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Grafting Effect of Different Olive Cultivars on “Barnea” Olive (K18) at Al-Karak Area

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Abstract

The experiment was conducted at Al-Rabba Agricultural Research Station (31°27′57.34″N, 35°740′984.0″E), North to Karak city. It was designed to study the impact of time of grafting of different olive cultivars using K18 olive as rootstock for them. Seven olive cultivars were selected (Nabali Baladi, Frontoio, Grosadi, Rassei, Manzanillo, Nasohi and K18). The K18 cultivar was used as the control, at which scion of K18 grafted on the K18 rootstock. Two factors, olive cultivars in addition to two different grafting times, late January and mid-March, were arranged in randomized complete block design replicated three times. Results showed that, different times of grafting significantly affected all parameters studied, except number of leaves. Significant differences were observed among cultivars for all variables studied, except for number of sprouts per grafting. The time of grafting Results showed that maximum sprouting percentage (73.8%), number of sprouts (4.1), shoot length (12.23 cm), shoot diameter (2.56 mm), leaves per shoot (17.05) and minimum days to sprouting (26.6) were recorded in olive trees grafted in mid-March. While trees grafted on late January take higher number of days to sprout (32.7), minimum sprouting percentage (67.7%) and shoot diameter (2.19 mm). The cultivars performance results showed that maximum sprouting percentage (71.8%), shoot length (11.48 cm), leaves per shoot (17.43), lower days to sprouting (28.5) and shoot diameter (2.06 mm) were attained by the cultivar Nabali Baladi, while Rassei showed lower sprouting percentage (62.7%), leaves per shoot (12.80) and maximum days to sprouting (30.1). It was concluded that mid-March is the optimum time for grafting of olive cultivars, specifically Nabali Baladi in this area.

Keyword: olive, wild rootstock, scion, propagation, grafting and timing

1. Introduction

Olea is one of the 30 genera belongs to the family Oleaceae and the most known species of this genera is Olive (*Olea europaea* L.) (Allevato et al., 2019; Daniel et al., 2006). Olive tree is a widespread throughout the world, and it remains the prevailing culture of the Mediterranean region, with about 98% of total world olive production. Olive trees are highly demanded crop for modern agriculture and for its oil. While modern horticulture using new technologies to produce high quality fruits and plants with minimum investment, which enable the growers to produce plants of higher fruit production (Awan et al., 2003). Success of vegetative propagation of fruit trees depends on; the genetic potential, physiological conditions of the mother plants, season of the year, hormonal balance and environmental factors as temperature, light and humidity (Elgimabi, 2009). Grafting can be a suitable method to propagate trees, that are hard to root (Flavio, Liege, & Luiz, 2011). It is a common successful technique used in many woody trees, to assist scion in sharing water and nutrients via roots and easy adaptation to the environment (Hussain et al., 2016).

Trees propagated through grafting conserve the same qualities of the mother plants, which is of important known capacity of the orchard trees (Hussain et al., 2009). Olive has many propagation problems through the other propagation methods as seeds, at which the daughter plants are not true to type, with inferior fruit quality, while propagation with cuttings is 30-50% under much control condition in few cultivars (Darikova et al., 2011). The development of this technique for olive cultivars will allow developing technology for other fruit trees as analyzing the rootstock-scion interaction on the biological characteristics of the resulting plant development, vigor, productivity, fruit quality and oil production. Also, it will help to study the possible characters transfer, and to improve the tolerance of the resulting plant to adverse soil conditions, climate and parasites (Kaniewski et al., 2012).

Olive cultivation is considered one of the most important crops, in the Karak area as compared to the other fruit trees, and considered as one of the most important sources of income for people. It was growing in a wide range of areas, with different cultivars, mainly "Nabali Baladi" and "Nabali Muhsen" (Lavee et al., 2008). In addition to the "Barnea (K18)" cultivar, which is the predominant cultivar in the new irrigated orchards because of its high productivity and its adaptability to mechanical harvesting. It has a high fruiting potential and oil content under irrigated conditions. It is partially tolerant to olive leaf spot and recovers well from initial verticillium infection. Its growth habit is upright and vertical (Kaniewski et al., 2012). This variety can be propagated by root cuttings, or grafted onto seed assets (Lavee et al., 2008). The ripening date for this variety is the end of October, in irrigated area, and mid-November in rainfed agriculture. The seed of this cultivar constitutes 20% of the fruit weight, which is a small percentage as compared to other cultivars, and of about half gram weight, of pointed head shape (Liu et al., 2013).

