Eggplant	*Solanum melongena*

Second: Environmental conditions: These include temperature, day and night, and relative humidity.
Third: The personal impact: it is due to the experience of the person in charge of the work and the extent of mastery of that process.
Fourth: The transfer of certain substances between the origin and the graft during the vaccination area.
Fifthly: pathological infections, such as fungal diseases, viruses, and mycoplasma, as many studies, indicated that mycoplasma moves to the healthy part of the affected part.

Table (3) The most important types, the origins of vegetable crops in Japan

Scion	**Rootstock**	
	Species	**Major Variety in Japan**
Watermelon	***Lagenaria***	**Oon k., Kachidoki No.2, Aioi, FR10, FR-choju**
	Cucurbita spp.	**No.8**
	Benincasa hispida	**Best**
Cucumber	***Cucurbita spp.***	**Hikari- power, Super-unryu, Kitora, Strong-lkki**
	Cucurbita ficifolia	**Kurodane**
Greenhouse melons	***Cucumis melo***	**Oi, Enken No.2, Berner Hill, Favourite**
	Benincas hispida	**Lion**
	Cucurbita spp.	**Uhryn**
	C. maxima x C. moschata	**Shintosa**
Melon grown in open field	***Cucurbita spp.***	**Kongo**
	C. maxima x C. moschata	**Shintosa**
	Cucumis melo	**Enken No.2, Kenkyaku**
Tomato	***Lycopersicon esculentum***	**Mate, Hawali 7998, Joint, BF Okitsu No.101, Helper M, Pfnt No. 2, Sukuramti No. 2, Ancher T.**
Eggplant	***Solanum torvum***	**Torvum vigor**
	Solanum integrifolium	**Hiranasu**
	Solanum melongena	**Taibyo VF, Meet, Karehen, Assist**

From (Bakir, 2008)

Necessary tools for vaccination

1) A scalpel or a suitable chopping blade.
2) The presence of strong and healthy seedlings of the desired plant, so that each seedling contains one leaf with a length of 6-7 cm as a minimum.
3) Tweezers retarding.
4) Empty seedlings trays.
5) Providing a medium for producing seedlings with a mixture of soil and peat moss in order to facilitate the removal of seedlings without damaging the root system,
6) Availability of greenhouses and shaded houses because air currents are one of the reasons for vaccination failure.

ISSN: 2456-3676

Grafted Method in Vegetable Crops

First: tube grafting

This method is used for grafting young seedlings that grow in seedling trays. This type of grafting is very popular among vegetable producers in Japan, because young seedlings are more suitable and matched in seams or acclimatization chambers. Origin seeds are sown with a period of 5-7 days after sowing seeds of the bait.

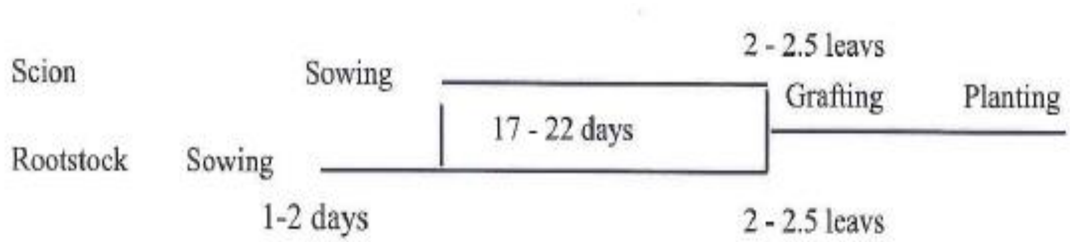

Figure (1) Schedule of tube grafting in tomato

Second: Cleft grafting

It is mainly used in tomato and eggplant grafting, where the bait stalk is cut at the fair-leaf stage and the origin at the four to five –leaf stage from right angles with 2-3 leaves remaining on the stem. Where the sharpened stalk of the bait (tapered tip) enters the corresponding cut incision at the end of the original, and the bait is then fixed with plastic tweezers.