There are many reasons that lead to alternate bearing of olive fruits production. The direct one is the increase or decrease in the cultivated areas, and the number of trees (fruitful or unfruitful). Also, among the reasons are climate changes, pests spread, and lack of awareness of farmers about agricultural practices. In addition, they take good care of their olive fields. So researchers should be find appropriate solutions to the obstacles and problems facing farmers to develop the olive cultivation sector in Karak Governorate (Loehle & Jones, 1988).

Based on the previous mentioned data, the idea of this project came to introduce the cultivation of a number of olive cultivars to this area. Keeping in mind for future prospects of olive and problems that growers are facing with producing true to type olive cultivars, the present research was initiated to study the impact of time of grafting on different olive cultivars using K18 as a rootstock for them.

2. Materials and Methods

The experiment was conducted at Al-Rabba Agricultural Research Station (31°27′57.34″N, 35°740′984.0″E), North to Karak city, and located at 100 km to the south of Amman, Jordan, during the year 2019 using fourty (40) years old K18 olive trees as the rootstock for all of the cultivars that to be grafted on it, for two grafting times". The experimental design was laid out in a randomized complete block with two factors arranged and replicated three times. Six olive cultivars: Nabali Baladi, Frontoio, Grosadi, Rassei, Manzanillo and Nasohi were used as scions, two different grafting times was done on late-January and mid-March by propagation with cuttings. In addition to the control treatment, by grafting cuttings of K18 cultivar on the same K18 rootstock. Each experimental unit contains 5 trees. All cultural practices were kept constant for all treatments. Monthly average temperature, average relative humidity (%) and rainfall were recorded during the experiment, which is presented in Table 1.

Throughout the experiment, the following parameters were evaluated, on the basis of days to sprouting by counting the days from date of grafting the scions until it starts sprouting, sprouting percentage by measuring number of sprouts per treatment and then percentage was calculated, shoot length, shoot diameter were measured through digital caliper and number of leaves by counting leaves on each shoot and then average was calculated. All the recorded data was statistically analyzed using analysis of variance (ANOVA) and means were compared using LSD test, when the F-values were significant (Marra et al., 2016). The data were analyzed using statistical software MSTATC.

Table 1. The monthly average of temperature (^oC), average relative humidity (%) and rainfall (mm) was recorded throughout the experiment were presented

Climate variables	**Temperature** (^oC)	**Relative Humidity** (%)	**Rainfall** (mm)
January	18	55.2	150
February	19	68.1	50
March	23	70.3	10
April	26	77	5
May	29	82	0

Source: http://www.arabia weather.com

3. Results and Discussion

3.1 Days to Sprouting

Days to sprouting parameter was significantly affected by different time of grafting and cultivars, while there is non-significant interaction of the cultivars with time of grafting. Maximum days to sprouting (32.7) were observed in trees grafted in mid-March, while minimum days to sprouting (26.6) were recorded in late of January as shown in Table 2. So, quick sprouting in mid-March may be due to high humidity and optimum temperature in March (https://www.arabian weather.com). Hussain et al. (2016) found that March is the best time for grafting in monsoon subtropical areas due to high humidity and rainfall that creates optimum conditions for graft success.

In case of different cultivars response, K18 took maximum days to sprouting (32.99), while minimum days were recorded in Nabali Baladi (28.0). The less days to sprouting in Nabali Baladi is due to a physiological response, at which early new wound-repair, that xylem is influenced by the activities of the scion rather than the rootstock. Stoddard and McCully (1980) found that leaves and buds near to the graft union are important sources of xylem-inducing stimuli, and an auxin gradient necessary for vascular tissue regeneration.

3.2 Sprouting Percentage

Sprouting percentage was significantly affected by time of grafting and cultivars used, while their interaction was non-significant (Table 2). So, trees grafted in mid-March showed maximum sprouting percentage (73.8%), while minimum percentage was recorded in the late of January (67.7%). The results are in accordance with Soumlidou et al. (1994) which states that seasonal variation in graft union appears to be related to quantitative changes in the supply of materials (carbohydrate) available in the scion for graft union healing. On the other hand, maximum sprouting percentage was recorded in Nabali Baladi (71.8%), followed by Frontoio (68.1%) and the minimum was recorded in K18 (58.88%). So, Nabali Baladi cultivar may have good response due to development of vascular tissue in the graft union, which ensures transport of water, nutrients, plant hormones and assimilates (Soundy et al., 2008). These findings are in accordance with Stoddard and Mccully (1980) who state that grafting success varies by changing both the time of grafting and cultivars.

Figure 1. Cleft grafting

Figure 2. sprouting

3.3 Number of Sprouts per Plant

Number of sprouts per plant was significantly affected by time of grafting, while cultivars and the interaction between them were non-significant. While in case of time of grafting, maximum number of sprouts (4.1) was observed in trees grafted in mid-March, and minimum sprouts (3.1) per plant was shown in late-January. Among the performance of different cultivars, Nabali Baladi and Frontoio showed the highest number of sprouts (3.49), while the K18 cultivar recorded the lower number of sprouts per tree (3.11). These results are in accordance with Nave et al. (2016) who state that the cultivars of the same genetic background show differences in growth and development due to alterations in transport of water and nutrients and even the transport of some hormones.

3.4 Shoot Length

Sprouts length was significantly affected by the time of grafting and olive cultivars (Table 2), while there is non-significant interaction effect of both. Maximum shoot length (12.23 cm) was showed in trees grafted in mid-March, while grafting in late-January had the minimum sprouts length (8.83 cm). Concerning olive cultivars, Nabali Baladi showed the higher shoot length (11.48 cm), followed by Frontoio (10.66 cm) and Grosa de (8.43 cm). These results are come in agreement with the findings of Webster (1998), who state that different scions have different shoot length with the same root stock. Also, they have different shoot length with different time of grafting. These results are agreed with Allevato (2019), at which the scion cultivar was the top contributor to those traits that mostly related to the commercial identity of the fruit. Most of all in terms of plant growth and yield performances. However, when both scions and rootstocks were clustered by class, some of these responses were clearly.

On the other hand, according to Loehle and Jones (1988), grafting has long been observed in forest trees but the adaptive significance of this trait has not been fully explained. Various authors have proposed that root grafting between trees contributes to mechanical support by linking adjacent root systems. This trait would be of greatest advantage in swamps where soils provide poor mechanical support. In agreement with our study, arid zone species rarely exhibit grafts which demonstrated that vines graft less commonly than trees, and herbs never do. Since the need for mechanical support coincides with this trend, these mechanical hypotheses seem to support this paper model.

3.5 Shoot Diameter

Time of grafting and olive cultivars had significant response to shoot diameter. Maximum shoot diameter (2.56 mm) was observed in mid-March, while trees grafted in late-January had lower shoot diameter (2.19 mm). Among the different cultivars studied, K18 had the higher shoot diameter (2.89 mm), followed by Nasohi cultivar (2.77 mm), while Nabali Baladi cultivar had the lowest shoot diameter (2.06 mm). The higher shoot diameter in cultivar K18 may be due to growth regulators, that are transported at different rates among grafts on the same rootstocks, which affects cytokinin production and causes differences in shoot growth, on the other hand, incompatibility in grafting between the original and graft, related to the absence of complete fusion between the rootstock and the scion after grafting, as well as the inability of the resulting plant to grow naturally and vice versa. If the fusion is complete between the rootstock and the scion, the growth of the resulting plant is normal, this is known as compatibility.

In cases of incompatibility, fusion may occur between the original and the scion, but the fusion is incomplete, at which the fusion area is weak and susceptible to breakage sooner or later. Sometimes the appearance of symptoms of compatibility is delayed for some time, and this may take up to a few years (Webster, 1998; Sharif et al., 2015). As the shoot length is higher in Nabali Baladi, which causes the diameter of shoot to remain lower.