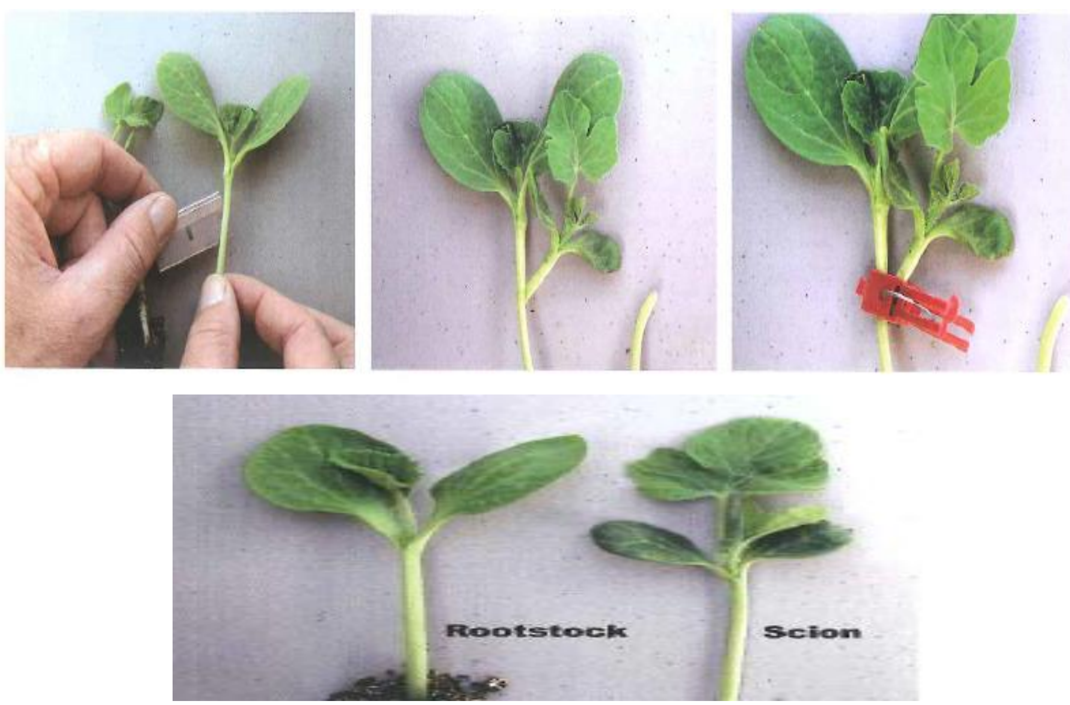

Figure (2) Grafting with the traditional incision

Vol. 5, No. 05; 2020

ISSN: 2456-3676

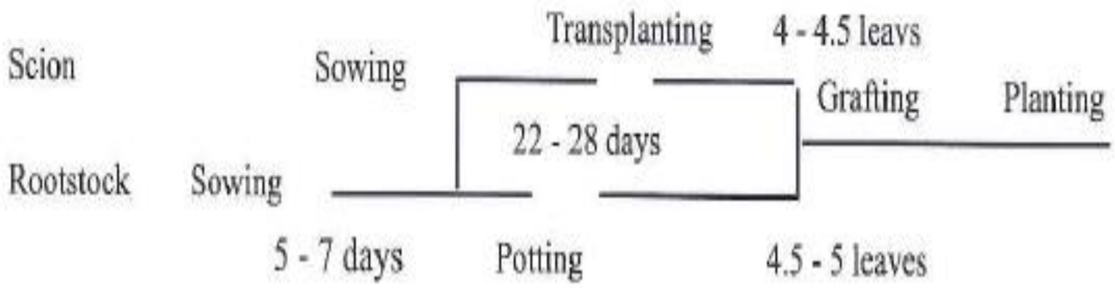

Figure (3) The schedule of vaccination of tomatoes with the traditional slit.