Table 2. Days to sprouting, sprouting percentage, Number of sprouts per plant, Number of leaves per shoot, Shoot diameter and Shoot length as affected by different time of grafting on different cultivars

Variables	Days to sprouting	Sprouting percentage (%)	No. of sprouts	Leaves per shoot	Shoot diameter (mm)	Shoot length (cm)
Timing (T)						
Late January	32.7_a	67.7_b	3.1_b	13.86_b	2.19_b	8.83_b
Mid-March	26.6_b	73.8_a	4.1_a	17.05_a	2.56_a	12.23_a
Significance	*	*	*	*	*	*
LSD	2.092	2.092	2.092	2.092	2.092	2.092
Cultivars (C)						
Nabali Baladi	28.0_g	71.8_a	3.49_a	17.44_a	2.06_g	11.48_a
Frontoio	30.0_f	68.1_{ab}	3.49_a	14.72_b	2.11_f	10.66_b
Grosa de	31.1_e	62.7_c	3.46_{ab}	12.81_c	2.54_e	8.43_c
Rassei	32.11_d	61.61_d	3.45_{ab}	12.76_c	2.67_d	8.40_{cd}
Manzanillo	32.23_c	60.11_e	3.44_b	11.98_d	2.72_c	8.32_d
Nasohi	32.87_b	59.14_f	3.41_c	11.45_e	2.77_b	8.19_e
K18	32.99_a	58.88_g	3.11_d	11.13_f	2.89_a	8.07_f
Significance	*	*	ns	*	*	*
LSD	1.941	6.285	0.577	2.757	0.272	0.525
Interaction						
T × C	ns	ns	ns	ns	ns	ns

3.6 Leaves per Shoot

Leaves per shoot were significantly affected by times of grafting, while olive cultivars had no significant effect on numbers of leaves per shoot. Olive trees grafted in mid-March had the higher number of leaves (17.05), while trees grafted in late January showed the lower number of leaves (13.86). Higher number of leaves in mid-March are referring to the greater number of sprouts and higher shoot length. Nabali Baladi produced large number of leaves (17.44), followed by Frontoio (14.72) and Grosa de (12.81). On the other hand, higher leave numbers in Nabali Baladi are referring to the higher shoot length which support a greater number of leaves than other olive cultivars studied. So, results are in line with Sharif et al. (2015) who stated that higher xylem to phloem ratio directly affect transport of nutrients and have additive impact on the plant growth.

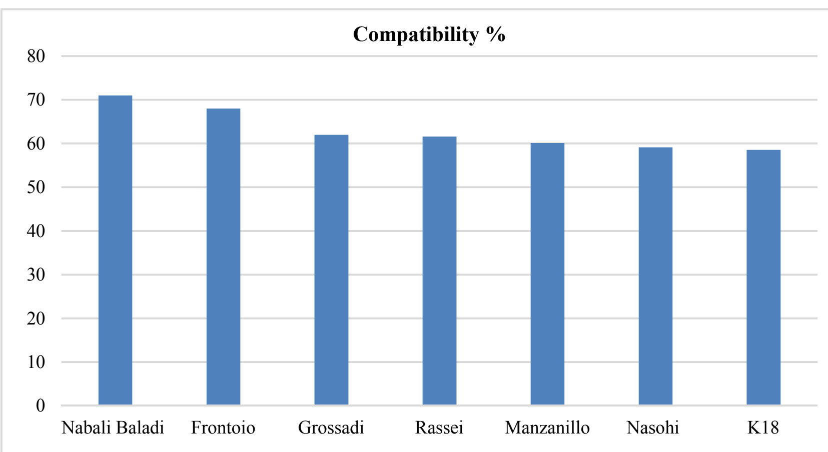

Figure 3. Grafting result and compatibility percentage% among cultivar with scion K18

4. Conclusion

Olive cultivars grafted in mid-March showed better performance for days to sprouting, sprouting percentage, number of sprouts, shoot length and shoot diameter. Hence, new olive trees can be successfully produced on K18 olive cultivar through grafting with higher success when grafted in the mid of March, specifically Nabali Baladi.

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Authors Contributions

Engineer Majda Al-Thanibat and Dr. Muawiyah Al-Assasfa were responsible for designing the experiment and collecting the data. Professor Saleh Al-Shdiefat was responsible for writing and reviewing the study. In addition to that, all authors were read and approved the final manuscript.

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Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could appear to influence the work reported in this paper.

Informed Consent

Obtained.

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The data supporting this study's findings are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data Sharing Statement

No additional data are available.

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