Third: Tongue approach grafting (Clift grafting).
This method is used for grafting cucumber seedlings, where the seeds of the cucumber plant are planted 10-13 days before vaccination, and pumpkin plants are planted 7-10 days before the vaccination also in order to ensure the similarity of Hypocotyls. It is used in the grafting of melon plants.

Figure (4) Grafting by converging the tongue

ISSN: 2456-3676

Fourth: Slant –cut grafting

This method is very common, and can be easily done by grafting vegetable seedlings, but it is important to remove the first leaf and side shoots when cutting the rootstocks in an oblique fashion. This type is used in upgrading.

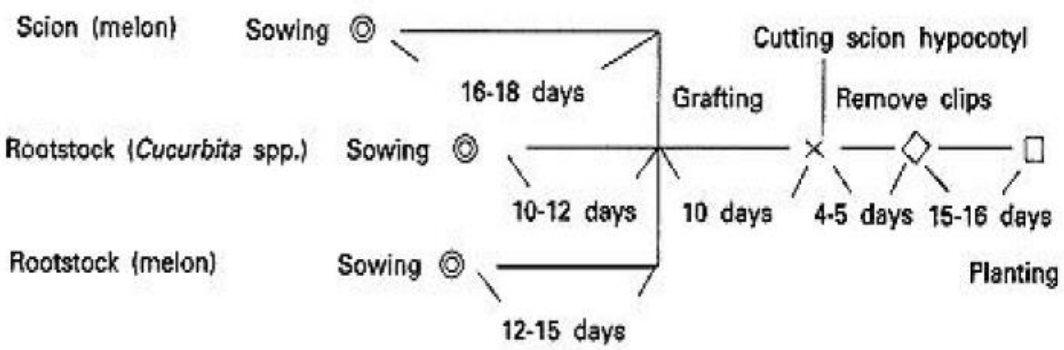

Figure (5) The schedule of vaccination in cucurbits

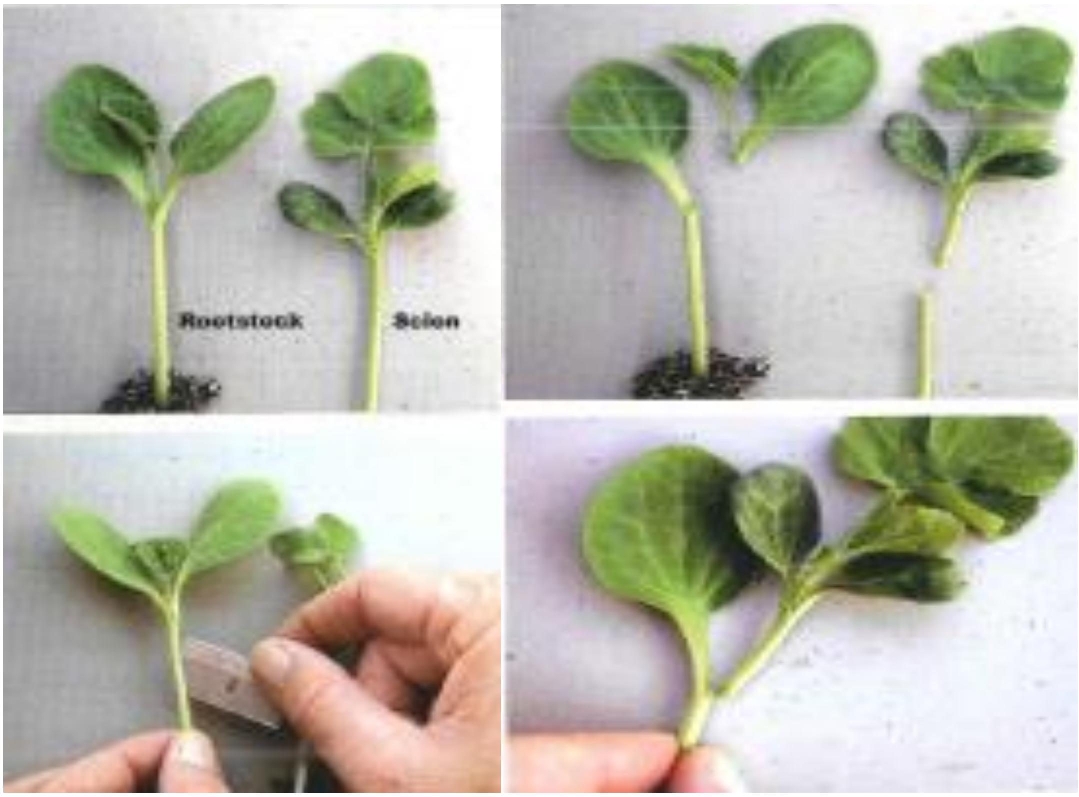

Figure (6) Grafting by oblique cutting

Vol. 5, No. 05; 2020

ISSN: 2456-3676

Fifth: Robotic grafting

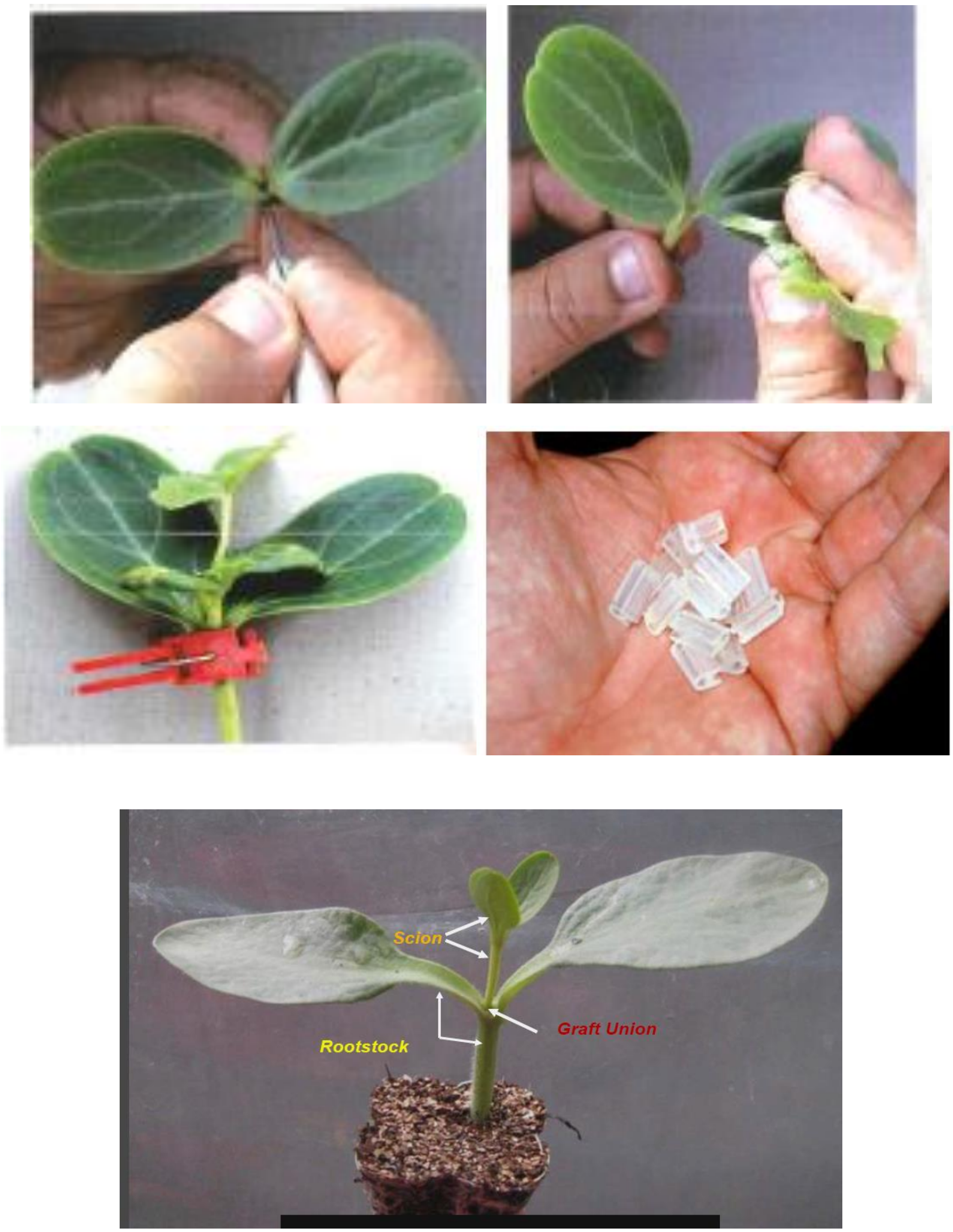

Figure (7) Grafting by cutting technology and the silicone tubes used in grafting

Figure (8) Root stock of cucurbita and sclon

Table (4) the methods of vaccination and the origins used in vegetable crops

Scion plant	Rootstock	Methods
Eggplant	***Solanum tonum, S. sissymbrifolium , Solanum khasionum***	**Tongue and cleft method**
Tomato	***Lycopersicon pinpinellifolium , S. nignum***	**Only cleft method Tongue and cleft methods**
Cucumber	***C. Moschata , Cucurbita maxima***	**Hole insertion and tongue method**
Watermelon	***Benincasa hispida , C. Moschata , C. melo , C. moschat x C.maxima , lagenaria sicerana***	**Hole insertion and cleft method, Splice grafting**
Bitter gourd	***C.maxima , lagenaria sicerana***	**Hole insertion and tongue method**

Figure (8) Grafting Steps in Cucumber with a Tongue Approach Technology

The effect of vaccination on qualitative and quantitative traits

Grafting is a technique that has an effective effect on fruit quality under optimal growth conditions, soil salinity, and on the root system (Florest et al. 2010). Gebologlu et al. (2011) obtained when growing tomatoes in lower quality soils that the yield was higher for grafted seedlings compared to ungrafted seedlings. When the eggplant was grafted to *Solanum torvum*, the vaccination resulted in an increase in the size of the fruits without affecting the quality of the crop, the percentage of sugars, flavor, color and carotene content.

Abdul-Razzaq and Hanchal (2014) also obtained their study of the sprout response to grafting, where they used two varieties of sprouting, namely Charleston (A) and Crimson (B) and the hybrid Shahd (C), to vaccinate three gourd hybrids, namely ES113 F1 (1), Ulmpic (1). 2), RS841 (3), the treatment, vaccination of Charleston over the original Ulmpic, was significantly higher in increasing the number of fruits and the total yield, while the treatment of vaccination of Charleston on the original RS841 was significantly superior in increasing the percentage of total dissolved solids, and the treatment exceeded the vaccination of Kremson over the original Ulmpic in Ziad. The total yield amounted to 76.6 tons per hectare, while the treatment of vaccination witnessed the original Ulmpic exceeded the remaining treatments in increasing the percentage of total soluble solids to 11.25%. And between both Al-Maliki and Abdullah (2014) in their study when grafting tomatoes by the two methods of naughty and pasting, the results showed the superiority of the pasting method significantly in increasing the success rate of vaccination compared to the method of slit vaccination and the vaccination led to a significant decrease in plant height, the number of leaves per plant and the rate of infection with pathogens Which is transported by soil, total acidity and the percentage of total soluble solids compared to non-grafted plants. The variety Randy is significantly superior to the variety Spirit, and by both methods significantly in the weight of the fruit, the yield of one plant and the ironing yield, as well as the Shannon cultivar germinated over the original Spirit and in both methods significantly in weight Fruit, plant yield, and total yield compared to unvaccinated plants of the same two cultivars.

The effect of grafting on flowering and harvest time.

Flowers are delayed in grafted plants in Pumpkin, Bottle gourd, Wax gourd, and sprigs, especially plants grafted on the original Shintosa (Yamasaki et al. 1994), while Sakata et al. (2007) indicated that grafting in another gourd plant species caused In the early flowers of the female flowering, and the flowering period affects the reaping time, which has a direct effect on the quality of the fruits.

Table (5): Countries that used vaccination in vegetables

Country	Watermelon	Cucumber	Melon	Tomato	Brinjil	Pepper
Israel	70%	----------	5%	15%	5%	-------
Japan	93%	72%	30%	48%	65%	5%
Korea	98%	95%	95%	15%	2%	25%
Greece	100%	5-10%	40-50%	2-3%	------	------
Spain	98%	------	3%	4500 ha.	-----	-----
Morocco	-----	------	-----	75%	-----	-----
Cyprea	80%	-------	------	170 ha.	-----	-----
Italy	30%	------	5-6 million	1200 ha.	------	------
France	------	3%	100 ha.	2800 ha.	------	-----
Netherland	-----	5%	------	50%	-----	-----
Turkey	30%	5%	-----	25%	10%	---

from (Ashok and Sankt, 2017)

Future prospects and solutions for vegetable grafting technology:

1) Determine the information about the origins and the grafts, as there is insufficient information regarding the use of other assets that are compatible with the varieties in open cultivation (open fields). And evaluation of grafted seedlings under different environmental conditions.

2) Autonomous technology (financing), the grafting process in herbaceous plants, including vegetable crops, requires the provision of credit to produce grafted seedlings on a commercial scale.

3) It is possible to start with this technology to produce seedlings grafted into vegetable crops to suit the prevailing environmental conditions in the region in addition to eliminating soil inhabitants from pests and disease epidemics so that they reduce production costs and generate a serious welcome for the product and provide the crop in the local markets in a serious health condition so that it does not affect Human health and the environment.

4) This technology is considered to have good positive effects for the assets used in grafting, so that it has a positive direct effect on the growth of the graft and improvement of the quality of the fruits produced. As the grafting affects the cells of the mesocarp, exocarp. It also has positive, satisfactory effects on fruit ripening and skin coloration. Fruits such as effects on ripeness and color of watermelon fruits, tomatoes and peppers

5) Through this technology, good solutions can be found to develop the vegetable industry and overcome its industrial problems. Research will increase the income of producers and farmers. And reduce the cost of purchasing large quantities of fertilizers or pesticides and pathogens that burden the producer and the farmer.

6) By spreading this technology by producing grafted seedlings, it is environmentally friendly and promotes the production of organic vegetables.

7) It is the responsibility of scientists and researchers to focus on making vaccination robots to increase the efficiency of vaccination and reduce the cost of labor. Especially in developed countries.

8) Researchers in this field should develop a database, software and mobile applications related to the grafted vegetable crops and the assets used.

9) Establishing a genetic bank for the assets that are used for vaccination, and working to multiply them annually.

10) He worked on organizing scientific technical workshops for training farmers and producers of vegetable crops so that they would have practical experience in vaccination technology and how to develop their production fields.

11) Work to establish scientific research stations supported by the public sector or the private sector to develop this technology in Iraq, as it has a major role in developing and improving the quality and quality of fresh and industrialized vegetable crops.

12) Through this technology, foreign exchange can be provided to the country, and grafted seedlings can be exported to neighboring countries, but under the supervision of specialists in this field, the field of production and manufacture of vegetable crops, to eliminate the cracking and forgery of the grafted seedlings.

ISSN: 2456-3676

13) Establishing a law to protect the producers of grafted seedlings, to protect them from traders and brokers who may enter this field and produce unhealthy grafted seedlings and manipulate market prices from the marketing of grafted seedlings.

14) Research centers in universities and technical institutes must conduct extensive scientific studies to develop this technology and find out about its problems and solve them in a scientifically correct manner, relying on the database of the assets, species and areas that are cultivated, whether under an adapted agricultural environment or in open fields.

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